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(54) FIXING OF STAY CABLE

(57) Method for installing a stay cable between a first connection point and second connection point of a construction comprising the following steps: pulling a first end of the stay cable (3) to the upper fixing point (1); fixing the first end of the stay cable in the fixing device (1); wherein the installation position of the fixing device (1) is changed from a first position to a second position after the first end of the stay cable pulled at least partly to the first connection point and/or after the first end of the stay cable is fixed to the fixing device.

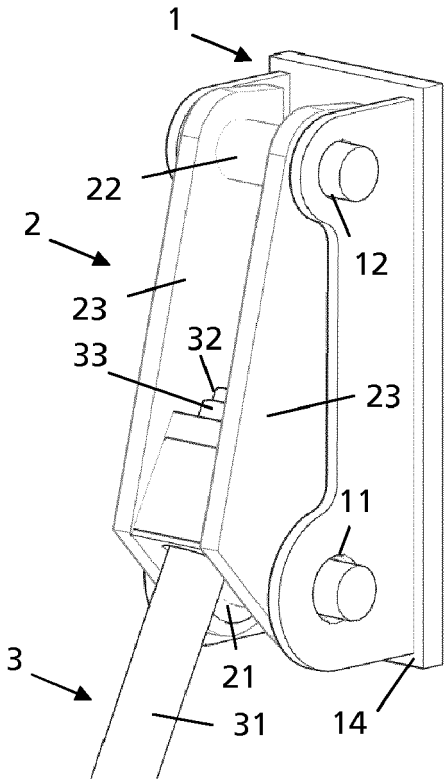

Fig. 2

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Description

Field of the invention

[0001] This invention concerns the fixation of a stay cable.

Description of related art

[0002] Stay cables are used in construction (civil engineering) for supporting large weights. They are used for example in stay bridges, but can be used in many other constructional fields such as arch bridges, high tower, stadium. One stay cable comprises a plurality of tensile elements, generally installed in a pipe, which are fixed at a respective anchorage at a first end and a second end of the stay cable. The tensile element are protected from external element by a pipe that can be made in one part or in several shelf part and that is generally made in HDPE but can be alternatively made of other plastic material or in Stainless steel. The pipe provide some protection to the tensile element from direct exposure to the external hazard such as weather condition, sun exposure or fire as an example. This external pipe also provide better aerodynamical behaviour, resistance to rain and wind induced vibration, and icing and de-icing phenomenon. The tensile elements are for example strands made of seven wires, however they can also being made of individual parallel wire. The tensile elements can be made in steel or carbon or any high performance material for carrying load in one main direction. The stay cable connects an upper connection point with a lower connection point. The upper connection part is connected within a pylon or mast and the lower connection being connected within a bridge deck, a roof or directly to the ground as an example. There are different methods to install a first end of the stay cable at the upper connection point.

[0003] The stay cable can be prefabricated. This means that the plurality of tensile elements is preassembled generally in a pipe to form the stay cable before the first end of the stay cable is installed on the upper connection point. This has the advantage of an easier and faster preassembly operation in an industrial installation on the ground that can be out of the vicinity of the structure with easy control and production, a limited assembly activities on the site and a fast installation time. However depending on the length of the stay cable and its number of tensile elements, the prefabricated stay cable can become very heavy. This results in heavy equipment for lifting the stay cable to the upper connection point. In addition, this technology requires a large prefabrication area which is not always available. A further disadvantage of this technology is the connection to the upper connection point. The first end of the stay cable can be fixed by blocking the first end behind a through-hole at the upper connection point of a constructional element, e.g. a pylon. Alternatively, the first end of the stay cable can be fixed with a clevis at the upper connection point as for example shown in WO00/56994. Both methods bring the difficulty to get the first end of the prefabricated stay cable in the correct orientation for fixing it. Another disadvantage of the existing clevis is that the pin is placed in the same axis than the stay cable and there is few space between the anchorage and a clevis pin such that installation and maintenance becomes difficult. Both connection technologies have the disadvantage that the first end of the stay cable must be oriented correctly to be connected to the first connection point. This is however difficult for long stay cables due to the large stay cable weight.

