

LIFTING DEVICE FOR OFFSHORE PLATFORMS

[0001] The invention relates to a lifting device for an offshore platform as well as to methods of raising or lowering an offshore platform with the lifting device and
5 methods of raising and lowering a support leg of an offshore platform with the lifting device.

[0002] An offshore platform is known from US 2011/0305521 A1, which can be pulled to an operating position by means of a barge. The offshore platform has
10 four vertically movable support legs with one foot arranged at the end towards the seabed in each case. The support legs are moved relative to the platform by means of pinions. Toothed racks, into which the pinions engage, are provided along the support legs. By actuation of the pinions the support legs can first be positioned on the seabed and the platform can then be raised out of the sea.

[0003] A comparable lifting mechanism is disclosed in US 5,188,484 A, in which an offshore platform comprises four support legs, along which one toothed rack is arranged in the longitudinal direction in each case and which is [sic] movable
15 along the toothed racks by means of driven pinions engaging therein.

[0004] In addition, jacking systems are known which allow a stepwise raising of the platform and a stepwise lowering of the support legs by means of two locking rings capable of being moved relative to each other.
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[0005] US 2,944,403 relates to an hydraulic jacking system with two clamping rings which have in each case a plurality of clamping jaws which are arranged along the periphery of the clamping rings and which are capable of being pressed against the outer wall of the support leg by means of hydraulic cylinders.
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[0006] US 3,565,400 discloses a jacking system with two circumferential clamping rings which are divided along a contact face bevelled in the longitudinal direction and which increase the clamping force against the outer wall of the support leg by tensile force on the outer part of the clamping rings. The clamping rings are set permanently closed around the support legs.
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[0007] In the lifting apparatus of GB 792,592 of the firm DeLong, in the case of the clamping rings the clamping action is achieved by inflatable elements which pass around the support leg along the periphery and which press the clamping jaws
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against the outer wall of the support leg.

[0008] In addition, lifting devices based upon a pin-and-hole engagement are known.

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[0009] A lifting system with two locking rings, which are movable towards each other and which allow the platform to be raised or lowered along the support legs by a pin-and-hole engagement, is known from EP 2 221 417 A1.

10 [0010] A drawback with the known systems on the one hand is that a lifting method by means of toothed racks and pinions requires a design of the support legs which is relatively complicated and expensive to produce, and on the other hand the known lifting devices by means of locking rings are designed only for a specific combination of leg diameters and lifting capacities which are adapted in
15 each case only to a specific lifting platform. The components of the locking rings cannot unfortunately either be adapted to the respective support leg with only little outlay or be installed subsequently around the support leg, and also cannot be removed again from the support leg subsequently. The known designs always require an entirely new dimensioning of the complete lifting device for every new
20 implementation on a platform. An additional drawback with the systems based upon a pin-and-hole engagement is that they allow the platform to be locked only in positions pre-set by the position of the hole along the support leg.

[0011] The object of the invention is to provide an apparatus and methods of the type named in the introduction, which reduce or prevent the drawbacks named above.
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[0012] The object is attained in its first aspect by a lifting device named in the introduction with the features of Claim 1, and in its second aspect by methods with the features of Claim 12, and in its third aspect by methods with the features of Claims 19 to 23. [sic]
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[0013] Preferred embodiments of the invention form the subject matter of the Sub-Claims.
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[0014] The lifting device according to the invention is intended for the lifting and/or lowering of an offshore platform along at least one support leg. In this case a lifting device should be understood as being both a lifting device and a lowering

device. It is referred to only as a lifting device for the sake of simplicity. The platform is capable of being raised by means of at least one lifting device from a conveying position floating in the water or resting on a barge into an operating position above the surface of the sea. Drilling rigs, conveying and processing plants as well as wind energy plants etc. can be operated on the platform in the operating position. The lifting device is also suitable for lowering the support leg from a conveying position into an installation position which makes contact with the seabed.

10 [0015] The lifting device can also of course be used for lowering the platform from the operating position into the conveying position and for lifting the support legs from the installation position into the conveying position.

15 [0016] The lifting device according to the invention comprises a specified number of standardized segments connected to one another to form at least one closed locking chain, the number of the standardized segments being determined by the required lifting capacity of the lifting device and the lifting capacity being determined by the overall load which in turn is determined by the weight of the offshore platform increased by the operative loads. As well as the weight of the
20 offshore platform itself, the number of support legs and thus the number of locking chains to which the overall load of the offshore platform has to be distributed are crucial for the lifting capacity.

25 [0017] Standardized segments are preferably understood in this case as being segments which are completely identical or similar structurally and which preferably have in each case a pre-set lifting capacity which is independent of the weight of the respective offshore platform. It is also possible for segments to be pre-set a specific shape from which the number of segments is selected. The standardized segments are suitable for locking chains of different peripheral length and thus support legs of very different cross-section and cross-sectional peripheral length, and they are fitted in the various locking chains. Adjacent segments of the closed locking chain are connected to one another by connecting plates of a length which is determined by the peripheral length of the at least one support leg and by the number of segments. In this way, it is preferably possible for a large
30 number of standardized segments to be selected for support legs with a large cross-section and thus a large peripheral length for offshore platforms with a naturally relatively high weight and to be connected to one another by means of the connecting plates adapted with respect to length. The same principle applies
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for support legs of any cross-section and platforms of any weight.

[0018] According to the invention the standardized segments are designed not for a specified cross-section of the support leg, and in particular not for a specified curvature of the outer wall of the support leg, but rather for a specified standardized frictional force which can be transmitted by a segment between the support leg and the platform. The standardized segments are suitable for locking chains for support legs of any cross-section or at least a widely varying cross-section, in particular a circular cross-section of any diameter or an at least widely varying diameter.

