Coupling device for connecting and disconnecting to a coupling head to be lifted

FIELD OF THE INVENTION

The present invention relates to a coupling device for connecting and disconnecting to a coupling head to be lifted, the coupling device comprising;

at least two pivotably mounted arm members, mutually pivotable between an open position wherein the coupling head can be received in and released from an interior cavity defined by the at least two arm members, and a closed position wherein the coupling head can be secured in the interior cavity to enable lifting of the coupling head. More in general the invention relates to a system for lifting a load, to be used with a crane, specifically to a quick connector lifting tool designed for efficiently lifting and lowering heavy loads.

BACKGROUND OF THE INVENTION

Traditional systems of lifting and lowering heavy loads, particularly in offshore environments, often involve time-consuming and labour-intensive processes. These systems typically require multiple parts of specialized equipment to enable the lifting operation. Prior art reference WO8301059A1 describes a lifting tool wherein the tool comprises a pair of legs that open and close such that a shank is inserted into the internal cavity. The shank is connected to a load to be lifted, wherein the lifting tool legs comprise an internal ring that interacts with the shanks such that a coupling is formed. A locking system is provided to allow the safe and secure lock of the load when in use. The lifting tool described in WO8301059A1 has the draw back that if the locking system fails, the operation is compromised as well as the security of any person working around the lifting tool.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an innovative tool that simplifies and expedites the lifting and lowering operations, while ensuring optimal safety for operators.

The invention aims to enhance the speed, safety, and ease of handling such loads, thereby improving productivity, and reducing potential risks associated with lifting operations of heavy loads.

The invention therefore provides a coupling device for connecting and disconnecting to a coupling head to be lifted, comprising;

at least two pivotably mounted arm members, mutually pivotable between an open position wherein the coupling head can be received in and released from an interior cavity defined by the at least two arm members, and a closed position wherein the coupling head can be secured in the interior cavity to enable lifting of the coupling head,

a first cam following member arranged at an exterior of at least one arm member for engaging the coupling head and pivot the at least one arm member to the open position upon lowering the coupling device on the coupling head,

a second cam following member arranged within the interior cavity for engaging the coupling head and pivot the two arm members from the closed position to the open position upon lowering the coupling device with respect to the coupling head while the coupling head is in the interior cavity.

The coupling device having a first cam following member at an exterior as well as a second cam following member arranged within the interior cavity enables quick attachment to a coupling head as well as quick release from the coupling head. Therefore, the coupling device according to the invention facilitates efficient lifting and controlled lowering operations of a load. By streamlining the process of load handling, the invention minimizes manual effort of an operator, reduces operational time, and ensures the safety of operators involved in lifting and lowering tasks.

In other words, the present invention discloses a system for lifting and lowering a load, to be used with a crane, the system comprises a unique configuration of components that enable rapid and secure attachment of the tool to the load.

The invention provides a quick connector tool for lifting heavy loads made of two halve parts, that is the two arm members, and offers several notable advantages over conventional lifting systems/tool. The system streamlines the lifting, connecting, lowering and disconnecting process, reducing operational time and increasing overall productivity. The secure attachment and retaining elements ensure the load remains stable and prevents accidents caused by slippage or detachment. This ensures that the load does not unexpectedly drop or descend, enhancing safety during lifting operations, without the need of extra features, such as active locking mechanisms. The invention enables the lifting of heavy and big loads to be carried out in a seamless manner, wherein the stabbing operation of the coupling head into the cavity is easily carried out, by the qualified operators. Moreover, the invention provides a simple coupling device that can be produced in a wide range of dimensions, in order to adapt to the specifics of the load that needs to be lifted and/or operated, such that the production of the system can be done in a simple manner.

The specific and simple design, which include features that make the system user-friendly and accessible to crane operators with varying levels of expertise. Additionally, the specific configuration and workability of the proposed invention provides a simple way to prevent unexpectedly drop or descend, enhancing safety during lifting operations. The system effectively prevents the load from slipping or releasing unintentionally.

The system's specific configuration for retaining loads and/or components securely accommodate a wide range of load sizes, providing versatility across various onshore and offshore applications.

By minimizing the need for additional labour, when stabbing operation is done, and specialized needs or features on the system, the invention reduces operational costs associated with lifting and lowering heavy loads.

The interior cavity is defined by the at least two arm members. The cavity can be symmetrically divided between the two arm members. However, an asymmetric division of the cavity between the two arm members is conceivable as well.

