

TUG WITH AN ALL AROUND TOWING INSTALLATION

FIELD OF INVENTION

- 5 The invention relates to a tug. More specifically, the invention concerns a tug having an all around towing system.

BACKGROUND OF THE INVENTION

- 10 In harbours and restricted sailing areas, ships are usually assisted by one or more tugs. The ship and tug are connected by a towline and the tug manoeuvres in the required position to pull the ship. In addition to towing, the tug can also perform pushing operations.

- 15 Tugs in general have a fixed towing hook or towing winch on deck and the towline is connected to this equipment. Further an accommodation and wheelhouse are mounted on deck, thereby hindering the towline to rotate freely around.

- A solution to enable free rotating all around in the horizontal plane is offered by
20 various rotating towing installations. Examples include DE881312 (Schlepper für Schiffe by Buff 1951), NL1012977 (Ontwerp van sleepboot by M. van der Laan 1999) and NL1027414 (Sleepboot met verplaatsbare sleepinstallatie by Mampaeij 2006). These patents describe a 360° rotatable towing installation on either a circular track or an oval track, running on the outer side of the accommodation / wheelhouse. On this
25 towing installation a towing hook or winch is fitted where the towline to the assisted ship is connected. Typical diameter or width of the towing installation is in the range of 66 - 100% of the tug's width. By moving the towing point to the ship's side, the heeling moment is reduced and capsizing risk minimized.

- 30 All around towing systems offer interesting functionality with regards to towing operations, but the design of the rail construction, the production, installation, repairs and maintenance involve high cost and also the design of the carriage involves high production cost. Further the whole installation is mounted on the deck of the tug and is subjected to the highly corrosive environment. The so-called carrousel tug (according
35 to NL1012977) involves all around rail segments welded into the supporting structure, followed by machining to achieve a circular shape. The carriage is formed by a full

circular outer ring with a large number of supporting wheels distributed over the whole circumference. The DOT tug (according to NL1027414) involves all around horizontal rail structure with two parallel supporting plates combining a large welding length and a solid structure without possibilities to easily modify, repair or exchange. The carriage
5 is formed by two separate carriages with a complex stool and double hinge structure.

The object of the present invention is to provide an improved all around towing system on a tug which does not have the drawbacks described above, i.e. easy manufacturing of the rail and supporting construction, reduction of welding length,
10 easy mounting and replacement of the rail construction, a simplified carriage construction without hinges and internal moving parts.

SUMMARY OF THE INVENTION

15 In one aspect, the invention provides an all around towing system for a tug comprising:
a heavy plate mounted on a deck of the tug;
an upper rail segment and a lower rail segment disposed on the upper and lower surfaces of an outer edge of the heavy plate, respectively;
20 a carriage movable along the upper and lower rail segments;
a set of bearing wheels arranged for guiding the carriage along the upper and lower rail segments;
characterized in that the heavy plate further comprises respective upper and lower grooves on the upper and lower surfaces of the heavy plate, and in that the
25 upper and lower rail segments are respectively mounted in the upper and lower grooves of the heavy plate.

This object is achieved by the design of the rails and the carriage. The rails consist of separate segments mounted partially inside a groove in a heavy plate which
30 is a thick steel plate. The heavy plate is mounted on the deck of the tug in a primarily horizontal arrangement and extends all around outside the supporting structure. In this heavy plate on both the upper side and the lower side grooves are machined, wherein the rail segments can be fitted. To transfer the sideward towing force, the grooves only require relative small depth. As example a groove in range of 10-20 mm can be used
35 for a 80 mm thick rail. Larger and smaller sized rails will scale in similar ratio. The carriage is formed by an 'U'-shaped structure around the edge of the heavy plate and

equipped with bearing wheels on both upper and lower surfaces of the carriage. These bearing wheels are in contact with the upper and lower rail segments and are positioned on the inner surface of the carriage to transfer the outward force from the towline. The towline from the assisted ship is connected to the carriage by any suitable means. This can be for example a towing hook or a towing winch.

According to further advantageous design, the outer circumferences of the upper and lower rail segments have the same outer and inner diameter in that the upper and lower rail segments are laterally aligned to each other. The grooves are mirrored around the centre line of the heavy plate. For ease of mounting and strength support, the upper and lower rail segments are fitted with bolt or threaded construction to connect to each other through the heavy plate in the grooved section.

According to another advantageous design, the rails on the upper and lower side are moved along the circumference to produce an overlapping structure in order to increase the bending strength and structural stability. The upper rail segment can for example extend halfway above the lower rail segment and similarly the lower rail segment extends halfway below the adjacent upper rail segment.