[0004] An alternative for installation of the stay cable to assemble the tensile elements individually or in subgroups directly on the site through a pipe up to the upper connection point. This means that tensile elements or a sub-numbers of tensile elements are lifted sequentially to the upper connection point, where they are fixed. For strands as tensile elements this technology is called Single Strand Installation (SSI). This has the advantage that the transported tensile elements are much lighter and the lifting equipment can be realised much smaller. Also no prefabrication area is needed. A further advantage is that this technology can easily adapt to a project size. However, this technology has the disadvantage of a longer installation times, in particular for very long stay cables, working in elevated position and limited access for the control. For very long stays, over 500 m, it is also difficult to handle the installation of each tensile element as the weight of the pipe containing the duct cannot be taken by the tensile element until a certain number is already installed. On shorter cable stay we generally lift the pipe with one first tensile element that is sufficient to hold the weight of the pipe.

Brief summary of the invention

[0005] It is the object to find an improved fixation for stay cables, in particular for the upper connection point and/or for the very long stay cables.

[0006] In one embodiment, this object is solved by the method for fixing a stay cable and a fixing device according to the independent claims.

[0007] Since the fixing device can change its position from a first position to a second position, it is possible to lift and/or fix the first end of the stay cable in a first position in which lifting or fixing is easier. By moving the fixing device in the second position, the fixing device can be brought in the desired position for holding the stay cable under tension. The first position also allows a better access to the first end of the stay cable, in particular to an anchorage of the tensile elements, for maintenance.

[0008] In one embodiment, this object is solved by a method for maintenance of a stay cable between a first connection point and second connection point of a construction, wherein the stay cable is fixed at the first connection point to a fixing device, characterized by changing the installation position of the fixing device between

a first position for maintenance and a second position for holding the stay cable under tension.

[0009] In one embodiment, this object is solved by a fixing device for fixing a first end of a stay cable at a first connection point of a constructional site. The fixing device comprises a holding means for holding the first end of the stay cable such that the longitudinal axis of the stay cable at the first end corresponds to a holding axis of the holding means. The fixing device comprises further a fixing mechanism for fixing the fixing device to the first connection point.

[0010] Further embodiments are described in the dependent claims and below.

[0011] In one embodiment, the fixing mechanism is configured to change the installation position of the fixing device from a first position to a second position, when the first end of the stay cable is hold in the holding means.

[0012] In one embodiment, the fixing mechanism has a first fixing point for pivotally supporting the fixing device at the first connection point such that the installation position is changeable by rotating the fixing device around the first fixing point. This allows to fix the fixing device at the first connection point of a building or a constructional element such that the first connection point can support via the fixing device the weight of stay cable and still to change the position of the fixing device by rotating the fixing device around the first fixing point.

[0013] In one embodiment, the fixing mechanism has a first fixing point, wherein the first fixing point is arranged offset of said holding axis. As a consequence, the first end of the stay cable is better accessible for maintenance (even in the second position). This allows further to have a lever on the first fixing point which facilitates to change the position of the fixing mechanism, when the weight of the stay cable is supported by the first fixing point.

[0014] In one embodiment, the fixing mechanism has a first and a second fixing point. This allows to fix the fixing device in different positions, even when the weight of the stay cable is supported by the fixing device. This allows to adapt the orientation of the fixing device and/or of the first end of the stay cable. This can allows to adapt the orientation of the first end of the stay cable better to the second connection point to reduce the stress on the stay cable and the fixing device. This allows to fix the stay cable in a maintenance position for better accessing the first end of the stay cable, in particular the anchorage. This allows also to adapt the orientation of the first end of the stay cable to the level of tension between the lower and first connection point, e.g. during the process of increasing the tension of the stay cable.

[0015] In one embodiment, the distance between the first and the second fixing point is larger than the shortest distance between the first fixing point and the holding axis. This has several distinct advantages. First, the force needed at the second fixing point to change the position of the fixing device is lower, due to the lever at the second fixing point. Thus, the force to hold the fixing device in a certain (preferably rotational) position is reduced. Second, this allows an amplification of the movement of the first connection point at the first fixing point to the second fixing point which has a number of applications. One application is to introduce a damper or a spring between the first connection point and the second fixing point.

