

Lifting Device with A Dimensionally Stable Clamping Element

The invention relates to an apparatus for clamping a device to an elongate body extending in a longitudinal direction, which apparatus is displaceable to and fro along a longitudinal extent of the elongate body and is provided with a self-locking mechanism which comprises at least one clamping element which is pivotable about an associated axis of rotation between a clamping position and a neutral position. The invention also relates to a method for installing and to a method for deinstalling an offshore device.

Apparatuses for moving a device along an elongate body are known in particular in the form of lifting devices and the use thereof for offshore devices. By means of lifting devices, offshore devices such as platforms which comprise at least one support leg are planted on the seabed.

The offshore platform is brought to the predetermined area in the sea. There, the legs are carefully lowered onto the seabed or a pre-installed base frame by means of a lifting device and, once the legs are securely grounded on the seabed or base frame, the platform floating on the seawater is raised to the operating height above the waves by means of the same lifting device or a further lifting device.

Once the platform has reached its operating height with the aid of the lifting device, the platform is fixed at said height.

A pneumatic lifting device is known from US 2,775,869. For each support leg, two circumferential rows of pneumatically operated expandable clamping tubes are disclosed. Clamping tubes arranged one above the other are connected to one another by a pneumatically operated air spring. Disadvantageously, the clamping effect diminishes in the event of a defect in the compressed air supply, and the support legs slip through the circumferential expandable clamping tubes.

A lifting device comprising two rows of gripping shoes encircling a support leg is described in US 2,841,961. The gripping shoes have teeth pointing towards the support leg wall, which teeth in the clamped state press into the wall material and may disadvantageously damage the latter. The clamping apparatus of US 2,841,961 has the disadvantage that the large shoes arranged with a form fit around the circumference of the support leg are difficult to

manufacture. In addition, a complicated and power-hungry mechanism for controlling the clamping mechanism is necessary.

5 US 2,822,670 relates to a lifting device having an engaging mechanism. In this case, locking bolts are inserted into cutouts in the wall of the support legs and the weight is supported thereon. Disadvantageously, on the one hand the support legs, in order to receive the locking bolts, must be perforated with holes at regular intervals over the entire length intended for the displaceability, which holes weaken the stability of said support legs, and on the other hand the size of the lifting steps is defined by the distance between the cutouts and also cannot be
10 set more precisely.

US 4,002,038 describes a lifting device which comprises clamping elements in the shape of ring segments, the position of said elements being held by means of leaf springs supported on pins. The clamping elements are arranged in guides such as to be movable in a
15 semicircle. One disadvantage of the mechanism is that the holding of the position by means of a leaf spring is unreliable.

EP 0030540 relates to a clamping system for clamping a platform on a strip of a support leg. Two pairs of elliptical clamping elements have a clamping effect pointing in opposite
20 directions. The clamping elements of each pair are connected to one another by means of a cylinder and produce their clamping effect by drawing together the clamping elements of a pair. The system disadvantageously requires an operating cylinder for clamping purposes. The system is also disadvantageously not suitable for moving a platform along the support leg. The invention is delimited with respect to said document.

25 US 3,396,945 describes a lifting device for moving a platform along a strip of a support leg. The clamping elements have an oblique outer surface which cooperates with an oblique inner surface of a housing to form a clamping effect. Disadvantageously, the sliding of the oblique outer and inner surfaces on one another is associated with a considerable stressing
30 of the material.

The object of the invention is therefore to provide an apparatus of the type mentioned in the introduction which offers greater operational reliability, and to provide a method which enables easy installation and deinstallation of an offshore device.

35 With regard to the apparatus, the object is achieved by an apparatus of the type mentioned in the introduction having the features of claim 1.

The apparatus mentioned in the introduction for clamping a device is preferably a lifting device, and the elongate body is a support leg, preferably a support leg of circular cross-section, and the device is an offshore device, preferably an offshore platform having one
5 support leg or multiple support legs, preferably 3, 4 or more support legs.

Preferably, the at least one clamping element is of particularly advantageous construction. The clamping element has an arm running away from the axis of rotation, with a clamping surface, preferably a flat or curved clamping surface, arranged at an arm end remote from
10 the axis of rotation, wherein the clamping surface has the same relative position with respect to the arm in the clamping position and the neutral position and along the pivoting movement.

The clamping surface has contact points or contact regions for contact with the elongate body. The elongate body has an outer surface which is preferably free of curvature in one of
15 the two surface directions. By way of example, a cylindrical outer surface of a support leg is free of curvature along a longitudinal direction of the support leg. A flat clamping surface is likewise free of curvature in one of the surface directions, wherein the curvature-free direction of the clamping surface and the curvature-free direction of the outer surface of the
20 elongate body coincide in the clamping position. As a result, the force exerted on the elongate body in the clamping position is distributed over a larger surface area and thus is gentle on the elongate body.

