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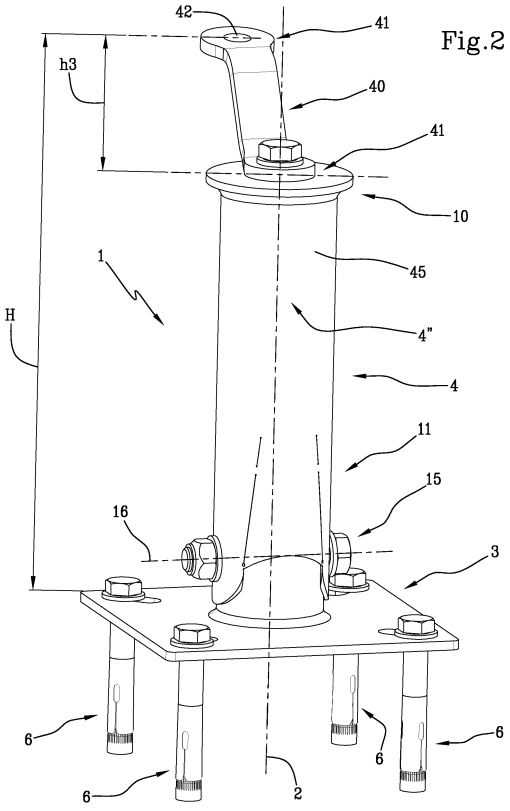
(54) Anchoring device for a life line

(57) An anchoring device (1) for a life line (100) comprising a first body (3) and a second body (4), where the first body comprises a fastening portion (5) intended to be fixed to a building structure and a connecting element (7) rigidly connected with the fastening portion, wherein the second body comprises an engaging portion (10) intended to be engaged by a cable (50) of the life line and a coupling portion (11) comprising a lateral wall (12) which delimits a housing cavity (13) conformed such as to at least partially receive the connecting element (7), where the second body is fixed in a pivoting manner to the first body and where the lateral wall of the coupling portion has a weakened line (20) structured in such a way that the lateral wall opens along the weakened line at a predetermined threshold value of a force applied on the engaging portion.

Fig.2



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Description

[0001] The present invention relates to an anchoring device for a life line and an associated life line.

[0002] There are known safety life lines to protect against falls from a height, comprising two anchoring devices rigidly and firmly fixed to a building structure at a certain reciprocal distance and a steel cable securely attached to the two devices and tensioned at a suitable operating tension, for example 2kN. During use, the operator attaches (for example by means of a snap hook or the like) one end of the individual safety cable to the life line cable, the other end of the individual cable being attached to the harness worn by the operator. In the event of the operator losing his balance, the life line slows down or arrests the operator's fall from a height, preventing the violent impact of the latter with the ground or underlying structure.

[0003] Support devices are known which are plastically deformable in order to absorb the stresses deriving from an operator's fall.

[0004] For example, EP2602403 discloses an anchor terminal for life lines comprising anchor means associated with a support, featuring connection means, to which at least two side elements are rotationally linked so as to lean on a roof, wherein the two side elements and/or the support have a number of bends which, on being adequately loaded, become plastic hinges.

[0005] The Applicant has realized that the known anchoring devices for life lines pose several drawbacks and/or could be improved in one or more respects.

[0006] The Applicant has perceived the need to provide an anchoring device for life lines that is capable of ensuring a greater resistance against the stresses deriving from a fall (and/or suitable static and/or dynamic verification tests). In this manner it will be possible to ensure high safety standards for operators. The Applicant has also perceived the need to develop an anchoring device that is simple in its structure and manufacture, also by reducing the dimensions of all or part of the structure for fastening it to the building structure.

[0007] The Applicant has moreover realized that it is desirable for at least a sizable part (e.g. at least a preponderant part) of the anchoring device to be removable from the building structure in a simple manner (for example with simple, rapid manual operations and the use of simple tools) which is not destructive to the structural parts of the anchoring device.

[0008] The object of the present invention is to provide an anchoring device for life lines that can remedy the drawbacks of the known devices and/or improve them.

[0009] One or more of these objects, and possibly others, including those that will become apparent in the course of the following description, are achieved by an anchoring device for life lines having the technical features contained in the following embodiments, as well as in one or more of the appended claims, also combined with the following embodiments, which represent further embodiments of the invention.

[0010] In one aspect the invention relates to an anchoring device for a life line extending prevalently along a longitudinal direction and comprising a first body and a second body distinct from the first body and firmly coupled thereto.

[0011] The first body comprises a fastening portion intended to be fastened (for example with a suitable fastening means) firmly (and preferably rigidly) to a building structure and a connecting element connected (preferably rigidly, for example by welding) with the fastening portion. Preferably, the connecting element extends longitudinally and has a longitudinal end edge on the side longitudinally opposite the fastening portion. The second body, which preferably extends prevalently longitudinally, comprises an engaging portion intended to be engaged by a cable of the life line, preferably on a first side of the second body, and, on the side longitudinally opposite the engaging portion, a coupling portion.

[0012] The anchoring device further comprises a hinge by means of which the second body is fixed to the first body in a pivoting manner about a rotation axis that is transversal (more preferably perpendicular) to the longitudinal direction. Preferably, said rotation axis is also transversal (more preferably perpendicular) to the direction along which the cable of the life line extends when the latter is installed. Preferably, said rotation axis crosses through the coupling portion and the connecting element.

[0013] Preferably, either the coupling portion or the connecting element comprises a lateral wall that delimits a housing cavity conformed in such a way as to receive (respectively) the other between the coupling portion and the connecting element, preferably by longitudinal insertion. The lateral wall of the coupling portion has, preferably on the second side opposite the first side relative to said rotation axis, at least one weakened line having overall (that is, considering the entire weakened line) a resistance to tearing (that is, to complete breakage of the lateral wall through its whole thickness along the weakened line) that is smaller than the resistance to tearing of the lateral wall portions adjacent to the line.

[0014] Preferably, said weakened line is structured in such a way that the lateral wall opens (by breaking) along said weakened line, enabling the rotation of the second body relative to the first about the rotation axis, at a predetermined threshold value of a force applied on the engaging portion (or, more precisely, on the point of attachment of the cable) and directed substantially perpendicularly to the longitudinal direction and to the rotation axis and preferably with a direction that goes from the second to the first side (during use, said applied force coincides with the tension and direction of the cable). Threshold value means, like usual, a value below which the weakened line will not open and above which

it will open.