[0016] In one embodiment, the fixing device comprises a flexible element, like a damper or a spring, wherein the flexible element is connected with the second fixing point and is configured to be connected with the first connection point. This has the advantage that the main weight is carried by the first fixing point, but nevertheless a flexible element can be arranged between the fixing device or the stay cable and the first connection point. This embodiment is in particular advantageous, when the distance between the first and the second fixing point is larger than the shortest distance between the first fixing point and the holding axis.

[0017] In one embodiment, the rotation axis of the first fixing point is perpendicular to the holding axis such that a rotation of the fixing device changes the angle of the holding axis with respect to a vertical direction.

Brief Description of the Drawings

[0018] The invention will be better understood with the aid of the description of an embodiment given by way of example and illustrated by the figures, in which:

Fig. 1 shows a three-dimensional view of an embodiment of the fixing device in the first position during lifting of the stay cable;

Fig. 2 shows a three-dimensional view of the embodiment of the fixing device in the second position with the first end of the stay cable fixed in the fixing device;

Fig. 3 shows a transparent side view of the embodiment of the fixing device in the first position during lifting of the stay cable;

Fig. 4 shows a transparent side view of the embodiment of the fixing device in the second position with the first end of the stay cable fixed in the fixing device;

Detailed Description of possible embodiments of the Invention

[0019] One embodiment of the invention is a construction like a bridge, a tower, a skyscraper, a building, a stadium etc. The construction comprises at least one stay cable 3 between a first connection point and a second connection point. Preferably, the shortest line between the first connection point and the second connection point is not aligned with a vertical direction. The vertical direction is defined as the direction of the gravity. Preferably, the first connection point is arranged above the second connection point. The second connection point could be

on a deck of a bridge or any other horizontal surface which has to be carried by the stay cable or on a foundation connected to the ground. The first connection point could be on a tower, a pylon, a pipe, etc.

[0020] The stay cable 3 has a first end connected/fixed to the first connection point of the construction and a second end connected/fixed to the second connection point. When the stay cable 3 is under tension, it establishes an exchange of load between the first connection point and the second connection point. For example in a bridge, the deck on the second connection point is supported via the stay cable by the first connection point of a pylon. In another example of a tower, the second connection point of a foundation supports the first connection point of a tower. Preferably, the stay cable 3 in the operating state is not aligned or has an angle with respect to the direction of gravity. In one embodiment, the stay cable 3 is longer than 50 m, preferably longer than 100 m, preferably longer than 200 m, preferably longer than 400 m. Even if the invention brings a lot of benefit for long stay cables, it can also be applied for shorter stay cables with a lot of benefice.

[0021] In one embodiment, the stay cable 3 comprises a plurality of tensile elements constituting the cable 31. Each end of the plurality of tensile elements is fixed in an anchorage 32 at the first end and the second end of the stay cable, respectively. The tensile elements are for example strands. However, also other tensile elements and also other designs of the stay cable 3 are possible. The details of the design of stay cables are common knowledge and shall not be described here.

[0022] Fig. 1 to 4 show the fixation of the first end of the stay cable at the first connection point. The construction comprises a support means 1, a fixing device 2 and the stay cable 3.

[0023] The support means 1 is configured to support the fixing device 2 at the first connection point of the construction. The support means 1 could be fixed in the corresponding construction element (e.g. a concrete element) or could be integral part of the construction element (e.g. a steel construction element). The support means 1 has preferably a first support point 11 and a second support point 12. The first support point 11 is configured to support the fixing device 2 pivotally. The second support point 12 is configured to fix the fixing device 2. In this embodiment, the first and/or second support point 11 and/or 12 are realised as a recess for supporting a pin or axle 5 on which the fixing device 2 is supported.