The first cam following member being arranged at an exterior, means that the cam following member is arranged at an outside surface as seen from the cavity, and

can be contacted with the coupling head. The cavity is on the contrary at the interior of the coupling device.

Lowering the coupling device on the coupling head, includes that the first cam following member contacts the coupling head to drive the associated arm member to the open position. The first and/or second cam following member can have any suitable shape and can extend around a part or an entire circumference of the coupling device.

The coupling device is part of a hoisting system and suspends usually from a lower end of a hoisting cable.

In an embodiment, the coupling device comprises a lock system coupled with the at least two arm members to lock the at least two arm members in the open position during release of the coupling head from the interior cavity. The lock system all the more enables a secure, predictable and quick release of the coupling head from the coupling device. Therefore, the lock system locks, in other words “maintains”, the at least two arm members in the open position. Advantageously, the addition of a lock system allows to remove the coupling device from the coupling head when opening the arm members such that the device is easy to be removed or disconnected from the coupling device, while the operator skills do not need to be such, since the operation can be promptly and easily carried out.

In an embodiment of the coupling device, the lock system comprises a control unit that is remotely operable, preferably wirelessly operable, for controlling an operating mode of the lock system, the operating modes including lock position and allow free movement. The lock system comprising a control unit that is remotely operable minimizes the need for direct involvement of an operator during coupling of the coupling device to a coupling head or release of a coupling head from the coupling device.

In an embodiment of the coupling device, the lock system comprises a mechanical and/or hydraulic member to lock the at least two arm members in its position.

In an embodiment of the coupling device, at least the second cam following member comprises a sloped section that subtends an angle α with the vertical,

wherein α < 60°. The second cam following member comprising a sloped section that subtends an angle α with the vertical, facilitates to drive the pivoting of the at least two pivotably mounted arm members to the open position by the own weight of the coupling device. Therefore, for release of the coupling head from the coupling device, the coupling device needs to be lowered, for example by paying out a hoisting cable connected to the coupling device. The coupling head and the second cam following member constitute a cam transmission that transforms lowering of the coupling device into rotation of the arm members. The source of motive power is the own weight of the coupling device.

The angle α < 60° with respect to the vertical is made when the coupling device is suspended from a hoisting line and the arm member is in closed position. In other words, a longitudinal axis of the arm member is aligned with the vertical.

In an embodiment of the coupling device, the at least two arm members each comprise an internal retaining element, and wherein, in use, the coupling head interacts with the internal retaining elements to lock the at least two arm members into the closed position allowing lifting and/or lowering of the load associated with the coupling head. The at least two arm members each comprising an internal retaining element, enables safe and secure coupling of the coupling device to a coupling head because the retaining elements assure closure of the at least two arm members in the closed position.

In an embodiment of the coupling device, the two internal retaining elements are arranged at lower body portions of the at least two arm members. The two internal retaining elements being arranged at the lower body portions of the at least two arm members facilitates functioning of the retaining elements by the weight of the load to be lifted. In other words, the retaining elements extend below the cavity.

In an embodiment of the coupling device, at least one of the at least two arm member comprises a support face defining the interior cavity, wherein the internal retaining element comprises at least a portion of the support face, wherein the portion of the support face is sloped upwards towards a centre line of the coupling device and wherein the upwards sloped section subtends an angle β with the horizontal, wherein β < 45°, preferably 1°< β < 25°, and most preferably 1°< β < 15°. The internal retaining element comprising at least a portion of the support face,

wherein the portion of the support face is sloped upwards towards a centre plane of the coupling device and wherein the upwards sloped section subtends an angle β with the horizontal, all the more facilitates functioning of the retaining elements by the weight of the load to be lifted. Support face refers to the face of the cavity that in use contacts the coupling head and takes up the weight of a load that is lifted by the coupling head. The angle β with respect to the horizontal is made when the coupling device is suspended from a hoisting line and the arm member is in closed position. The specific configuration of the arm members, including the inclined surface, that is the upward sloped portion,, towards the inside of the coupling device and counter-parts of the coupling head do provide a simple and secure system that does not need to rely on active locking mechanisms to maintain the lifting operation under high safety standards.