[0019] It is preferable for lifting devices with closed locking chains for support legs of different peripheral length to have the structurally identical standardized segments in each case. The locking chains differ from one another only in the number of the standardized segments as well as, in particular, the length of the connecting plates between adjacent segments.

[0020] The lifting device comprises a plurality of segments connected to one another to form a closed locking chain. The segments are preferably substantially similar structurally, and advantageously completely identical structurally. As a result, it is possible for the locking chains to be produced in an inexpensive manner. The locking chain has a periphery and at least one radius, and the locking chain is variable in its periphery and at least one radius by the segmented design and the possibility of inserting additional segments and removing superfluous segments. It is advantageously capable of being used for a wide spectrum of cross-sections of the support legs.

[0021] The closed locking chain can extend around a support leg which is precisely circular in the cross-section at a right angle to a longitudinal direction of the support leg, but also an elliptical support leg and even a support leg which is triangular, square, rectangular or polygonal in cross-section.

[0022] In a preferred embodiment of the invention, the method serves for the production of at least two lifting devices for offshore platforms of different weight and/or with support legs of different peripheral length, by each of the at least two lifting devices being produced in accordance with one of the methods named above and by the same standardized segments being used for producing the locking chains of each of the at least two lifting devices and by the different lengths

of the locking chains adapted to the different peripheral lengths being formed by connecting plates of different length.

5 [0023] In this way, lifting devices for various offshore platforms can be produced from the same segments, which results in a saving in costs as compared with lifting devices designed in a completely individual manner.

10 [0024] It is preferable for the segments, advantageously each of the segments, to have locking elements which are arranged along the periphery and which face radially towards the inside. The term "locking" is to be understood in a broad manner in this case, so as to comprise, as well as clamping, *i.e.* pressing two faces against each other, in addition the meshing or engaging of one or more pins in one or more holes. The locking elements can be clamping jaws, teeth of a gearwheel or of a toothed rack or even pins or holes which co-operate with
15 complementary locking elements arranged in each case on the support leg.

[0025] The segments are arranged at a distance from one another along the periphery, and they preferably have clamping jaws movable in a reciprocating manner in a radial direction, preferably clamping jaws capable of being displaced
20 in a reciprocating manner, and the clamping jaws of the segments form a clamping cross-section variable in size during their co-operation. In this case "movable in a reciprocating manner in a radial direction" means that at least one component of the movement of the clamping jaws extends in a precisely radial direction.

25 [0026] The structural design of the segments can be different.

[0027] In one embodiment of the invention the segments have in each case at least one resilient container capable of being filled with a flowable medium and expansible as a result of being filled, the container pressing the clamping jaws
30 towards the support leg when it is filled with the medium and, in this way, reducing the clamping cross-section. The resilient container can be designed in various ways. The medium can be gas or liquid, in particular air, oil or water.

35 [0028] In a more special embodiment of the invention the segments have in each case two parts which are U-shaped in each case in the clamping cross-section and are movable towards each other in a radial direction and which engage one in the other, and the resilient container is arranged between the two segment parts engaging one in the other, the segment part situated radially on the inside forming

the clamping jaw. In particular, the resilient container can be designed in this embodiment in the form of a hose, which is introduced into the space of variable size which is formed by the two U-shaped segment parts engaging one in the other. In this case the hose extends in the longitudinal direction of the two U-shaped profiles. As a result of the hose being filled with the medium, the hose extends and presses the two U-shaped profiles apart from each other and, in this way, one of the clamping jaws against the outer wall of the support leg.

[0029] In a preferred embodiment of the invention the clamping jaws are arranged in a movable manner on the segments by means of a self-locking mechanism, and they have in each case at least one friction-increasing element on their radial inner side. The self-locking mechanism makes it possible for the clamping jaws to reduce the clamping cross-section as a result of the tensile force produced by the inherent weight of the platform and acting upon the locking chain and, in this way, for the locking chain to be clamped on the outer wall of the support leg by self-locking. On the one hand a self-locking mechanism is easy to maintain and, as a result, inexpensive, and on the other hand the self-locking is particularly secure since no additional hydraulic system is necessary in order to exert an adequate clamping pressure or an adequate clamping force. The clamping pressure is maintained even in the event of a sudden failure of the control means.

[0030] It is advantageous for the self-locking mechanism to comprise at least one arm arranged on inner sides of segment bodies and pivotable about at least one axis, the pivot axes extending preferably tangentially to the peripheral direction. The at least one arm is articulated in a pivotable manner, preferably by means of a swivel joint, with its radially outer end to the inner side of the segment body. It is advantageous for one clamping jaw to be arranged in each case on the radially inner end of the arm, the clamping jaw in turn being articulated to the radially inner end of the arm preferably by a swivel joint. The clamping cross-section is capable of being varied by pivoting of the at least one arm.

[0031] It is preferable for the clamping jaws to be provided on the radial inner side thereof with friction-increasing elements, in particular elastomers or friction linings, which are preferably separate from one another. The friction-increasing elements increase the friction resistance and reduce the clamping pressure required and, in this way, prevent the locking chain from slipping on the outer wall of the support leg.

[0032] In order to trigger the self-locking in a reliable manner it is helpful first to trigger an initial locking of the locking chain on the support leg. To this end, according to the invention an actuator is provided which is allocated to each segment and which is operatively connected to the at least one arm of the segment and pivots the arm so far that, whilst exerting an initial pressure, the clamping jaw presses upon the outer wall of the support leg and prevents the locking chain from slipping, so that the self-locking can be triggered in any case.

