Title: APPARATUS FOR MOORING SHIPS

Abstract: The invention relates to an apparatus for mooring ships that have a magnetisable hull, embodied with a series of magnets disposed on or at a quayside, wherein the magnets have magnetic cores that are comb-shaped, with the teeth of the comb forming the magnetic poles and are oriented away from the quayside.
Apparatus for mooring ships

The invention relates to an apparatus for mooring ships that have a magnetisable hull, embodied with a series of magnets disposed on or at a quayside.

Such an apparatus is known from the magazine *Delta* of 4 July 2002, published by the Delft University of Technology. In this publication it is proposed to use a series of switchable magnets for the mooring of ships. However, the article mentions a few problems that could arise in connection with the possible influence of the applied magnetic field on the cargo of the ship and the equipment on board the ship. When the apparatus is used for mooring a container ship it is, moreover, the question whether the magnetic field does not form an impediment to the removal of the containers from the ship.

The intended purpose of the invention is to provide an apparatus of the kind referred to in the preamble, wherein the problems just mentioned do not occur and with which further advantages can be attained that will become apparent hereinbelow.

In a first aspect, the apparatus according to the invention is characterised in that the magnets possess multiple poles oriented away from the quayside. Such multiple poles may be embodied in various ways, for example, as viewed in cross section- a repeating pattern of circular poles.

However, in accordance with the invention it is preferred for the magnets to have magnetic cores that are comb-shaped, with the teeth of the comb forming the magnetic poles. It is desirable for the magnetic poles to alternately form north and south poles.

Surprisingly, it has been shown that with the use of magnets embodied in accordance with the invention, it is possible to moor very large ships at the quayside, while the magnetic field to be applied can stay within the limits of the magnets themselves and the ship's hull in the immediate vicinity of the magnets.
It is desirable for the width of the teeth of the comb to approximately correspond to the thickness of the ship's hull. This measure effectively ensures that the magnetic field stays within the limits as mentioned above.

In order to realise such an apparatus that serves the intended purpose, the same may suitably be realised such that the magnets are switchable, and provided with excitation windings around the teeth of the comb.

Advantageous is an embodiment wherein the excitation windings are not alternating current- but direct current-fed. In this way it is possible to avoid eddy-current losses and the accompanying generation of heat in the ship's hull.

In a further aspect of the invention, the apparatus is characterised in that the magnets on the quayside are moveable in the vertical direction. This makes it possible for the apparatus to be used in harbours that are subject to tidal movement. The up-and-down movement of the moored ships can simply be followed by the magnets. In a preferred embodiment, the apparatus is characterised in that a control system is provided for alternately switching on and off predetermined groups of magnets, such that during operation in a predetermined period of time each magnet is switched off and on at least once, while the magnets are never switched off all at the same time. If the magnets are disposed in a fixed arrangement, this system makes it possible to apply a very high frequency of switching on and off, allowing for the moored ships' varying height and allowing the system to be used in a harbour subject to tidal movement. If the magnets are moveable in the vertical direction it is further possible to switch the magnets on and off at a relatively low frequency allowing the tidal movement of the ship to be followed, while the movement in the vertical direction of the magnets may be limited.

Hereinbelow the invention will be further elucidated by way of a non-limiting exemplary embodiment and with reference to the drawing.

The drawing shows in:
- Fig. 1 a schematic illustration of a ship moored with the aid of an apparatus according to the invention;
- Fig. 2 a single magnetic core of a magnet of the apparatus according to the invention, and
- Fig. 3 a schematic cross section of a magnet of an apparatus according to the invention.

Similar parts in the figures are identified by identical reference numbers.

Referring first to Fig. 1, showing a schematic illustration of a ship 1 moored along a quayside 2, at the water side of the quayside 2. A series of magnets 3 are disposed keeping the ship moored. Each of the magnets 3 forms a magnetic circuit with the hull 4 of the ship 1. To this end the ship’s hull 4 needs to be of magnetisable material. This requirement is usually met, since most hulls of ships are manufactured in a magnetisable variety of steel.

Fig. 2 represents a magnetic core 5 of a single magnet 3, showing clearly that in the embodiment illustrated the same is shaped like a comb. The form of the magnetic core 5 is such that the teeth 6 of the comb are provided on a rear plate 7. The teeth 6 form the magnetic poles of the magnet 3 and when the ship 1 is moored, they are oriented towards the ship’s hull 4. It is also conceivable to arrange these magnetic poles in any other arbitrarily repeating pattern such as, for example, a repeating pattern of - viewed in cross-section - circular poles.