Because the clamping elements each have only a single axis of rotation, simple control of the apparatus is advantageously also possible.
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In particular, the apparatus mounted on the elongate body is suitable, without further reorganizing, both for lowering the elongate body, preferably the support leg, through the offshore platform onto the seabed and for lifting the device, preferably the platform, along the
30 elongate body to the operating height.

The term clamping is to be understood in a general sense here. It encompasses the clamping effect of friction-increasing coatings on the clamping surfaces, such as elastomers, and of friction materials bound in synthetic resins which are known from brakes and clutches, but also the presence of spikes, teeth and serrations on the clamping surfaces which can
35 penetrate into outer walls of the elongate body.

A clamping position is understood to mean an angular position of the clamping element in which the associated flat clamping surface has contact with an outer wall of the elongate body and applies the self-locking. A neutral position is understood to mean an angular position of the clamping element in which the clamping element, in particular the at least one clamping surface, has no direct contact with the outer wall of the elongate body. The clamping position may also vary within predefined angle ranges as a function of the weight of the device and the like, and the neutral position may also encompass an angle range. The clamping element may comprise one, two or a greater number of clamping surfaces, and preferably a clamping position is assigned to each clamping surface.

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Preferably, the arm of the at least one clamping element is configured in a dimensionally stable manner between its axis of rotation and the at least one clamping surface of the clamping element. This is a particularly low-maintenance embodiment of the invention.

15 The at least one clamping surface, with its region which leads during the pivoting movement from the neutral position into the clamping position, advantageously passes through a pivot line of smaller radius than a trailing region of the at least one clamping surface.

During the pivoting movement, different points and parts of the clamping element generally describe different pivot lines. In particular, the points along the clamping surface describe pivot radii of different diameter. Preferably, the pivot radius of the region of the clamping surface increases as the distance by which the region of the clamping surface trails behind the pivoting movement when the pivoting movement runs from the neutral position into a clamping position increases. Due to this geometric arrangement of the clamping surfaces relative to the axis of rotation, a simple self-locking is achieved by reducing the clamping cross-section.

Preferably, a central point of the clamping surface in the clamping position is spaced apart from the axis of rotation by a short lever parallel to the clamping surface and by a long lever perpendicular to the clamping surface. The ratio of long to short lever corresponds to at least (half of) the coefficient of friction between the clamping surface and the outer wall of the elongate body. The weight force acting externally on the clamping element generates, via the lever effect of the long and short lever, a clamping force which acts on the elongate body, wherein the quotient of weight force and clamping force corresponds to the quotient of short to long lever. Because the friction corresponds at least to the clamping force multiplied by the coefficient of friction, locking occurs when there is a lever ratio which corresponds to the coefficient of friction.

Advantageously, the self-locking mechanism can inhibit the displacement of the device both to and fro along the elongate body. The self-locking mechanism is preferably provided in duplicate for each clamping element and, depending on the setting at a particular point in time, inhibits the displacement either to or fro.

Preferably, the at least one clamping element has a further clamping surface in addition to the clamping surface. The clamping surface and the further clamping surface are preferably located symmetrically opposite one another. Advantageously, the clamping element has in a pivot plane a cross-section with clamping surfaces arranged at an angle to one another along the cross-section, said clamping surfaces being separated from one another by a spacer region.

By forming two clamping surfaces, it is advantageously possible to generate clamping effects in two movement directions along the elongate body and thus to provide the self-locking mechanism in duplicate in a particularly simple manner. When the apparatus is configured as a lifting and lowering apparatus and in particular is configured as a lifting device, both a lowering of the support leg and a lifting of the platform can be carried out without having to reorganize the apparatus on the support leg or, as in the case of a strandjack lifting/lowering system, without providing a further independent lowering system. The spacer region corresponds to the neutral position. When the spacer region is oriented parallel to the longitudinal direction, that is to say is located directly opposite the outer wall of the elongate body during operation, the clamping element has no direct contact with the elongate body and no clamping effect is produced. Depending on the direction in which the clamping element is pivoted about the axis of rotation, a clamping effect forms between the clamping surface and the elongate body or a further clamping effect forms between the further clamping surface and the elongate body, and this prevents the elongate body from slipping through in the longitudinal direction or counter to the longitudinal direction of the apparatus according to the invention.

