Title: MOORING DEVICE AND METHOD OF MOORING

Abstract: Current invention relates to a mooring device (1), suitable for mooring a ship (S) comprising a magnet (12) suitable for making contact by magnetic force to a hull (H) of a ship (S), characterised in that the magnet (12) is positioned on a first end of an arm (2). The invention further relates to a method of mooring, comprising the following steps: providing a mooring device according to the invention on a water surface neighbouring structure, having a ship, barge, vessel or the like (S) approaching the structure, having the magnet (12) of the mooring device (1) facing the hull of the approaching ship (S) and allowing contact between the hull (H) of the ship (S) and the magnet (12) and switching the magnet (12) on.
Title: Mooring device and method of mooring

The invention relates to a mooring device.

More specifically the invention relates to a mooring device with a magnetic connector.

Such devices are for instance disclosed in the international patent application WO 2004 050 471. In this application, a series of magnets are disposed on a quayside, wherein the magnets are provided with magnetic cores that are comb shaped and wherein the teeth of the comb form the magnetic poles and are oriented away form the quayside.

In this device, the ship is not allowed any motion other than the vertical tidal induced motion of the ship. Motion induced by for example swell, wind and initial mooring and/or manoeuvring speed of the ship cannot be compensated by the proposed system. These motions can possibly impose impacts of the hull against the mooring magnets, causing damage and eventually possible holes in the hull.

In the shipping industry, in particular in bunkering transport, it is known to moor a bunkering vessel to a cargo ship, e.g. on open water, to load the freight from the bunkering vessel to the cargo ship. The mooring of the bunkering vessel to the cargo ship is usually done with the ropes on board of the bunkering vessel and/or the cargo ship. The mooring process is usually time consuming. For example, it may be difficult to connect the ropes between the two vessels. In addition, it may be a dangerous process for the workers involved to the mooring process. Further, during offloading of the bunkering vessel and loading of the cargo ship, the bunkering vessel may rise and the cargo ship may lower, thereby imposing for example slack in the ropes or too high strengths in the ropes, which may induce dangerous situations.

It is an object of the invention to provide a mooring device and/or a mooring method that obviates at least one of the above mentioned drawbacks.
A further object of the invention is to provide a mooring device that is preventing damage of the ships to be moored, while at the same time providing a secure, safe and reliable mooring with possible compensations for tidal motion, swell motion, initial mooring motions, manoeuvring motions and/or other movements of the ship to be moored.

At least this and/or other drawbacks may be solved by a mooring device according to claim 1 and a method of mooring according to claim 17. The invention further relates to a mooring system according to claim 14.

Thereto, the invention provides for a mooring device arranged to be mounted on a first object for mooring the first object to a second floating object, wherein the mooring device comprises a magnet at an end of an arm, wherein, during use, the magnet is connected via magnetic force to the second object, wherein the mooring device is arranged, during use, to reposition the magnet on the second object upon a varying height difference between the first and the second object.

By providing a magnet to moor the second object to the first object, a firm and reliable connection can be obtained. By allowing the magnet to be repositioned on the second object during use, movement of the second object with respect to the first object can be compensated. A relatively quick and safe connection between the first object and the second object may be obtained, since approximately no ropes may have to be used and/or handled.

The first object may be a floating object or a fixed object. The first object may e.g. be a quayside or a barge or a vessel or a pontoon or a mooring pile or a jetty or a wharf or a dock or a bank, etc.

The magnet can be a permanent magnet, an electromagnet and/or a semi-permanent magnet. Various magnet types may be used. The magnet can for example be a known clamping plate magnet, which is often used in industrial environments and known to the person skilled in the art.

Preferably, the mooring device is arranged to reposition the magnet upon a varying height difference between the first object and the second object.
For example, during loading/offloading of the second object, the draft of the second object may vary. So, the height difference between the first object and the second object will vary. When the height difference becomes too large or too small, the magnet can be repositioned.

