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(54) DEVICE FOR MOORING A VESSEL

(71) We, ISHIKAWAJIMA-HARIMA JUKOGYO KABUSHIKI KAISHA, a Company organised under the laws of Japan of No. 2—1, 2—chome, Ote-machi, Chiyoda-ku, Tokyo-to, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a device for mooring a vessel.

In and near harbours, vessels are, in general, manoeuvred by a tug boat. That is, the tug boat directly pushes a vessel or tows a vessel with a tow-rope. A floating crane is often berthed alongside a vessel or a vessel is berthed alongside a pier by mooring ropes.

An object of the invention is to provide a mooring device enabling such operation to be simplified, particularly with enormous tankers.

According to the invention a device for mooring a ship or the like comprises an apertured plate, a flexible rim secured to one side of the plate adjacent its periphery to define with said plate a recess, means adapted to connect the aperture in said plate to a source of vacuum on the side of the plate remote from the rim whereby, when said rim is placed against a surface, the plate can be secured and held to the surface by applying a vacuum to the recess and means on said plate to limit deformation of the rim when the recess is subjected to a vacuum, a support for the plate, joint means permitting some relative angular movement between the support and the plate and one or more power actuators connected to the support.

Such a device has many advantages in connection with the handling of large vessels in harbour.

(i) Because of the positive and strong force produced in a simple manner by the suction cup a vessel may be made fast in a very simple manner;

(ii) Since the suction cup assembly may assume various positions, a vessel may be moored in different attitudes;

(iii) Even a mammoth-sized vessel may be moored by the suction cup assemblies so that towing or mooring may be much facilitated

(iv) Buffers can absorb the shock of an impact produced when a vessel is berthed alongside another vessel or a pier, and the energy of waves can be simply and positively absorbed.

(v) The position of the suction cup may be changed to any desired place and its angular position may be varied in dependence on the particular task;

(vi) The suction cup can be mounted upon the support plate in such a way that it may swing or move linearly, or pivot;

(vii) The angular position of the suction cup may be maintained by power actuators e.g. hydraulic cylinders.

(viii) When the suction cup is mounted upon a self-propelled carriage on a tug boat or the like, it may be displaced to any desired position so that the optimum pushing or towing angle may be attained; thus any type of vessel may be pushed or towed and the pushing or towing position may be changed very simply;

(ix) The direction of the tug boat may be changed easily so that hydraulic pressures exerted on the tug boat may be adjusted.

(x) When the mooring device is installed

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in the dock, a vessel may be moved in the dock by movement of the mooring device.

The invention may be carried into practice in various ways and certain embodiments will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a front view of a suction cup assembly employed in a mooring device according to the invention;

Figure 2 is a sectional view thereof showing one embodiment of the joint means;

Figure 3 is a view looking in the direction indicated by the arrows A—A in Figure 2;

Figure 4 is a side view of an adaptation of the joint means of Figures 2 and 3;

Figures 5 to 7 are views used for explaining one use of mooring device embodying the present invention;

Figure 8 is a side view of another embodiment of the present invention;

Figure 9 is a cross sectional view, on enlarged scale, of a universal joint in the embodiment shown in Figure 8;

Figure 10 is a view looking in the direction indicated by the arrow B in Figure 9;

Figure 11 is a side view of a tug boat provided with a mooring device constituting another embodiment of the present invention;

Figure 12 is a view illustrating to an enlarged scale, the bow portion of the tug boat of Figure 11;

Figure 13 is a top view of the tug boat of Figure 11;

Figure 14 is a side view, partly in section and on enlarged scale of the mooring device of Figure 11;

Figure 15 is detail of Figure 13;

Figure 16 is a view used for the explanation of another embodiment of the present invention;

Figure 17 is a top view of the mooring device in Figure 16; and

Figure 18 is a side view of the mooring device in Figures 16 and 17.

Referring first to Figures 1 to 3, a suction cup assembly I comprises a plate 1 of any suitable shape (circular in the instant embodiment) and made of any suitable material such as steel, rubber or a combination thereof, and a ring-shaped hollow rubber lip 2 semi-circular in cross-section and provided with a port 3 for intercommunicating between the surrounding atmosphere and the hollow space in the lip ring 2 as best shown in Figure 2. A port 4 is formed at the centre of the plate 1 so that the air within the space defined by the plate 1 the rubber lip 2 and a surface such as the side of a hull or a pier, may be evacuated by a line 6 and a vacuum pump 5 thereby firmly securing the suction cup assembly I to the hull or pier. When the suction cup assembly I is so attached firmly to the hull or pier, the rubber lip 2 is deformed and firmly pressed against the hull or pier to ensure the air-tightness of the seal between the suction cup assembly I and the co-operating surface. A vacuum tank 7 in the pipe line 6 prevents a too sudden decrease in the degree of vacuum when attachment is made.