[0024] In this embodiment, the support means 1 comprises two side walls 13 and a connecting element 14 for connecting the two side walls 13. The two side walls 13 have each a first recess or through-hole forming together the first support point 11. Preferably, the recess/hole axis of the first recess in the first side wall 13 corresponds to the recess/hole axis of the first recess in the second side wall 13 such that the pin/axle 5 extends through the first recess in the first side wall 13 and the first recess in the second side wall 13. The two side walls 13 have each a second recess or through-hole forming together the second support point 12. Preferably, the recess/hole axis of the second recess in the first side wall 13 corresponds to the recess/hole axis of the second recess in the second side wall 13 such that the pin/axle 5 extends through the second recess in the first side wall 13 and the second recess in the second side wall 13. However, this embodiment shall not limit the invention and many other realisation of the support means 1 with a first support point 11 and/or a second support point 12 are possible.

[0025] The fixing device 2 comprises a first fixing point 21, a second fixing point 22 and a holding means 24.

[0026] The holding means 24 is configured to hold the first end of the stay cable 3. The holding means 24 has a holding axis which corresponds with the longitudinal axis of (the first end of) the stay cable 3, when the first end of the stay cable 3 is hold in the holding means 24. In the shown embodiment, the holding means 24 is realized by a through-hole or a recess. Once the first end of the stay cable 3 is led through the recess, a blocking means is fixed on the first end, preferably on the anchorage, to block the first end of the stay cable 3 to move back through the recess or hole under tension or load. The blocking means could be a nut fixed on a thread around the first end of the stay cable 3. Here the hole or recess axis corresponds to the holding axis. Other realisations of the holding means 24 are possible. The holding means 24 could for example be a clevis. In the shown embodiment, the fixing device 1 comprises two side walls 23. The holding means 24 is preferably arranged between the two side walls 23.

[0027] The first fixing point 21 is configured to fix the fixing device 2 at the first connection point of the construction. The first fixing point 21 is configured to fix the fixing device 2 at the first support point 11 of the support means 1. The first fixing point 21 is configured to fix the fixing device 2 while changing the installation position of the fixing device 1. Preferably, this is achieved by fixing the fixing device 2 pivotally around first fixing point 21 and/or the first support point 11. In the embodiment of the support means 1 described above, the fixing device 1 at the first fixing point 21 is pivotally supported on the pin or axle 5. In the shown embodiment, the two side walls 23 have each a first recess or through-hole forming together the first fixing point 21. Preferably, the recess/hole axis of the first recess in the first side wall 23 corresponds to the recess/hole axis of the first recess in the second side wall 23 such that the pin/axle 5 extends through the first recess in the first side wall 23 and the first recess in the second side wall 23. Preferably, the two side walls 23 are connected with a hollow cylinder, preferably with a cylinder axis corresponding to the axis of the first recess in the two side walls 23 and/or with the same inner diameter and/or form as the first recess of the two side walls 23. However, other realisations of the first fixing point 21 are possible. In one embodiment, the first fixing point 21 is offset from the holding axis. In one embodiment, the axle 5 or the hollow cylinder of the first

fixing point 21 do not overlap with the stay cable 3 hold in the holding means 24. In another embodiment, it is also possible by fixing the fixing device 2 such that a translation (and optionally a rotation) of the fixing device 2 is possible to a second position. Any other embodiment for fixing the fixing device 2 to the support means is possible, which allows to change the position of the fixing device 2 (by translation and/or rotation) with respect to the support means 1.

[0028] The second fixing point 22 is configured to fix the fixing device 2 at the first connection point of the construction. The second fixing point 22 is configured to fix the fixing device 2 at the second support point 12 of the support means 1. The second fixing point 22 is configured to fix the fixing device 2 in a certain (rotational) installation position. Preferably, the fixing device 2 can be installed in at least a first position and a second position, preferably in multiple positions. In the embodiment of the support means 1 described above, the fixing device 1 at the second fixing point 22 is supported on the pin or axle 5 supported in the second support point 12. In the shown embodiment, the two side walls 23 have each a second recess or through-hole forming together the second fixing point 22. Preferably, the recess/hole axis of the second recess in the first side wall 23 corresponds to the recess/hole axis of the second recess in the second side wall 23 such that the pin/axle 5 extends through the second recess in the first side wall 23 and the second recess in the second side wall 23. Preferably, the two side walls 23 are connected with a hollow cylinder, preferably with a cylinder axis corresponding to the axis of the second recess in the two side walls 23 and/or with the same inner diameter and/or form as the second recess of the two side walls 23. However, other realisations of the second fixing point 22 are possible. In one embodiment, the second fixing point 22 is offset from the holding axis. In one embodiment, the distance between the first and the second fixing point 21 and 22 is larger than the shortest distance between the first fixing point 21 and the holding axis.