In an advantageous embodiment, the magnet of the mooring device is repositioned upwardly and/or downwardly, thereby overcoming vertical movement of the second object with respect to the first object and vice versa.

For example, when the height difference becomes so large or so small that the angle of the arm exceeds a certain predetermined threshold, the magnet can be repositioned. For this purpose, the arm may be provided with an angle measurement sensor. When the height difference becomes too large, e.g. a high angle of the arm with respect to the horizontal, the magnet may be repositioned upwardly. When the height difference becomes too small, e.g. a small angle of the arm with respect to the horizontal, the magnet may be repositioned downwardly.

By providing the arm extendible, the arm of the mooring device can also overcome movement of the second object with respect to the first object. For example, an extendible arm may overcome horizontal movements between the first object and the second object. The arm may be provided with a pressure sensor for measuring the extension of the arm. The pressure sensor may e.g. measure the pressure onto the arm and/or the hydraulics of the arm to detect whether the arm e.g. is connected. Also, when the distance between the first object and the second object exceeds a certain limit, the arm may be shortened. For this purpose, the mooring device and/or the arm may be provided with a distance sensor. When the distance between the first object and the second object is less than a certain limit, the arm may be extended to push the first object and the second object more away from each other.

Preferably, the magnet is rotatable arranged at the end of the arm to allow the magnet to be relatively optimally positioned with respect to the second object, for example before connecting, or to allow the magnet to
overcome e.g. yaw motion between the first object and the second object. For example, the magnet is oriented substantially upwardly before connecting to the second object to minimize damage of the magnet to the second object. The magnet will usually be coupled to the hull of the floating second object. The hull may be substantially vertically oriented at the side facing the first object to be connected. To measure the orientation of the magnet, the magnet may be provided with a position sensor.

By providing a switchable magnet, the magnet can be turned on and off when necessary. For example, in an emergency case, a swift decoupling of the second object and the first object is thus possible. For example, the magnet can be switched on when the second object approaches the first object to connect to the second object as soon as the magnet contacts the second object.

The magnet may be provided as a semi-permanent electromagnet. Such a magnet may for example only require electrical current for switching the magnet on and off. So, in case of a power failure during use, e.g. during loading/offloading, the magnet still remains connected to the second object, due to its semi-permanent magnetic character. Even during power failure, the connection between the first object and the second object may be safeguarded. Also, the semi-permanent electromagnet may be switched on and/or off manually, which may provide additional safety.

The mooring device may be provided with many sensors, e.g. an angle measurement sensor for measuring the angle of the arm, a pressure sensor for measuring the pressure onto the arm and/or the hydraulic system, a distance sensor for measuring the distance between the first object and the second object or a position sensor for measuring the orientation of the magnet. Many other sensors and detection units may be provided, such as a rotational sensor for an axis of the magnet. Preferably, a control unit is provided to read the data provided by the sensors and to control the mooring device. The sensors provide the control unit with data regarding certain parameters. If the measured data are above or below a certain predetermined threshold, the
control unit may identify this and may send a control signal to the mooring device to correct.

For example, if the position sensor detects that the orientation of the magnet deviates too much from a vertical position, the control unit sends a control signal to the mooring device and/or the magnet, e.g. to an (electro)motor, to rotate the magnet to adapt the orientation of the magnet. In the control unit the threshold values are predetermined. For example, if the distance sensor detects a certain distance between the first object and the second object, the control unit can determine whether the detected value is within the predetermined thresholds. If the determined value exceeds a predetermined threshold, the control unit may send a control signal to e.g. the hydraulic system of the arm to shorten the arm so the distance will come below the threshold value. The mooring device is thus automatically controlled. When interference is necessary, e.g. in case of an emergency, the mooring device can also be controlled manually.

By providing a mooring system comprising at least two mooring devices, the first object can be connected to the second object at various positions, thereby obtaining a firm and reliable connection. In an embodiment, the mooring system may comprise four mooring devices mounted on the first object. Depending on the first object, e.g. size, capacity, length etc. of the first object, more or less mooring devices may be provided.