[0015] According to the Applicant, the weakened line ensures that the plastic yielding of the device is controllable with precision (as regards both the entity of the stress at which the plastic yielding occurs and the location thereof). As a consequence of the yielding, the second body rotates, thanks to the hinge, and is led toward a condition in which its prevalent direction of extension is aligned with the cable (and hence with the tensile force). In this manner, the anchoring device is capable of effectively reducing, in a controlled manner, the stresses deriving from the operator's fall (or deriving from a certification test on the mechanical strength of the anchoring device) and of safely resisting detachment of the device itself from the building structure. In greater detail, starting from a condition of zero forces and increasing the force applied on the engaging portion (that is, increasing the cable tension), an increase in torque occurs, which tends to rotate the second body relative to the first about said rotation axis. This rotation, at low torques, is prevented by the mechanical interference between the lateral wall and said one or the other between the coupling portion and the connecting element. At low torques, the anchoring device (in particular the second body) is not deformed in any substantial manner, but may possibly undergo slight deformations (plastic and/or elastic). The cable tension also generates a torque which tends to cause the entire anchoring device to rotate about a further rotation axis lying along the fastening portion of the first body. This rotation is opposed by the fastening means of the portion fastening to the building structure, which typically undergo a pull disadvantageously along their main direction of extension (this pull tending ad extract the fastening means from their seats). At higher torques (and tensions) equal to or greater than a predetermined threshold value, the lateral wall opens in a controlled manner along the weakened line, thereby enabling, thanks to the plastic deformation thereof, the controlled rotation of the second body about said rotation axis. As a result of the rotation, the engaging portion moves closer to the other anchoring device of the life line, thereby decreasing the distance between the two anchoring devices and thus also the cable tension (due to the increase in the deviation of the cable perpendicularly to its line of operation). Furthermore, as a result of the rotation, the distance along the longitudinal direction between the engaging portion and the fastening portion decreases, thus also decreasing the arm of the force which generates the aforesaid torque that tends to cause the entire anchoring device to rotate about the further rotation axis lying along the fastening portion. In this manner, the extraction force that is generated on the fastening means will also decrease. Moreover, as a result of the rotation, the distance along the longitudinal direction between the engaging portion and the rotation axis decreases, thus also decreasing the arm of the force which generates the aforesaid torque that tends to cause the second body to rotate about said rotation axis. The more the second body rotates (as a result of a progressive increase in the cable tension), the greater the decrease in the arm of the rotating torque is (both about the rotation axis and about the aforesaid further rotation axis lying along the fastening portion). When the second body is completely rotated, i.e. disposed with its main direction of extension perpendicular to the longitudinal direction, the distance along the longitudinal direction between the engaging portion and the rotation axis of the hinge will become zero; as a result, no torque will act on the second body to rotate it about said rotation axis (the second body being subjected only to a tensile force opposed by the hinge). Moreover, the arm of the force which generates the aforesaid torque that tends to cause the entire anchoring device (or rather, the first body in this condition) to rotate about the further rotation axis lying along the fastening portion is reduced to a minimum (it depends on the longitudinal distance between the rotation axis of the hinge and fastening portion), thus relieving the tensile force acting on the fastening means (at very low values of the aforesaid arm, the fastening means undergo a pull that is mainly transversal to their main direction of extension, i.e. they undergo more shear than pull). Ultimately, in the aforesaid configuration the device ensures a solid anchorage to the building structure and a high structural breaking strength.

[0016] Breakage along the weakened line and the consequent progressive plastic deformation of the lateral wall can also result in the absorption of part of the stress (though the Applicant judges the effects above described to be the most important of the present invention).

[0017] The Applicant has found that the present solution enables to reduce the dimensions of all or part of the structure for fastening to the building structure, for example the base of the anchoring device, which can be made smaller (and/or less thick), with a consequent reciprocal nearing of the fastening means and the structure (e.g. screws or bolts in suitable anchors).

[0018] Preferably, the coupling portion comprises said lateral wall. Preferably, a portion of said end edge of the connecting element, corresponding to a second side of the coupling portion opposite said first side, is situated in the housing cavity in a predetermined longitudinal position.

[0019] The Applicant declares that the scope of protection of the present application shall be considered to embrace an anchoring device (not illustrated or further described hereinafter, but within the grasp of the person skilled in the art in light of the present teaching) wherein it is the connecting element of the first body, rather than the coupling portion of the second body, to be endowed with the aforesaid lateral wall which delimits a housing cavity conformed in such a way as to receive the coupling portion (i.e. the connecting element is external rather than internal to the coupling portion), the lateral wall of the connecting element having the aforesaid weakened line. The solution wherein the coupling portion is external to the connecting element is preferred in that in the event of a fall of the operator or of a strength test on the life line, it will be sufficient to replace only the second body in order to restore the life line, since the first body will not be

deformed or damaged.

[0020] Preferably, the weakened line extends with at least a longitudinal component (i.e. the extension of the weakened line along the longitudinal direction has a length other than zero).

[0021] Preferably, the weakened line extends at least partially in at least a portion of one or the other between said coupling portion and said connecting element (respectively).

[0022] Preferably, said predetermined threshold value of said force applied on the engaging portion is greater than 3 kN, more preferably greater than or equal to 5 kN, and/or less than or equal to 12 kN, more preferably less than or equal to 10 kN. The aforesaid preferred values of the threshold tension advantageously make it possible on the one hand to tension the cable at the typical operating tension (2kN), or to perform static tests on the life line up to 5-6 kN, without the occurrence of plastic yielding of the device, and on the other hand to allow plastic deformations or breaks at the typical stresses induced by a fall.

[0023] Preferably, the lateral wall has, preferably on the second side opposite the first side relative to said rotation axis, (at least) two weakened lines (in other words the two weakened lines are both on the same side relative to said rotation axis), each having the features described herein for the aforesaid weakened line. Advantageously, the two lines enable a portion of wall interposed between the two lines to be raised, in a controlled manner, relative to the remaining lateral wall.

[0024] It shall be observed that the person skilled in the art knows how to design the entire coupling portion and the connecting element, including the weakened line(s), in such a way as to respect the aforesaid predetermined threshold values of the cable tension. In particular, he will design the weakened line(s) based on, among other things, the longitudinal distance between the point of anchorage of the cable and the rotation axis, the distance between the predetermined longitudinal position and the rotation axis, the thickness of the lateral wall, etc.

[0025] Preferably, the rotation axis passes in a longitudinal position interposed between said predetermined longitudinal position (or said end edge portion of the connecting element) and said fastening portion. Preferably, each weakened line extends on both sides of said predetermined longitudinal position (in other words the weakened line(s) straddle said predetermined longitudinal position). In this manner, advantageously, a particularly strong area of mechanical interference is generated between the lateral wall of the coupling portion and the connecting element, in the aforesaid end edge portion of the connecting element and/or in the end edge portion of the coupling portion on the first side. This localization of stresses facilitates the positioning of the weakened line(s) and the calibration thereof in order to obtain the aforesaid predetermined threshold tension values.

[0026] Preferably, said hinge comprises a pin which entirely crosses through the coupling portion and the connecting element, in the coupled configuration, and extends along said rotation axis, the pin being longitudinally interposed between said predetermined longitudinal position and at least a portion of a longitudinal end edge of the coupling portion on the side longitudinally opposite the engaging portion. It shall be observed that the main function of the pin is to fix the reciprocal longitudinal position of the first and second bodies and constrain the rotation of the second body relative to the first about said rotation axis (it can therefore be free relative to the through holes in which it is inserted).

[0027] Preferably, the/each weakened line extends from a point on, or in proximity to, the longitudinal end edge of the coupling portion.

[0028] Preferably, the weakened lines are reciprocally adjacent relative to a direction that is perpendicular to the longitudinal direction (for example, relative to the rotation axis); more preferably, they are aligned along the perpendicular direction.

[0029] Preferably, the direction of extension of said/each weakened line (obtained by interpolation of the weakened line with a straight line) forms, with the longitudinal direction, an angle comprised between + 20° and - 20°, preferably comprised between +10° and -10°.

[0030] Preferably, the directions of extension of the weakened lines are reciprocally convergent in a direction going from a longitudinal end of the coupling portion to the engaging portion.

[0031] Preferably, the weakened lines are reciprocally arranged in mirror-like fashion relative to a plane perpendicular to the axis of the pin and passing in a median position of the anchoring device.