In an embodiment of the coupling device, at least one of the at least two arm member comprises a Centre of Gravity, CoG, horizontally spaced from the centre line of the coupling device. The at least one of the at least two arm members comprising a CoG horizontally spaced from the centre line of the coupling device facilitates pivoting of the at least two arm members towards the closed position wherein the coupling head is secured in the interior cavity.

In an embodiment, the coupling device comprises a pivoting mechanism coupled with the at least two arm members and defining a pivot axis of the at least two pivotably mounted arm members. The coupling device comprising a pivoting mechanism coupled with the at least two arm members, facilitates a defined and predictable movement of the at least two arm members between the open and closed position. Preferably, the at least two arm members are pivotable around one and the same pivot axes. It is however conceivable that the at least two arm members are pivotable around different pivot axis. Important is that at least one of the at least two arm member comprises a Centre of Gravity that is offset with respect to the pivot axis of the at least one of the at least two arm members.

In an embodiment of the coupling device, the at least two pivotably mounted arm members each have a top body portion opposite the corresponding lower body portion, wherein the pivoting mechanism is coupled with the at least two arm members at their top body portion, and wherein the interior cavity is defined by the

lower body portions of the at least two arm members. The pivoting mechanism being coupled with the at least two arm members at their top body portion, all the more facilitates a defined and predictable movement of the at least two arm members between the open and closed position.

In an embodiment of the coupling device, a centre of the cavity is arranged at a distance from the pivot axis to enable movement of the coupling head towards the pivot axis while the at least two arm members pivot towards the open position. The centre of the cavity being arranged at a distance from the pivot axis, on the one hand facilitates pivoting of the at least two arm members pivot towards the open position because to a certain extent, free movement of the coupling head in the cavity towards the pivot axis is possible. On the other hand, secure locking is facilitated, since the enabled movement of the coupling head towards the pivot axis also enables to filter out unintended release of coupling head.

In an embodiment of the coupling device, the distance between the centre of the cavity and the pivot axis corresponds with about a maximum diameter dimension of the cavity. The distance between the centre of the cavity and the pivot axis corresponding with about a maximum diameter dimension of the cavity, all the more provides free movement of the coupling head and filtering out of unintended release of coupling head. As an example, the outside diameter of the coupling device is preferably between about 2 – 3 meters, in particular for offshore hoisting purposes, however any suitable outside diameter is conceivable. As a consequence, the cavity has a diameter of 1 – 2 meters.

In an embodiment, the coupling device comprises a defined play with respect to a coupling head, when the coupling head is positioned in the cavity to provide freedom to the coupling head to move toward the pivot axis. The coupling device comprising a defined play, all the more defines the enabled free movement of the coupling head and filtering out of unintended release of coupling head.

In an embodiment of the coupling device, at least one of the at least two arm members comprises a mass distribution around the pivot axis such that upon lowering the coupling device and contacting the coupling head, the second cam following member forces pivoting of the at least one of the at least two arm member around the pivot axis towards the open position.

In an embodiment, the coupling device comprises a CoG above the cavity when the arm members are in closed position. The coupling device comprising a CoG above the cavity when the arm members are in closed position, enables that the at least two arm members can be driven towards the open position by the own weight of the coupling device.

In an embodiment of the coupling device, the pivoting mechanism comprises a pin extending through both the at least two arm members, and wherein the pin defines the pivot axis. This provides a device that is durable in construction, inexpensive to manufacture, carefree in maintenance, easy to assemble, and simple and effective in use, while the pin can be easy to remove or replace, when the pivoting is not functioning as predefined. Moreover, the skilled person will appreciate that by having a pin in the pivoting mechanism, the distance between the pivot axis and the cavity can be short, such that the device can become as compact as needed.

In an embodiment of the coupling device, the system further comprises a hoisting member provided at a top end of the pivoting mechanism, such that a hoisting line can be connected to the system for the lifting of the load, in particular the hoisting line can be connected around the hoisting member.

In an embodiment of the coupling device, both the at least two arm members comprise a cavity section that co-shape the interior cavity. Both the at least two arm members comprising a cavity section, enables to minimize required pivotal movement with respect to a centre plane, for release of the coupling head from the coupling device. Preferably, the cavity sections are similar in shape, even identical. However, it is conceivable that the cavity sections are different in shape.

In an embodiment of the coupling device, both the at least two arm members comprises identical parts. Preferably, the two arm members are identical. The at least two arm members comprising identical parts of being identical, simplifies manufacture of the coupling device.