Preferably, the magnets of the mooring devices each have a different upward position. For example, one magnet is positioned relatively high onto the second object and one magnet may be positioned lower onto the second object. Such that, when there is upward movement between the second object and the first object, one mooring device at a time can be repositioned. The other mooring device may then remain connected, until repositioning for the second mooring device may become apparent. Preferably, in the mooring system, the control unit takes account of the positions of the other mooring devices when repositioning one mooring device, such that the mooring devices
are approximately in a suitable position and/or the repositioning of the
mooring devices may be one by one, preferably in a regular manner.

By providing a mooring method using at least one mooring device
and/or a mooring system, a relatively quick, safe and reliable method for
mooring a first object to a second object may be provided.

A mooring device is presented, suitable for mooring a ship
comprising a magnet, suitable for making contact by magnetic force to a hull of
a ship, wherein the magnet is positioned on a first end of an arm.

A method of mooring is provided, which method comprises the
following steps: providing a mooring device on a water surface neighbouring
structure, having a ship, barge, vessel or the like approaching the structure,
having the magnet of the mooring device facing the hull of the approaching
ship, allowing contact between the hull of the ship and the magnet and
switching the magnet on, such that a secure mooring is performed.

Further advantageous aspects of the invention can be found in the
dependent claims.

For a better understanding, embodiments of the invention will be
further elucidated by the following Figures, wherein:

Figure 1a is a schematic side view of a mooring device according to a
first embodiment of the invention;

Figure 1b is a schematic side view of an alternative embodiment of
the invention;

Figure 1c is a schematic side view of a further alternative
embodiment of the invention;

Figure 2 is a schematic side view of an actuator, applied inside an
extendable arm according to the first embodiment of the invention;

Figure 3 is a partly worked open schematic perspective view of a
casing of a first end of the extendable arm of the mooring device according to
the first embodiment of the invention;
Figure 4 is a schematic perspective view of an extendable arm element according to a further alternative embodiment of the invention;

Figure 5 is a schematic side view of a connection between a connector and a magnet bracket according to yet another embodiment of the invention;

Figure 6 is a schematic perspective view of a base of the mooring device according to the first embodiment of the invention;

Figure 7a is a first schematic front view of a ship being moored by means of a mooring device according to the invention during low tide,

Figure 7b is a second schematic front view of a ship being moored by means of a mooring device according to the invention during high tide,

Figure 8a is a first schematic front view of a bunker ship being moored by a ship by means of a mooring device according to the invention when the bunker ship is loaded,

Figure 8b is a second schematic front view of a bunker ship being moored by a ship by means of a mooring device according to the invention when the bunker ship is unloaded,

Figure 9 shows a front view of an embodiment of a mooring system according to the invention;

Fig. 10 shows a side view of a part of the mooring system of Fig. 9.

In the figures and the description the same or corresponding parts will have identical or similar reference signs. The embodiments shown should not be understood as limiting the invention in any way or form.

Figure 1 depicts a mooring device 1 for boats, ships or vessels, ranging from small private leisure yachts to large commercial vessels.

The mooring device 1 can be mounted on a first object 27 e.g. on a boat's deck or on a quayside and can replace or provide an addition to conventional mooring system such as ropes and/or shore attachments. The mooring device is arranged to moor a second floating object 28 to the first
object 27. The second object 28 can be a ship S or a vessel S or a barge, etc. The first object 27 can also be a floating object or a fixed object, e.g. a quayside Q.

The mooring device 1 can be applied singly or in a row of several units, wherein the number of mooring devices 1 is depending on the needs of the vessel to be sufficiently secured.

The mooring device 1 comprises an elongated arm 2 capable of extending or stretching out in length by means of an extendable arm element 3, which is housed by a solid, protective casing 4. The elongated arm is capable of elongating in the same manner as the position of the extendable arm element 3 would stipulate within any point, within its restrictions, that the arm can move to.