According to another advantageous design, the bolted connections formed between the upper and lower rail segments and the heavy plate are positioned along the inner curvature of the rail segments to prevent the rail segments from rotating out of the groove by the outward load. As example the bolted connection is at approximately 15 - 40% of the rail width measured from the inner curvature of the rail segments.

According to another advantageous design, the upper groove has a smaller diameter than the lower groove, preferably the outer edge of the upper groove has a smaller diameter than the inner edge of the lower groove. Hereby the thickness of the heavy plate can be reduced. In case of significant difference between the groove diameters, the lever between upper and lower rail increases and counters up and down rotation around the outer edge of the heavy plate. This can be advantageous when installing larger towing components on the carriage.

According to another advantageous design, the carriage has two rigid parts.

Preferably each rigid part of the carriage includes one connecting or guiding structure for connection to the towline or the separate cable structure. The marginally flexible construction can be a connection steel structure allowing small deformation in the range of a few mm, thereby allowing each rigid part to flex marginally from the other rigid part and to follow small deformations of the rails. These deformations can have various reasons, e.g. production tolerances, small plastic deformations, wear on rail surface.

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According to another advantageous design, the carriage is fitted with two connection or guiding structures positioned at a distance of at least 20% of the carriage length measured from half length of the carriage. The towline from the towed ship divides at certain distance from the carriage (e.g. forming a triangle shape with each angle 60°) into two parts and both parts extend to either connection structures and thereby distribute the load (evenly) over the circumference of the contacting rail segments.

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According to another advantageous design, the connection structures are replaced by guiding structures, the split towline runs on the outer side of the guiding structures and around the guiding structures towards the centre. These guiding structures can consist of a fixed curved smooth surface or a rolling surface. At the centre of the carriage both cable ends can be connected to each other or fixed to the carriage. Further the connection can also involve a release system to allow both ends to part and move outward around the guiding structures.

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According to another advantageous design, the towline is connected to a separate cable structure running through or around the guiding structures.

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According to another advantageous design, the carriage consists of two rigid parts which are connected to each other with a marginally flexible construction. Each rigid part consists of two main upper bearing wheels on the upper surface of the carriage and two lower main bearing on the lower surface of the carriage.

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According to another advantageous design, the carriage consists of two rigid parts, which are connected to each other with a flexible construction. The rigid parts

are similar to the previous design, but the connecting structure allow significant flexing in the range of a few cm or more. This construction can be composed of all kind of flexing structures, hinges, sliding parts. Hereby each rigid part can flex compared to the other rigid part and thereby follow various significant changes in the radius of the rails. This will not only allow for small deformations of a few mm, but also allows to move along an oval / elliptical rail shape. In case of the towline or separate cable structure is connected to a connection structure on each rigid part, the resultant force pushes the rigid parts together. In case the towline or separate cable structure runs through the guiding structures on each rigid part towards the centreline, the resultant force again pushes both rigid parts together. In both cases a significant push force is generated by the towline load and the connection does not need to generate pull forces. A simple flexible buffer like structure between both rigid parts is sufficient.

According to another advantageous design, the main bearing wheels consist of at least four wheels on the upper and inner half surface of the carriage and at least four wheels on the lower and inner half surface of the carriage. Also five, six, seven or even eight wheels on either sides can be applied. The bearing wheels are preferably equally distributed over the carriage length to distribute the force properly to the upper and lower rail segments.

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According to another advantageous design, the main bearing wheels have a rotating axis rectangular to the heavy plate. These bearing wheels are positioned on the inner surface of the carriage to transfer the outward pull from the carriage to both the force from the upper bearing wheels to the upper rail segment and simultaneously from the lower bearing wheels to the lower rail segment.

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According to another advantageous design, the main bearing wheels are fitted with a flange, the upper main bearing wheel has the flange on the upper side corresponding to the upper level of the rail segment. The same arrangement applies to the lower side of the lower main bearing wheel. Hereby the carriage is positioned not only in radial outward direction by the bearing wheels, but also in vertical direction by the flanges.

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According to another advantageous design, the main bearing wheels are fitted with flanges whereby the main bearing wheels take the radial load and the flanges take the load parallel to the rotating axis.