[0033] The actuator can be for example a controllable hydraulic or pneumatic cylinder or a spindle drive or even a spring. It is preferable for a safety mechanism to be provided. It is advantageous for a permanently acting activator, which can be deactivated by means of a counteracting mechanism, to be formed by means of a spring. In the event of failure of any control means including the control means of the actuators, however, a secure self-locking caused by the initiation always takes place in each position on the support leg.

[0034] It is preferable for a centring device to be present. It is advantageous for the centring device to be releasable. The centring device positions the locking chain concentrically around the support leg during the clamping procedure. As a result, the clamping jaws are loaded equally, and, in particular, an undesired tipping of a clamping jaw situated at a greater distance from the outer wall of the support leg is prevented.

[0035] In addition, the clamping mechanism preferably has a mechanical tipping barrier. The tipping barrier prevents an undesired tipping of the clamping jaws and thus a sudden loss of the clamping force.

[0036] The centring device can be a mechanical spacing holder of the locking chain to the support leg, and it can preferably be designed in the form of a centring ring which extends around the support leg and which is connected by spacing holders to the locking chain. The centring ring is also a stop for the clamping jaws.

[0037] The centring device can comprise an instrument for measuring the angle of the arms relative to the segment or an instrument for measuring the distance from the outer wall of the support leg as well as a control means of the actuators designed in the form of hydraulic cylinders.

[0038] It is preferable for the connection between adjacent segments, preferably

identical in design, to be made releasable. As a result, it is possible, after the platform has reached its operating position above the surface of the sea, for the locking chain to be opened and to be removed completely from the support leg. The platform is fastened without the lifting device to the support leg by bolt connections or other suitable connections.

[0039] In a further preferred embodiment of the lifting device, lifting cylinders orientated in the longitudinal direction and having one end towards the platform and one end towards the locking chain are provided, and the two ends have fastening means for fastening to the platform and to the locking chain respectively. The lifting cylinders make it possible for the platform to be raised with the locking chain firmly clamped, by all the lifting cylinders of the lifting device being retracted simultaneously. Corresponding remarks apply to the lowering of the platform.

[0040] It is advantageous for the lifting device to comprise at least one further locking chain, which is arranged along the support leg preferably between the platform and the locking chain facing away from the platform. The at least one further locking chain towards the platform is arranged fixed in position relative to the platform during the lifting procedure. The lifting device operates by successive alternate firm clamping and release of the locking chains, so that the support legs can be lowered in a jacking operation, until they are in contact with the seabed and the platform can be raised out of the water in a jacking operation.

[0041] The further locking chain and the locking chain are structurally identical, and in particular the further locking chain has further actuators which trigger an initial locking.

[0042] With respect to the second aspect of the invention the object is attained by a method of producing a lifting device with the features of Claim 14 *[sic]*.

[0043] The method according to the invention is based on the concept of using standardized segments, which are connected by means of connecting plates to form a closed locking chain, in order to produce a lifting device. In this case the segments are not adapted to the external shape of the support leg, but the same segment can be used for support legs of different cross-section. The lifting capacity of an individual segment is pre-set, and after that the lifting capacity of the lifting chain and the lifting device is determined. It is preferable for segments of pre-determined lifting capacities to be kept ready. The lifting capacity of the lifting

device is preferably then determined with reference to the weight of the offshore platform. In addition, it is preferable for the number of the support legs and the number of the locking chains to be added in order to calculate the lifting capacity of the lifting device. In this case the lifting capacity of the lifting device is the force or the weight respectively which has to hold the lifting device on the support leg without slipping.

[0044] The number of the standardized segments of each of the locking chains is determined from the lifting capacity of the lifting device or of the locking chain respectively. In this case there are entered into the calculation the force with which the clamping elements of the segments press against the outer wall of the support leg, and in particular how great the force *per* unit of area is and how great the force *per* unit of area should be so that the wall of the support leg is not damaged by the clamping force. The number of the segments *per* locking chain is determined from these requirements, and the lengths of the connecting plates between adjacent segments are determined with reference to the number of the segments *per* locking chain and of the peripheral length of the at least one support leg, and the adjacent segments are connected to one another by means of the connecting plates. The connecting plates are connected to the segments preferably in a releasable manner by means of screw, hook or pin fastenings. In this case the connecting plates preferably extend along the periphery tangentially to the peripheral direction of the support leg. They can be arranged stacked or in groups at a distance from one another in the longitudinal direction between the segments.

[0045] It is advantageous for at least one connecting plate or a group of connecting plates between two segments to be made adjustable in length, in order to compensate tolerances of all the components with respect to the periphery.

[0046] It is advantageous for lifting cylinders, which are connected fixed in position by their free ends to either a further locking chain or the platform, to be mounted on individual segments, and preferably all the segments, of the locking chain. Each lifting device preferably has a locking chain and a further locking chain, which are movable relative to each other. The segments for producing the lifting device can be removed from an existing lifting device, by the existing lifting device being dismantled into its segments and connecting plates and by the specified number of segments being removed from the existing lifting device and being connected to one another to form the new lifting device by means of the newly

calculated length of the connecting plates.

[0047] With respect to the third aspect of the invention the object is attained by a method of lifting as well as by a method of lowering an offshore platform, which
5 are carried out by at least one of the lifting devices named above.

[0048] The method of lifting the platform is carried out by the locking plate in a first position on the support leg being released preferably by extension of the lifting cylinders and by the locking chain in a second position at a further distance from
10 the platform on the support leg being initially locked preferably by actuation of the actuators. After that, the further locking chain is released in a third position along the support leg, and by means of the release of the further locking chain in the second position the initially locked locking chain is clamped firmly in the second position by self-locking. The lifting cylinders are retracted and the further locking
15 chain is locked in a fourth position initially on the outer wall of the support leg. After that, the locking chain in the second position is released and, as a result, the initially locked further locking chain is clamped firmly in the fourth position by self-locking. The procedure is then repeated from the first step and is carried out until the platform has reached the operating height above the seabed.