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The clamping element may be configured in various ways. The at least one clamping surface may be integrally connected in one piece with the respective arm. Preferably, the at least one clamping surface has a guide into which at least one clamping component is introduced. The clamping components of a guide form the at least one clamping surface. One, two, three or optionally a greater number of clamping components may be introduced into the guide. The guide need not be completely filled. The individual clamping components can advantageously be fixed separately in the guide. Depending on the number of clamping

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components, the size of the clamping surface changes and therefore the size of the clamping surface and thus the force acting on the outer wall of the elongate body per unit area can be adjusted. In particular, individual clamping components may be fixed at different positions along the guide. Clamping components arranged further outwards from the perpendicular
5 connecting line between the axis of rotation of the clamping element and the outer wall of the elongate body generate a lesser clamping force on the outer wall of the elongate body. The clamping force can thus be adjusted by displacing the clamping component in the guide.

10 The clamping elements are arranged differently around the elongate body in different embodiments of the invention.

Preferably, the clamping elements are arranged in clamping members of a continuous clamping chain arranged around the elongate body. The clamping members are in this case preferably arranged around the elongate body and adjacent clamping members are
15 preferably connected to one another in an articulated manner by means of long connecting plates. The long connecting plates advantageously have no contact with the outer wall of the elongate body during operation. The connecting plates are preferably of rectilinear construction. The clamping members themselves may have individual boxes which are in turn connected to one another in an articulated manner by short connecting plates. Short and
20 long connecting plates are in this case preferably arranged along the circumference of the elongate body and are each formed tangentially to the circumference.

Advantageously, the self-locking mechanism comprises clamping members which can be arranged around the elongate body, each clamping member having at least one clamping
25 element, wherein the at least one clamping element is pivotable relative to the clamping members about its respective axis of rotation and forms a clamping cross-section of variable size around the body. The clamping members may each be configured as one, two, three or a greater number of boxes and may have a plurality of clamping elements arranged one above the other in the longitudinal direction, the clamping elements of each box preferably
30 being connected to one another by an adjusting rod which enables simultaneous adjustment of the clamping elements of a box.

The adjusting rod makes it possible in particular to adjust the clamping elements which can be actuated thereby, in order to generate an initial locking. The self-locking is formed by the
35 clamping force which occurs subsequently after the initial locking, which clamping force is increased by the weight force of the device itself.

In one particularly preferred embodiment of the invention, the clamping elements are arranged in at least two clamping member groups which are movable relative to one another along the elongate body, and each of the clamping member groups forms a separate self-locking mechanism.

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This embodiment allows an onward movement of the two clamping member groups in pilgrim step in the longitudinal direction and counter to the longitudinal direction.

10 In one embodiment of the invention, one clamping member group is provided in a fixed position relative to the platform, and the further clamping member group is configured so as to be movable relative to the platform by means of hydraulically operated cylinders. The pilgrim step between the two clamping member groups is thus made possible. It is conceivable that the two clamping member groups are directly connected to one another by hydraulically operated cylinders or the hydraulically operated cylinders connect the further
15 clamping member group directly to the platform.

The clamping member groups may be configured differently. Preferably, the clamping members of one group are configured as a clamping chain. Preferably two clamping chains are provided, which are arranged one above the other in the longitudinal direction of the
20 support leg and enable both a lifting of the platform in pilgrim step and a lowering of the platform in pilgrim step and also a lowering and lifting of the support leg. In addition, the apparatus according to the invention is also suitable as a clamping system for durably holding the platform in the operating position. No further and additional fastening means are necessary for operation because the apparatus according to the invention is operationally
25 reliable in the clamping state due to self-locking. In addition, a redundancy can be achieved on each support leg due to the duplicate construction of the clamping chains.

In another embodiment of the invention, the clamping member groups are not configured as clamping chains which run around an elongate body, preferably the support leg, but rather
30 the clamping members are configured as a U-shaped profile and have, on the inner side of the U-shaped profile, opposite clamping elements between which there can be guided a strip which is fixedly arranged on the elongate body. The clamping members of a clamping member group may be provided opposite one another on the support leg on one respective strip or running around the support leg on multiple strips. The clamping members of a
35 clamping member group are not directly connected to one another but together they perform their clamping effect.

Advantageously, at least one stop is provided for the clamping element, which stop prevents the clamping element from pivoting beyond the clamping position in the pivoting direction. This is a safety feature of the apparatus.

- 5 Teeth are preferably arranged on the clamping surfaces, which teeth engage in the outer surface of the elongate body and increase the clamping effect. It is also conceivable that the clamping surfaces are covered in some other way with a friction-increasing elastomer layer and friction materials bound in synthetic resins, as known from brakes and clutches, in order to achieve an increased clamping effect.

