A marine transportation combination in which a first vessel, such as a tug, and a second vessel, such as a barge, are coupled together by interengaging formations which project as to one and receive as to the other of the first and second vessels and permit vertical pivoting of the two vessels about the point of coupling, the second or cargo vessel having a stern notch which receives the bow portion of the first vessel, there being disposed between the sides of the first vessel and the wing portions which define the notch, bumpers preventing substantial relative yawing of the two vessels.

19 Claims, 13 Drawing Figures
FLEXIBLE COUPLED ARTICULATED VESSEL

THE BACKGROUND OF THE INVENTION

The present invention relates to a marine push-tow- ing transportation combination, and, more particularly, to an articulated vessel employing a flexible coupling arrangement.

The use of tug-barge combinations for transporting cargos by water offers many advantages over the use of self-propelled vessels such as tankers and the like. While the tug-barge combination can be used quite successfully in calm or sheltered water, the push-towing technique is generally unsuitable for open water travel because of the winds and seas encountered. In an attempt to reap the economic advantages offered by tug-barge marine transportation, and to overcome the adverse conditions encountered in open water or ocean going travel, numerous articulated vessels have been proposed. These articulated vessels have taken numerous forms and designs including both rigidly coupled systems and systems employing flexible couplings, i.e. systems allowing substantial relative movement of the coupled vessels. An example of the later type system is shown in U.S. Pat. No. 3,568,621 to Kawasaki. The Kawasaki system basically discloses coupling arrangements which either permit relative roll of the two vessels or which while substantially preventing such roll, allows substantial relative bobbing or heaving of the two vessels. It will be readily recognized that permitting large amplitudes of relative heaving in heavy seas can result in extremely large forces being exerted on the coupling means holding the two vessels together and indeed the vessels themselves possibly resulting in damage to the coupling systems and disengagement of the vessels. From a practical point of view in terms of maneuverability of the vessels and over all economy as to fabrication, it is desirable that certain relative motions of the two vessels be allowed while others be prevented as much as possible.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved articulated marine combination employing a novel flexible coupling.

Another object of the present invention is to provide a coupling system for a marine combination which permits certain relative movements of the coupled vessels but restrains or substantially restrains other such motions.

Still another object of the present invention is to provide a coupled marine combination which permits certain relative motions between the vessels and which is capable of withstanding forces encountered in open waters.

These and other objects of the present invention will become apparent from the description given herein, the drawings and the appended claims.

In general, the present invention provides a marine transportation combination in which a portion of a first vessel is received in a vertical stern notch of a second vessel, the notch being open at the top and bottom, the first vessel being coupled to the second vessel by a coupling means disposed generally centrally of the notch between the first and second vessels and permitting vertical pivoting of the first and second vessels around the coupling means but preventing substantial relative heaving of the vessels. The combination further in- cludes means disposed between the sides of the first vessel and the adjacent wings defining the notch on the second vessel to prevent substantial relative yawing or rolling of the first and second vessels.

In general, the interengaging formations take the form of female formations i.e. sockets or recesses and male formations i.e. projecting, generally complimentary shaped members, receivable in said sockets. The male and female members are sized and dimensioned to accommodate the above described pivotal movement.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top planar view generally depicting one embodiment of the present invention.

FIG. 2 is an elevational view of the embodiment shown in FIG. 1.

FIG. 3 is a top planar view generally depicting another embodiment of the present invention.

FIG. 4 is an elevational view of the embodiment shown in FIG. 3.

FIG. 5 is partial perspective view of another embodiment of the present invention.

FIG. 6 is an enlarged, fragmentary view of the coupling arrangement shown generally in FIG. 1.

FIG. 7 is a fragmentary view, in perspective, of the coupling arrangement shown generally in FIG. 3.

FIG. 8 is an enlarged elevational view, partly in section, showing the bumper or fendering means employed in the embodiments shown in FIGS. 1 and 3.

FIG. 9 is a top planar view taken on the lines 9—9 of FIG. 8.

FIG. 10 is a side elevational view showing the coupling arrangement of FIG. 7.

FIG. 11 is a top planar view taken on the lines 11—11 of FIG. 10.

FIG. 12 is a side elevational view showing a means for securing the vessels together when the vessels are mated and the coupling means are engaged.