To a first end 2a of the elongated arm 2, a connector 8 is attached. To this connector 8, a first end 10a of a first actuator 10 is pivotly connected. A second end 10b of this first actuator 10 is pivotly connected to the baseplate 7 or to the single unit bracket 6a. By the arrangement of the first actuator 10, it can rotate the elongated arm 2, thus allowing the second extending end 2b to move upwards and downwards.

In figure 1, the arm is provided with one extendable arm element 3, which is internally driven by a second actuator 11 as shown in figure 2. A first end 11a of the second actuator 11 is connected to the connector 8 and a second end 11b is connected to the extendable arm element 3. By the arrangement of the actuator, the extendable arm element 3 can extend or shorten the arm 2. Alternatively, the extending arm can comprise more than one extending element and can be arranged in a telescopic manner for instance by means of a set of concentrically arranged telescopic elements.

The protective casing 4 of the elongated arm 2 is supported by a hinge 5, pivotly built within two opposing supporting walls 6 of a single unit bracket 6a. The single unit bracket 6a is connected to a base plate 7, which can be mounted on e.g. a ship S, as depicted in the figures 8a and 8b or on a quayside, as depicted in figures 7a and 7b. The hinge 5 is arranged near a first
end 2a of the arm 2, such that a second end 2b of the arm 2 is extending from the single unit bracket 6a.

The actuator 10 can be chosen to be a hydraulic cylinder, a pneumatic cylinder, a linear electrical actuator and/or any other suitable actuator.

The actuator 10 can be prompted by for example a smaller hydraulic pump placed on the end and exterior of the mooring device 1 in its entirety, within the spatial restrictions of the place it is mounted on. Alternatively the actuator can be prompted by e.g. an onboard hydraulic, electric or pneumatic system, when such system is available.

The pivoting motion of the extendable arm 2 ensures the adjustment of the mooring system to the motion of the vessel S e.g. due to swell, oscillation of water and possible rising or descending movement due to load alleviation or load discharge.

Thus the mooring system 1 allows up- and downward motion of the vessel S 28 while maintaining the vessel S 28 moored.

The elongated arm 2 supports a large electromagnet 12 which is pivotally connected to the end of the extending arm element 3. The electromagnet 12 is pivotally connected by means of a connecting shoe 13. The connecting shoe 13 is at a first side pivotally connected to the extending arm element 3 by means of an upwardly arranged axis 14. The connecting shoe 13 is at a second side 13b pivotally connected to the magnet bracket 15 by means of a lying axis 16.

Both axes 14 and 16 allow the magnet bracket 15 to adapt its position to the shape and rounding of a hull H of a vessel S 28 to be moored. Thus, the surface of the hull H need not be perfectly perpendicular to the mooring magnet surface 12a in order to be moored. Since most hulls H are by nature of non-planar design this additional motion provides more flexibility to the mooring system 1.
In order to maintain the magnet bracket 15 and the magnets 12 in a substantially upright position, a third actuator 17 can be arranged between at its first end 17a to the extending arm element 3 and at its second end 17b to the connecting shoe 13. The actuator 17 can arrange the orientation of the magnet bracket 15 and the magnet 12 with respect to a lying axis of rotation.

In an alternative embodiment as depicted in figure 1b, the magnet bracket 15 and the magnets 12 can be maintained in a substantially upright position by means of an extendable pilot arm 18, as is schematically depicted in figure 1b. The pilot arm 18 can be at a first end 18a pivotally connected to the supporting walls 6 of the single unit bracket 6a and at a second end 18b pivotally connected to the connector shoe 13.

In another embodiment as schematically represented by figure 1c, the arm can be provided with a link system comprising a knee joint 19.

In a further alternative embodiment, a further actuator 20 is arranged between the extending arm element 3 and the magnet bracket 15. The actuator 20 can arrange the orientation of the magnet bracket 15 and the magnet 12 with respect to an upright axis of rotation.

Thus the actuator 17 provides flexibility towards the orientation of the hull of a ship to be moored in a horizontal sense and the actuator 20 provides flexibility towards the orientation of the hull of the ship in a vertical sense.