The magnetic poles formed by the teeth 6 of the magnetic core 5 are alternately north and south poles. In Fig. 3 therefore, some of the teeth 6 carry the letters N and S to indicate whether a north or a south pole is concerned. As shown in Fig. 3, the windings 8 for exciting the magnet are disposed between the teeth 6 of the magnetic core 5. The person skilled in the art is quite familiar with such electrical windings and they need no further elucidation.

The magnets 3 shown in Fig. 1 are preferably arranged on the quayside 2 so as to be moveable in the vertical direction.
It is further preferred for the magnets 3 to be coupled to a control system (not shown) for switching predetermined groups of magnets alternately on and off, such that during operation in a predetermined period of time each magnet 3 is switched on and off at least once while, however, the magnets 3 are never switched off all at the same time. This is a simple manner of providing the possibility for the moored ship to follow the tidal movements in the harbour, while the magnets 3 substantially maintain a vertical position on the quayside.

2. If a possibility of vertical movement is provided for the magnets 3, the frequency of switching the magnets 3 on and off may be chosen to be relatively low. However, if the magnets 3 disposed on the quayside are fixed without possibility of vertical movement, the frequency of switching the magnets 3 on and off should be relatively high.

The protective scope merited by the invention is determined exclusively by the appended claims without being limited in any way by the preceding discussion. Said discussion of the invention merely serves to elucidate the appended claims.
CLAIMS

1. An apparatus for mooring ships that have a magnetisable hull, embodied with a series of magnets disposed on or at a quayside, characterised in that the magnets possess multiple poles oriented away from the quayside.

2. An apparatus according to claim 1, characterised in that the magnets have magnetic cores that are comb-shaped, with the teeth of the comb forming the magnetic poles.

3. An apparatus according to claim 2, characterised in that the width of the teeth of the comb approximately corresponds to the thickness of the ship’s hull.

4. An apparatus according to one of the claims 1-3, characterised in that the magnetic poles alternately form north and south poles.

5. An apparatus according to one of the claims 1-4, characterised in that the magnets are switchable, and provided with excitation windings around the teeth of the comb.

6. An apparatus according to claim 5, characterised in that the excitation windings are direct current-fed.

7. An apparatus according to one of the claims 1-6, characterised in that the magnets on the quayside are moveable in the vertical direction.

8. An apparatus according to one of the preceding claims, characterised in that a control system is provided for alternately switching on and off predetermined groups of magnets, such that during operation in a predetermined period of time each magnet is switched off and on at least once, while the magnets are never switched off all at the same time.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B63B21/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbol)

IPC 7 B63B

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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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>DE 19 11 949 A (DEMAZ ZUG GMBH) 8 October 1970 (1970-10-08) the whole document</td>
<td>1,2,4-7</td>
</tr>
<tr>
<td>Y</td>
<td>US 4 030 441 A (NAGATA TOSHIRO ET AL) 21 June 1977 (1977-06-21) column 3-column 4; figures 4,5</td>
<td>1,2,4-7</td>
</tr>
<tr>
<td>A</td>
<td>DE 11 29 081 B (HAMBURGER HOCHBAHN AG) 3 May 1962 (1962-05-03)</td>
<td></td>
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</tbody>
</table>

Further documents are listed in the continuation of box C.  

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### INTERNATIONAL SEARCH REPORT

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 1911949 A</td>
<td>08-10-1970</td>
<td>DE 1911949 A</td>
<td>08-10-1970</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 51108497 A</td>
<td>25-09-1976</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 53003877 B</td>
<td>10-02-1978</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 1517737 A</td>
<td>12-07-1978</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NL 7514814 A</td>
<td>21-09-1976</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 6169286 A</td>
<td>14-05-1987</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 86107190 A</td>
<td>15-07-1987</td>
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<tr>
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<td></td>
<td>DE 3628544 A1</td>
<td>16-04-1987</td>
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<tr>
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<td></td>
<td>FR 2588543 A1</td>
<td>17-04-1987</td>
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<td></td>
<td>GB 2181897 A, B</td>
<td>29-04-1987</td>
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<td></td>
<td>JP 1977057 C</td>
<td>17-10-1995</td>
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<td></td>
<td></td>
<td>JP 7003805 B</td>
<td>18-01-1995</td>
</tr>
<tr>
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<td></td>
<td>JP 62202507 A</td>
<td>07-09-1987</td>
</tr>
<tr>
<td>DE 1129081 B</td>
<td>03-05-1962</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>

Form PCT/SA/210 patent family annex (July 1992)