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With regard to the method, the object is achieved by a method for installing an offshore device comprising a platform and at least one support leg, by means of an apparatus as mentioned above having at least two, preferably precisely two, clamping member groups. The apparatus is mounted around the at least one support leg, and the clamping surfaces of
15 the clamping elements of the two clamping member groups alternately perform a clamping effect on the at least one support leg. In this way, the support leg is lowered counter to the longitudinal direction in pilgrim step by means of the apparatus. According to the invention, the clamping elements of the two clamping member groups can be pivoted through their neutral positions and then the further clamping surfaces of the clamping elements of the two
20 clamping member groups can alternately perform a clamping effect on the support leg and in this way the platform is lifted in the longitudinal direction to the operating height. Advantageously, there is no need for any reorganizing, that is to say in particular an opening and re-closing, of one or both clamping chains.

- 25 Preferably, the platform is durably clamped at the operating height by means of the apparatus. There is thus no need for additional fastening means such as bolts or the like for durably fastening the platform because the self-locking apparatus is sufficiently reliable for durably keeping the platform at the operating height.

- 30 In another embodiment of the invention, the apparatus is used for lifting the platform, and the platform lifted to the operating height is durably fastened at said height on the support legs by means of further fastening means.

- With regard to the method, the object is also achieved by a method for deinstalling an
35 offshore device comprising a platform and at least one support leg, by means of an apparatus of the aforementioned type having at least two, preferably precisely two, clamping member groups, in which the further clamping surfaces of the clamping elements of the two

clamping member groups alternately perform a clamping effect on the at least one support leg and in this way the platform is lowered towards the sea surface counter to the longitudinal direction in pilgrim step by means of the apparatus, the clamping elements are pivoted through their neutral positions and then the clamping surfaces of the clamping elements of the two clamping member groups alternately perform a clamping effect on the support leg and in this way the at least one support leg is retracted in the longitudinal direction.

Advantageously, no reorganizing of the apparatus is required either during the installation or during the deinstallation because preferably all the clamping elements are pivoted through their respective neutral position when changing the relative movement of either the support leg or the platform with respect to the seabed while retaining the relative movement direction between the support leg and the platform.

The invention will be described in thirteen figures on the basis of a number of exemplary embodiments.

In the figures:

- Fig. 1 shows a perspective view of a lifting device according to the invention,
- Fig. 2 shows a sectional view along the line II/II in Fig. 1,
- Fig. 3 shows a perspective view of a clamping element according to the invention,
- Fig. 4 shows a second embodiment of a lifting device according to the invention,
- Fig. 5 shows a perspective view of a clamping member in Fig. 4,
- Fig. 6a shows a side view of a first clamping element in a neutral position,
- Fig. 6b shows a side view of the first clamping element in Fig. 6a in a further clamping position,
- Fig. 7a shows a perspective view of a second clamping element,
- Figs. 7b, 7c, 7d show a perspective view of the second clamping element with in each case precisely one clamping component per clamping surface,

Fig. 8 shows a side view of a third clamping element in a free position,

Fig. 9 shows a side view of the third clamping element in a clamping position.

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Fig. 1 shows the basic structure of the lifting device 1 according to the invention. In Fig. 1, an offshore device is illustrated with one of at least three, advantageously four, support legs 2 and a platform 3. The platform 3 is not shown to its full extent, but rather only the region around the support leg 2. The offshore device may be able to float and is moved, with the support legs 2 raised, to the region in the sea intended for installation. It is also conceivable that it is not able to float and is moved by resting it on a barge.

The lifting device 1 comprises a clamping chain 4 and a further clamping chain 6. The two clamping chains 4, 6 are substantially identical. The support leg 2 is movable to and fro relative to the platform 3 in a longitudinal direction L. It can be lowered or lifted through an opening in the platform 3 by means of the lifting device 1. The lifting device 1 enables a lifting and lowering of the platform 3 along the planted support leg 2.

For installation purposes, first the raised support legs 2 are lowered onto the seabed by means of the lifting device 1. The seabed may be prepared beforehand. The lowered support legs 2 may reach directly onto the seabed or may be placed onto a base frame installed previously on the seabed. A common base body may also be fastened to the support legs 2. Then, by means of the lifting device 1, the platform 3 floating in the sea is raised out of the sea and lifted along the support leg 2 to the operating height and is durably fastened to the support leg 2 at the operating height.

A movement of the lifting device 1 along the support leg 2 takes place in both directions along the longitudinal direction L in the pilgrim step of the two clamping chains 4, 6. A movement of the lifting device 1 in the direction away from the seabed along the support leg 2 for the purpose of lifting the platform 3 out of the sea takes place as follows: First, the clamping chain 4 is clamped to the support leg 2, the further clamping chain 6 is released from the support leg 2, and cylinders 7 arranged between the two clamping chains 4, 6 are retracted and thus the platform 3 is raised by the stroke of the cylinders 7. The further clamping chain 6 is then clamped to the support leg 2. The clamping chain 4 is released, and the cylinders 7 arranged between the two clamping chains 4, 6 are extended. The clamping chain 4 is thus moved upwards along the support leg 2 and is clamped again to the support leg 2 in a position further up, that is to say further away from the seabed, then the further

clamping chain 6 is released, the cylinders 7 are retracted, and the platform 3 is thereby once again lifted a little further by the cylinder stroke. In this way, the platform 3 is lifted out of the sea in pilgrim step along the support leg 2 to the operating height. The platform 3 can be lowered in the same way, and the initially raised and unanchored support leg 2 of the offshore device can be lowered downwards to the seabed through the opening of the platform 3 by means of the lifting device 1 in the same way.

