

PATENT SPECIFICATION (11)

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- (21) Application No. 13268/75 (22) Filed 1 April 1975 (19)
 (31) Convention Application No. 49/149 304U
 (32) Filed 11 Dec. 1974 in
 (33) Japan (JP)
 (44) Complete Specification published 1 Feb. 1978
 (51) INT. CL.² B63B 21/56 35/70
 (52) Index at acceptance
 B7S CX2



PUSH

(54) A TUG AND BARGE COMBINATION FOR PUSH TOWING

(71) We, AOKI CONSTRUCTION COMPANY LIMITED, a joint stock company of Japan, having a place of business at 1-5, Minami Oyodo-cho, Oyodo-ku, 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 for push towing.

In recent years, push towing has been proposed as an alternative to the use of conventional cargo ships, for the transportation of commodities in bulk. In push towing, a tug is releasably connected to and arranged to push a barge. The barge has formed in its stern a recess which receives the bow of the tug, and the tug may be provided with lugs mounted for movement outwardly of the tug and into receptacles in the recess of the barge, in order to lock the tug and barge together. It has previously been proposed in U.K. Patent 1,437,744 (to which attention is directed) to mount the lugs such that a first lug is mounted at the bow of the tug for movement parallel to the longitudinal centreline thereof, and such that two further lugs are mounted on opposite sides of the tug to be moved in directions at right angles to the longitudinal centreline of the tug.

As will be explained in more detail hereinafter, the previously proposed lug arrangement suffers from the disadvantage that severe shear forces can be applied to the lugs by virtue of wave action and other external forces which in use act on the tug and barge combination, and it is an object of the invention to provide an improved tug and barge combination in which such shear forces to which the lugs are subjected, are reduced.

In accordance with the present invention, there is provided a tug and barge combination for push towing, including in the stern of the barge a recess in which is received the bow of the tug, lugs on the tug at the bow thereof and at the sides thereof, the lugs extending into receptacles in the recess in such a manner as to secure the tug and barge

together the lugs on the sides of the boat being mounted for movement inwardly and outwardly of the tug, the outward directions being inclined relative to the longitudinal centreline of the tug towards the stern thereof.

In order that the invention may be more fully understood, an embodiment thereof will now be described by way of example with reference to the accompanying drawings in which

Figure 1 is a side elevational view showing a previously proposed pusher tug and its associated barge;

Figure 2 is a plan view of the pusher tug and barge shown in Figure 1;

Figure 3 is a cross-sectional view taken along the line Q—Q in Figure 2;

Figure 4 is a plan view of an embodiment of the present invention;

Figure 5 is a diagram showing a force acting on the lug which is located on the bow of the pusher tug shown in Figure 4; and

Figure 6 is a diagram showing a force acting on the lug located on the starboard side of the pusher tug shown in Figure 4.

Reference will firstly be made to the previously proposed tug and barge combination shown in Figures 1, 2 and 3. The combination comprises a barge 1 and a tug 2 having its bow received in a recess in the stern of the barge. Three cylindrical lugs 4 are respectively located at the bow and on opposite sides of the pusher tug 2, and a plurality of receptacles 3 are provided in the recess of the stern of the barge 1 to receive the lugs and thereby connect the tug 2 to the barge 1. Each lug 4 can be moved inwardly and outwardly of the tug 2 by means of a respective piston and cylinder assembly 5 on the tug 2. By the introduction of the lugs 4 into their corresponding receptacles 3, the barge and the pusher tug are fixedly connected at three points. The lug 4 at the bow to the tug is mounted for movement in a direction parallel to the longitudinal centreline of the tug whereas the port and starboard lugs 4 are mounted for movement in directions at right angles to the tug's longitudinal centreline.

(A) As shown in Figure 3, the receptacles 3 are located at a plurality of different horizontal levels. Such an arrangement permits the barge to be coupled to the pusher tug for different draughts of the barge, since the lugs 4 can be intromitted into the receptacles 3 appropriate to the draught of the barge.

As a modification to the above described arrangement in which each of the lugs 4 is actuated by a respective piston and cylinder assembly 5, the port and starboard lugs 4 could be actuated simultaneously by a common piston and cylinder assembly.

In order to smooth movement of the lugs 4 into and out of the receptacles 3, it is preferred to feed lubricant into the receptacles.

An embodiment of the present invention will now be described with reference to Figure 4, in which those parts like to those described with reference to the preceding Figures 1 to 3, are marked with the same reference numerals. It will be seen that the lugs are not arranged as shown in Figure 3, but the port and starboard lugs 4 have a backward obliquity, and particularly are arranged such that their axes are arranged so as to be directed towards the stern of the tug and such as to define an angle of 60° with the longitudinal centreline extending from the bow to the stern of the tug.