To release the suction cup assembly I from the hull or pier, the pipe line 6 is put into communication with the surrounding atmosphere; the pressure within the assembly I returns to atmospheric pressure, the suction cup assembly I may be easily removed from the hull or pier, and the lip 2 recovers its normal shape.

Compression and recovery of the rubber lip 2 is assisted by the port 3 allowing flow of air between the interior of the lip and the surroundings.

A ring-shaped fender 8 made of hard rubber is attached within the plate 1 coaxially with the rubber lip 2, but at a smaller diameter and height than the rubber lip 2. Thus after initial compression of the rubber lip 2 during attachment to a surface, the fender ring 8 bears most of the load exerted on the suction cup assembly I and excessive deformation of the rubber lip 2 is prevented and its service life is lengthened. The height of the fender 8 is designed in dependence upon the maximum permissible compression of the rubber lip 2 under the maximum vacuum in the cup.

Furthermore, in order to prevent damage to the hull or pier, a ring-shaped fender 9 may be attached to the outer side periphery of the suction cup assembly I as best shown in Figure 2.

As shown in Figurres 2 and 3, three conical buffers 10, are attached to the back surface of the plate 1 for absorbing forces and shocks. Similar buffers 13 are securely attached head to head with the buffers 10 and with their bases on the front surface of a support 11 which in turn is attached to a ship's hull. The suction cup assembly I and the support 11 are interconnected by a plurality of chains 12 to hold the buffers 10 and 13 in close contact. Shocks between ship and pier, and shocks due to engagement and dis-engagement of the suction cup assembly I are absorbed by the buffers 10 and 13. The chains 12 serve not only to hold the components assembled but also to limit the movement of the buffers 10 and 13. The buffers 10 and 13 effectively absorb the forces caused by rolling, pitching and heaving.

Figure 4 shows the use, instead of the buffers 10 and 13 of a plurality of coiled springs 14 capable of withstanding various repeated loads such as expansion, com-

pression, torsion, bending and shear between the suction cup assembly I and the support 11.

It is to be understood that, in accordance with the invention, the matter described with reference to Figures 1 to 4 is intended to be used in combination with a power actuator connected to a support.

Figures 5, 6 and 7, show mooring devices according to one aspect of the present invention with a suction cup as described above with buffers 10 and 13 or coil springs 14 movably mounted on a floating crane 19 so that the floating crane 19 may be made fast to a vertical surface. Each of a pair of mooring devices one at each side of the bow comprises a mount 22 comprising an arm 20 and a power or hydraulic cylinder 21 so operatively coupled to the arm 20 as to be able to cause the latter to swing in a horizontal plane, and the suction cup assembly I has its support 11 attached to the leading end of the arm 20.

Each of the mooring devices at both sides of the stern comprises, as shown in Figure 7, a mount 25 comprising a carriage 23 and a hydraulic cylinder 24 for moving the carriage 23 horizontally at a right angle to the vessel's side, and the suction cup assembly I has its support 11 attached to the carriage 23.

In operation, the mooring devices I are extended from the floating crane 19, and attached to the side of another vessel or pier. Thereafter, the vacuum pump 5 is driven to cause the suction cup assemblies I to firmly attract the hull's side or pier so that the floating crane 19 is secured in its berth.

Figure 8 shows another embodiment of the invention in which the suction cup assembly I is mounted upon a mount 31 attached to a tug boat or vessel through a ball-and socket joint 32 and a plurality of hydraulic cylinders 35 for swinging the suction cup assembly I in a desired angular direction. The ball-and-socket joint 32 used in the present invention comprises a dumb-bell-shaped member 33 and socket members 34 which are attached to the support 11 and the mount 31, respectively, and receive therein the ball sections of the dumbell-shaped member 33.

When the mooring device of the type described is attached to a tug boat, the hydraulic cylinders 35 are so actuated as to swing the suction cup assembly I in such a way that it may be snuggly attached to the hull's side of a vessel to be towed even if the hull is inclined to the axis of the tug. Therefore pushing or towing of a vessel by a tug boat and also mooring of a vessel may be much facilitated.

Instead of the ball-and-socket joint 32, a universal joint may be used.

It should be noted that such universally mounted mooring devices may be attached to the mounts 22 and 25 described with reference to Figures 6 and 7. Also, the buffers 10 and 13 may be eliminated and the suction cup assembly I and the mount 31 may be interconnected with each other through the universal joint 32 and a plurality of hydraulic cylinders 35.