[0032] Preferably, said/each weakened line comprises one or more segments, aligned along the weakened line, at which the lateral wall has less material, or a less resistant material, than the adjacent lateral wall portions.

[0033] Preferably, said/each weakened line comprises one or more segments, aligned along the weakened line, in which the lateral wall has less thickness than the adjacent lateral wall portions. Preferably, each segment is a groove fashioned on the lateral wall, more preferably a slit (or cut) passing through the entire thickness of the wall. Preferably, said/each weakened line and/or the segments thereof is/are obtained by removing material compared to adjacent lateral wall portions, more preferably by cutting (e.g. laser) through the entire thickness.

[0034] Preferably, said/each weakened line and/or the segments thereof is a substantially straight line (leaving aside the possible curvature of the lateral wall, for example when the wall is cylindrical and the directions of extension are not parallel to the longitudinal direction).

[0035] Preferably, said/each weakened line comprises a first section (interposed between, and at a distance from, the

two extremities of the weakened line) extending in proximity to said predetermined longitudinal position locally having (or precisely along said section) a resistance to tearing greater than the local resistance to tearing of the adjacent portions of weakened line(e.g. of the adjacent segments), more preferably locally having a resistance to tearing equal to the local resistance to tearing of the lateral wall portions adjacent to the weakened line. Advantageously, the first section, situated in the vicinity of a point of maximum stress, enables to easily set the predetermined threshold cable tension at which the opening of the weakened line will occur, for example by varying the length of the first section along the weakened line, said setting being made based on the material of the coupling portion, its thickness, the longitudinal height of the second body, etc.

[0036] Preferably, the minimum longitudinal distance taken between all points of said first section and said predetermined longitudinal position is less than or equal to 4mm, more preferably less than or equal to 3 mm (including equal to zero in the case of the first section straddling the predetermined longitudinal position). The minimum distance is preferably greater than or equal to 0.5 mm, more preferably greater than or equal to 1 mm.

[0037] Preferably, said first section extends entirely on the side of said predetermined longitudinal position facing towards the rotation axis.

[0038] Preferably said/each weakened line comprises (more preferably consists in) a first continuous segment and a second continuous segment, the two continuous segments being cuts passing through the wall and being separated by said first section.

[0039] Preferably, said/each weakened line (more preferably said first continuous segment) is separated from the longitudinal end edge of the coupling portion by a second section locally having a resistance to tearing greater than the local resistance to tearing of the adjacent portion of weakened line (e.g. of the first segment), more preferably locally having a resistance to tearing equal to the local resistance to tearing of the lateral wall portions adjacent to the weakened line. Advantageously, it is possible to easily set the threshold cable tension at which the opening of the weakened line will occur, also by varying the resistance (e.g. the length) of the second section along the weakened line.

[0040] Preferably, the lateral wall has structural continuity (that is, it has no grooves or cuts) in said first section and/or said second section.

[0041] Preferably, the overall length of said/each weakened line (taken along the line of extension thereof) is greater than or equal to 5 cm, more preferably greater than or equal to 6 cm, and/or less than or equal to 12 cm, more preferably less than or equal to 10 cm.

[0042] Preferably, the length (taken along the line of extension of the weakened line) of said first section is greater than or equal to 3 mm, more preferably greater than or equal to 4 mm, and/or less than or equal to 20 mm, more preferably less than or equal to 15 mm.

[0043] Preferably, the length (taken along the line of extension of the weakened line) of said second section is greater than or equal to 0.5 mm, more preferably greater than or equal to 1 mm, and/or less than or equal to 6 mm, more preferably less than or equal to 5 mm.

[0044] Preferably, the length (taken along the line of extension of the weakened line) of said first segment is greater than or equal to 3 cm, more preferably greater than or equal to 4 cm, and/or less than or equal to 10 cm, more preferably less than or equal to 9 cm.

[0045] Preferably, the length (taken along the line of extension of the weakened line) of said second segment is greater than or equal to 1 cm, more preferably greater than or equal to 1.5 cm, and/or less than or equal to 5 cm, more preferably less than or equal to 4 cm.

[0046] Preferably, the lateral wall (of the coupling portion) has two additional weakened lines (both of the two additional weakened lines being on the same side relative to said rotation axis) on its first side, each having overall (i.e. considering the entire line) a resistance to tearing less than the resistance to tearing of the lateral wall portions adjacent to the further line and extending, with at least a longitudinal component, in proximity to the longitudinal end edge of the coupling portion.

[0047] Preferably, the additional weakened lines have the same structural features as the aforesaid weakened lines. It shall be observed that the aforesaid predetermined threshold values of the cable tension do not apply to the additional weakened lines. Advantageously, the additional weakened lines facilitate the aforesaid rotation of the second body relative to the first about the rotation axis, by virtue of controlled plastic deformation of the lateral wall in proximity to the same.

[0048] Preferably, the additional weakened lines are symmetrical to the weakened lines relative to a plane passing along the axis of the pin and comprising the longitudinal direction. Advantageously, in this manner the device can be oriented on either of the two sides.

[0049] Preferably, the longitudinal end edge portion of the coupling portion which is on the first side of the second body in a position (relative to the rotation axis) opposite the weakened line(s) (more preferably in a position interposed between the two additional weakened lines) has a curvature (with an outward facing concavity) mating with the curvature of the outer surface of the lateral wall of the adjacent coupling portion.

[0050] Preferably, said longitudinal end edge portion is in the longitudinal position in which the rotation axis is located.

[0051] Advantageously, such a conformation of the longitudinal end edge makes it possible to control the deformation

of the coupling portion on the first side during the aforesaid rotation of the second body relative to the first.

[0052] Preferably, two opposing portions of the longitudinal end edge of the coupling portion that is on the first side of the second body and on opposite sides of the aforesaid longitudinal end edge portion are rounded, with a convexity facing outwards. In this manner, advantageously, the edge portions will not come into contact with the fastening portion during the aforesaid rotation of the second body.

[0053] Preferably, the first body and the second body are reciprocally and removably couplable (i.e. in a simple manner - for example with simple, rapid manual operations with the use of simple tools - and one that is not destructive of the structural parts of the anchoring device).

[0054] Preferably, between an inner surface of the lateral wall and an outer surface of the connecting element there is a slight play (such as to enable an easy fit and at the same time give a certain stability to the coupling).

[0055] Preferably, the connecting element and at least the coupling portion (more preferably the second body) have a cross-section profile perpendicular to the longitudinal direction that is circular in shape, more preferably they have a substantially cylindrical conformation.

[0056] Preferably, the connecting element is internally hollow.

[0057] Preferably, the fastening portion is a plate, more preferably flat and lying on a plane transversal (e.g. perpendicular) to the longitudinal direction, endowed with a plurality of through openings for engaging fastening means, such as bolts or rivets. Preferably, one or more of the through openings is/are a slot(s) whose main directions of extension converge in a median point of the fastening portion (lying on a median axis of the device).

[0058] Preferably, the anchoring device is symmetrical relative to a plane perpendicular to the axis of the pin and passing in a median position of the anchoring device. Preferably, the anchoring device is symmetrical relative to a plane passing through the axis of the pin and comprising the longitudinal direction.

[0059] Preferably, the engaging portion comprises an engaging element which is distinct from the rest of the second body and configured to be engaged by the cable of the life line.

[0060] Preferably, the second body comprises a pole, comprising the aforesaid coupling portion, and the engaging element fixed to a longitudinal end of the pole opposite the coupling portion.