20 [0049] The platform can have a plurality of support legs, preferably three, but also four, six or eight support legs.

[0050] The offshore platform is moved into the operating position by means of a
25 barge or in a self-floating manner and the support legs are lowered to the installation setting by means of the lifting device described, until the feet of the support legs come into contact with the seabed. After that, the lifting device is actuated again and, in this way, the platform is raised out of the water. The platform is raised so far above the surface of the water that in its operating position
30 it is no longer subject to the impact of the waves.

[0051] The method of lowering the platform by means of at least one lifting device is carried out in a corresponding manner and in accordance with the features of Claim 12 [sic].

35 [0052] Both in the case of the method of lifting and of lowering the platform the self-locking mechanism is designed in such a way that it is triggered by a force acting upon the locking chain and directed towards the seabed.

[0053] A method of raising the support leg is carried out in accordance with the features of Claim 13, and a method of lowering the support leg is carried out in accordance with the features of Claim 14. [sic]

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[0054] The invention is described in five [sic] figures with reference to an embodiment. In the figures:

Fig. 1 is a perspective view of a locking chain – facing away from the platform – of a lifting device according to the invention;

10 Fig. 2 is a side view of the lifting device in Fig. 1;

Fig. 3 is a plan view of the lifting device in Fig. 1;

Fig. 4 is a perspective internal view of a segment of the locking chain in Fig 1;

Fig. 5 is a perspective external view of the segment in Fig. 1;

15 Fig. 6 is a perspective view of a locking chain – facing away from the platform – of a second lifting device according to the invention, and

Fig. 7 is a partial perspective view, partially in section, of a segment according to the invention as shown in Fig. 6.

20 [0055] Offshore platforms are moved into position self-floating with support legs 2 or resting on a barge in the sea. There the support legs 2 raised during the transportation are lowered to the seabed and the platform is then raised out of the sea or off the barge and is locked permanently in an operating position.

25 [0056] In the figures part of a lifting device 1 is shown, which on the one hand serves to lower one of the support legs 2 of the offshore platform from the state raised for the transportation, until it comes into contact with a seabed. Each of the support legs has allocated to it the structurally identical lifting device 1. On the other hand, the platform can then be raised further out of the sea into the operating position whilst using all the lifting devices 1 simultaneously. It is
30 arranged in the operating position at a distance from the surface of the sea and above the surface of the sea. In the operating position the platform is capable of being locked without the lifting device 1.

35 [0057] Fig. 1 shows a portion of the support leg 2 of the platform (not shown). The platform would be situated on the lower edge of the picture of Fig. 1. In this embodiment four support legs 2 capable of being moved at a right angle to the

plane of the platform in a longitudinal direction **L** extend through the platform. It is also possible, of course, for platforms to be provided with three, six, eight or any other number of support legs 2.

5 [0058] The platform of the embodiment illustrated is buoyant together with the four retracted support legs 2. It can therefore be pulled into position by means of a ship, and the support legs 2 are raised during the transportation.

10 [0059] The support legs 2 of the platform moved into position are first lowered with the aid of a locking chain 3 illustrated in Fig. 1 and facing away from the platform, until support feet (not shown) arranged at the end of the support legs 2 towards the seabed have come into contact with the seabed. The support feet can be anchored in the seabed in various ways, for example with suction apparatus such as suction sockets or by elephant feet. It is simplest for a tubular support leg 2
15 closed towards the seabed to be positioned on the seabed and to be pressed into the seabed and to be based in this way independently of the axial loads of the support leg 2 and the mechanical properties of the seabed.

20 [0060] After the support legs 2 have been anchored in the seabed by way of their support feet, the platform is raised out of the water with the aid of the lifting devices 1 and is moved vertically along the longitudinal direction **L** of the support legs 2 until the operating height is reached at which the platform is no longer subject to the impact of the waves.

25 [0061] The complete lifting device 1 comprises the locking chain 3 facing away from the platform and a structurally identical locking chain towards the platform as shown in Fig. 1, which are arranged one above the other along the longitudinal direction **L** of the support leg 2 and extend in a concentric manner around the support leg 2 in each case. The further locking chain 3 illustrated in Fig. 1 and at a
30 greater distance from the platform is referred to below as the locking chain 3 facing away from the platform. The locking chain mounted closer to the platform is referred to below as the locking chain towards the platform. The components allocated to the locking chain (3) facing away from the platform and to the locking chain towards the platform are referred to accordingly as facing away from the
35 platform and towards the platform respectively.

[0062] The locking chain 3 facing away from the platform comprises eight segments 6. One of the segments 6 is covered by the support leg 2 in Fig. 1.

Each segment 6 has two segment bodies 7, 8 mounted one above the other in the longitudinal direction **L**. A segment body 7 facing away from the platform and a segment body 8 towards the platform are screwed to each other by way of a connecting flange. A lifting cylinder 9 extending in the longitudinal direction **L** passes from each of the segment bodies 8 towards the platform to the platform.

[0063] The locking chain 3 facing away from the platform has a diameter which remains substantially constant along the periphery, and it extends in a substantially concentric manner around the support leg 2.