According to another method of use, the suction cup assembly I is mounted upon a mount 36 which is movable along a rail 37 laid around the bow of a tug boat 30 (Figure 11) in an approximate semicircle as best shown in Figure 13. Thus the suction cup assembly I may be moved along the semi-circular rail 37 from one side of the hull to the other so that the optimum pushing or towing angle may be achieved.

Figures 12 to 15 show a wheeled carriage 36 on the rail 37 with wheels 38 and 39 of the carriage 36 slidable in guide grooves 40 and 41 formed in the rail 37. A toothed rail 42 radially inwards of the rail 37 is in mesh with a driving gear 45 attached at the lower end of a driving shaft 44 of a motor 43 on the carriage 36. The motor 43 can thus drive the carriage 36 and hence the suction cup assembly I along the rail 37, and includes a clutch (not shown) so that the driving gear 45 may be selectively disengaged from the toothed rail 42.

The suction cup assembly I is mounted upon the carriage 36 through a universal joint and hydraulic cylinders 35 in such a way that the suction cup assembly I may be extended from the hull of the tug boat 30 at any angular attitude and any position around the bows.

Thus the tug boat 30 may be moored to a vessel in a simple but positive manner with the optimum pushing or towing angle.

Figures 16 to 18 show mooring devices adapted to be installed along a dock so as to facilitate the movement of a vessel 47 into or out of a dry dock or along a pier. A suction cup assembly I is attached through a universal joint to a transverse member 51 which is mounted upon a wheeled carriage 49 which in turn rides upon rails 48 laid on each side of the dock. The transverse member 51 comprises a hydraulic cylinder so that it may be extended transversely of the carriage 49. A plurality of hydraulic cylinders 53, each having a guide roller 52 attached to the leading end of its piston are attached to the outer periphery of the suction cup assembly I.

In operation, the carriage 49 and hence the suction cup assembly I is moved to a desired position along the rails 48, and the transverse member 51 is extended so that the suction cup assembly I may be attached to the side of the vessel 47 entering into or departing from the dock. Thereafter the vacuum pump 5 is operated so that the

suction cup assembly I is firmly attached to the vessel 47. In like manner, other suction cup assemblies I are attached to the vessel 47 so that the latter may be made fast in a simple manner. Thereafter the carriages 49 are moved along the rails 48 so that the vessel 47 may be pulled into or out from the dock. When the vessel 47 is in the dock, the attracting forces of the suction cup assemblies I are released, but the guide rollers 52 are pressed against the hull's sides under the forces of the hydraulic cylinders 53. Thus when the water in the dock is pumped out, the vessel 47 may vertically sink gradually along the guide rollers 52 to be guided to the bottom of the dock without any vibration or tilting. Further, of course, it is possible to install the buffer members to the suction cup assemblies I and to support the suction cup assemblies I from the transverse member 51 through the universal joint 50.

Since the suction cup assembly I is attached to the transverse member 51 through the universal joint 50, the angular position of the suction cup assembly I may be arbitrarily varied. It is to be understood that the hydraulic cylinders may be placed between the suction cup assembly I and the transverse member 51 so that the suction cup assembly I may be maintained at a desired angular position.

Various modifications may be effected within the scope of the invention. The plate 1 may be made of any suitable material in addition to steel and/or rubber. The semicircular rail 37 of Figure 13 may be laid at the stern or along the whole side of a vessel, or on the side plating, and may be of corresponding form. The toothed rail 42 can also be positioned other than as shown. The rail 37 can have any number of guide grooves for the wheels 38 and 39, to prevent derailing of the carriage.

WHAT WE CLAIM IS:—

1. A device for mooring a ship or the like, said device comprising an apertured plate, a flexible rim secured to one side of the plate adjacent its periphery to define with said plate a recess, means adapted to connect the aperture in said plate to a source of vacuum on the side of the plate remote from the rim whereby, when said rim is placed against a surface, the plate can be secured and held to the surface by applying a vacuum to the recess, means on said plate to limit deformation of the rim when the recess is subjected to a vacuum, a support for the plate, joint means permitting some relative angular movement between the support and the plate, and one or more power actuators connected to the support.

2. A device as claimed in Claim 1 in which the means to limit deformation of the rim comprises a fender secured to the said one side of the plate within the recess.

3. A device as claimed in Claim 1 or Claim 2 in which the rim has a hollow interior in communication with the atmosphere.

4. A device as claimed in any preceding Claim in which the support is adapted to be mounted on a vessel or a pier.

5. A device as claimed in any preceding Claim, in which a source of vacuum is coupled to the connection means.

6. A device as claimed in any preceding Claim in which the joint means comprise shock absorbing buffers.

7. A device as claimed in any of Claims 1 to 5 in which the joint means comprise a universal joint.

8. A device as claimed in any of Claims 1 to 5 in which the joint means comprise shock absorbing buffers and a universal joint.