In the embodiment as depicted in figure 5, a connector 21 is provided. The connector 21 can be mounted on the extendable arm element 3 of the mooring device 1. A connector shoe 13 is at a first side 13a around an upward axis 14 pivotally connected to the magnet bracket 15 and at a second side 13b around a lying axis 16 pivotally connected to the connector 21. The connector shoe 13 is at the second side 13b provided with edges 22 and 23. The edges 22 and 23 are shaped to be able to touch on end surface 21a of the connector 21 when the connector shoe 13 has rotated about a certain angle A.
with respect to a vertical axis. This angle \( A \) can for instance be chosen to be +30°.

In figure 6, the single unit bracket 6 is depicted in more detail. The supporting walls 6a can be connected to the base plate 7 by means of knee plates 24. The hinge 5 can comprise an axis 5a which is pivotally connected to the supporting walls 6a, by means of bearings 25.

The surfaces 22 and 23 of the connector shoe 13 can be provided with approach detectors 25 and 26 such as restrictive sensors. The magnet 12 can be controlled by restrictive sensors 25 and 26 that can be arranged to switch on the electromagnet 12 within the restrictive area and turn off the effective working of the electromagnet 12 when the outside boundaries of the mounting place are reached to ensure safety and effective working of the system.

Alternatively or additionally a rotational sensor can be used for measuring the rotation of the lying axis 16. This sensor can control the switching of the magnet 12 as well. Similarly force sensors can be applied to measure the forces exerted on the arm 2, the magnet 12 and/or the base structure 6 and 7.

The moment either restrictive boundary is reached and the electromagnet 12 is switched off. When the magnet 12 is switched off, no magnetic force will remain to fix the magnet to the hull and thus the extendable arm 2 and the magnet 12 can automatically move back towards an initial position, where the magnet can be switched on again.

The arm 2 can be moved back to its idle or original position for example by retracting the extending arm element 3 by means of actuator 11 from the hull H of a ship S, moving the arm back to its idle or original position by means of actuator 10, extending the arm by moving the extendable arm element 3 towards the hull H of the ship S 28, switching the magnet on to regain secure mooring of the ship S 28.
Thus when the vertical movement of the ship is beyond the reach of the extendable arm 2, the magnet can, step by step, move relative to the hull H of the ship S. This way of moving/stepping over the surface will be preferable performed when more than one mooring device 2 is used, such that the separate mooring devices can step along the surface alternately such that at any time at least one magnet can be in contact with the hull. Thus the ship can be maintained moored without breaking loose.

The operational abilities of the mooring device 1 can also be controllable through remote control which can e.g. overrule an automatic sensor system with the switches 25 and 26. The electromagnet 12 can function as an accretion method to any surface suitable for electromagnetic attachment. This can entail ship hulls H (quay side mooring) or anything else meant for this objective (harbour side mooring).

In an aspect of the invention the mooring system can be vessel mounted. In that case, the quayside or the structure to be moored by can additionally be provided with special metal strips or plates, in order to facilitate the mooring by means of the mooring device 2.

To further ensure the adjustment of the involved vessel to oscillation of water and possible rising or descending movement, the elongated arm’s function is extended in its support of the electromagnet 12 by a rotational construction with the upright and lying axes of rotation 14 and 16, as described above. This rotational constructions, which in fact functions as a homokinetic element ensures the adaptive movement of the electromagnet 12; up and down; and left to right, thus allowing movement in several degrees of freedom, like for instance six axes.

A single mooring device 1 can solely be effective as a mooring system, but can similarly or alternatively be combined with a number of other, similar mooring devices 1 to create a complete cooperating mooring system. In practical use, a secure mooring is performed by at least two mooring points,
such that for secure mooring two mooring devices 1 can be needed in the mooring system.

Such mooring systems can facilitate the mooring of larger vessels, where the amount of mooring devices 1 can be dependent on e.g. size and weight. In such a mooring system, each single mooring device 1 can be placed in a different position regarding the height of the elongated arm 2 of each single mooring device 1.