[0064] The lifting cylinder 9 has an end towards the locking chain and an end towards the platform, which ends are articulated by way of a pin connection in each case to one of the segment bodies 8 – towards the platform – of the locking chain 3 facing away from the platform and on the platform respectively. The end of the lifting cylinder towards the locking chain has a fastening plate 11 which is towards the locking chain and extends in the longitudinal direction **L** and which engages in a fork 13 extending from the segment body 8 towards the platform and is connected in an articulated manner by means of a pin arranged in the peripheral direction of the locking chain 3 facing away from the platform. A fixing plate 12 extending from the end of the lifting cylinder towards the locking chain in the longitudinal direction **L** engages in a corresponding fork (not illustrated) connected in a fixed manner to the side of the platform facing away from the sea.

[0065] In addition, for each of the support legs 2 the complete lifting device 1 has the locking chain (not illustrated) which is towards the platform and which – in contrast to the locking chain 3 facing away from the platform – is directly connected to the platform by way of pin connections. No lifting cylinders are provided between the platform and the locking chain towards the platform.

[0066] The individual segments 6 are orientated in the longitudinal direction **L** and are arranged at a distance equidistantly from one another along the periphery of the support leg 2. The segments 6 are connected to one another in each case on both sides to adjacent segments 6 in each case by way of two groups of four connecting plates 16, 17 in each case. The group of connecting plates 16 facing away from the platform are connected in an articulated manner laterally to segment bodies 7 facing away from the platform and the group of connecting plates 17 towards the platform are connected in an articulated manner laterally to segment bodies 8 towards the platform by way of a pin connection with

longitudinal axes of the pins extending in the longitudinal direction **L**. Instead of a pin connection other suitable connections, such as screw or hook connections, can also be chosen.

5 [0067] Each of the segments 6 comprises two clamping jaws 18, 19 which are provided at a distance from each other one above the other in the longitudinal direction **L** and which are arranged on radial inner sides of the segment body 7, 8 facing away from the platform and towards the platform respectively by way of one arm 21, 22 sloping in the radial direction in each case. Each of the two arms 21,
10 22 of one of the segments is connected by way of a swivel joint to the radial inner side of a segment body 7, 8 facing away from the platform and towards the platform respectively and is connected by way of a further swivel joint in an articulated manner to a radial outer side of the clamping jaws 18, 19 facing away from the platform and towards the platform respectively. The swivel joints of the
15 two arms 21, 22 are pivotable in each case about an axis extending tangentially to the peripheral direction.

[0068] Fig. 2 shows the arrangement of Fig. 1 in a side view. The same references designate the same components as in Fig. 1, as also in the further
20 figures. Each segment 6 has segment bodies 7, 8 facing away from the platform and towards the platform which are arranged one above the other in the longitudinal direction **L** and which are connected in an articulated manner in each case on both sides by connecting plates 16, 17 to an adjacent segment body 7, 8 in the peripheral direction at the level of the points of engagement of the segment
25 bodies 7, 8. The two segment bodies 7, 8 and the lifting cylinder 9 allocated to the respective segment 6 are preferably arranged one above the other precisely in the longitudinal direction **L**. A lifting direction of the lifting cylinder 9 extends parallel to the longitudinal direction **L**.

30 [0069] Fig. 3 is a plan view of the locking chain 3 facing away from the platform in Fig. 1 and Fig. 2. The clamping jaws 18 facing away from the platform and the clamping jaws (not illustrated) – towards the platform – of the locking chain 3 facing away from the platform are in contact with an outer wall of the support leg 2 which is circular in cross-section. The clamping jaws 18, 19, which are
35 dimensioned as a whole in such a way as to carry the entire weight of the platform distributed to four support legs 2 and four lifting devices 1, exert in each case a clamping force upon the outer wall of the support leg 2. After the platform has been raised out of the water and has reached its operating position by means of

the lifting devices 1, the platform can be locked permanently on the support legs 2 by means of holding means (not shown). The locking chains 3 of the lifting devices 1 facing away from the platform are then released on pin connections of specific fixing plates 16, 17 facing away from the platform and towards the platform on the segments 6 and are removed completely. Corresponding remarks apply to the locking chains towards the platform.

[0070] Fig. 4 shows one of the segments 6 in a view obliquely radially from the inside to the outside. In Fig. 4 the manner of functioning of a self-locking mechanism is evident. The self-locking mechanism is doubled *per* segment 6 in this case. A part of the self-locking mechanism facing away from the platform comprises the sloping arm 21 which faces away from the platform and which is mounted on the segment body 7 facing away from the platform in a manner rotatable about the axis of rotation extending in the peripheral direction of the locking chain 3 facing away from the platform. The clamping jaw 18 facing away from the platform is articulated on the arm facing away from the platform about a further axis of rotation extending in the peripheral direction of the locking chain 3 facing away from the platform.

[0071] Corresponding remarks apply to a part of the self-locking mechanism of the segment 6 towards the platform. It comprises the arm 22 towards the platform, which slopes at a setting angle and which in turn is connected by way of a pin connection to the clamping jaw 19 of the same segment 6 towards the platform in a manner articulated about a[n axis?] parallel to the further axis of rotation of the first part of the self-locking mechanism and which is arranged on the segment body 8 towards the platform in a manner articulated about a[n axis?] parallel to the axis of the first part of the self-locking mechanism. Inner sides of the clamping jaws 18, 19 form a clamping cross-section. The size of the clamping cross-section varies with the size of the setting angle of the arms 21, 22.

[0072] Since the arm 21 facing away from the platform and the arm 22 towards the platform are arranged parallel to each other and sloping radially inwards towards the platform, a movement of the lifting device 1 in Fig. 1 from above to below produces a self-locking of the locking chain 3 facing away from the platform on the support leg 2 as a result of a weight force engaging on the lifting cylinder, since the clamping cross-section is reduced.