[0061] Preferably, the engaging element is a single plate-like body (i.e. obtained by cutting and bending from a sheet) comprising, at the two end opposite ends thereof, two through openings for fastening it to the rest of the second body (e.g. by means of a bolt) and attaching the cable, respectively, the two ends extending on two planes at a given reciprocal longitudinal distance (e.g. comprised between 2 and 10 cm). Advantageously, the engaging element thus structured is subject to a plastic deformation upon a sufficient cable tension being reached, which tends to reduce the aforesaid longitudinal distance and increase the overall length of the engaging element along the direction of the cable.

[0062] Preferably, the thickness of the lateral wall of the coupling portion and/or of the connecting element and/or of the plate and/or of the engaging element is greater than or equal to 2 mm and/or less than or equal to 4 mm.

[0063] In a further aspect, the invention relates to a life line comprising a pair of anchoring devices according to the present invention and a cable attached to the respective engaging portions and under tension.

[0064] Additional features and advantages will become more apparent from the detailed description of some non-exclusive example embodiments of an anchoring device and an associated life line in accordance with the present invention.

[0065] The description will be set forth here below with reference to the appended figures, provided only by way of illustration and thus not limitation, which show:

- figure 1: a partial perspective view of a life line in accordance with the present invention;
- figure 2: a perspective scale view of an anchoring device in accordance with the present invention in the coupled configuration;
- figure 3: an exploded perspective scale view of the anchoring device of figure 2 (also corresponding to an uncoupled configuration of the device);
- figure 4: a further perspective scale view of the anchoring device of figure 2;
- figure 5: a side scale view of a detail of the anchoring device of figure 2, with some elements that would not be visible drawn with broken lines.

[0066] With reference to the figures, the reference number 1 generally indicates an anchoring device for a life line in accordance with the present invention and the reference number 100 an associated life line. In general, the same reference number is used for similar elements, also in the variant embodiments thereof.

[0067] The life line 100 comprises a pair of anchoring devices 1 ('head devices') fixed to a building structure 200 at a reciprocal distance and a cable 50 attached to respective engaging portions under tension between the two head anchoring devices.

[0068] Optionally, a further anchoring device 1 ('intermediate device') is fixed to the building structure in a position interposed between the two aforesaid head anchoring devices and comprises a respective engaging portion structured

so as to prevent lateral deviations of the cable. In this respect, it shall be observed that the terms anchorage and engagement also comprise, as may be inferred from the example provided here, simple containment of the cable (which can slide longitudinally inside the engaging portion of the intermediate device) relative to the lateral deviations thereof, as in the case of the intermediate device.

[0069] The anchoring device 1 (be it a head or intermediate device) extends prevalently along a longitudinal direction 2 and comprises a first body 3 and a second body 4 that is distinct from the first and firmly (and preferably removably, for example thanks to the pin) couplable to the first body.

[0070] During use, typically, but not necessarily, the longitudinal direction 2 coincides with the geographic vertical direction.

[0071] The first body 3 comprises a fastening portion 5 intended to be fixed firmly and rigidly to a building structure 200 (for example by means of suitable fastening means 6, such as bolts, which engage with suitable anchors inserted in the building structure) and a connecting element 7 rigidly connected (for example by welding 8) with the fastening portion. The connecting element has a prevalent longitudinal extension and a longitudinal end edge 9 on the side longitudinally opposite the fastening portion 5. The second body 4 has a prevalent longitudinal extension and comprises an engaging portion 10 intended to be engaged by a cable 50 of the life line on a first side 4' of the second body and, on a side longitudinally opposite the engaging portion, a coupling portion 11.

[0072] The coupling portion comprises a lateral wall 12 which delimits a housing cavity 13 conformed in such a way as to be able to receive said connecting element by longitudinal insertion, preferably in such a way that in the use configuration a portion 9' of said end edge 9, corresponding to a second side 4" of the coupling portion opposite said first side 4', will be inside the housing cavity in a predetermined longitudinal position 14 (marked with a broken line in figure 5) along the coupling portion.

[0073] The anchoring device further comprises a hinge 15, by means of which the second body is fixed in a pivoting manner to the first body about a rotation axis 16 transversal (preferably perpendicular) to the longitudinal direction and to the direction of extension of the life line.

[0074] Preferably, the hinge comprises a pin 15' (for example a bolt locked by a nut as in the figure) which entirely crosses through the coupling portion 11 and the connecting element 7 along the rotation axis 16, the pin being longitudinally interposed between the predetermined longitudinal position 14 and at least a portion of a longitudinal end edge 17 of the coupling portion on the side longitudinally opposite the engaging portion. Preferably, between the inner surface of the lateral wall 12 and the external surface of the connecting element 7 there is a slight play, for example of about half a millimetre.

[0075] Preferably, the lateral wall 12 of the coupling portion 11 has, on the second side 4" of the second body, opposite the first side 4' relative to the rotation axis, two weakened lines 20, each having overall a resistance to tearing less than the resistance to tearing of the lateral wall portions adjacent to the line.

[0076] Each weakened line 20 extends with at least a longitudinal component and partially in a portion of the connecting element. Advantageously, each weakened line 20 extends in a longitudinal direction on both sides of the predetermined longitudinal position 14. Preferably, each weakened line has a direction of extension (for example in figure 5 the straight line passing along the weakened line 20) which forms, with the longitudinal direction 2, an angle 21 equal for example to 6°.

[0077] Preferably, the weakened lines 20 are reciprocally aligned relative to the direction parallel to the axis of the pin (in other words, they are in the same longitudinal position).

[0078] Preferably, the directions of extension of the weakened lines (fig 5) are reciprocally convergent in the direction going from a longitudinal end 17 of the coupling portion to the engaging portion 10.

[0079] Preferably, the weakened lines are reciprocally arranged in mirror-like fashion relative to a plane perpendicular to the rotation axis 16 and passing in a median position of the anchoring device 1 (or of the pin 15').

[0080] By way of example, as shown in the illustrated examples, each weakened line 20 consists in a first continuous segment 22 and a second continuous segment 23 aligned along the weakened line, the two continuous segments being cuts (e.g. obtained by laser cutting and about a half of a tenth of a millimetre wide) passing through the entire thickness of the lateral wall and being reciprocally separated by a first section 24 (indicated with a broken line in figure 5) without any cuts or grooves. However, any alternative number and/or construction and/or positioning of the weakened lines falls within the scope of the present invention. By way of example (not shown) it is possible to make only one weakened line, for example shaped like an upside-down 'U'. For example, each weakened line can comprise any number whatsoever of segments aligned with one another, including a single continuous segment. Moreover, rather than in a through cut, each segment can consist in a groove in which the thickness of the wall is reduced compared to the adjacent lateral wall portions, for example by partial removal of material. Furthermore, rather than a cut or continuous groove, each segment can consist in a close succession of holes passing through the thickness. Regardless of how said segments are made, they advantageously have a lower local mechanical strength (zero resistance in the examples) than the adjacent lateral wall portions. Moreover, the first section (just as the second section, see below) can consist, as an alternative to the section without cuts or grooves, in a groove or in a close succession of through cuts or holes, having, in any case, a local mechanical strength comprised between the higher one of the adjacent lateral wall portions and the lower one of

the segments 22, 23.

[0081] By way of example, the first section 24 extends entirely on the side of said predetermined longitudinal position 14 facing towards the rotation axis (in other words, with reference to figure 5, the first section 24 is entirely below the position 14), the distance 'e' between the predetermined longitudinal position 14 and the proximal end of the first section being, for example, equal to about 1.5 mm. However, the present invention also envisages the case (not shown) in which the first section straddles, or extends completely over, the position 14.

