

Locking device for elongated element slidable in buoyant body

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This invention relates to a locking device for an elongated element which is slidable, in the direction of its elongation, in a buoyant body, such as a platform for use at sea which can be jacked up upon these elements. Such platforms are used for offshore oil work and have at least three legs or piles which rest upon the floor of the sea.

In known platforms, each leg is movable relative to the floating platform by means of a driven pinion which engages rack teeth on the leg. By operation of the pinions the platform may be lifted to beyond the reach of the waves, and it is then desirable to lock the platform in position relative to the legs so as to relieve the strain on the pinions which could be exposed to forces greater than normally met during lifting of the platform; and thereby also guide pieces between the legs and platform will be subject to lesser load and can have a higher construction.

Prior jack-up platforms are referred to in European Patent Application No. 0 024 939 which claims a U.S. priority of 29th August 1979 but was not published until 11th March 1981.

The present invention provides a locking device for such a leg or other elongated element, by displacement of the rack piece out of engagement with the rack and separate locking means.

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According to the present invention we provide a locking device for an elongated element which in its longitudinal direction is slidably received in a buoyant body and is provided with at least one toothed rack along
5 at least a part of the length of the elongated element, which toothed rack is arranged to engage with at least one pinion the drive and bearing means of which are attached to the buoyant body, which device comprises (a) at least one rack piece intended to be connected to the body
10 having buoyancy, said rack piece comprising a plate having a substantially isosceles trapezoidal periphery with rack teeth disposed along the large base side of the trapezium, and having a tooth profile adapted to engage with and thus lock onto the toothed rack profile, whereby the rack
15 piece is displaceable along at least half a tooth pitch in the longitudinal direction of the rack and is also movable in a direction perpendicular to the longitudinal direction of the rack, out of engagement with the rack, and
20 (b) guide blocks which enclose the rack piece and which are displaceable both jointly and separately in longitudinal direction of the rack, each being provided with a guide face inclined at the same angle made with the axis of the elongated element as that of the inclined trapezoidal adjacent side of the rack piece; the guide blocks
25 being adapted to be enclosed by means which is intended to be movable by said rack along the elongated element and to be lockable by the locking device.

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By this means a meshing displacement can be effected by means of only one longitudinal displacement device. For the approaching movement of the guide blocks enables a possibly pure-meshing displacement, which a
5 uniform displacement in the same direction of the guide blocks enables a longitudinal displacement to be made. By displacing the one block quicker than the other, also a combined longitudinal and meshing displacement is also possible, and thus an optimally quick locking.

10 The displacement of the guide blocks may take place in different manners, e.g. by hydraulic cylinders. According to a further embodiment of the invention, however it is preferable that the guide blocks are each displaceable by at least two screwed spindles, while
15 said screwed spindles are arranged in such a way that the centre lines of the one set of screwed spindles coincides with those of the other set and each pair of screwed spindles with coinciding centre lines is connected rotatably relative to each other. Thus, an
20 accurately guided displacement of the guide blocks is

achieved, while the self-braking effect of a screw connection needs an additional protection. By connecting a set of screwed spindles with coinciding centre lines rotatably relative to each other, there is advantageously effected a locking in longitudinal direction.

When in accordance with a further embodiment of the invention, the inclination of the guide faces is equal to the pressure angle of the teeth, the tooth forces are transmitted advantageously without additional force onto the guide blocks. The transmission forces can be resolved into a vertical and a horizontal component, the vertical component being discharged via the displacement device of the guide blocks towards the body with buoyancy, while the horizontal component, via guide faces between the guide blocks and the body with buoyancy, is transmitted directly thereto.

One embodiment of the locking device according to the invention will now be explained, by way of example, with reference to the diagrammatic drawing, in which

Fig. 1 is a cross-section of a part of a lifting platform in situ of one of the piles;

Fig. 2 shows a locking device according to the invention in the non-blocking position;

Fig. 3 shows the locking device according to Fig. 2 in the blocking position; and

Fig. 4 is a cross-section on the line IV-IV in Fig. 2.

Fig. 1 shows a part of a lifting platform 1 wherein

a passage 2 is provided for a leg 3. Two toothed racks 4 extend in longitudinal direction of the leg 3 on either side thereof. The leg 3 may have any desired construction or cross-section. For instance, the leg 3 may be a lattice leg consisting of a plurality of elongate standards interconnected by cross-rods, each standard being provided with one or a plurality of toothed racks. Further possible constructions for the legs are cross-sectionally round, square or differently shaped tubes.

With each toothed rack 4 can mesh one or a plurality of pinions for displacing the leg 3 relative to the platform 1. The pinions are accommodated in drive mechanisms 5, which find support via springs 6 acting on the one end against the lifting platform 1 and on the other end against a yoke 7, which is rigidly connected to the lifting platform 1. In order to maintain a proper positioning of the leg relative to the lifting platform, there are provided a pair of spaced apart guides 8 and 9. For effectively locking and securing the leg 3 relative to the lifting platform 1, there is mounted adjacent each toothed rack 4 a locking device 10 according to the invention, which locking device 10 will be further explained and elucidated in the following with reference to Figs. 2-4.