The two clamping chains 4, 6 of the lifting device 1 are substantially identical. Here, the clamping chain 4 is arranged on the support leg 2 at a greater distance from the seabed than the further clamping chain 6 during operation. Each of the two clamping chains 4, 6 has a plurality of clamping members 10 which may each also be configured in the form of multiple boxes 11 arranged parallel next to one another along the circumference of the support leg 2.

Boxes 11 of each clamping member 10 which are arranged immediately next to one another are connected to one another in an articulated manner by short rectilinear connecting plates 12. Clamping members 10 arranged immediately next to one another are connected to one another in an articulated manner by means of rectilinear long connecting plates 13 running around the support leg 2 in the circumferential direction. The long connecting plates 13 are longer than the short connecting plates 12. The two clamping chains 4, 6 are movable relative to one another in and counter to the longitudinal direction L. Clamping members 10 of the two clamping chains 4, 6 which are arranged precisely opposite one another in the longitudinal direction L are connected in pairs by one of the cylinders 7.

The boxes 11 are identical. A sectional view of one of the boxes 11 can be seen in Fig. 2. In the longitudinal direction L, a plurality of clamping elements 20 are arranged along each box 11 in such a way as to be able to pivot about a respective axis of rotation 21. The axes of rotation 21 are arranged in a fixed position relative to the box 11 and thus in a fixed position on the associated clamping chain 4, 6. The axes of rotation 21 are arranged tangentially to the outer wall of the support leg 2. The clamping elements 20 project on the inside beyond a radial extent of the box 11, in order to make contact with an outer wall of the support leg 2. On the outside, fastening eyes 26 for the short or long connecting plates 12, 13 project from the box 11. The term 'inside' refers in principle to the direction pointing towards the support leg 2, and the term 'outside' refers in principle to the direction pointing away from the support leg 2. Laterally in the circumferential direction, the clamping elements 20 of a box 11 are all connected to a vertically running adjusting rod (not shown) which makes it possible to adjust the clamping elements 20 of a box 11 simultaneously and all in the same direction. The box 11 has rollers 25 on the inside, which rollers ensure a minimum distance of the box 11 from

the outer wall of the support leg 2. In particular, the rollers 25 make it possible to tighten the two clamping chains 4, 6 placed around the support leg 2 even in a neutral position of the clamping elements 20, and nevertheless to allow a displacement in the longitudinal direction L.

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Fig. 3 shows in a perspective view one of the identical clamping elements 20 of Fig. 2. A cutout for the passage of the axis of rotation 21 is nevertheless not shown in Fig. 3. The clamping element 20 is substantially shaped like a slice of pie with a rounded tip through which the axis of rotation 21 (not shown) is passed. The inner circumference of the clamping element 20, which during operation faces towards the support leg 2, has three surfaces which are each rectilinear and are each at an angle to one another. One clamping surface 22 and a further clamping surface 23 each have horizontal teeth 22a, 23a running perpendicular to the longitudinal direction L. Provided between the two clamping surfaces 22, 23 is a flat spacer region 24 which has no teeth and is smooth.

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The mode of operation of the clamping elements 20 will be described with reference to Fig. 2. First, the two clamping chains 4, 6 are securely tightened around the support leg 2. During this, preferably any play must be omitted by the tightening of the two clamping chains 4, 6 in order to permit the subsequent proper clamping effect of the two clamping chains 4, 6. Once the two clamping chains 4, 6 have been tightened, the rollers 25 of each of the boxes 11 bear with force against the outer wall of the support leg 2. The two clamping chains 4, 6 nevertheless remain movable to and fro in the longitudinal direction L when the clamping elements 20 are in the neutral position.

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In the neutral position shown in Fig. 2, the flat spacer regions 24 are not in contact with the outer wall of the support leg 2 but rather are spaced apart from the outer wall of the support leg 2 by a small distance, for instance 2 mm to 4 mm. In the neutral position, the spacer regions 24 are located directly opposite the outer wall of the support leg 2. In the neutral position, the associated clamping chain 4, 6 can be displaced along the support leg 2.