A plurality of mooring devices 1 can thus ensure that when discharging or loading of any kind, a vessel can always be attached to at least all but one of the single mooring devices 1. Due to the functioning of the aforementioned and explained restrictive sensors 25 and 26 in synchrony with the functioning of the aforementioned and explained electromagnet 12, the separate mooring devices 1 can step by step move along the surface of the hull H of the ship S to be moored.

This will maximize safety and guarantee secure attachment of the vessel S to a desired choice of place of attachment, whether this is quay side Q, harbour side or vessel side enabling it to mimic the flexibility of ropes making it manageable on the water and its random movements and flows.

To further ensure adaptability to the water's movements the entire structure can be placed on a sled or carriage like basis which enables it to slide forward and backward, confined by e.g. a large spring, controlled by a large hydraulic arm and or actuated by an actuator, which can bring it back to its original starting point. The sled can further provide an additional retraction possibility for securing that the arm can remain within the fender line of the ship, for example during transport or travel.

In any embodiment of the invention as described before numerous adaptations and modifications are possible. For instance, in order to gain flexibility, the magnet bracket can alternatively or additionally be supplied with suction cups, when mooring by means of magnetic forces is impossible, for example when polyester boats are being moored by a quayside mounted
mooring device. By applying vacuum to these cups an additional or alternative force can be exerted on the hull of a ship.

Although most embodiments refer to the mooring of a ship by a shore, quay or other fixed world structures, the system can be applied for ship to ship mooring, such as pushed lighter or dumb barge transport or bunkering transport.

In the embodiments shown, several actuators 10, 11, 17 and 20 are described. These actuators can be hydraulically, pneumatically and/or electromagnetically driven. Besides the actuating function, these actuators can be arranged as dampers to absorb sudden motions of the ship S.

The single mooring devices 1 or a system of a multitude of mooring devices 1 can be controlled by a suitable logic circuit. Such logic circuit can for instance be a logic computer such as a PLC or a PC.

Since the mooring devices 1 can be used for fuel loading bunker ships flammable and explosive liquids and vapors can thus be emitted, all of the electrical connection, wiring, actuators and other electrical equipment can be made suitable for the highest explosion standards. For this reason a hydraulic or pneumatic actuator system can be advantageous.

Figure 9 shows a front view of a mooring system 30 comprising multiple mooring devices 1. In this embodiment, four mooring devices 1 are shown. Of course more or less mooring devices 1 may be provided for the mooring system.

The mooring devices 1 are mounted onto a first object 27, which can be a static object e.g. a quayside or a jetty or a mooring pile or which can be a floating object, e.g. a vessel or barge or ship. Figure 10 shows a side view of the mooring system 30 of figure 9. For reasons of simplicity, only two of the four mooring devices are shown.

Each mooring device 1 comprises a magnet 12 which is coupled to a support 29 via an arm 2. The arm 2 is in this embodiment extendible. The support 29 can for example comprise a base plate 7 with supporting walls 6
and a bracket 6a. The support 29 can be mounted onto the first object 27. For example, the support 29 can be mounted onto a quayside, or the support 29 can be mounted onto the deck of a vessel, e.g. a bunkering vessel. The magnet 12 can be a well known clamping plate magnet, allowing the magnetic force to be distributed in the metal e.g. the hull of a vessel, only. Preferably, the magnet 12 is an electromagnet.

In figure 9 and figure 10 is shown that the magnets 12 each have a different upward position. One magnet 12 has a higher position than another magnet 12. The magnets 12 are arranged to be repositioned onto the second object 28 during use. For example, when during offloading of the first object 27, the first object 27 rises with respect to the second object 28. When the height difference between the first object 27 and the second object 28 becomes too large, the magnet that was positioned lowest, in figure 9, magnet 12b, may have to be repositioned to a higher position. Thereto, the magnet 12 can be switched off, such that the magnet 12 can become loose from the second object 28. Then the arm 12 can be controlled to reposition the magnet 12 to a higher position. Preferably only one magnet 12 at a time can be repositioned to provide for a safe and secure mooring by the other magnets.

