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(54) A TUG AND BARGE COMBINATIONS

(71) We, AOKI CONSTRUCTION COMPANY LIMITED, a joint stock company of Japan, of 1-5 Minami Oyodo-cho, Oyodoku, Osaka, 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 tug and barge combination which has particular application to push towing.

In recent years, 'push towing' has been proposed as an alternative to the use of conventional ocean going cargo ships for the transportation of commodities in bulk. In push towing a tug is releasably connected to and arranged to push a barge.

According to the invention there is provided a tug and barge combination, the barge having a stern recess therein in which is received the bow of the tug, the tug including a plurality of lugs extending outwardly into some of a plurality of receptacles in the recess thereby securing the tug and barge together, the lugs being movable inwardly and outwardly of the hull of the tug to be received in other of said receptacles whereby to permit the tug and barge to be secured together in different positions in which the barge and tug have different drafts.

The invention will be better understood from the following description of preferred embodiments thereof, given by way of example only, reference being had to the accompanying drawings, wherein:

Figure 1 is a side elevational view of a preferred embodiment of the present invention showing a state of an ocean-going tug and barge combination, with the barge fully loaded;

Figure 2 is a side elevational view of the embodiment of Figure 1 showing a state of the ocean-going pusher-barge combination with the barge empty;

Figure 3 is a top plan view of the embodiment of Figures 1 and 2 showing a connection of the tug and the barge;

Figure 4 is a cross-sectional view showing the ocean-going tug-barge combination when the barge is full-loaded;

Figure 5 is a cross-sectional view showing the ocean-going tug-barge combination when the barge is empty-loaded;

Figure 6 is a side elevational view partly in cross-section showing a device for simultaneously inserting and retracting connecting lugs into and from ports on both sides of a recess in the barge, the lugs being shown disengaged from the barge;

Figure 7 is a side elevational view of the arrangement figure 6 but with the lugs extended into the ports;

Figure 8 is a cross-sectional view showing another form of the connecting lugs and cooperating receptacles on the barge;

Figure 9 is a cross-sectional view, partly enlarged, showing the coupled state of a tapered connecting lug and a complementary shaped receptacle on the barge.

Figure 10 is a cross-sectional view of the tapered connecting lug of Figure 9 prior to being coupled to the receptacle; and

Figure 11 is a cross-sectional view of the arrangement of Figure 10 immediately prior to coupling.

Referring to Figures 1, 2 and 3, a pusher tug A is connected to a barge B, loaded with cargo and having no self-propelling mechanism. The stern B' of the barge B is provided with a deep indentation or recess C in which the bow of the pusher tug A is received.

The pusher tug A is provided near the centre part *a* of the left side (or port side) of the hull with a connecting lug 1 which is extensible and retractible of the hull by means of a hydraulic cylinder 2. The tug is also provided near the centre part *b* on its right (or its starboard) side with another connecting lug 4 which is extensible and retractible by another hydraulic cylinder 5. Further, the tug A is provided in the vicinity of its bow *d* with a connecting pin 7 which is extensible and retractible by means of

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a hydraulic cylinder 8.

The barge B is provided on its left side in the recess C with a port or receptacle 3 near the stern D, in which is received the connecting lug 1. In the same way, the right side of the barge is provided with another receptacle on port 6 near the stern E, and in which is received the lug 4. Further, in the innermost part C' of the recess C in the barge, there is provided a receptacle or port 9 to receive and hold therein the connecting lug 7 provided at the bow d of the tug A.

Thus, the lugs and receptacles provide a rigid connection between the tug boat A and the barge B at a plurality of points (in the above-described embodiment, it is at three points). When the barge B is unloaded of its cargo, its draft will change, and in order to accommodate the change in draft, the pusher tug must be moved downwardly relative to the barge. To permit the tug to be connected to the unloaded barge, further receptacles are provided in the recess of the barge below the receptacles mentioned above, as is shown in Figures 4 and 5.

As is apparent from Figures 1 and 4, when the barge B is in its fully loaded state, hence deep draft, the connecting lug 1 on the left side of the tug is held in the port 3, the connecting tug 4 on the right side of the tug is held by the port 6, and the connecting lug 7 held in the port 9, whereby the pusher boat A and the barge B are joined together at the three points.

However, when the barge B is unloaded of its cargo, as shown in Figures 2 and 5, the connecting lug 1 at the left side is inserted and held by a receptacle on port 3' below the port 3, the connecting lug 4 is inserted and held in a port 6' formed below the port 6, and the connecting lug 7 at the bow of the tug is inserted into a port 9' provided below the port 9 and held therein by means of the cylinder 8.

In the above-described arrangement shown in Figures 1 to 5 inclusive, the connecting lugs 1 and 4 are extended and retracted independently of each other by the separate, actuating cylinders 2 and 5.