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In order that the clamping elements 20 can execute a rotational movement by pulling on the box 11 and thus can build up a clamping force F_N , first an initial clamping of the clamping elements 20 on the outer wall of the support leg 2 must take place. To this end, the clamping elements 20 are rotated out of the neutral position. The initial clamping is brought about by displacing an adjusting rod (not shown) which rotates the clamping elements 20 first in an anticlockwise direction out of the neutral position until contact is established between the further clamping surface 23 and the outer wall of the support leg 2 for each of the clamping

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elements 20. Due to the initial clamping, a further relative movement of the support leg 2 with respect to the clamping elements 20 leads to a friction-induced further rotational movement of the clamping elements 20 until the intended clamping position is reached in which the defined clamping force F_N acts on the support leg 2. The defined clamping force F_N is stipulated by the construction. In the event of a tensile force subsequently acting on the lower cylinder 7, the initial clamping prevents any sliding of the two clamping elements 4, 6 along the outer wall of the support leg 2 and releases the actual self-locking.

If, after the initial clamping, a tensile force acts in the longitudinal direction L on the cylinder 7, of which only a small part is shown in Fig. 2, for example due to the fact that the weight of the platform 3 suspended on the cylinder 7 pulls on the box 11 via the cylinder 7, the box 11 is drawn downwards towards the seabed, and the clamping elements 20 are rotated further in the anticlockwise direction by a small angle, and the clamping force F_N on the support leg 2 is increased until the defined clamping force F_N acts on the support leg 2. The teeth 23a of the clamping surface 23 engage in the outer wall of the support leg 2, and the eight clamping elements 20 rotate by a further angle in the anticlockwise direction due to the force pulling downwards on the box 11. Due to the geometry of the clamping element 20, the rotational movement gives rise to an increasing clamping effect and the increasing clamping force F_N of the clamping element 20 on the outer wall of the support leg 2. The geometric construction of the clamping element 20 shown in Fig. 2 is illustrated in Fig. 6. A second embodiment of the clamping element 20 is shown in Fig. 7.

Figs. 4 and 5 show a lifting device 1 which likewise comprises the clamping elements 20 of Fig. 3 but no continuous circumferential clamping chains 4, 6 according to Fig. 1. Fig. 4 shows the clamping members 10 which are arranged in a clamping member group running around the support leg 2. With regard to its function, the clamping member group corresponds to that of the clamping chain 4 in Fig. 1.

One of the clamping members 10 is shown in greater detail in Fig. 5. The clamping member 10 has a U-shaped profile 50, on the inside of the opposite legs of which there is arranged in each case a row of three clamping elements 20. The clamping elements 20 of the two rows lie exactly opposite one another in pairs on a flat strip 51. The clamping elements 20 are pivotable about the axes of rotation 21, which are arranged parallel to one another. The axes of rotation 21 are oriented in the radial direction of the support leg 2. The two rows of clamping elements 20 are spaced so far apart that they exert a clamping effect on the flat strip 51 guided therebetween. The flat strip 51 is fastened by one of its narrow longitudinal edges to the outer wall of the support leg 2, for example by welding. The clamping members

10 thus do not form, as in Fig. 1, one of the two clamping chains 4, 6 running around the support leg 2, the clamping members 10 of which are connected to one another by circumferential long connecting plates 13, but rather the clamping members 10 of the clamping member group are not directly connected to one another; they merely collaborate
 5 by simultaneously performing or releasing a clamping effect. As shown in Fig. 4, the clamping members 10 are securely connected to two cylinders 7. On the side remote from the clamping member 10, the cylinders 7 are connected for example directly to the platform 3 or to a further one of the clamping members 10 which engages in the same flat strip 51.

10 Fig. 6a and Fig. 6b show side views of a clamping element 20 according to Fig. 4 or Fig. 2. Fig. 6a shows the clamping element 20 in a neutral position, in which the clamping element 20 has no direct contact with the outer wall of the support leg 2. Fig. 6b shows the clamping element 20 in the further clamping position. In the further clamping position, the further clamping surface 23 has contact with the outer wall of the support leg 2. The clamping
 15 element 20 has a symmetry surface 60, at which the clamping element 20 is of mirror-symmetrical construction. A surface normal of the symmetry surface 60 is arranged tangentially to the pivoting direction R of the clamping element 20. The clamping element 20 has the clamping surface 22 located opposite the further clamping surface 23 at the symmetry surface 60. Fig. 6a shows that the clamping element 20 is pivotable to and fro
 20 through the neutral position shown in Fig. 6a between a clamping position, in which the clamping surface 22 has direct contact with the outer wall of the support leg 2, and the further clamping position, in which the further clamping surface 23 has contact with the outer wall of the support leg 2.