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According to another advantageous design, in addition to the main bearing wheels, the additional supporting wheels are mounted on the carriage to position the carriage properly on the upper and lower rail segments, both in radial inward direction and against up and down rotation around the outer edge of the heavy plate. As a practical example a number of additional wheels are positioned on the outer side of the upper and lower rail segments with the rotating axis rectangular to the heavy plate. Hereby the upper and lower rail segments are enclosed between the main bearing wheels and the additional wheels on the inner and on the outer side ensuring proper guidance. By mounting these additional wheels both on the upper side against the outer side of the upper rail segment and on the lower side against the outer side of the lower rail segment the carriage moves smoothly along the rail segments with little up and down rotation. To facilitate mounting and adjustment, the additional bearing wheels on the outside of the rail segment may be fitted with an eccentric bush around the shaft. By turning the eccentric bush, the wheel may be positioned accurately near the rail segment surface. The additional bearing wheels positioned on the outside of the rail segment may be fitted with flanges, the upper main bearing wheel with flanges on the upper side and the lower main bearing wheel with flanges on the lower side. In case of a towline at a large upward angle (e.g. in case of a ship with a high deck or in case of the tug heeling sideward with a large angle), the flanges of the lower outer wheels will assist the flanges of the lower inner wheels in sharing the vertical load.

According to another advantageous design, additional wheels are mounted on the upper and outer half surface of the carriage in contact with the outer side of the upper rail segment to take the vertical downward load. This load consists of a combination of gravity load of the carriage and towline load.

According to another advantageous design, additional wheels are mounted on the lower and outer half surface of the carriage in contact with the outer side of the lower rail segment to take the vertical upward load. This load consists of a combination of gravity load of the carriage and towline load.

According to another advantageous design, the carriage consists of a certain length around the outer circumference of the rail segments to distribute the local towline load over part of the rail length. The length of the carriage will be in the range of at least 5% preferably in range of 10 - 20% of the outer circumference of the rail segments. Along the upper part and the lower part wheels are mounted along the

circumference to transfer the load from the carriage to the rail segments.

According to another advantageous design, the production process of the rail segments can be done by cold rolling a straight bar over a number of rollers in a heavy hydraulic press to form the bar into the requested curvature by plastic deformation. This allows easy production with little material losses and a high accuracy of the rail width to match the width of the groove and the distance between the rollers on the inside and the outside of the rail. Also, other similar mechanical presses can be considered to shape the straight rail into the requested curvature. In case of large rail segments additional heating of the rail material may be used to perform part heated rolling.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more clearly understood from the following description of the embodiments thereof, when taken in conjunction with the accompanying drawings. However, the embodiment and the drawings are given only for the purpose of illustration and explanation, and are not to be taken as limiting the scope of the present invention, the scope of which is to be determined by the set of appended claims.

Figure 1 shows a conventional all around towing system on a tug in perspective view with main components;

Figure 2 shows a conventional carrousel towing system in section view at a set of wheels;

Figure 3 shows a conventional DOT towing system in section view at a set of wheels;

Figure 4 shows an all around towing system according to an embodiment of the invention;

Figure 5 shows a sectional view of the all around towing system;

Figure 6 shows the all around towing system in a perspective view from an angle from above; and

Figure 7 consisting of Figures 7a and 7b shows the carriages with two rigid parts with flexible connection structures.

DETAILED DESCRIPTION OF THE EMBODIMENT

The tug 1 represented in Figure 1 is provided with a central deck 2, a circular towing installation 3, a towing hook 4 and a towline 5 to the ship towed (not shown). Inside the towing ring is the accommodation 6 and on top of the accommodation the wheelhouse 7 and funnels 8. The towing installation can for example consist of a circular rotating ring extending all around the circular fixed structure by means of rollers/bearings.

Figure 2 represents a cross section of the carousel towing system with the steel structure of the tug's hull 11, the lower rail 12 and the upper rail 13, the box shaped rotating circular carousel ring structure 14 and the upper load bearing wheel 15 and the lower load bearing wheel 16. The upper load bearing wheel has a flange 17 on the lower edge to prevent the carousel structure from moving upward. The same applies to the lower load bearing wheel with flange 18. The arrow 19 indicates the direction of the outward towing force. Since the carousel forms a ring structure all around, there is no need for additional wheels to prevent the ring structure to move outward. The rotating axis 20 of the load bearing wheels is positioned vertically.

Figure 3 represents a cross section of the DOT system with the steel structure of the tug's hull 21, the single horizontally mounted rail structure 22, supported by two girders 23. The rotating structure is formed by two carriages, one of them shown simplified in section with a heavy plate 24 fitted with again load bearing wheels on the outer side 25 and on the inner side 26. The load bearing wheels are equipped with flange 27 on wheel 25 and flange 28 on wheel 26 to prevent the rotating structure from moving upward. The arrow 29 indicates again the outward towing force and the rotating axis 30 of the wheels is again vertically. Further a number of smaller supporting wheels are fitted to counter the gravity force (not shown).