In an embodiment, the coupling device consists of two identical arm members and the pin. The coupling device consisting of two identical arm members and the pin reduces part count of the coupling device.

In an embodiment, the coupling device comprises a monitoring system for monitoring engagement between the at least two arm members and the coupling head, the monitoring system comprising one or more of an imaging device configured for determining locations and/or positions and/or displacements of the at least two arm members and the coupling head, a sensor system for measuring mechanical parameters such as strain and pressure, in particular a contact pressure between the coupling head, and at least one for the retaining elements.

The coupling device comprising a monitoring system for monitoring engagement between the at least two arm members and the coupling head all the more enables streamlining of the process of load handling, and minimizes manual effort of an operator, reduces operational time, and ensures the safety of operators involved in lifting and lowering tasks.

In an embodiment, the coupling device comprises a dampening member arranged in the interior cavity for dampening any movement of the coupling head, when inserted in the cavity. The coupling device comprising a dampening member arranged in the interior cavity all the more avoids unintended opening of the coupling device and subsequent release of coupling head from the coupling device.

The invention therefore provides a system comprising a coupling device as defined above, and a coupling head mountable or connected to a load or a load carrying platform.

In an embodiment of the system, the coupling head comprises a cam member forming a cam follower device with at least the second cam following member. This all the more enables to pivot the at least two arm members by mutual movement of the coupling device and the coupling head. Preferably, the cam member of the coupling head constitutes a respective first and second cam follower device with respectively the first cam following member and the second cam following member.

In an embodiment of the system, the cam follower device transforms linear motion into rotary motion of at least one of the at least two arm members. The cam follower device transforming linear motion of the coupling device into rotary motion enables operating the coupling device simply by lowering the coupling device. The linear motion means a lowering of the coupling device on the coupling head. The coupling head itself is “stationary” on a deck level or on land.

The invention therefore provides a lifting and lowering assembly comprising the system as defined above, wherein the coupling head is connected to a load element such that the load element can be lifted and lowered. The load element can be a monopile, a nacelle or any other conceivable load element.

The invention therefore provides a method for lifting and lowering a load, using a crane having a hoisting cable attached to the coupling device of the system as defined above, wherein the method comprises:

- lowering the coupling device on the coupling head, and
- establishing a connection between the coupling device and the coupling head by insertion of the coupling head into the interior cavity of the coupling device such that the at least two pivotably mounted arm members pivot into the open position to allow the coupling head to be received into the interior cavity and upon insertion of the coupling head into the interior cavity, pivoting the at least two pivotably mounted arm members into the closed position to lock the coupling head to the coupling device.

In an embodiment of the method according to the invention, the method comprises lifting the coupling device, such that the at least two internal retaining elements frictionally interact with the coupling head to lock the at least two pivotably mounted arm members into the closed position.

In an embodiment of the method according to the invention, the step of establishing a connection between the coupling device and the coupling head is executed above ground level or deck level, preferably at least 1 meter above ground or deck level.

In an embodiment of the method according to the invention, the method comprises the steps of;

- connecting the system to a component, the component being one or more of a monopile, a transition peace, a nacelle, a wind turbine, a propeller blade, etc.
- providing the component with a coupling head,
- connecting the coupling device to the coupling head,
- hoisting the component, for positioning the component in or on an installation

- disconnecting the coupling device from the component, and subsequently
- handling of a similar or identical component on the ground or on the deck of a vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be discussed in more detail below, with reference to the attached drawings, in which;

figure 1 is a cross sectional side view of a first embodiment of the coupling device according to the invention;

figure 2 is a perspective view of a second embodiment of the coupling device according to the invention;

figure 3 is a perspective view of a detail of the embodiment of fig. 1;

figure 4 is a side view of another detail of the embodiment of fig. 1; and

figure 5A – 5F show subsequent method steps of coupling and decoupling the coupling device of figure 1.

DETAILED DESCRIPTION

Figure 1 is a cross sectional side view of a first embodiment of the coupling device 1 according to the invention. The embodiment will be described under reference to figures 1 – 3. The coupling device 1 is configured and used for connecting and disconnecting to a coupling head 2 to be lifted. The coupling head 1 is shown as coupled to the coupling device 1. The coupling device 1 as shown has two arm members 3, 4. In a closed position as shown, the two arm members 3, 4 engage the coupling head 2. The two arm members 3, 4 engage the coupling head 2 from opposite sides. The two arm members 3, 4 are pivotably arranged. The two pivotably mounted arm members 3, 4 are mutually pivotable between an open position and a closed position, as shown. In the open position, the coupling head 2 can be received in and released from the coupling device 1. In the open position, the coupling head 2 can be received in and released from an interior cavity 5 of the coupling device 1.