In an example, the first object 27 can be a bunkering vessel and the second object 28 can be cargo ship. The mooring system 30 is arranged onto the deck of the bunkering vessel. To offload the cargo of the bunkering vessel 27 to the cargo ship 28, for example when there is no fixed mooring arrangement available, the bunkering vessel 27 can be moored to the cargo ship 28 using the mooring system 30. When the cargo ship 28 is sufficiently near to the bunkering vessel 27, the cargo ship 28 can be connected to the bunkering vessel 27 using magnetic force of the magnets 12.

By positioning the magnets 12 in an approximately upward position before approaching the cargo ship 28, the magnets 12 can connect smoothly and firmly to the hull of the cargo ship 28 without damaging the cargo ship 28. When approaching the hull of the cargo ship 28, each magnet 12 has a
different upward position, such that when connected to the hull of the cargo ship 28, each magnet 12 is also connected at a different height. For example, magnet 12c is higher than magnet 12a. Magnet 12b is positioned lowest in this embodiment.

During offloading of the bunkering vessel 27, the draft of the bunkering vessel 27 will decrease and due to the loading of the cargo ship 28, the draft of the cargo ship 28 will increase. Thus it may occur that for example the lowest positioned magnet 12 becomes too low and has to be repositioned to a higher position. When continuing with offloading of the bunkering vessel 27, a following magnet 12a may become positioned too low and may have to be repositioned to a higher position. This way, the magnets may move upwards step by step, one by one and a varying height difference between the bunkering vessel 27 and the cargo ship 28 may be accommodated.

An angle sensor provided on each arm, may detect the angle of the arm and when exceeding a certain predetermined threshold, it may give a signal to a control system for repositioning the magnet. The mooring device 1 may be provided with multiple sensors and may be controlled by a control unit. The control unit may read the data provided by the sensors and may determine whether the data are within predetermined boundaries. If a measured value is below or above such a preset boundary, the control unit may send a control signal to the mooring device to correct such that the value of the specific sensor becomes within limits again. The control unit is thus arranged to control the mooring device. When a mooring system with multiple mooring device is present, the control unit is also arranged to adapt the positions of the mooring devices with respect to each other such that an optimal mooring arrangement can be obtained.

The invention further relates to a mooring device 1, suitable for mooring a ship S comprising a magnet 12 suitable for making contact by magnetic force to a hull H of a ship S, characterised in that the magnet 12 is positioned on a first end of an arm 2. Further, the arm 2 is pivotally connected
to a base 6,7, wherein the base 6,7 is able to be positioned on a quayside, a bank, another ship, a barge, a dock, a quay, a wharf, a jetty and/or other structures where a ship S can be moored by. The arm 2 can be extendable.

In an other aspect of the invention, the arm 2 comprises a casing 4 and an extendable arm element 3 wherein the casing 4 and the extendable arm element 3 are interconnected with an actuator 11, wherein the actuator is able to move the extendable arm element in relation to the casing 4.

In a further aspect of the invention, the magnet bracket 15 is rotatable connected to an end of the arm 2.

In an other aspect of the invention, the angle of rotation A of the magnet is restricted by approach switches 25, 26 which are able to control the force of the magnet.

In an other aspect of the invention, a mooring system is provided with at least two such mooring devices.

In a further aspect of the invention, the mooring system comprises a central logic circuit for controlling the actuators 10, 11, 17, 20 of each of the mooring devices 1 of the system.

In an other aspect of the invention, a method of mooring is provided, comprising the following steps: providing at least one mooring device or a mooring system, in an initial position on a water surface neighbouring structure, having a ship, barge, vessel or the like S approaching the structure, having the magnet 12 on the end of the arm of the mooring device 1 facing the hull H of the approaching ship S, allowing contact by means of magnetic force between the hull H of the ship S and the magnet 12 and switching the magnet 12 on.