[0073] In addition, the self-locking mechanism is coupled to an initial-locking

mechanism. The latter comprises a lever 40 facing away from the platform and an actuator 41 facing away from the platform and acting upon it.

[0074] The lever 40 facing away from the platform and guided away from the platform by way of the segment body 7 facing away from the platform is connected on the one hand radially on the inside in an articulated manner to the arm 21 facing away from the platform and radially on the outside to the actuator 41 facing away from the platform. The actuator 41 facing away from the platform drives the lever 40 facing away from the platform and pivots the arm 21 facing away from the platform by way of the lever 40 facing away from the platform. The arms 21, 22 facing away from the platform and towards the platform are connected to each other by way of a pin connection. In this way, the actuator 41 facing away from the platform can pivot the two clamping jaws 18, 19 of the segment 6 jointly in a circular movement at the same time in a radial direction and in the longitudinal direction **L**. As a result of the radial portion of the circular movement of the clamping jaws 18, 19, opposed clamping jaws 18, 19 of the locking chain 3 facing away from the platform move slightly towards each other and thus reduce the clamping cross-section between the clamping jaws 18, 19 and allow an initial firm clamping of the locking chain 3 facing away from the platform to the outer wall of the support leg 2.

[0075] The force of the initial locking acting upon the support leg 2 is lower than that of the self-locking. The actuators 41 facing away from the platform serve to exert an initial pressure upon the outer wall of the support leg 2, which pressure presses the clamping jaws 18, 19 sufficiently strongly against the outer wall as to prevent the locking chain 3 facing away from the platform from slipping during the build-up of the self-locking. To this end, it is necessary for at least the force of gravity of the clamping jaws 18, 19 to be overcome.

[0076] In principle, each of the locking chains 3 facing away from the platform is capable of being enlarged by a further part of the self-locking mechanism by the insertion of further segment bodies 7, 8 with an associated arm 21, 22 and an associated clamping jaw 18, 19 in the longitudinal direction **L**.

[0077] Fig. 4 shows the radial inner side of the two clamping jaws 18, 19 with six rubber inlays 50 in each case which are arranged on the inside and which are arranged in two arrangements of three orientated in the longitudinal direction **L**, the two arrangements of three being separated from each other by a guide rail 51.

[0078] The following position details refer to a position along the longitudinal direction **L** of the support leg 2, a third position being provided closest to the platform, a fourth position being provided second closest, a first position being provided second furthest from the platform and a second position being provided furthest.

[0079] After the four support legs 2 are set on the seabed, the lifting process for raising the platform out of the water takes place in principle in the following steps carried out in succession: First of all, the locking chain 3 facing away from the platform is in a first position along the support leg 2. The locking chain 3 facing away from the platform is released, and the hydraulic cylinders 9 of the locking chain 3 facing away from the platform are moved out, and then the actuators 41 – facing away from the platform – of the locking chain 3 facing away from the platform are retracted, and, in this way, the clamping cross-section between the clamping jaws 18, 19 is reduced until an initial locking of the clamping jaws 18, 19 on the outer wall of the support leg 2 takes place. The initial locking prevents the clamping jaws 18, 19 from slipping along the outer wall of the support leg 2 in the following step. After the build-up of the initial locking the lifting cylinders 9 are retracted again, and as a result the locking chain 3 facing away from the platform is loaded to an increasing degree with the load of the platform and the self-locking of the locking chain 3 facing away from the platform is built up, and the locking chain towards the platform is released. As a result of the actuators towards the platform moving out, the clamping jaws 18, 19 of the locking chain towards the platform are released completely from the outer wall of the support leg 2 in a third position. The locking chain 3 facing away from the platform is now firmly clamped in a second position. The lifting cylinders 9 are retracted, and the platform is raised by the stroke of the lifting cylinders 9. Then the locking chain towards the platform is initially locked on the outer wall of the support leg 2 in a fourth position. After the locking chain towards the platform is initially locked, the actuators 41 facing away from the platform are actuated, and the self-locking of the locking chain 3 facing away from the platform is released. The self-locking of the locking chain towards the platform in the fourth position is built up to the extent that the self-locking of the locking chain 3 facing away from the platform is released. As a result, the overlying load is shifted from the locking chain 3 facing away from the platform to the locking chain towards the platform. Since the load rests completely on the locking chain towards the platform, the locking chain 3 facing away from the platform can be released from the support leg 2. The lifting cylinders 9 are then

5 moved out again, and the locking chain 3 facing away from the platform is in turn firmly clamped on the outer wall of the support leg 2 in the extended state of the lifting cylinders 9 first by means of initial locking and subsequent self-locking. After that, the locking chain towards the platform is released again by the actuators
10 towards the platform being moved out. To the extent that the self-locking of the locking chain towards the platform is released, the self-locking of the locking chain 3 facing away from the platform is built up until the complete load again rests on the locking chain 3 facing away from the platform. The procedure is repeated so many times until the platform has reached its operating height above the surface
10 of the sea. During the entire lifting process the locking chain 3 facing away from the platform and the locking chain towards the platform are positioned in a concentric manner around the support leg 2 with the aid of a centring device (not illustrated).

15 [0080] In the operating position the platform is permanently locked to the support legs 2, preferably by means of a further clamping mechanism designed for permanent holding or by means of a pin [connection] or similarly suitable means. In the operating position of the platform the lifting device 1 can be opened completely by the release of the connecting plates 16, 17 and can be removed
20 completely from the support leg 2. The lifting device 1 is only required again when the platform has to be lowered for dismantling for example. The process for lowering the platform takes place in a corresponding manner.