Furthermore, the lugs 4 and the receptacles 3 are both tapered and their surfaces are covered with an elastic material such as rubber, neoprene or the like so that, when the connecting lugs 4 are intromitted into the receptacles, the lugs are tightly engaged in the receptacles with substantially no clearance. By constructing the lugs 4 and the receptacles 3 in this manner, less resistance occurs upon insertion and retraction of the lugs 4 into and from the receptacles 3 as compared with the previously described cylindrical lugs hence the connection and disconnection of the pusher tug and the barge can be performed very easily.

The cylinder of each assembly 5 is mounted, by means of a respective rod 7, on a supporting column 8 of triangular shape when viewed in plan, the rods 7 being pivotally mounted on the column 8. The column will tend to be held in position by the reaction forces produced as a result of engagement of the lugs 4 in their respective receptacles 3, which are transmitted to the column 8 through the rods 7. It will be seen that generally, in the absence of other forces applied to the tug and barge combination, the sum of the reaction forces acting on the column 8 will be zero, and thus the column 8 need not be located fixedly to the boat. With such an arrangement, in the event that the sum of the reaction forces becomes non-zero, the forces will be distributed through the column 8, have a sum of zero.

It is of course possible that, instead of fixing the connecting rods to a single supporting column 8, they can be fixed individually to an appropriate portion in the hull.

Further, as shown in Figure 4, a pressure accumulator 9 is provided for each assembly 5, which functions to constantly impart fluid pressure to the piston so that the lugs 4 may not be drawn out of their respective receptacles by the force of sea waves and other external forces.

In use of the tug and barge combinations described above, wave action and other external forces can apply to the tug a force which urges it rearwardly to tend to pull the tug from the stern recess of the barge, and as a result, the lugs 4 on the port and starboard sides of the tug are subjected to shear stress. The example of the tug and barge combination shown in Figure 4 tends to reduce the shear forces applied to the lugs as will now be explained in detail. Referring now to Figure 6, the lug 4 will be subjected to a force OJ when the tug and barge are pulled apart by an external force such as wave action. The force OJ has a component OI where $OI = OJ \cos 30^\circ$ ($\cos 30^\circ = 0.86$) which acts on the lugs 4 on either side of the pusher tug as a shearing force. It will however be appreciated that if the lugs 4 are arranged at right angles to the tug's longitudinal centreline as described with reference to Figures 1 to 3, the shear force OI applied to the lugs 4 will equal OJ. Thus, because the port and starboard lugs 4 of the described example of the present invention are provided with the aforementioned backward obliquity, the shear force applied thereto is reduced as compared with the arrangement of the prior proposal described hereinbefore.

The lug 4 at the bow of the pusher tug 2 experiences no shear force as a result of the external force.

Alternatively, when an external force acts on the tug in a direction opposite to that described with reference to Figure 6, i.e. to urge the tug and barge towards one another, then as illustrated in Figure 5 only a slight shearing force acts on the lug 4 at the tug's bow. For example, if the apex angle of the tapered head of the lug 4 is $Q = 15^\circ$, the shearing force on the lug equals the external force times $\sin 7.5^\circ$ ($\sin 7.5^\circ = 0.12$). In this case substantially all the shearing forces are received by the lug 4 and the corresponding receptacle 3 at the tug's bow, and the lugs 4 on the port and starboard sides of the tug experience substantially none of the external force.

Thus, it will be appreciated that the backwardly directed port and starboard lugs 4 of the described embodiment of the present invention reduces shearing forces applied

thereto and as a result, the lugs can be made to less stringent manufacturing requirements. Furthermore, an improved locking together of tug and barge is provided which is much more resistant to the severe forces thereon produced by wave action.

WHAT WE CLAIM IS:—

1. A tug and barge combination for push towing, including in the stern of the barge a recess in which is received the bow of the tug, lugs on the tug at the bow thereof and at the sides thereof, the lugs extending into receptacles in the recess in such a manner as to secure the tug and barge together, the lugs on the sides of the boat being mounted for movement inwardly and outwardly of the tug, the outward direction being inclined relative to the longitudinal centreline of the tug towards the stern thereof.

2. A combination as claimed in claim 1 wherein a lug is provided at the bow and at each side of the tug, the said lugs being

angularly spaced at substantially 120° from each other.

3. A combination as claimed in claim 1 or claim 2 wherein the lugs are all connected to a support column centrally of the tug.

4. A combination as claimed in any preceding claim wherein the lugs are each connected to the tug by a respective ram for extending or retracting the respective lug into or out of engagement with its respective receptacle.

5. A tug and barge combination for push towing, substantially as hereinbefore described with reference to and as shown in Figures 4 to 6 inclusive of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1978.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.



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