[0029] Fig. 1 and 3 show now the fixing device 2 in a first position. Preferably, the holding axis of the holding means 24 is substantially vertical in the first position. Preferably, the installation position of the fixing device 2 can be changed by rotating the fixing device 2 around the first fixing point 21. In one embodiment, the fixing device 2 is fixed in this first position by fixing a distance holder 4 between the second support point 12 and the second fixing point 22. This distance holder 4 could be placed on the hollow cylinders or the pin 5 of the second fixing point 22 and on the pin 5 of the second support point 12. In a preferred embodiment, the distance holder 4 comprises for installation of the stay cable 3 a lifting device 41. The lifting device 41 could be a winch or a lifting jack for lifting the stay cable 3 with a lifting tensile element 42 like a lifting strand. The lifting tensile element 42 is fixed with a first end at the first end of the stay cable 3 and at the second end in the lifting device 41. The lifting device is arranged such over the holding means 24 that the tensile element 42 extends through the holding means 24 (preferably through the through-hole of the holding means 24). Preferably, the holding axis corresponds to the longitudinal axis of the tensile element or to the lifting direction. Then the lifting device 41 lifts the first end of the stay cable 3 up to the first connection point and/or to the fixing device 2. Fig 1 and 3 show the first end of the stay cable 3 pulled up by the lifting tensile element 42 and the lifting device 41. Due to the vertical alignment of the holding axis and/or the arrangement of the lifting device 41 above the holding means 24, the first end of the stay cable 3 is automatically oriented correctly and can be without any effort for orientation inserted in the holding means 42. Then, the first end of the stay cable 3 is fixed/blocked in the holding means 3. In the shown embodiment, the first end of the stay cable 3 is lifted through the recess or through-hole and is blocked by a blocking means like a nut 33.

[0030] The fixing device 2 changes its position from a first position to a second position, after the first end of the stay cable 3 is at least partly lifted and/or is fixed in the holding means 24. The change of position of the fixing device 2 can be achieved by a distance holder 4 which is also configured to adapt or reduce the distance between the second fixing point 22 and the first connection point/ second support point 12 (with the load of the stay cable 3). Alternatively, this could be achieved by other equipment configured to adapt or reduce the distance between the second fixing point 22 and the first connection point/ second support point 12 (with the load of the stay cable 3). The fixing device 2 could comprise a third fixing point for mounting a distance change equipment for changing the distance between the second fixing point 22 and the second support point 12. The distance change equipment could be connected between the third fixing point and a third support point of the support means 1. The second position is preferably the position of the fixing device 2 in which the stay cable 3 is in operation and/or under tension.

[0031] The time for changing from the first position to a second position could vary depending on the embodiment.

[0032] In one embodiment, the first end of the stay cable 3 is completely lifted and inserted in the holding means 24 and (optionally) fixed in the holding means 24, before the installation position of the fixing device 2 is changed. In this embodiment, preferably the second end of the stay cable 3 is fixed at the second connection point after lifting the stay cable 3 and/or fixing the first end of the stay cable 3 in the fixing device 2. The position of the fixing device 2 could be changed to the second position before starting to increase the tension of the stay cable 3. It is also possible to follow with the orientation of the holding axis defined by the position of the fixing device 2 during the fixation of the second end of the stay cable 3 at the second connection point and/or during the increase of the tension of the stay cable 3 continuously the

orientation of the longitudinal axis of the first end of the stay cable 3.