The interior cavity 5 is defined by, in this case, the two arm members 3, 4. Therefore, both of the two arm members 3, 4 comprise a cavity section 17, 18 that co-shape the interior cavity 5. This enables to make use of two identical arm members 3, 4, which is beneficial for manufacturing and maintenance. In the closed position, the coupling head 2 can be secured in the interior cavity 5 to enable lifting of the coupling head 2. The coupling head 2 is associated with a load as will be clear, the load itself is not shown.

The movement of the arm members 3, 4, between the open and closed position, is driven by the own weight of the coupling device 1. Therefore, the coupling device 1 comprises a first cam following member 6. The first cam following member 6 is arranged at an exterior of at least one arm member 3. The first cam following member 6 therefore faces the coupling head 2 that is waiting to be picked up by the coupling device 1. In use, the first cam following member 6 engages the coupling head 2. The first cam following member 6 engages, in other words contacts, a cam 19 of the coupling head 2. While lowering the coupling device 1 on the coupling head 2, the two arm members 3, 4, pivot to the open position. The two arm members 3, 4, pivot away from each other to the open position to allow the coupling head 2 access to the interior cavity 5. Once the coupling head is in the interior cavity 5, the two arm members 3, 4 can and will pivot to the closed position under their own weight. Therefore, the two arm members 3, 4, each comprise a Centre of Gravity 13 that is offset with respect to the pivot axis 15. The centre of gravity 13 of the arm member 4 is shown. In this view, the centre of gravity 13 of the arm member 4 is horizontally space from a centre line 12 of the coupling device 1.

The coupling device 1 comprises a second cam following member 7. The second cam following member 7 is different from the first cam following member 6. The second cam following member 7 is arranged within the interior cavity 5 of the coupling device 1. The second cam following member 7 therefore faces the coupling head 2 in the interior cavity 5. The second cam following member 7 engages the coupling head 2 for pivoting the two arm members. The second cam following member 7 engages, in other words contacts, a cam 19 of the coupling head 2. While lowering the coupling device 1 further on the coupling head 2, the two arm members 3, 4, pivot to the open position. The two arm members 3, 4, pivot away from each other to the open position to allow the coupling head 2 to release from the interior

cavity 5. Once the coupling head 2 is released from the interior cavity 5, the two arm members 3, 4 can and will pivot to the closed position under their own weight.

The coupling head 2 comprises a cam member 19. The cam member 19 forms a cam follower device with at least the second cam following member 7. the cam follower device transforms linear motion of the coupling device 1 into rotary motion of the two arm members 3, 4. In this case, the cam member 19 also forms a cam follower device with the first cam following member 6.

The coupling device 1 comprises a lock system 8. The lock system 8 is operative to maintain a position of the two arm members 3, 4. In case of release of the coupling head 2 from the coupling device 1, it can be helpful to temporarily maintain the open position of the coupling device 1. The lock system 8 is coupled with the two arm members 3, 4 to lock the two arm members in the open position during release of the coupling head 2 from the interior cavity 5. The lock system 8 comprises a control unit not shown. The control unit controls an operating mode of the lock system 8. The operating modes of the lock system 8 include lock position of the arm members 3, 4 and allow free movement of the arm members 3, 4. The control unit is remotely operable. The control unit is preferably wirelessly operable. In this case, the locking system comprises a mechanical and/or hydraulic member 22 to lock the at least two arm members 3, 4 in its position. It will be clear that any conceivable locking member will suffice for the locking system 8.

Now turning back to the movement of the arm members 3, 4, between the open and closed position. The pivotal movement is driven by the own weight of the coupling device 1. The second cam following member 7 comprises a sloped section 9 as shown in fig. 3. The sloped section subtends an angle α with the vertical, wherein $\alpha < 60°$. The sloped section 9 subtends an angle α with the vertical, when the coupling device 1 is in closed position. The sloped section 9 subtends an angle α with the centre line 12 of the coupling device 1. The sloped section 9 facilitates pivoting of the arm members 3, 4.