The tug 31 represented in Figure 4 is according to an embodiment of the present invention. It is provided with a central deck 32, a circular towing installation 33, a triangular connection 34 and a towline 35 to the ship towed (not shown). Inside the towing ring is the accommodation 36 and on top of the accommodation, the wheelhouse 37 and funnels 38. The towing installation 33 includes a fixed heavy plate 40, a fixed circular support 41 and a rotating outer carriage which is rotatable 360 degrees with respect to the tug 31 about the central deck 32.

Figure 5 represents a sectional view of the towing system 33 according to the invention, with the ship's structure formed by a heavy thick horizontal plate 40, a circular support 41, an upper rail segment 42 positioned in the upper groove 43 in the heavy plate and a lower rail segment 44 positioned in the lower groove 45. Further, the carriage frame 46 with an U-shaped form fitted with two upper main bearing wheels 47 and lower main bearing wheels 48. The upper main bearing wheels are arranged and positioned on the upper and inner half surface of the carriage 46 for guiding the carriage 46 along the inner side of the upper rail segment 42. The lower main bearing wheels 48 are arranged and positioned on the lower and inner half surface of the carriage 46 for guiding the carriage 46 along the inner side of the lower rail segment 44. The upper and lower main bearing wheels 47, 48 are each equipped with a flange 49 of upper wheel 47 and flange 50 of lower wheel 48, respectively to prevent the carriage 46 from moving up and downward. The upper and lower main bearing wheels 47, 48 have a vertically rotating axis 51. The arrow 52 indicating the outward towing force and the rotating axis 51 is again vertically.

Further, a set of additional outer wheels 53, 54 are provided on the upper and lower surfaces of the carriage 46. The carriage frame 46 is fitted with additional upper wheels 53 and additional lower wheel 54. The additional upper wheels 53 are arranged and positioned on the upper and outer half surface of the carriage 46 in contact with the outer side of the upper rail segment 42. The additional lower wheels 54 arranged and positioned on the lower and outer half surface of the carriage 46 in contact with the outer side of the lower rail segment 44. The additional upper and lower wheels 53, 54 are each equipped with a flange 55 of upper wheel 53 and the flange 56 of lower wheel 54, respectively. Also, the additional upper and lower wheels 53, 54 have a vertically rotating axis 57.

Figure 6 represents the towing system in perspective view with the ship's structure 58, the heavy thick plate 40, the upper rail segment 42, the towing system 33, the two guiding structures 59 and the towline 35 from the assisted ship. The carriage 46 is formed by two rigid parts 61, 62 connected to each other. Each of the guiding structures 59 is mounted on the surface of each rigid part 61, 62 of the carriage. The towline divides into two line parts 60 with internal angle α , which are connected to the guiding structures 59 or are guided through the guiding structures 59 and run from the outside towards the centreline of the carriage 46. Preferably the angle α is between 45° and 75° . The two line parts 60 can have a circular section or a

flat rectangular section. The flat rectangular section can be used with smaller diameter guiding structures, because the minimal bending ratio is defined by radius of the guiding structure divided by the radius of the line. The two lines can also consist of standard lifting slings with flat sections and integrated connection eyes on both ends.

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The right part 61 of the carriage 46 is shown transparent with internals and showing the main upper bearing wheels 47, the additional upper wheel 53 and the additional lower wheel 54. The left rigid part 62 of the carriage 46 is shown solid with main upper bearing axle 66 and an additional upper axle 67.

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Figure 7 represents the carriages in the same perspective view as in Figure 6, but without surrounding structures for clarity. The carriage in Figure 7a consists of two guiding structures 59, a rigid right carriage part 61 and a rigid left carriage part 62 connected by a marginally flexible structure 63. This can be a flexible steel plate bolted or welded to the rigid parts. The carriage in Figure 7b consists of two guiding structures 64, composed of either a fixed or rotating roller, a rigid right part 61 and a rigid left part 62. Between both parts a flexible structure is fitted, in this drawing shown as two rubber fender blocks 65 with only take compressive forces. Also, other structures with hinges and sliding faces can be considered.

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Although the invention has been described above with reference to a preferred embodiment, numerous modifications may be made without departing from the scope of the present application. The all around towing installation may be constructed in all kind of different arrangements of rails, wheels and rollers both on fully circular shapes and on oval or non-circular shapes. The design is intended for unrestricted all around operation, but the design may be used for only part rotation, e.g. rails over a half circle from one side to the other over the aft deck.

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Instead of upper and/or lower rail segments, the heavy plate (groove) surface may also be treated to increase the hardness (or by adding material) and thereby allowing to operate the bearing wheels directly on the heavy plate without the need for additional rails.

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