Further, the method may comprise the step of measuring the angle of each of the arms 2 with respect to an upright axis by approach switches 25, 26, angle measurement sensors, tension registration and/or force registration sensors, providing a signal by means of these switches or sensors when the angle A of the arm 2 with respect to an upright axis surpasses a threshold.
value, switching off the magnet 12 of the corresponding mooring device 1 to release the magnet from the hull H of a ship S, moving the arm 2 to its initial position, switching the magnet 2 on to re-establish a firm contact with the hull H of the ship S by means of magnetic forces, repeating the above listed five steps during loading, off-loading of the ship S and/or tidal motion of the ship S.

These and other adaptations and modifications are possible without departing from the spirit and scope of the invention as defined in the following claims.
Claims

1. A mooring device arranged to be mounted on a first object for mooring the first object to a second floating object, wherein the mooring device comprises a magnet at an end of an arm, wherein, during use, the magnet is connected via magnetic force to the second object, wherein the mooring device is arranged, during use, to reposition the magnet on the second object.

2. The mooring device according to claim 1, wherein the mooring device is arranged to reposition the magnet upwardly and/or downwardly.

3. The mooring device according to claim 1 or 2, wherein the mooring device is arranged to reposition the magnet upon a varying height difference between the first object and the second object.

4. The mooring device according to any one of the preceding claims, wherein the arm is extendible.

5. The mooring device according to any one of the preceding claims, wherein the magnet is rotatable arranged at the end of the arm.

6. The mooring device according to any one of the preceding claims, wherein the magnet is a switchable magnet.

7. The mooring device according to any one of the preceding claims, wherein the magnet is repositioned when an angle of the arm exceeds a certain predetermined threshold value.

8. The mooring device according to claim 7, further comprising an angle measurement sensor for measuring the angle of the arm.

9. The mooring device according to any one of the preceding claims, wherein the magnet is oriented substantially upwardly before connecting to the second object.

10. The mooring device according to claim 9, wherein the magnet comprises a position sensor for measuring a orientation of the magnet.
11. The mooring device according to any one of the claims 4 – 10, further comprising a pressure sensor for measuring an arm extension.

12. The mooring device according to any one of the preceding claims, further comprising a control unit for reading data provided by one or more sensors and for controlling the mooring device.

13. The mooring device according to any one of the preceding claims, wherein the first object is floating.

14. A mooring system comprising at least two mooring devices according to any one of the claims 1 – 13.

15. The mooring system according to claim 14, wherein the mooring devices, during use, each have a different upward position.

16. The mooring system according to claim 14 or 15, wherein the mooring system is arranged to reposition a single mooring device at a time.

17. A method for mooring a first object to a second floating object, comprising
   - arranging a mooring device according to any one of the claims 1 – 13 and/or a mooring system according to any one of the claims 14 – 16 on the first object,
   - providing the second floating object neighbouring the first object,
   - connecting the second floating object to the first object via at least one mooring device.

18. The mooring method according to claim 17, further comprising repositioning the magnet of the mooring device upon a varying height difference between the first object and the second object.

19. The mooring method according to claim 18, further comprising, when a mooring system is arranged, repositioning a single mooring device at a time.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. E02B3/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>DE 92 07 648 U1 (ROHR GMBH, 6701 OTTERSTADT, DE) 20 August 1992 (1992-08-20) page 1, line 22 - line 31 page 3, line 5 - page 4, line 16; figures</td>
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<td>WO 2004/050471 A (UNIV DELFT TECH [NL]; GEMEENTEWERKEN ROTTERDAM [NL]; VERWEIJ MARTIN DA) 17 June 2004 (2004-06-17) cited in the application page 2, line 13 - line 17 page 3, line 9 - line 37; figure 1</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search

26 February 2010

Date of mailing of the international search report

04/03/2010

Name and mailing address of the ISA/
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Authorized officer

De Coene, Petrus

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