9. A device as claimed in any preceding Claim in which the plate is mounted on the joint means.

10. A device as claimed in any preceding Claim in which the joint means are mounted on the support.

11. A device as claimed in any preceding Claim in which the plate is connected to the one or more power actuators, for moving the plate relative to the support.

12. A device as claimed in any preceding Claim further including one or more additional power actuators extending from the plate adapted to engage a vessel or pier.

13. A device as claimed in any preceding Claim, mounted on a vessel or a pier.

14. A device as claimed in Claim 13 including a guide mounted on the vessel or the pier, the device being movable on the guide.

15. A device for mooring a ship or the like arranged substantially as herein specifically described with reference to the accompanying drawings.

16. A method of manoeuvring a vessel in which a device as claimed in any of Claims 1-15 is mounted on the vessel or on a tug or a pier or dock and is attached by suction to a tug or pier, or to the vessel, and the tug is moved or an actuator connected to the support is moved.

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suction cup assembly I is firmly attached to the vessel 47. In like manner, other suction cup assemblies I are attached to the vessel 47 so that the latter may be made fast in a simple manner. Thereafter the carriages 49 are moved along the rails 48 so that the vessel 47 may be pulled into or out from the dock. When the vessel 47 is in the dock, the attracting forces of the suction cup assemblies I are released, but the guide rollers 52 are pressed against the hull's sides under the forces of the hydraulic cylinders 53. Thus when the water in the dock is pumped out, the vessel 47 may vertically sink gradually along the guide rollers 52 to be guided to the bottom of the dock without any vibration or tilting. Further, of course, it is possible to install the buffer members to the suction cup assemblies I and to support the suction cup assemblies I from the transverse member 51 through the universal joint 50.

Since the suction cup assembly I is attached to the transverse member 51 through the universal joint 50, the angular position of the suction cup assembly I may be arbitrarily varied. It is to be understood that the hydraulic cylinders may be placed between the suction cup assembly I and the transverse member 51 so that the suction cup assembly I may be maintained at a desired angular position.

Various modifications may be effected within the scope of the invention. The plate 1 may be made of any suitable material in addition to steel and/or rubber. The semicircular rail 37 of Figure 13 may be laid at the stern or along the whole side of a vessel, or on the side plating, and may be of corresponding form. The toothed rail 42 can also be positioned other than as shown. The rail 37 can have any number of guide grooves for the wheels 38 and 39, to prevent derailing of the carriage.

WHAT WE CLAIM IS:—

1. A device for mooring a ship or the like, said device comprising an apertured plate, a flexible rim secured to one side of the plate adjacent its periphery to define with said plate a recess, means adapted to connect the aperture in said plate to a source of vacuum on the side of the plate remote from the rim whereby, when said rim is placed against a surface, the plate can be secured and held to the surface by applying a vacuum to the recess, means on said plate to limit deformation of the rim when the recess is subjected to a vacuum, a support for the plate, joint means permitting some relative angular movement between the support and the plate, and one or more power actuators connected to the support.

2. A device as claimed in Claim 1 in which the means to limit deformation of the rim comprises a fender secured to the said one side of the plate within the recess.

3. A device as claimed in Claim 1 or Claim 2 in which the rim has a hollow interior in communication with the atmosphere.

4. A device as claimed in any preceding Claim in which the support is adapted to be mounted on a vessel or a pier.

5. A device as claimed in any preceding Claim, in which a source of vacuum is coupled to the connection means.

6. A device as claimed in any preceding Claim in which the joint means comprise shock absorbing buffers.

7. A device as claimed in any of Claims 1 to 5 in which the joint means comprise a universal joint.

8. A device as claimed in any of Claims 1 to 5 in which the joint means comprise shock absorbing buffers and a universal joint.

9. A device as claimed in any preceding Claim in which the plate is mounted on the joint means.

10. A device as claimed in any preceding Claim in which the joint means are mounted on the support.

11. A device as claimed in any preceding Claim in which the plate is connected to the one or more power actuators, for moving the plate relative to the support.

12. A device as claimed in any preceding Claim further including one or more additional power actuators extending from the plate adapted to engage a vessel or pier.

13. A device as claimed in any preceding Claim, mounted on a vessel or a pier.

14. A device as claimed in Claim 13 including a guide mounted on the vessel or the pier, the device being movable on the guide.

15. A device for mooring a ship or the like arranged substantially as herein specifically described with reference to the accompanying drawings.

16. A method of manoeuvring a vessel in which a device as claimed in any of Claims 1-15 is mounted on the vessel or on a tug or a pier or dock and is attached by suction to a tug or pier, or to the vessel, and the tug is moved or an actuator connected to the support is moved.

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