[0033] In one embodiment, the installation position of the fixing device 2 starts to change, when the first end of the stay cable 3 is partly lifted. This could be advantageous, if the second end of the stay cable 3 is fixed at the second connection point before lifting the stay cable 3. Thus, the orientation of the longitudinal axis of the first end of the stay cable 3 could change with a certain height of the first end of the stay cable 3 towards the second connection point. Therefore, it is also possible to follow with the orientation of the holding axis defined by the position of the fixing device 2 during the lifting the stay cable 3, the fixation of the second end of the stay cable 3 at the second connection point and/or during the increase of the tension of the stay cable 3 continuously the orientation of the longitudinal axis of the first end of the stay cable 3.

[0034] In a preferred embodiment, the stay cable 3 is prefabricated before (starting the) lifting the first end of the stay cable 3 to the first connection point. However, it could also be possible to lift sequentially the tensile elements of the stay cable 3 sequentially to the first connection point and fix the first end of the tensile elements of the stay cable 3 in the fixing device 2, respectively.

[0035] In the described embodiment, the first connection point is not on the ground and/or is the upper connection point such that the first end of the stay cable 3 must be lifted to the fixing device 2. It is however also possible that the first connection point is on the ground and/or is the lower connection point. A similar problematic appears, when one second of the stay cable is fixed at the upper second connection point and the first end of the stay cable 3 must be pulled to the fixing device 2 for fixing the first end of the stay cable 3 in the fixing device 2. At the beginning the first end of the stay cable 3 lays on the ground and the pulling tensile element pulling or transporting the stay cable 3 towards the fixing device 2 is horizontal. When the first end of the stay cable 3 approaches the fixing device 2, the longitudinal axis of the first end of the stay cable 3 changes its orientation towards the second connection point. The fixing device 2 can then adapt its installation position according to the installation progress. Maybe in a first position, the installation position is so that the holding axis is horizontal, while at a second position the holding axis is directed towards the second connection point or to an angular direction between the horizontal direction and the direction towards the second connection point. In this embodiment, the lifting device 41 is more general a pulling device 41 and the lifting tensile element 43 is more general a pulling tensile element 43.

[0036] In one optional embodiment, the second fixing point 22 in the second position of the fixing device 2 is directly connected to the second support point 12 of the first connection point.

[0037] In another optional embodiment, the second fixing point 22 is connected via a flexible element to the second support point 12 of the first connection point. The flexible element can vary the operation position of the fixing device 2 from a first position to a second position (and to many more positions). This embodiment is particularly advantageous, if the distance between the first and the second fixing point 21 and 22 is larger than the shortest distance between the first fixing point 21 and the holding axis. This arrangement causes an amplification of the displacement/speed. The displacement/speed between the second fixing point 21 and the second support point 22 is larger than the true displacement/speed of the first connection point. Therefore, also very small displacements/speeds of the first connection point could be treated more effectively by the flexible element between the second fixing point 21 and the second support point 22 due to the larger displacement/speed.

[0038] In one embodiment, the flexible element is a spring (force proportional to displacement). The spring could be for example a cup or disc spring. The spring has the advantage that a displacement of the first (and/or second) connection point is not directly transmitted to the stay cable 3. This reduces the stress of the stay cable under displacement of the first (and/or second) connection point. Such a displacement of the first connection point could be caused by a strong gust of wind or an earthquake.

[0039] In one embodiment, the flexible element is a damper (force proportional to speed). The damper has the advantage that a displacement of the first connection point is reduced.

[0040] In one embodiment, it is also possible to fix the fixing device 2 first at the first end of the stay cable 3 and pull or transport it then to the first connection point or to the support means 1 for fixing the fixing device 2 similar to a clevis.

[0041] The fixing device 2 which can assume different installation or operation positions has several advantageous. It helps on one side for installation of the stay cable. On the other side, it can be used to perform maintenance or to use the change in position of the fixing device 2 to introduce flexible elements between the fixing device 2 and the connection point.

[0042] The invention is not limited to the described embodiments, but could be realised within the scope of protection in any other way.

Claims

1. Method for installing a stay cable between a first connection point and second connection point of a construction comprising the following steps:

   pulling a first end of the stay cable to the first connection point;
   fixing the first end of the stay cable in the fixing device;
   characterized in that

the installation position of the fixing device is changed from a first position to a second position after the first end of the stay cable is pulled at least partly to the first connection point and/or after the first end of the stay cable is fixed to the fixing device.