The locking device 10 is provided with a rack piece 11 comprising a plate-like portion having substantially an isosceles trapezoidal circumference, whereby along the large base side thereof there is provided teeth 12 adapted to coact with the teeth of the opposite toothed rack 4. The short side of the rack piece 11 extends

parallel to an adjacent portion of the lifting platform 1. The two slanting sides of the rack piece 11 have a gradient that corresponds with that of the teeth 4, 12. Furthermore the two slanting sides are provided with flanged edges 13 which are slidably retained in guide members 14 forming part of guide blocks 15. In each of these guide blocks 15, which consist of a block-shaped piece of material provided with a sloping face that corresponds with the coacting face of the rack piece 11, there are provided a pair of threaded bores for receiving screwed spindles 16, 17. In alignment with each screwed spindle 16 is positioned a screwed spindle 17, and between both screwed spindles there is positioned a spacer 18 consisting of a shaft-like portion having a centre line that coincides with that of the two screwed spindles 16, 17. An assembly of a screwed spindle 16, a spacer 18 and a screwed spindle 17, secured against displacement in longitudinal direction, is received between two rigidly interconnected parts of the lifting platform 1. By means of bearings 19, the screwed spindles 16 and 17 are rotatably mounted relative to the lifting platform 1 and by means of bearings 20 relative to the spacers 18, or relative to each other. The screwed spindles 16, 17 are rotatable by means of driving gear, not shown. Each set of screwed spindles 16, 17 is coupled mutually, so that each set of screwed spindles 16, 17 is rotated at the same angular speed. The set of screwed spindles 16 of each locking device 10 should be adapted thereby for rotation independently of the set of screwed spindles 17 of said



locking device 10.

The operation of the above described device is as follows.

When the lifting platform 1 has arrived at the proper location, the legs 3 are brought downwards by means of the drive mechanisms 5 until these reach the floor. Through the further operation of the drive mechanisms 5, the lifting platform 1 is subsequently moved upwards along the legs until the required distance above the water surface is attained. During these mutual movements of legs 3 and platform 1, the securing devices 10 are in the position shown in Fig. 2, while the guides 8, 9 ensure that a leg 3 is guided properly relative to the lifting platform 1.

In order to relieve the guides 8, 9 and the drive mechanisms 5 in the resulting lifted position as much as possible of forces and moments originating from the piles, e.g. during a heavy storm, the locking devices are brought from the position shown in Fig. 2 into the position shown in Fig. 3, which is effected by suitably driving the screwed spindles 16 and 17. By simultaneously rotating the screwed spindles 16 and 17 at the same speed, the teeth of the rack piece 11 can be properly positioned relative to the teeth of the toothed rack 4. By rotating the screwed spindles 16 and 17 at equal speed in opposite directions, the rack piece 11 can be pressed towards the leg 3 without changing the position of the teeth 4, 12 relative to each other. Naturally it is also possible, by a suitable control, to

rotate the screwed spindles 16, 17 at different speeds so that the rack piece 11 is smoothly brought into engagement with the toothed rack 4.

By arranging two toothed racks 4 as well as two locking devices 10 opposite each other, a particularly effective gripping of the legs 3 can be effected.

In the embodiment shown, the gradients of rack piece 11 and guide blocks 15 are chosen to be equal to the pressure angles of the teeth. As a result, it is advantageous that the forces originating from the piles are transmitted without additional forces to the guide blocks 15. These forces can be thought of as resolved into a vertical and horizontal component. The vertical component is transmitted via the screwed spindles 16, 17 to the frame of the lifting platform 1. The horizontal component on the other hand is directly transmitted from a guide block 15 onto the adjacent portion of the lifting platform 1.

The embodiment described can be modified, within the scope of the invention. For instance, the guide blocks 15 may be moved instead of by screwed spindles, by hydraulic or pneumatic cylinders. Also, although it is preferable that the angles of inclination of the rack piece and the guide blocks are equal to the pressure angle of the teeth, said angles may, if desired, also have a different value.

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In the above, there has only been described a lifting platform provided with legs, but this should not be considered to be a restriction of the range of use of the locking device according to the invention.



CLAIMS

1. A locking device for an elongated element which in its longitudinal direction is slidably received in a buoyant body and is provided with at least one toothed rack
5 along at least a part of the length of the elongated element, which toothed rack is arranged to engage with at least one pinion the drive and bearing means of which are attached to the buoyant body, which device comprises (a) at least one rack piece intended to be connected to the
10 body having buoyancy, said rack piece comprising a plate having a substantially isosceles trapezoidal periphery with rack teeth disposed along the large base side of the trapezium, and having a tooth profile adapted to engage with and thus lock onto the toothed rack profile, whereby the
15 rack piece is displaceable along at least half a tooth pitch in the longitudinal direction of the rack and is also movable in a direction perpendicular to the longitudinal direction of the rack, out of engagement with the rack, and
(b) guide blocks which enclose the rack piece and which
20 are displaceable both jointly and separately in longitudinal direction of the rack, each being provided with a guide face inclined at the same angle made with the axis of the elongated element as that of the inclined trapezoidal adjacent side of the rack piece; the guide
25 blocks being adapted to be enclosed by means which is intended to be movable by said rack along the elongated element and to be lockable by the locking device.

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2. A locking device according to Claim 1, which includes screwed spindles for displacing the rack piece, each guide block being movable by at least two screwed spindles, said screwed spindles being arranged in such a way that the centre lines of the one set of screwed spindles coincide with those of the other set and each set of screwed spindles with coinciding centre lines are connected rotatably relative to each other.
3. A locking device according to Claim 1 or 2, wherein the angle of inclination of the guide faces is equal to the pressure angle of the teeth.
4. A locking device for an elongated element, substantially as hereinbefore described with reference to the accompanying drawings.
5. An elongated element provided with at least one locking device according to any preceding claim.

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