25 [0081] Fig. 6 shows a second embodiment of a locking chain 3 according to the invention facing away from the platform with a plurality of segments 6 which are arranged at equal distances from one another and which are connected to one another by way of pairs of connecting plates 16, 17. The connecting plates 16, 17 are connected to eyelets of the segments 6 in an interchangeable and articulated manner so as to be releasable in each case by way of screws, hooks or pins. A
30 fork 13 for fastening the lifting cylinders 9 is provided on the end of each segment 6 towards the platform.

[0082] Fig. 6 shows *inter alia* that the locking chain 3 facing away from the platform can be released by releasing the connecting pins from the support leg 2
35 and can be removed and can be set to a greater lifting capacity of another support leg 2 by the insertion of further segments 6. It is also possible for the connecting plates 16 between the segments 6 to be connected in an articulated manner by longer connecting plates 16, so that the lifting force determined by the number of

the segments 6 of the locking chain 3 facing away from the platform remains the same, but the periphery of the locking chain 3 facing away from the platform is increased.

[0083] Fig. 7 is a perspective view, partially in the form of a section of a segment 6 in Fig. 6 with a segment part 70 radially on the outside and a segment part 71 radially on the inside, in which case the segment part 71 radially on the inside is made U-shaped in cross-section at a right angle to the longitudinal direction **L** of the support leg 2 along its longitudinal extension and is inserted so as to be movable in an exclusively radial direction into the segment part 70 radially on the outside, and in which case the segment part 70 radially on the outside is likewise made U-shaped in cross-section along its longitudinal extension and the two U-shaped segment parts 70, 71 are turned horizontally through 180° and are inserted one into the other and remain movable with respect to each other in the radial direction. A hose (not shown in this case), which extends in the longitudinal direction **L** and which is capable of being extended by a flowable medium such as for example air or water and presses the segment part 71 radially on the inside radially inwards onto the support leg 2, extends into the space formed by the two U-shaped profiles. The hose can be resiliently extensible or can have a suitably folded cross-section which when filled with air or water allows the radial extension of the hose to be increased. The sides of the hose extending in the radial direction can be folded for example for this purpose. A segment part radially on the inside has a clamping jaw 18 which preferably has a thin lining, for example an elastomer or the like, which increases the adhesion.

List of References

- 1 lifting device
- 2 support leg
- 5 3 locking chain facing away from the platform
- 6 segments
- 7 segment body facing away from the platform
- 8 segment body towards the platform
- 10 9 lifting cylinder
- 11 fixing plate towards the locking chain
- 12 fixing plate towards the platform
- 13 fork
- 15 16 connecting plates facing away from the platform
- 17 connecting plates towards the platform
- 18 clamping jaw facing away from the platform
- 19 clamping jaw towards the platform
- 20 21 arm facing away from the platform
- 22 arm towards the platform
- 40 lever facing away from the platform
- 25 41 actuator facing away from the platform
- 50 rubber inlay
- 51 guide rail
- 30 70 outer segment part
- 71 inner segment part
- L longitudinal direction

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CLAIMS

1. A lifting device for an offshore platform with a weight along at least one support leg (2) with a peripheral length with a specified number of standardized segments (6) connected to one another to form at least one closed locking chain (3), wherein the number of the segments (6) determines the lifting capacity of the lifting device (1) which is determined by the weight of the offshore platform, and with connecting plates (16, 17) connecting adjacent segments (6) to one another and having a length which is determined by the peripheral length of the at least one support leg (2) and the number of the segments (6), wherein the specified number of segments (6) and the connecting plates (16, 17) determined in their length are connected to one another to form the at least one locking chain (3).
2. A lifting device according to Claim 1, characterized in that locking elements (18, 19) arranged along the periphery start from the segments (6).
3. A lifting device according to Claim 1 or 2, characterized in that clamping jaws (18, 19), which are arranged at a distance from each other along the periphery and are capable of moving in a reciprocating manner in the radial direction and which together form a clamping cross-section capable of varying in size, start from the segments (6).
4. A lifting device according to Claim 1, 2 or 3, characterized in that the segments (6) have in each case at least one resilient container which is capable of being filled with a flowable medium and is capable of being expanded by the filling and which presses the clamping jaw (18, 19) against the support leg (2) and, as a result, reduces the clamping cross-section.
5. A lifting device according to Claim 4, characterized in that the segments (6) have two parts (70, 71), which are movable towards each other in the radial direction and are U-shaped in the clamping cross-section and which engage one in the other, and resilient hoses are arranged between the two segment parts (70, 71) engaging one in the other, and one of the clamping jaws (18, 19) is arranged on the segment part (71) radially on the inside.