[0082] Preferably, each weakened line 20 (in particular the first continuous segment 22) is separated from the longitudinal end edge 17 of the coupling portion by a second section 25 without any grooves or cuts.

[0083] The table below provides some examples of dimensional values (in millimetres) for three different anchoring devices in accordance with the present invention, in which device #1 is the one represented in the appended figures, whereas devices #2 and 3 have a first body equal to that of device #1 and a second body with a different longitudinal height (and thus different weakened lines). In all three devices, the first body has a thickness of 3 mm, the inner and outer diameters of the connecting element are 64 and 70 mm, the total longitudinal height (h1) of the connecting element is 110 mm, the longitudinal distance (h2) between the rotation axis and the base plate is 40 mm, the longitudinal height of the engaging element (h3) is about 70 mm, the inner and outer diameters of the coupling portion are 71 and 76 mm and the thickness of the lateral wall of the second body is 2.5 mm. All three devices are made of steel. The weakened lines are designed in such a way that the respective coupling portion opens along at least a portion of the weakened lines upon the reaching of a threshold value of the cable tension equal to about 8-9 kN.

Table 1

	#1	#2	#3
Total longitudinal height (H)	350	500	750
Length of first segment (l1)	62.5	59	53
Length of second segment (l2)	20	20	20
Distance between first segment-edge (d)	1.5	3	4
Length of first section (D)	5	7	12
Total length of weakened line (L)	89	89	89

[0084] As can be seen from table 1, with an increase in the height of the second body (and thus of the rotating torque, the cable tension being equal), it is advisable to increase the length D of the first section and the distance d between the first segment and the end edge 17 (and hence the associated local resistance to tearing) in order to obtain a threshold value of the cable tension of around 8-9 kN. Moreover, as an example design rule, the distance 'e' was maintained constant for the three devices and equal to around 1.5 mm.

[0085] It shall be observed that a predetermined threshold value means not so much an exact value of the cable tension, but rather an interval of values, as wide as 2kN, within which the weakened line will yield. If, for example, a predetermined threshold value of about 9 kN is fixed, in practical terms the yielding of the weakened line can occur at a value comprised between 8 and 10kN (or between 8.5 and 9.5 kN), because of the variability introduced by manufacturing tolerances, material, test conditions, etc.

[0086] Preferably, the lateral wall of the coupling portion further has (see figure 4), on the first side 4', two additional weakened lines 30, by way of example mirror-like symmetrical to the weakened lines 20 relative to a plane passing through the axis 16 of the pin and comprising the longitudinal direction 2. In this manner, the device, symmetrical relative to the aforesaid plane, can be mounted with the cable facing either of the two sides 4' and 4". However, for the purposes of the present invention, this symmetry of the weakened lines 20 and 30 is not necessary, since the additional weakened lines 30, during use, are active above all in the portion thereof in proximity to the longitudinal end edge 17. In particular (though not shown), the weakened lines 30 can lack the respective second segment and the respective first section. Preferably, as can be seen in particular in figure 5, all of the end points of the segments 22 and 23 and/or the corner points of the end edge 17 are radiused, with, by way of example, a radius greater than or equal to 0.4 mm and less than or equal to 1 mm. In this manner, advantageously, the risk of cracks forming and/or of undesirable tears is thus reduced.

[0087] Preferably, the portion 26 of the longitudinal end edge 17 of the coupling portion that is on the first side 4' of the second body in a position interposed between the two additional weakened lines 30 has a curvature mating with the curvature of the outer surface of the lateral wall of the adjacent coupling portion. Preferably, the portion 26 of the longitudinal end edge is in the longitudinal position in which the rotation axis 16 is located.

[0088] Preferably, two opposing portions 27 of the longitudinal end edge 17 of the coupling portion which are on the first side 4' of the second body and on opposite sides of the aforesaid portion 26 of the longitudinal end edge are rounded,

with a convexity facing outward.

[0089] By way of example, the connecting element 7 and the second body 4 have a substantially cylindrical tubular conformation; however, the present invention envisages any conformation whatsoever of the two elements, such as ones with a square or rectangular cross section.

[0090] Preferably, the fastening portion is a flat plate 28 lying in a plane perpendicular to the longitudinal direction, and endowed with a plurality of through slots 29 for engaging the fastening means 6. Preferably, the slots have main directions of extension converging in a median point of the fastening portion.

[0091] Preferably, the second body 4 comprises a pole 45 (e.g. of a tubular shape) comprising the coupling portion 11 and an engaging element 40 (belonging to the engaging portion) fixed to a longitudinal end of the pole opposite the coupling portion and configured to be engaged by the cable of the life line.

[0092] Preferably, the engaging element is a single plate-like body comprising, at the two ends 41 thereof, two through openings for fastening to the pole 45 (e.g. by means of a bolt) and attaching the cable, respectively, the two ends extending on two planes at a given reciprocal longitudinal distance h3.

[0093] When the life line is installed (without the intermediate device) and, for example, subjected to a tensile strength test, consisting in the application, in the midpoint of the cable, of a tensile force directed as the rotation axis 16 and progressively increasing, this force generates a tension in the cable which represents a tensile force in the location of the engaging element 40, which in turn generates the two rotational torques as described above on the device 1. Below the threshold tension (for example up to around 8kN), the anchoring device 1 undergoes only slight deformations and the fastening means an associated progressively increasing extraction force. When the threshold tension (which corresponds with the maximum extraction force the fastening means are subjected to) is reached, the first sections 24 of the weakened lines 20 break in a controlled manner (by tearing along the weakened line), enabling the opening of the weakened lines 20 (and raising of the lateral wall portion interposed between the two lines relative to the adjacent lateral wall portion) and the consequent rotation of the second body relative to the first. As a result of the rotation, the point of engagement 42 of the cable moves closer to the other anchoring device of the life line, thereby decreasing the instantaneous tension of the cable. This rotation also determines a progressive plastic deformation of the coupling portion in proximity to the aforesaid portions 26 and 27 of the longitudinal end edge on the first side 4' (the portion of lateral wall interposed between the two further lines 30 becomes progressively curled). As the tensile force increases at the midpoint of the cable, the tension thereof increases once again until reaching a value (for example comprised between 7 and 10 kN) at which the second sections 25 break as well, enabling the second body to rotate further, up to the complete rotation of the second body (i.e. it is disposed with its main direction of extension perpendicular to the longitudinal direction).

Claims

1. An anchoring device (1) for a life line (100) having a prevalent development along a longitudinal direction (2) and comprising a first body (3) and a second body (4), distinct from the first body and firmly coupled to the first body, where the first body comprises a fastening portion (5) destined to be fixed firmly to a building structure and a connecting element (7) connected to the fastening portion, where the second body comprises an engaging portion (10) destined to be engaged by a cable (50) of the life line at a first side (4') of the second body and, on a longitudinally opposite side to the engaging portion, a coupling portion (11), wherein the second body is fixed, preferably by means of a hinge (15), to the first body in a pivoting manner about a rotation axis (16) that is transversal to the longitudinal direction, wherein one from between the coupling portion (11) and the connecting element (7) comprises a lateral wall (12) which delimits a housing cavity (13) conformed such as to at least partially receive the other from between the coupling portion (11) and the connecting element (7), and wherein the lateral wall exhibits at least a weakened line (20) having overall a smaller resistance to tearing than portions of lateral wall adjacent to the line, said weakened line being structured in such a way that the lateral wall opens along said weakened line, enabling rotation of the second body with respect to the first about the rotation axis, at a predetermined threshold value of a force applied on the engaging portion and directed substantially perpendicularly to the longitudinal direction and the rotation axis.