25 A perpendicular connecting line 61, which intersects a central point of the axis of rotation 21 and is perpendicular to the outer wall of the support leg 2, passes through the further clamping surface 23 in the further clamping position shown in Fig. 6b, and it does not precisely delimit the latter. The further clamping surface 23 is distanced perpendicularly from the axis of rotation 21 by a long lever arm LH. The central point of the further clamping
 30 surface 23 is arranged offset from the axis of rotation 21 by a short lever arm KH.

With a material pairing of further clamping surfaces 23 and the outer wall of the support leg 2 having a coefficient of friction μ of for example $\mu < 0.2$, the geometry is such that the clamping force F_N is five times greater than the axial force F and thus generates a friction
 35 force F_R which brings about a sufficient locking effect.

Fig. 7a shows in a perspective view a second embodiment of the clamping element 20 according to the invention. The clamping element 20 is once again of mirror-symmetrical construction at the symmetry surface 60. The clamping element 20 has a circular opening for the axis of rotation 21. Here, too, the clamping surface 22 and the further clamping surface 23 are mirror-symmetrical along the symmetry surface 60. The clamping surface 22 has three clamping components 70, each having a circular contact surface. The three ring-shaped surfaces 71 together form the further clamping surface 23 of the clamping element 20. The clamping element 20 has two lateral cheeks 72 which are spaced apart from one another and have two outer guides 74. On their sides facing towards the cheeks 72, the clamping components 70 are conically expanded and are pushed with direct contact into the corresponding guide 74 which is formed between the two cheeks 72. Each of the two guides 74 is delimited by a T-shaped stop piece 76 at its end facing towards the symmetry surface 60. The T-shaped stop piece 76 has a flat surface facing towards the support leg 2, said flat surface projecting somewhat beyond a plane of the conical guide piece of the clamping component 70 but remaining behind the clamping surface 22, 23. As a result, a stable clamping state is ensured even in the event of relative movements of the support leg 2 in the horizontal direction with respect to the platform 3 and/or the clamping apparatus. One T-leg of the T-shaped stop piece 76 is introduced into the clamping element 20 between the two cheeks 72.

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Figs. 7b, 7c and 7d show the embodiment of the clamping element 20 of Fig. 7a in each case in a slightly modified version. The clamping element 20 in Fig. 7b has in each clamping surface 22, 23 precisely one clamping component 70 which is provided directly adjacent to the T-shaped stop piece 76 and in contact with the T-shaped stop piece 76 in the respective guide 74 of the clamping surface 22, 23. The two clamping components 70 of the embodiment shown in Fig. 4b are pushed into the guides 74 at the mutually facing ends of the two guides 74. Fig. 7c shows an embodiment of the clamping element 20 likewise with a respective one of the clamping components 70 in each of the two guides 74, the clamping component 70 being provided in each case at the outer end of the guides 74 so that the two clamping components 70 are at a maximum distance from one another. Fig. 7d shows an embodiment in which the two clamping components 70 are provided centrally in the respective guide 74. Embodiments with mixed positions of the clamping components 70 in the respective guide 74 are also conceivable.

The different arrangement and number of the clamping components 70 enables a different distribution of the clamping force F_N . The clamping components 70 are displaceable to and fro along the guides 74 and can be fixed in any position along the guides 74. The ratio of the

clamping force F_N to the friction force F_R can be set by the different arrangement of the clamping components 70 along the guides 74.

5 Figs. 8 and 9 disclose a further embodiment of a clamping element 20 according to the invention, which can be installed for example in one of the two clamping chains 4, 6 of Fig. 1 but also in the clamping member 10 shown in Figs. 4 and 5. The clamping principle corresponds to that of the clamping elements 20 shown in Fig. 6 or Fig. 7. However, the clamping element 20 of Figs. 8 and 9 has in each case only precisely the one clamping surface 22.

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List of references

	1	lifting device
	2	support leg
5	3	platform
	4	clamping chain
	6	further clamping chain
	7	cylinder
10		
	10	clamping members
	11	boxes
	12	short connecting plates
	13	long connecting plates
15		
	20	clamping elements
	21	axis of rotation
	22	clamping surface
	22a	teeth
20	23	further clamping surface
	23a	teeth
	24	flat spacer regions
	25	rollers
	26	fastening eyes
25		
	50	U-shaped profile
	51	flat strip
	60	symmetry surface
30	61	perpendicular connecting line
	62	diagonal
	70	clamping components
	71	ring-shaped surfaces
35	72	lateral cheeks
	74	guides
	76	T-shaped stop piece

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KH short lever arm
LH long lever arm
L longitudinal direction