2. Method according to claim 1, wherein the fixing device has a first fixing point, wherein the fixing device is pivotally supported around the first fixing point, wherein the installation position is changed by rotating the fixing device around the first fixing point.

3. Method according to claim 2, wherein the fixing device has a second fixing point for fixing the fixing device in the second position to a support point (12) of the first connection point.

4. Method according to claim 3, wherein in the first position, a pulling device (41) is installed between the second fixing point and the support point (12) for pulling the first end of the stay cable.

5. Method according to one of claims 1 to 4, wherein the fixing device comprises a through-hole through which the first end of the stay cable is led and above which a blocking element is installed on the first end of the stay cable for fixing the first end of the stay cable to the fixing device.

6. Method according to one of claims 1 to 5, wherein the fixing device is oriented in the first position such that a longitudinal axis of the stay cable hold in the fixing device and/or the longitudinal axis of the though-hole is substantially vertical.

7. Method according to one of claims 1 to 6, wherein the fixing device is oriented in the a second position such that a longitudinal axis of the stay cable hold in the fixing device and/or the longitudinal axis of the though-hole includes an angle with respect to the vertical direction and/or is directed towards the second connection point.

8. Method according to one of claims 1 to 7, comprising the further step of fabricating a stay cable with the first end and/or installing the fixing device in the first position on the first connection point, before pulling the stay cable.

9. Fixing device for fixing a first end of a stay cable at a first connection point of a construction comprising:

a holding means for holding the first end of the stay cable such that the longitudinal axis of the stay cable at the first end corresponds to a holding axis of the holding means; and
a fixing mechanism for fixing the fixing device to the first connection point;
characterized in that the fixing mechanism is configured to change the installation position of the fixing device from a first position to a second position, when the first end of the stay cable is hold in the holding means or when the stay cable is pulled to the fixing device.

10. Fixing device according to claim 9, wherein the fixing device has a first fixing point for pivotally supporting the fixing device at the first connection point such that the installation position is changeable by rotating the fixing device around the first fixing point.

11. Fixing device according to claim 10, wherein the first fixing point is offset from the holding axis.

12. Fixing device according to claim 10 or 11, wherein the rotation axis of the first fixing point is perpendicular to the holding axis such that a rotation of the fixing device changes the angle of the holding axis with respect to a vertical direction.

13. Fixing device according to one of claims 10 to 12, wherein the fixing device has a second fixing point for fixing the fixing device in at least two rotational positions to the first connection point.

14. Fixing device according to claim 13, wherein the distance between the first and the second fixing point is larger than the shortest distance between the first fixing point and the holding axis.

15. Construction comprising a first connection point, a second connection point, a fixing device according to one of claims 9 to 14 connected to the first connection point and a stay cable connected between the second connection point and the fixing device.