2. The device according to claim 1, where said predetermined threshold value is greater than 3 kN, and/or less than, or equal to 12 kN.

3. The device according to claim 1 or 2, wherein the coupling portion (11) comprises said lateral wall (12) and where the connecting element (7) has a longitudinal end edge (9) on a longitudinally opposite side to the fixing portion (5), where a portion (9') of said end edge of the connecting element, corresponding to a second side (4") of the coupling portion opposite said first side (4") is in the housing cavity at a predetermined longitudinal position (14), where the rotation axis (16) passes into a longitudinal position interposed between said predetermined longitudinal position and said fastening portion and where the weakened line (20) develops on said second side and on both sides of

said predetermined longitudinal position (14).

4. The device according to any one of the preceding claims, where said weakened line (20) develops starting from a point on, or in proximity of, a longitudinal end edge (17) of the coupling portion.

5. The device according to any one of the preceding claims, where said weakened line (20) develops with at least a longitudinal component and where the development direction of said weakened line (20) forms, with the longitudinal direction (2), an angle comprised between + 20° and - 20°.

6. The device according to any one of the preceding claims, where the lateral wall (12) exhibits, on the second side (4") opposite the first side with respect to said rotation axis, two weakened lines (20), the first line coinciding with said weakened line and the second line having the same characteristics as claimed for said weakened line, and where the development directions of the two weakened lines (20) are reciprocally convergent in a direction going from a longitudinal end (17) of the coupling portion to the engaging portion (10).

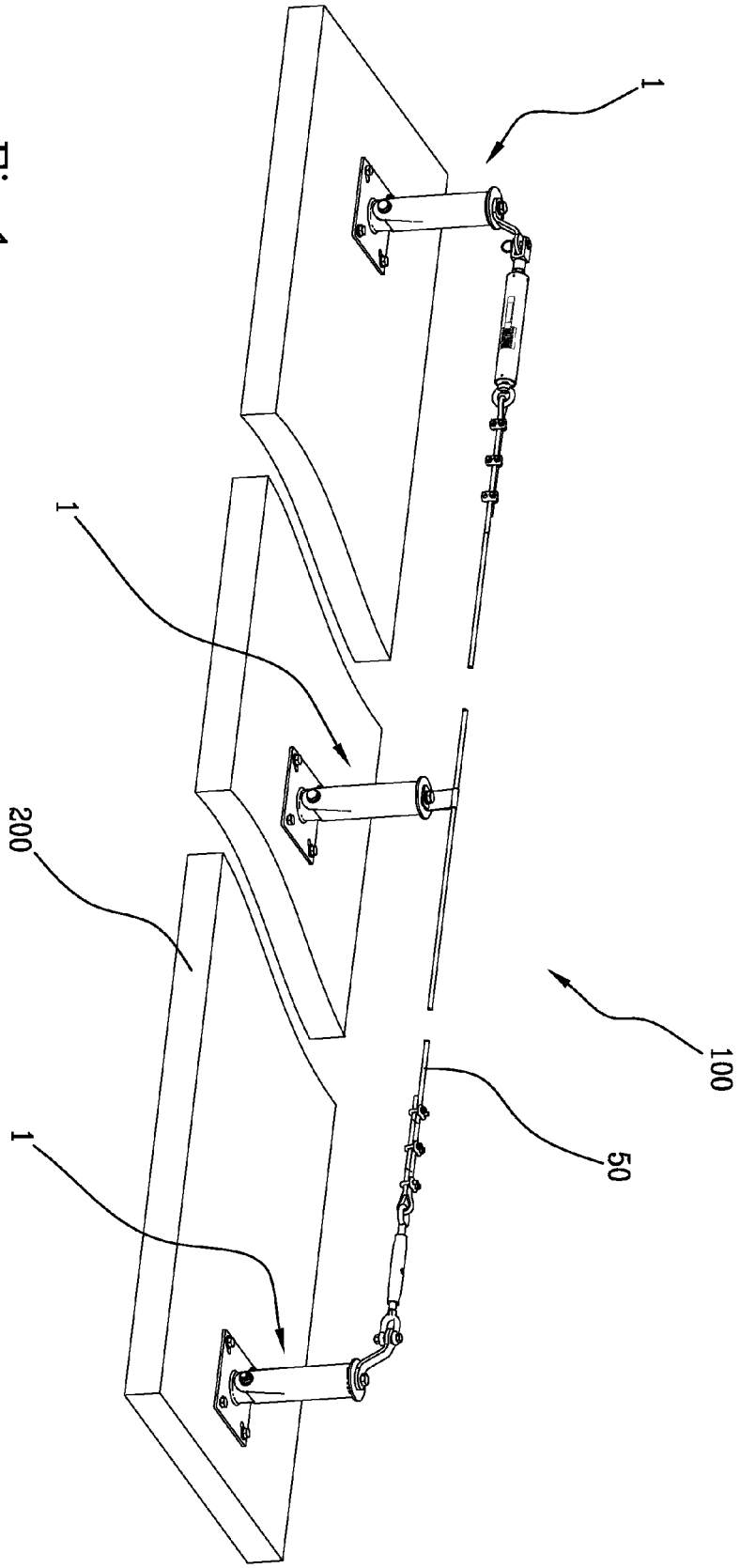
7. The device according to any one of the preceding claims, where said or each weakened line (10) comprises one or more segments (22, 23), aligned along the weakened line, where each segment is a groove fashioned on the lateral wall or a cut passing through an entire thickness of the wall.

8. The device according to any one of the preceding claims, where said or each weakened line (20) comprises a first tract (24) developing in proximity of said predetermined longitudinal position (14) locally having a resistance to tearing that is greater than the local resistance to tearing of the adjacent portions of weakened line and where the length of said first tract is greater than or equal to 3 mm, and/or less than or equal to 20 mm.

9. The device according to the preceding claim, where the minimum longitudinal distance taken from all points of said first tract and said predetermined longitudinal position is less than or equal to 4mm, and/or greater than or equal to 0.5 mm, and where said first tract develops entirely on the side of said predetermined longitudinal position facing towards the rotation axis (16).

10. The device according to any one of the preceding claims, where said or each weakened line (20) is separated from a longitudinal end edge (17) of the coupling portion by a second tract (25) locally having a resistance to tearing greater than the local resistance to tearing of the adjacent portion of weakened line, and where the length of said second tract is greater than or equal to 0.5 mm, and/or less than or equal to 6 mm.