The two arm members each comprise an internal retaining element 23. The retaining element 23 is operative to maintain the coupling device 1 in a closed position. Therefore, the coupling head 2 interacts with the internal retaining elements 23. The coupling head 2 contacts the internal retaining elements 23 to lock the two arm

members into the closed position. This allows secure lifting and/or lowering of the load associated with the coupling head 2.

In this case, the two internal retaining elements 23 are arranged at respective lower body portions 24, 25 of the two arm members 3, 4. The two arm members 3, 4, comprise a support face 10. The support face 10 co-defines the interior cavity 5. The support face 10 is operative to transfer a lifting force between the coupling device 1 and the coupling head 2. The internal retaining element 23 comprises a portion 11 of the support face 10. The portion 11 of the support face is sloped upwards towards a centre line 12 of the coupling device 1. During use of the coupling device 1, the centre line 12 extends along the vertical, and does normally coincide with the vertical. The upwards sloped section 11 subtends an angle β with the horizontal, wherein $\beta < 45°$, preferably $1° < \beta < 25°$, and most preferably $1° < \beta < 15$. The upwards sloped section 11 subtends the angle β when the coupling device 1 is in closed position and suspends from a hoisting cable that is not shown.

Importantly, the pivotal movement of the arm members 3, 4 is driven by the own weight of the coupling device 1. Therefore, the two arm members 3, 4 each comprise a Centre of Gravity, CoG, 13 horizontally spaced from the centre line 12 of the coupling device. It will be clear that the respective Centres of Gravity, CoG, 13 of, the two arm members 3, 4 are at opposite sides of the centre line 12 of the coupling device 1. As a consequence, by default the arm 3, 4 pivot towards each other and will take the closed position.

Figure 4 shows a single arm member 3 that can freely rotate around the pivot axis 15. This demonstrates the position of the CoG 13 of the arm member 3. The hoisting force 20, and the gravitational force 31 are aligned.

To facilitate pivoting of the arm members 3, 4, the coupling device 1 comprises a pivoting mechanism 14. The pivoting mechanism 14 is coupled with both the two arm members 3, 4. The pivoting mechanism 14 defines a pivot axis 15 of the two pivotably mounted arm members 3, 4. In this case, the two arm members have the pivot axis 15 in common. It is however conceivable that two arm members 3, 4 have a different pivot axis, like for example parallel pivot axes that are offset. In this case as shown, the pivoting mechanism 14 comprises a pin 16. The pin 16 extends through both the two arm members 3, 4. The pin 16 defines the pivot axis

15. In an ideal case, the coupling device consists of two identical arm members 3, 4 and the pin 16.

The two pivotably mounted arm members 3, 4 each have a top body portion 26, 27 and a lower body portion 24, 25. The pivoting mechanism 14 is coupled with the two arm members 3, 4, at their respective top body portion 26, 27.

The interior cavity 5 is defined by the lower body portions 24, 25 of the two arm members 3, 4. The cavity 5 has a centre 28 when the coupling device 1 is in closed position. The centre 28 of the cavity 5 is arranged at a distance from the pivot axis 15. This offset of the centre 28 with respect to the pivot axis 15 enables movement of the coupling head 2 towards the pivot axis 15 while the at least two arm members 3, 4 pivot towards the open position. In this case, the distance, or in other words the offset, between the centre 28 of the cavity and the pivot axis 15 corresponds with about a maximum diameter dimension of the cavity 5. It will be clear that any suitable distance will suffice, as long as movement of the coupling head 2 within the cavity 5 from the support 10 toward the pivoting axis 15 is possible to such an extent that the two arm members 3, 4 can commence pivoting towards the open position. To put it in different words, the cavity 5 is configured to provide a defined play 21 with respect to a coupling head 2 positioned in the cavity 5 to provide freedom to the coupling head 2 to move towards the pivot axis 15. The defined play 21 is shown in fig. 3.

The two arm members 3, 4 each comprise a mass distribution around the pivot axis 15. The mass is distributed such that upon lowering the coupling device 1 and contacting the coupling head 2, the second cam following member 7 forces pivoting of the two arm members 3, 4 around the pivot axis 15 towards the open position. In effect, the coupling device 1 comprises a CoG above the cavity 5 when the arm members 3, 4 are in closed position.