It is, however, possible to simultaneously operate the lugs 1 and 4 by a common cylinder as indicated in Figures 6 and 7.

According to this embodiment, the lug 1 is connected to a piston 11 by way of an end arm 1', a connecting arm 16, and another connecting arm 15 which is secured at one end of a piston rod 12 of the piston 11, while the lug 4 is connected to the piston 11 by way of an end arm 4', a connecting arm 16' and the other end of the connecting arm 15. The left side connecting arm 16 and the right side connecting arm 16' are pivotally connected at their one end to both ends of the connecting arm 15 by means of pivot pins 18 and 18', while the end arms 1' and 4' of the connecting pins 1 and 4, respectively, are pivotally connected at the other end of the connecting arms 16 and 16' by

means of pivot pins 20 and 20'.

A small connecting arm 17 for the left side and another small connecting arm 17' for the right side pivotally fitted at their one end on the respective fulcrums 21 and 21' provided on the cylinder, are pivotally connected at the other end thereof centrally of the connecting arms 16 and 16' by means of pivot pins 19 and 19', respectively. The length of the small connecting arms 17 and 17' is made half a length of the connecting arms 16 and 16'.

Ports 22 and 23 are provided for feeding lubricant into the guide path for the connecting pins 1 and 4, and the receiving and holding ports 3 and 6 to enable the connecting pins to smoothly slide along the guide paths and into and out of the ports 3, 6.

The connecting lugs of the above-described arrangement are operated in the following fashion.

When a pressurized fluid (either liquid or gas) is sent into the cylinder 10 from a fluid passage port 13, the piston 11 moves toward a fluid passage port 14, whereupon the connecting arm 15 secured at one end of the piston rod 12 fixed to the piston 11 also moves along with it. Since the small connecting arms 16 and 16' rotate on the pivot of the fulcrums 21 and 21', respectively, the loci of both pivot pins 20 and 20' lie on a straight line X-X' in Figure 6, and the left side connecting lug 1 and the right side connecting pin 4 are thus caused to project outwardly along the line X-X' to be inserted into the respective ports 3 and 6 as shown in Figure 7.

The connection of the pusher tug A to the barge B can be released by the reverse operation to the above. That is, when the pressurized fluid is sent into the cylinder 10 through the fluid passage port 14, the piston 11 moves toward the fluid passage port 13, whereupon the left side connecting pin 1 and the right side connecting pin 4 withdraw from the respective receiving and holding ports 3 and 6 and the pusher tug A and the barge B are thus separated.

The advantage to be derived from the linkage is that, when the piston 11 is near the fluid passage port 13, the speed of the connecting lugs 1 and 4 in the direction of the line X-X' is faster than the speed of the piston 11, and, when the piston is close to the fluid passage port 14, the speed of the connecting pins 1 and 4 on the straight line X-X' is slower than the speed of the piston 11. Conversely, as the speed reduces the thrusting force of the connecting lugs 1 and 4 increases, so that even if a large external force is imparted to both connecting lugs 1 and 4, sufficiently large inserting and retracting force counter to any fortuitous external force is provided.

In another arrangement for connecting the barge and tug together, the connecting lugs and the corresponding receptacles are shaped in a tapered form as shown in Figures 9, 10 and 11,

so as to obtain more rigid and tight coupling between each connecting lug and the corresponding receptacle, free from any gap or clearance between them to minimize undesirable vibrations and shocks caused by such gap to the pusher tug A and the barge B when joined together.

Referring now to Figures 9 to 11, three tapered connecting lugs 1, 4 and 7 are provided at the bow and both sides of the pusher tug A, and ports 3, 6 and 9 are formed in the wall of the recess at the stern of the barge B to receive the connecting lugs 1, 4 and 7. As shown in Figures 9 and 10, each of the tapered connecting lugs 1, 4 and 7 is connected to one end of a piston rod 24 of each of the cylinders 2, 5 and 8, and is made freely slidable back and forth along the guide path 25.

The inner surface F of each of the tapered ports 3, 6 and 9, and the outer surface G of each of the tapered connecting lugs 1, 4 and 7 may be, but is not necessarily, coated with an elastic material such as rubber or neoprene. The connecting lug and the port are formed in such a manner that, when the lug is engaged in the port, there exists no gap or clearance between them.

When the connecting lug and the port are in a cylindrical form, a certain degree of gap or clearance is necessary as an allowance for the insertion. Accordingly, even in their connected state, there inevitably remains such clearance between them, which allows movement between the pusher tug and the barge to cause impact therebetween. Thus, strong vibrations or shocks are brought about in the pusher boat and barge combination in rough seas, even if the gap between the connecting pin and the receiving and holding port is between 5 to 6 mm which is less than 1/100 of the diameter of a connecting lug having a diameter of 1 meter with the consequence that heavy impact is imparted to both the tug and barge to damage not only the lugs and receptacles but also the hulls and various instruments and appliances installed therein.