Fig.1



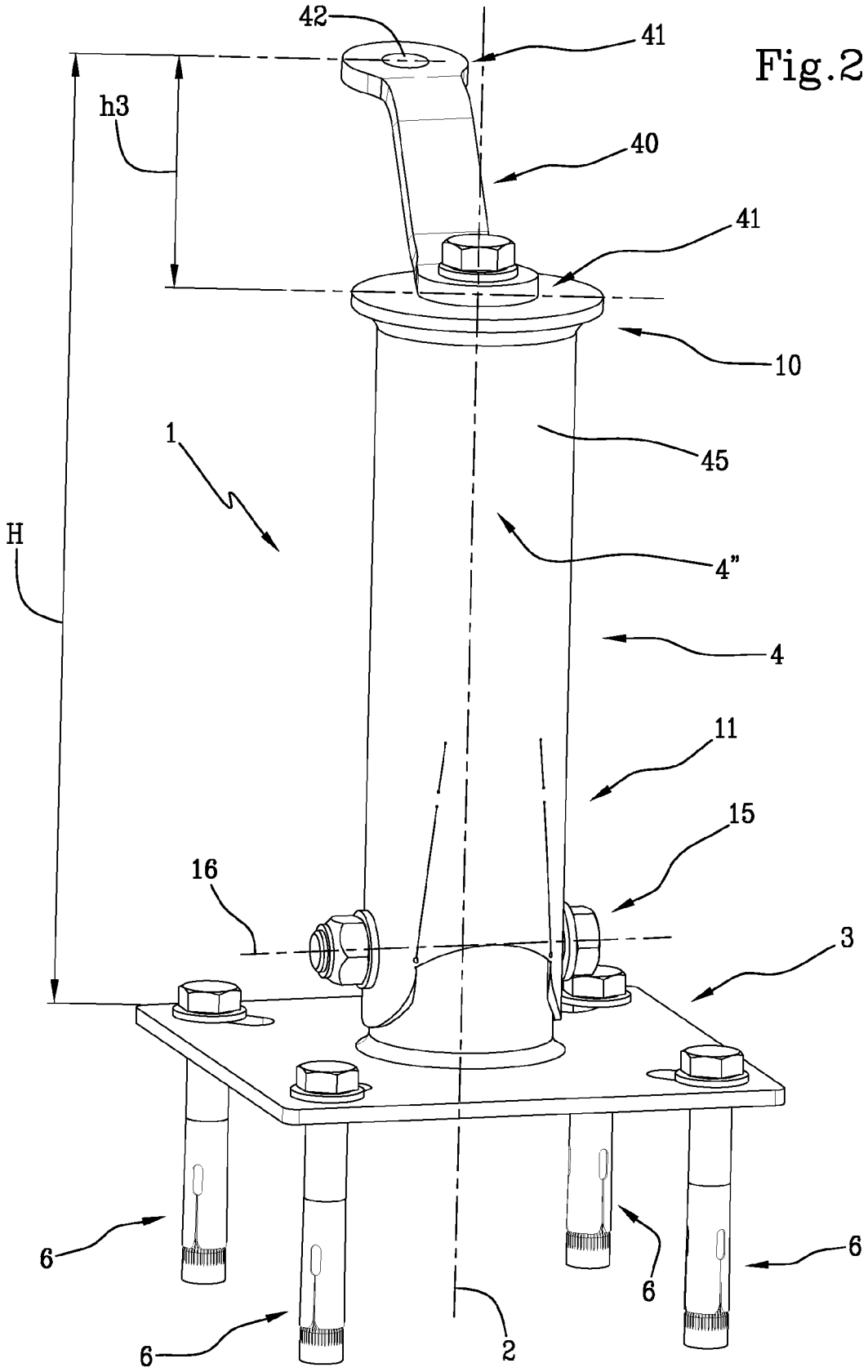


Fig.2

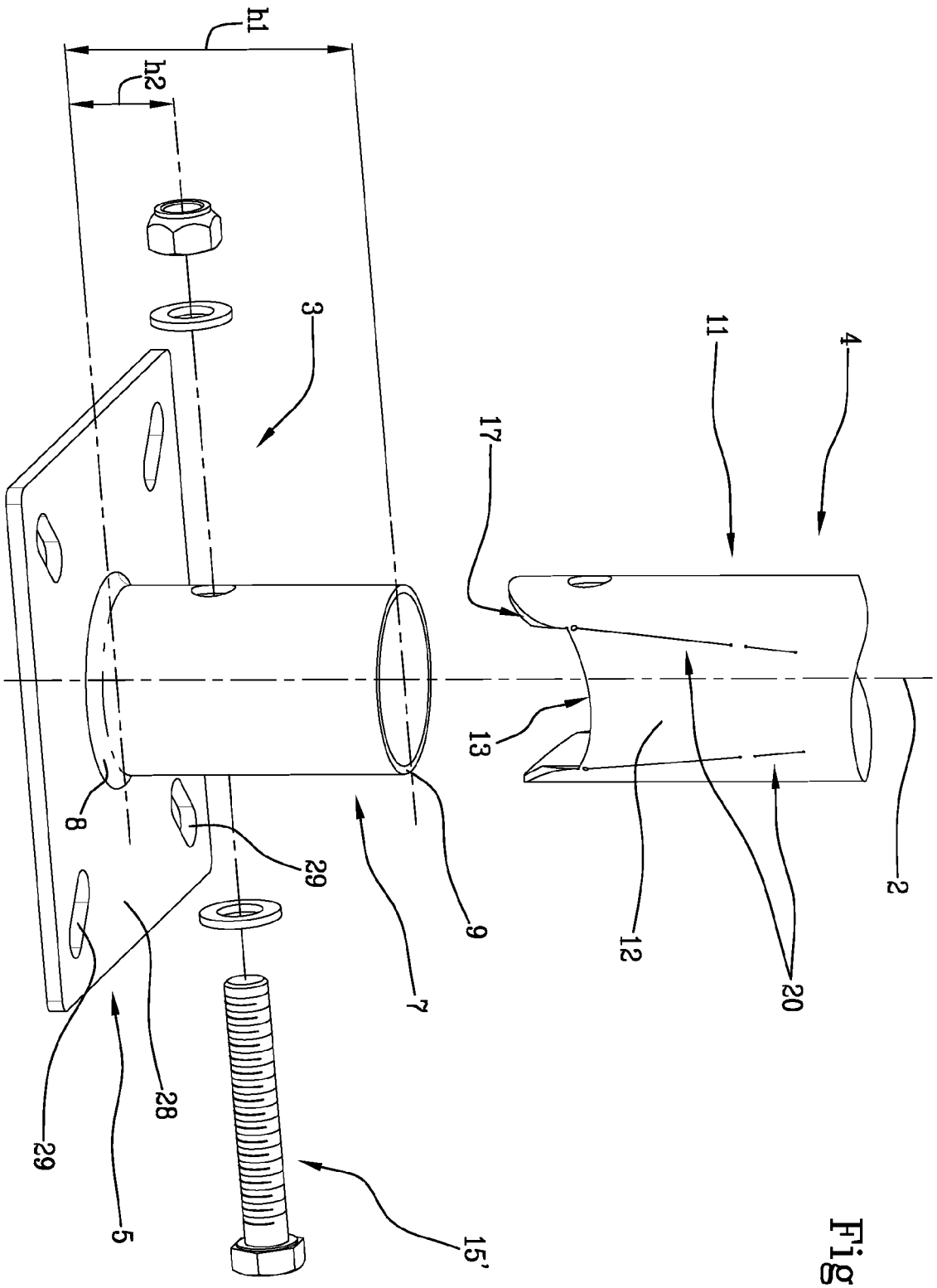


Fig.3

Fig.4

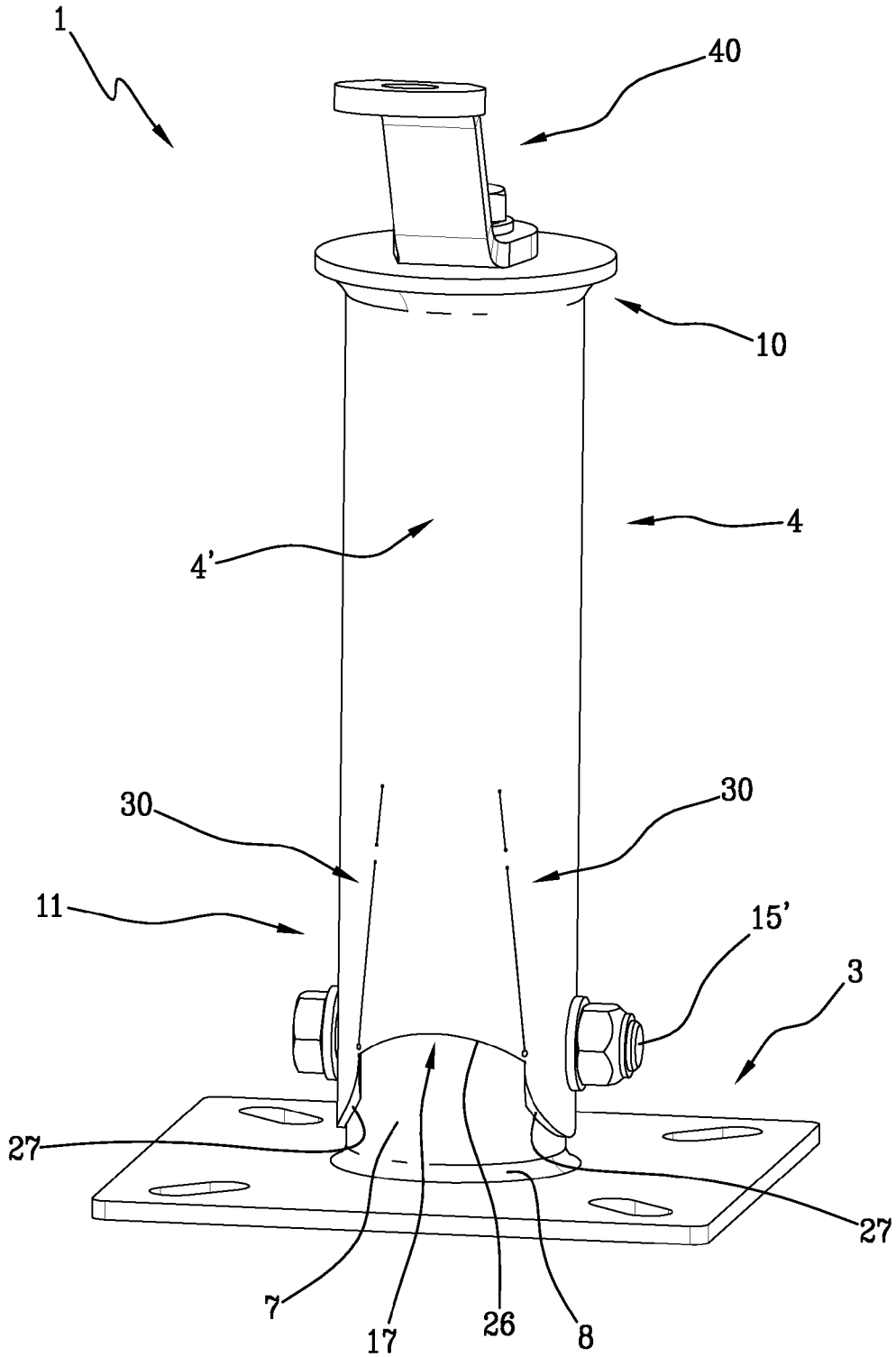
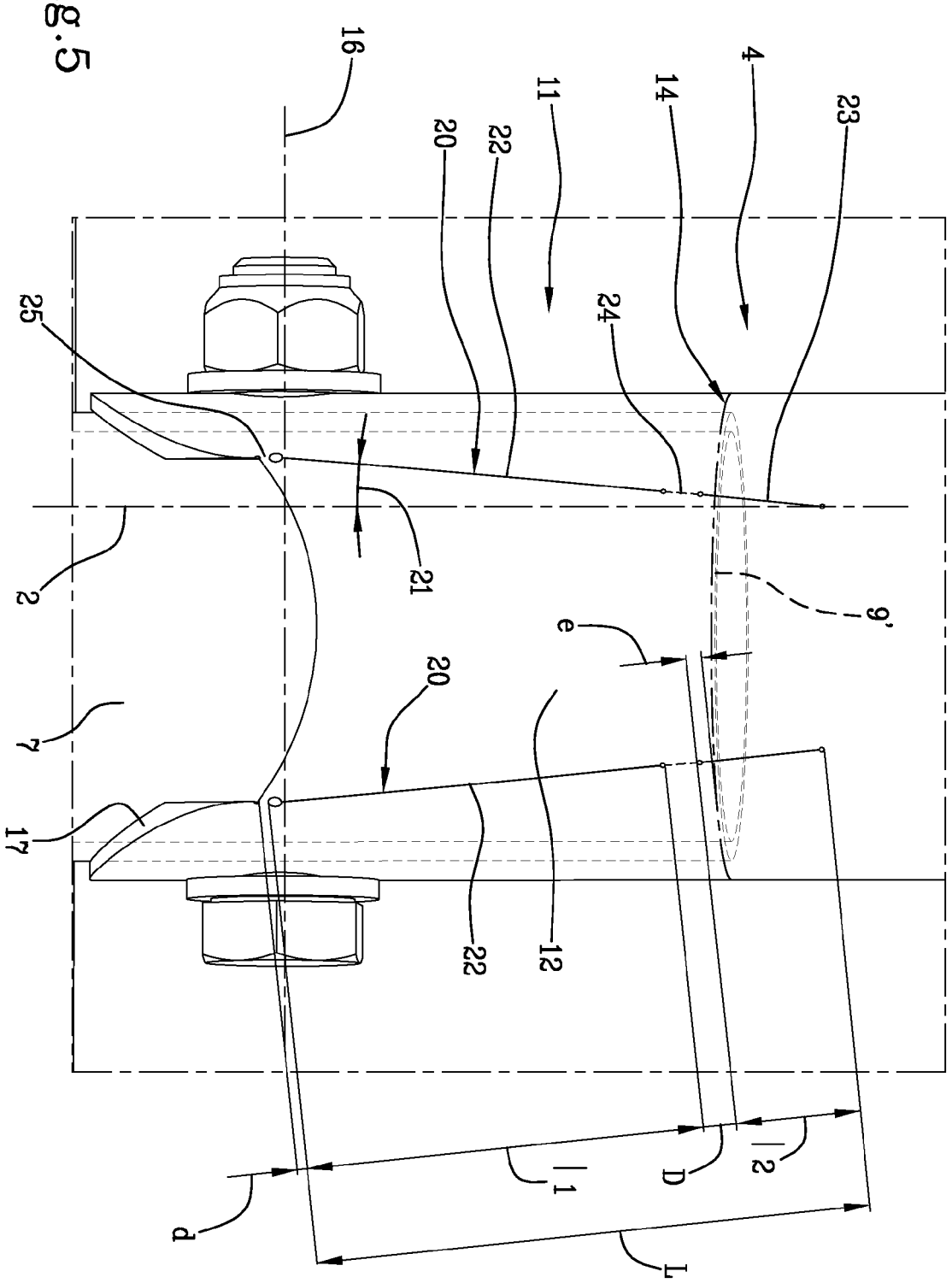


Fig.5



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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
The Hague	12 February 2015	Manera, Marco

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