As best shown in fig. 2, the coupling device 1 comprises a hoisting member 29. The hoisting member is provided at a top end of the coupling device 1. A hoisting line not shown can be connected to the coupling device for the lifting of a load. A hoisting line can be wrapped once or more around the hoisting member 29. The coupling device has a catch 30 that is funnel shaped to guide the coupling device 1 with respect to a coupling head 2.

Figure 5A – 5F show subsequent method steps of coupling and decoupling the coupling device 1 and a coupling head 2. Firstly, in fig. 4A the coupling device 1 is lowered on the coupling head 2. In fig. 4B and 4C, the arm members 3, 4 are gradually forced into the open position by the own weight of the coupling device 1. The coupling head 2 can now enter the cavity and in fig. 4D the arm members 3, 4 pivot towards the closes position by their own weight. As a result, a connection between the coupling device 1 and the coupling head 2 is established by insertion of the coupling head 2 into the interior cavity of the coupling device 1.

Fig. 5D – 5F show - subsequent method steps of decoupling the coupling device 1 from the coupling head 2. First the coupling device is lowered while the coupling head 2 is in the cavity. Therefore, the two pivotably mounted arm members 3, 4 pivot into the open position as shown in fig. 4E to allow the coupling head 2 to be released from the interior cavity. As a final step, in fig. 4F, the coupling device 1 is hoisted away from the coupling head 2.

Although the present invention has been described in detail with reference to a number of exemplary embodiments, the present invention is not limited by the disclosed examples from which the skilled person is able to derive other variations without departing from the scope of the invention as defined in the appended claims.

Claims

1. Coupling device (1) for connecting and disconnecting to a coupling head (2) to be lifted, comprising;

at least two pivotably mounted arm members (3, 4), mutually pivotable between an open position wherein the coupling head can be received in and released from an interior cavity (5) defined by the at least two arm members, and a closed position wherein the coupling head can be secured in the interior cavity to enable lifting of the coupling head (2),

a first cam following member (6) arranged at an exterior of at least one arm member (3) for engaging the coupling head and pivot the at least one arm member to the open position upon lowering the coupling device on the coupling head,

a second cam following member (7) arranged within the interior cavity for engaging the coupling head and pivot the two arm members from the closed position to the open position upon lowering the coupling device with respect to the coupling head while the coupling head is in the interior cavity.

2. Coupling device according to claim 1, comprising a lock system (8) coupled with the at least two arm members to lock the at least two arm members in the open position during release of the coupling head from the interior cavity.

3. Coupling device according to claim 2, wherein the lock system (8) comprises a control unit that is remotely operable, preferably wirelessly operable, for controlling an operating mode of the lock system, the operating modes including lock position and allow free movement.

4. Coupling device according to claim 3, wherein the lock system (8) comprises a mechanical and/or hydraulic member (22) to lock the at least two arm members in its position.

5. Coupling device according to a preceding claim, wherein at least the second cam following member comprises a sloped section (9) that subtends an angle α with the vertical, wherein α < 60°.

6. Coupling device according to a preceding claim, wherein the at least two arm members each comprise an internal retaining element (23), and wherein, in use, the coupling head (2) interacts with the internal retaining elements (23) to lock the at least two arm members into the closed position allowing lifting and/or lowering of the load associated with the coupling head (2).

7. Coupling device according to claim 6, wherein the two internal retaining elements are arranged at lower body portions (24, 25) of the at least two arm members (3, 4).

8. Coupling device according to claim 6 or 7, wherein at least one of the at least two arm member comprises a support face (10) defining the interior cavity, wherein the internal retaining element (23) comprises at least a portion (11) of the support face (10), wherein the portion (11) of the support face (10) is sloped upwards towards a centre line (12) of the coupling device and wherein the upwards sloped section subtends an angle β with the horizontal, wherein β < 45°, preferably 1°< β < 25°, and most preferably 1°< β < 15°.

9. Coupling device according to a preceding claim, wherein at least one of the at least two arm member comprises a Centre of Gravity, CoG, (13) horizontally spaced from the centre plane (12) of the coupling device.

10. Coupling device according to a preceding claim, comprising a pivoting mechanism (14) coupled with the at least two arm members, and defining a pivot axis (15) of the at least two pivotably mounted arm members (3, 4).

11. Coupling device according to a preceding claim, wherein the at least two pivotably mounted arm members (3, 4) each have a top body portion (26, 27) opposite the corresponding lower body portion (24, 25), wherein the pivoting mechanism (14) is coupled with the at least two arm members at their top body portion, and wherein the interior cavity (5) is defined by the lower body portions of the at least two arm members.