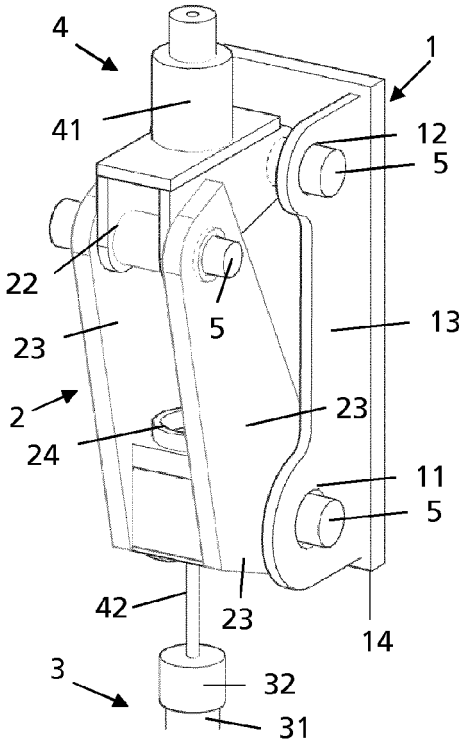

Fig. 1

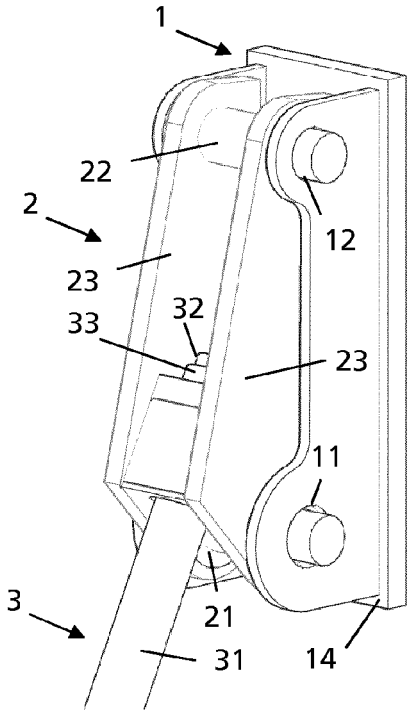

Fig. 2

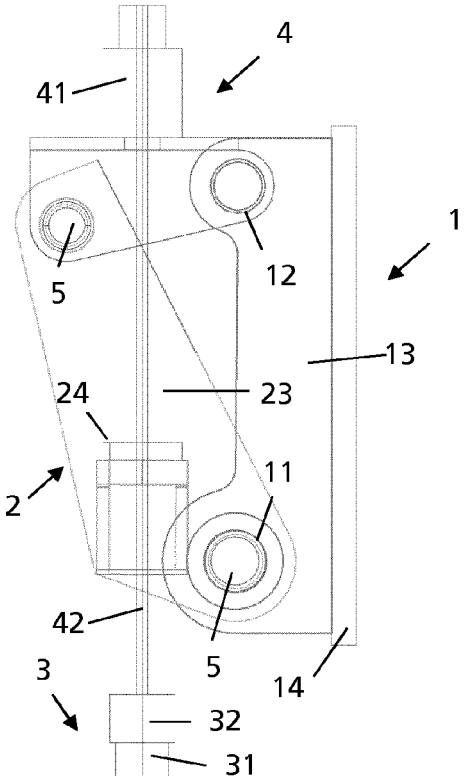

Fig. 3

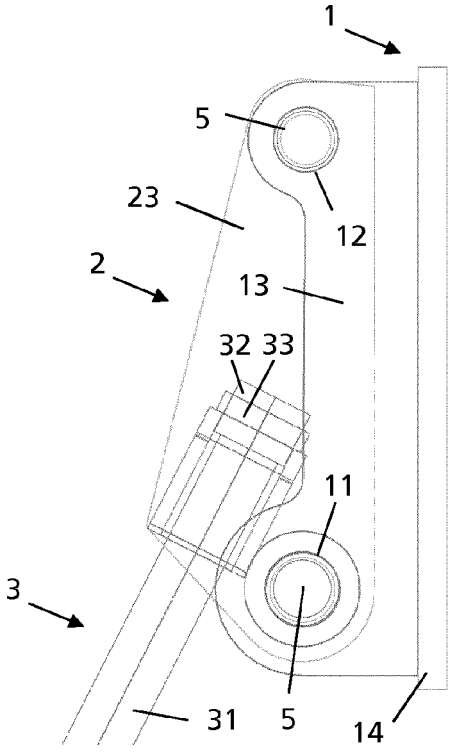

Fig. 4

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 6568

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,D	WO 00/56994 A1 (FREYSSINET INT STUP [FR]; STUBLER JEROME [FR]; ZIVANOVIC IVICA [FR]; M) 28 September 2000 (2000-09-28) * the whole document *	9-12,15	INV. E01D19/14
A	US 2 198 809 A (FINKE RALPH W ET AL) 30 April 1940 (1940-04-30) * the whole document *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E01D
E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 September 2017	Beucher, Stefan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

T : theory or principle underlying the invention
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L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 16 6568

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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28-09-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0056994 A1	28-09-2000	AU 3302200 A	09-10-2000
		FR 2791373 A1	29-09-2000
		MX PA01006115 A	06-05-2002
		WO 0056994 A1	28-09-2000
US 2198809 A	30-04-1940	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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