5 F axial force
 F_N clamping force
 F_R friction force

R pivoting direction

10

μ coefficient of friction

Claims

1. Apparatus for clamping a device (3) to an elongate body (2) extending in a longitudinal direction (L), which apparatus is displaceable to and fro along a longitudinal extent of the elongate body (2) and is provided with a self-locking mechanism which comprises at least one clamping element (20) which is pivotable about an associated axis of rotation (21) between at least one clamping position and a neutral position,
characterized in that the at least one clamping element (20) has an arm running away from the axis of rotation (21) thereof, with at least one clamping surface (22, 23) arranged at an arm end remote from the axis of rotation (21), and in that the at least one clamping surface (22, 23) has the same relative position with respect to the arm in the at least one clamping position and in the neutral position and in each position along the pivoting movement.
2. Apparatus according to claim 1,
characterized in that the arm is configured in a dimensionally stable manner between the axis of rotation (21) and the at least one clamping surface (22, 23).
3. Apparatus according to any one of claims 1 or 2,
characterized in that the self-locking mechanism inhibits the displacement of the device both to and fro along the elongate body.
4. Apparatus according to any one of claims 1, 2 or 3,
characterized in that the at least one clamping surface (22, 23) is flat.
5. Apparatus according to any one of claims 1 to 4,
characterized in that the at least one clamping element (20) is pivotable between the clamping position in which the “to” movement along the longitudinal extent of the elongate body (2) is self-locked and a further clamping position in which the “fro” movement along the longitudinal extent of the elongate body (2) is self-locked, via the neutral position.
6. Apparatus according to any one of the preceding claims,
characterized in that the at least one clamping surface (22, 23), with its region which leads during the pivoting movement from the neutral position into the clamping position, has a pivot line of smaller radius than a trailing region of the at least one clamping surface (22, 23).

7. Apparatus according to any one of the preceding claims,
characterized in that the at least one clamping element (20) has at least one guide (74)
for clamping components (70), and the clamping components (70) can be fixed at
5 different positions in the guide (74) and thus a clamping force (F_N) can be adjusted.
8. Apparatus according to any one of the preceding claims,
characterized in that the self-locking mechanism comprises clamping members (10)
which can be arranged along a circumference around the elongate body (2), and each
10 clamping member (10) comprises at least one of the clamping elements (20) which is
pivotal with respect thereto about its axis of rotation (21).
9. Apparatus according to any one of the preceding claims,
characterized in that adjacent clamping members (10) are connected to one another by
15 long connecting plates (13) and the clamping members (10) and the long connecting
plates (13) form a clamping chain (4, 6) arranged around the elongate body (2).
10. Apparatus according to any one of the preceding claims,
characterized in that the clamping members (10) have a U-shaped profile (50) and the
20 legs of the U have, on their inner sides, mutually opposite clamping elements (20),
between which a strip (51) can be guided.
11. Apparatus according to any one of the preceding claims,
characterized in that the clamping elements (20) are arranged in at least two clamping
25 member groups which are movable relative to one another in the longitudinal direction
(L), and each of the clamping member groups forms a separate self-locking
mechanism.
12. Apparatus according to any one of the preceding claims,
30 characterized in that the clamping elements (20) of a clamping member group together
form at least one clamping cross-section of variable size.
13. Apparatus according to claim 12,
characterized in that one clamping member group can be fastened to the device (3) via
35 hydraulically operated cylinders (7) in such a way as to be movable relative to the
device (3), and a further clamping member group can be fastened to the device (3) in a
fixed position relative to the device (3).

14. Method for installing an offshore device comprising a platform (3) and at least one support leg (2), by means of an apparatus (1) according to any one of claims 1 to 13, in which
- 5 the apparatus (1) is mounted around the at least one support leg (2),
the clamping surfaces (22) of the clamping elements (20) of the two clamping member groups (4, 6) alternately perform a clamping effect on the at least one support leg (2) and in this way the at least one support leg (2) is lowered towards the seabed counter to the longitudinal direction (L) in pilgrim step by means of the apparatus (1),
- 10 the clamping elements (20) are pivoted through their neutral positions and then the further clamping surfaces (23) of the clamping elements (20) of the two clamping member groups (4, 6) alternately perform a clamping effect on the at least one support leg (2) and in this way the platform (3) is lifted in the longitudinal direction (L) to the operating height.
- 15
15. Method for deinstalling an offshore device comprising a platform (3) and at least one support leg (2), by means of an apparatus (1) according to any one of claims 1 to 13, in which the further clamping surfaces (23) of the clamping elements (20) of the two clamping member groups (4, 6) alternately perform a clamping effect on the at least
- 20 one support leg (2) and in this way the platform (3) is lowered towards the sea surface counter to the longitudinal direction (L) in pilgrim step by means of the apparatus (1),
the clamping elements (20) are pivoted through their neutral positions and then the clamping surfaces (22) of the clamping elements (20) of the two clamping member groups (4, 6) alternately perform a clamping effect on the support leg (2) and in this
- 25 way the at least one support leg (2) is retracted in the longitudinal direction (L).