12. Coupling device according to a preceding claim, wherein a centre (28) of the cavity is arranged at a distance from the pivot axis (15) to enable movement of the coupling head towards the pivot axis (15) while the at least two arm members pivot towards the open position.

13. Coupling device according to claim 12, wherein the distance between the centre of the cavity and the pivot axis (15) corresponds with about a maximum diameter dimension of the cavity (5).

14. Coupling device according to a preceding claim #, wherein the cavity comprises a defined play (21) with respect to a coupling head (2), when the coupling head (2) is positioned in the cavity (5) to provide freedom to the coupling head to move towards the pivot axis (15).

15. Coupling device according to any of preceding claims 10 - 14, wherein at least one of the at least two arm members comprises a mass distribution around the pivot axis (15) such that upon lowering the coupling device and contacting the coupling head, the second cam following member (7) forces pivoting of the at least one of the at least two arm members around the pivot axis towards the open position.

16. Coupling device according to a preceding claim, wherein the coupling device comprises a CoG above the cavity when the arm members (3, 4) are in closed position.

17. Coupling device according to a preceding claim, wherein the pivoting mechanism comprises a pin (16) extending through both the at least two arm members, and wherein the pin defines the pivot axis.

18. Coupling device according to a preceding claim, comprising a hoisting member (29) provided at a top end of the pivoting mechanism, such that a hoisting line can be connected to the system for the lifting of the load.

19. Coupling device according to a preceding claim, wherein both the at least two arm members comprise a cavity section (17, 18) that co-shape the interior cavity.

20. Coupling device according to a preceding claim, wherein both the at least two arm members comprise identical parts.

21. Coupling device according to a preceding claim 17 - 20, consisting of two identical arm members and the pin (16).

22. Coupling device according to a preceding claim, comprising a monitoring system (32) for monitoring engagement between the at least two arm members and the coupling head, the monitoring system comprising one or more of an imaging device (33) configured for determining locations and/or positions and/or displacements of the at least two arm members and the coupling device, a sensor system (34) for measuring mechanical parameters such as strain and pressure, in particular a contact pressure between the coupling head, and at least one for the retaining elements.

23. Coupling device according to a preceding claim, comprises a dampening member (35) arranged in the interior cavity for dampening any movement of the coupling head (19), when inserted in the cavity.

24. System comprising a coupling device according to a preceding claim and a coupling head mountable or connected to a load or a load carrying platform.

25. System according to claim 24, wherein the coupling head comprises a cam member (19) forming a cam follower device with at least the second cam following member (7).

26. System according to claim 25, wherein the cam follower device transforms linear motion into rotary motion of at least one of the at least two arm members.

27. A lifting and lowering assembly comprising the system of any of the preceding claims 24 - 26, wherein the coupling head is connected to a load element such that the load element can be lifted and lowered.

28. A method for lifting and lowering a load, using a crane having a hoisting cable attached to the coupling device of the system of any of the preceding claims 24 - 26, wherein the method comprises:

- lowering the coupling device on the coupling head, and

- establishing a connection between the coupling device and the coupling head by insertion of the coupling head into the interior cavity of the coupling device such that the at least two pivotably mounted arm members (3, 4) pivot into the open position to allow the coupling head to be received into the interior cavity and upon insertion of the coupling head into the interior cavity, pivoting the at least two pivotably mounted arm members (3, 4) into the closed position to lock the coupling head to the coupling device.

29. Method according to claim 28, comprising lifting the coupling device, such that the at least two internal retaining elements (23) frictionally interact with the coupling head to lock the at least two pivotably mounted arm members into the closed position.

30. Method according to claim 28 or 29, wherein the step of establishing a connection between the coupling device and the coupling head is executed above ground level or deck level, preferably at least 1 meter above ground or deck level.

31. Method according to claim any of claims 28 - 30, comprising the steps of;
- connecting the system to a component, the component being one or more of a monopile, a transition peace, a nacelle, a wind turbine, a propeller blade, etc.,
- providing the component with a coupling head,
- connecting the coupling device to the coupling head,
- hoisting the component, for positioning the component in or on an installation
- disconnecting the coupling device from the component, and subsequently
- handling of a similar or identical component on the ground or on the deck of a vessel.

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