However, by making the connecting lugs 1, 4 and 7 and the ports 3, 6 and 9 in a tapered or conical form, each of the connecting lugs can be fitted into their respective ports without any clearance between them with the result that there is no possibility of the undesirable impact being caused to the tug and barge combination.

Further, in order to prevent the tapered or conical connecting lugs 1, 4 and 7 from slipping out of the ports 3, 6 and 9 by an external force caused for example by wave action, a pressure accumulator 26 is provided on each of the cylinders 2, 5 and 8 so as to constantly impart the fluid pressure to the piston. Thus the piston rod 24 constantly acts to drive the tapered connecting lugs 1, 4 and 7 into the ports 3, 6 and 9.

Also, as shown in Figure 11, since the connecting lugs 1, 4 and 7 are in the tapered or

conical shape, they can be readily inserted into and coupled with the receiving and holding ports 3, 6 and 9, even if there arises a difference α between the centre line P-P of each of the connecting lugs 1, 4 and 7 and the centre line S-S of each of the ports 3, 6 and 9 due to difference in the drafts between the pusher boat and the barge caused by the degree of cargo loading on the barge B and the weight of equipment on the pusher tug A. In more detail, the connecting lugs 1, 4 and 7 move outward in the arrow direction Y by means of the piston rod 24 which is actuated by feeding a pressurized fluid into the cylinders 2, 5 and 8 for the connecting lugs, and in the course of the outward shifting of the tapered connecting lugs, even when the tapered end M of the connecting pin only touches the corner surface L of each of the receiving and holding ports 3, 6 and 9, the pin can be easily thrust into the receiving and holding ports 3, 6 and 9. Conversely, when the connecting lugs are to be separated from the ports, the withdrawal of the lugs therefrom can be effected very easily, since the conical shape of each lug and its corresponding port brings about less frictional resistance between them than that caused between the cylindrical pin and the port.

Thus, the pusher tug and the barge can be rigidly joined together into a single seagoing unit which is less susceptible to undesirable vibrations and shocks caused by collision of the hulls of the pusher tug and the barge, whereby not only the connecting structure between the hulls and various instruments equipped in the pusher boat can be prevented from damage, but also any unpleasantness felt by the crews of the combination resulting from such vibrations and impact can be removed. Particularly, when the connecting pins and the receiving and holding ports of the conical shape are employed, the clearance between the connecting lugs and the ports can be substantially reduced and, moreover, even if there exists a difference in the draft between the pusher tug and the barge, connection and separation of the tug and barge can be effected without difficulty.

While the present invention has been illustrated and described by way of preferred embodiments thereof, it is to be understood that variations and modifications may be made therein without departing from the scope of the present invention. For example, the receptacles on ports which are arranged in two lines 3, 6, 9 and 3', 6', 9' as shown in Figures 1 to 5, may be made in multiple stages as shown in Figure 8. In the arrangement shown in Figure 8 the receptacles are arranged in a castellated form and the connecting lugs are provided with cooperating castellated ends. In this way, the tug and barge can be connected together for various different drafts of the pusher tug and the barge, and hence a more precise adjustment in the connection therebetween, depending on the draft, becomes feasible.



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WHAT WE CLAIM IS:-

1. A tug and barge combination, the barge having a stern recess therein in which is received the bow of the tug, the tug including a plurality of lugs extending outwardly into some of a plurality of receptacles in the recess thereby securing the tug and barge together, the lugs being movable inwardly and outwardly of the hull of the tug to be received in other of said receptacles whereby to permit the tug and barge to be secured together in different positions in which the barge and tug have different drafts.
2. A combination in accordance with claim 1 wherein the lugs are mounted one on each side of the tug and one at the bow thereof, the receptacles being arranged in verticle rows in the recess for receiving the lugs.
3. A combination in accordance with claim 1 or 2 wherein the lugs are received in more than one of the receptacles.
4. A combination in accordance with claim 3 wherein the lugs have castellated ends which are received in castellations in the recess.
5. A combination in accordance with claim

1 or 2 wherein the lugs are of generally cylindrical form.

6. A combination in accordance with claim 1 or 2 wherein the lugs are of a tapered or conical form.

7. A combination in accordance with any preceding claim including fluid operated actuator means for moving the lugs inwardly and outwardly of the tug's hull.

8. A combination in accordance with any preceding claim including a hydraulic piston cylinder assembly arranged to move more than one of the lugs inwardly and outwardly of the tug and hull.

9. A tug barge combination substantially as herein described with reference to Figures 1 to 7 or as modified in Figure 8 or Figures 9 to 11 of the accompanying drawings.

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