6. A lifting device according to any one of Claims 1 to 5, characterized in that the clamping jaws (18, 19) are arranged in a movable manner on the segments (6) by means of a self-locking mechanism.
- 5 7. A lifting device according to any one of Claims 1 to 6, characterized by at least one friction-increasing element (50) on the inner side of the clamping jaws (18, 19).
- 10 8. A lifting device according to any one of Claims 1 to 7, characterized by arms (21, 22) which are arranged on the inner sides of the segments and are pivotable about in each case one outer axis extending in the peripheral direction and on the inner ends of which one of the clamping jaws (18, 19) is arranged in each case, and in that the clamping cross-section is capable of varying by pivoting of the arms (21, 22).
- 15 9. A lifting device according to at least one of Claims 1 to 8, characterized by a centring device of the locking chain (3) relative to the support leg (2).
- 20 10. A lifting device according to any one of Claims 1 to 9, characterized by an actuator (41) which is allocated to one segment (6) in each case and which is operatively connected to the respective arm (21, 22) of the segment (6) and can pivot the arm (21, 22) in order to trigger an initial locking of the locking chain (3) on the support leg (2).
- 25 11. A lifting device according to Claim 10, characterized in that the actuator (41) comprises a safety mechanism which comprises a permanently acting spring which presses the clamping jaws (18, 19) radially inwards and has a mechanism which counteracts the spring and which deactivates the spring force during operation and releases the spring in the event of failure of the control means.
- 30 12. A lifting device according to at least one of Claims 1 to 11, characterized by lifting cylinders (9) which act in the longitudinal direction (L) and are arranged on a platform side of each of the segments (6) and the end of which towards the platform has a fastening means for fastening to the platform.
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13. A lifting device according to at least one of Claims 1 to 12, characterized by a further locking chain arranged along the at least one support leg (2) between the locking chain (3) and the platform, wherein the locking chain (3) and the further locking chain are movable relative to each other along the support leg (2).
14. A lifting device according to Claim 13, characterized in that one of the two locking chains (3) is arranged fixed in position relative to the platform during the lifting procedure.
15. A lifting device according to Claim 13 or 14, characterized by a control means for the lifting cylinders (9) and the actuators (41) as well as further actuators allocated to segments (6) of the further locking chain.
16. A method of producing a lifting device (1) according to any one of Claims 1 to 15 with at least one closed locking chain (3) in order to move an offshore platform with a weight along at least one support leg (2) with a peripheral length, in that a lifting capacity of the lifting device (1) is determined with reference to the weight of the offshore platform and a number of standardized segments (6) of the locking chain (3) is determined therefrom, lengths of connecting plates (16, 17) which connect adjacent segments (6) to each other are determined from the number of the segments (6) of the locking chain (3) and the peripheral length of the at least one support leg (2), and the connecting plates (16, 17) determined in their lengths are connected to one another to form at least one locking chain (3) in a releasable manner.
17. A method according to Claim 16, characterized in that the number of segments (6) keeps ready the lifting capacity required for lifting the offshore platform.
18. A method according to Claim 16 or 17, characterized in that a further locking chain is produced in the same method steps as the locking chain (3).
19. A method according to Claim 16, 17 or 18, characterized in that lifting cylinders (9) are mounted on the segments (6) of the locking chain (3).

20. A method of producing at least two lifting devices (1) for offshore platforms of different weight and/or with support legs (2) of different peripheral length, in that each of the at least two lifting devices (1) is produced according to any one of Claims 16 to 19, and the same standardized segments (6) are used in order to produce the locking chains (3) of each one of the at least two lifting devices (1) and the different lengths of the locking chains (3) adapted to the different peripheral lengths are formed by connecting plates (16, 17) of different length.
21. A method of lifting an offshore platform with a lifting device (1) according to at least one of Claims 1 to 15, in that a locking chain (3) is released in a first position on a supporting leg (2), lifting cylinders (9) are moved out and the locking chain (3) is initially locked on the support leg (2) in a second position at a distance further from the platform than the first position, a further locking chain is released in a third position along the support leg (2) and, as a result, the locking chain (3) is firmly clamped in the second position by self-locking, the lifting cylinders (9) are retracted, the further locking chain is initially locked in a fourth position at a distance further from the platform than the third position, the locking chain (3) is released in the second position and, as a result, the further locking chain is firmly clamped in the fourth position by self-locking.
22. A method of lowering an offshore platform with a lifting device (1) according to at least one of Claims 1 to 15, in that a locking chain (3) is released in a second position on a supporting leg (2), lifting cylinders (9) are retracted and the locking chain (3) is initially locked on the support leg (2) in a first position situated closer to the platform than the second position, a further locking chain is released in a fourth position along the support leg (2) and, as a result, the locking chain (3) is firmly clamped in the first position by self-locking, the lifting cylinders (9) are moved out, the further locking chain is initially locked in a third position situated closer to the platform than the fourth position, the locking chain (3) is released in the first position and, as a result, the further locking chain is firmly clamped in the third position by self-locking.

23. A method of lifting a support leg (2) with a lifting device (1) according to at least one of Claims 1 to 15, in that a self-locking mechanism is tripped, a locking chain (3) is released in a second position on the supporting leg (2), lifting cylinders (9) are retracted and the locking chain (3) is initially locked on the support leg (2) in a first position situated closer than the second position to the platform, a further locking chain is released in a fourth position along the support leg (2) and, as a result, the locking chain (3) is firmly clamped in the first position by self-locking, the lifting cylinders (9) are moved out, the further locking chain is initially locked in a third position situated closer to the platform than the third position, the locking chain (3) is released in the first position and, as a result, the further locking chain is firmly clamped in the third position by self-locking.
24. A method of lifting a support leg (2) with a lifting device (1) according to at least one of Claims 1 to 15, in that a self-locking mechanism is tripped, a locking chain (3) is released in a first position on a supporting leg (2), lifting cylinders (9) are moved out and the locking chain (3) is initially locked on the support leg (2) in a second position at a distance further from the platform than the first position, a further locking chain is released in a third position along the support leg (2) and, as a result, the locking chain (3) is firmly clamped in the second position by self-locking, the lifting cylinders (9) are retracted, the further locking chain is initially locked in a fourth position at a distance further from the platform than the third position, the locking chain (3) is released in the second position and, as a result, the further locking chain is firmly clamped in the fourth position by self-locking.
25. A method according to any one of Claims 21 to 24, characterized in that the locking chain (3) or the further locking chain is initially clamped or released respectively, in that the clamping jaws (18) or the further clamping jaws (19) are initially pressed or released respectively by means of actuators (41) or by means of further actuators on the outer wall of the support legs (2).