FIG. 13 is a top planar view taken on the lines 13—13 of FIG. 12.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIGS. 1 through 4, it is seen that the articulated ship of the present invention comprises a first vessel, e.g., a barge, shown generally as 10, and a second vessel, e.g., a tug, shown generally as 11 coupled together by flexible coupling 12 (FIGS. 1 and 2) or 13 (FIGS. 3 and 4), the couplings being described in greater detail below. In the embodiments shown in FIGS. 1 through 4, the powered vessel (tug) 11 is shown to include a stern portion 14, a bow portion 15 and sides 16 and 17, respectively. The cargo vessel (barge) 10 includes a bow portion 18 and a stern portion 19 a having a through going notch 20 therein, notch 20 being formed by a pair of aft extending stern wings 21 and 22. As best seen in FIGS. 1 and 3 when powered vessel 11 and cargo vessel 10 are mated, a forward portion of powered vessel 11 is received into notch 20 between cargo vessel stern wings 21 and 22. While generally the configuration of notch 20 will approximate that of the portion of vessel 11 received therein, such is not necessary.

While the couplings 12 and 13 have different configurations, as will be seen hereafter, both of the embodiments shown in FIGS. 1 and 2 or 3 and 4, respectively, include bumper or fendering means 23 and 24, bumper means 23 being disposed between side 17 of vessel 11...
and stern wing 22 of vessel 10, bumper means 24 being disposed between side 16 of vessel 11 and stern wing 21 of vessel 10. The construction and function of the bumper means 23 and 24 will be described more fully here- 

After referring now to FIG. 6, vessel 10 has a bulwark 25 extending about the bow portion 15 of vessel 11. Mounted on the forward portion of bulwark 25 is coupling member 26 having a generally U-shaped socket 27 opening fore of vessel 11. Secured to coupling member 26 on opposite sides thereof are guides 100 and 101. Disposed in surrounding relationship to coupling member 26, and guides 100 and 101 is reinforcing yoke 102, reinforcing yoke 102 being disposed between spreader of guides 101 or 102 or the upper or lower sections of member 26 forming recess 27. Secured to the apex wall 28 of stern notch 20 of vessel 10 is coupling member 29, coupling member 29 including a reduced neck portion 30c and an aft extending projection 30 at least a portion of which is generally cylindrically shaped but which has the end portions chamfered as at 30a and 30b to form somewhat of a truncated ellipsoid, coupling members 26 and 29 combined forming flexible coupling 12. A portion of socket 27 has a circular arc, the radius of which is slightly larger than the maximum radius of the cylindrical or truncated ellipsoid projection 30. However, the difference in radius is not so great as to permit substantial relative bobbing. While as shown, coupling members 26 and 29 are separate pieces secured to vessels 11 and 10, respectively, it is to be understood that they can be made integral with the vessels. It will be observed that the socket 27 of coupling member 26, in effect, acts as a bearing surface for coupling member 29. Because of the dimensioning of projection 30 relative to that of U-shaped socket 27, projection 30 is permitted to rotate on a generally horizontal axis, i.e. the long axis of projection 30, thus allowing vessels 10 and 11 relative pivot movement in a generally vertical direction about coupling 12, i.e. the vessels are allowed relative pitching. While guides 100 and 101 serve to direct projection 30 into socket 27 upon mating of vessels 10 and 11, they also serve the purpose of restraining relative port and starboard drift of vessels 10 and 11 once the coupling 12 is engaged and the vessels are mated.

Turning next to FIG. 7, the bow portion 15 of vessel 11 has a generally vertically extending channel 31 at the forwardmost part. Pivoted vertically within vertical channel 31 is a tapered coupling member 32, tapered coupling member 32 being pivotally mounted on pivot shaft 33 extending generally transversely of channel 31. A backup support 34 secured to vessel 10 serves as a safety device and prevents pivot pin 33 from being sheared should excessive force be exerted on tapered coupling member 32 in an aft direction. Secured to a mounting plate 35 attached to the apex wall 28 of notch 26 is coupling member 36, coupling member 36 being somewhat in the form of a toothed rack forming a series of forwardly converging tapered recesses 37, recesses 37 being vertically disposed. It will be observed from FIG. 7, that the forward converging taper of coupling member 32 is complimentary to that of the forward converging taper of the recesses 37 allowing the former to be inserted into the latter. As seen, the taper is such as to provide wedge shaped formations such that upon mating of vessels 10 and 11 and engagement of coupling members 32 and 36, coupling member 32 will in effect wedge the recesses 37. However, since tapered coupling member 32 is pivoted at 33, the above described vertical pivoting motion of vessel 10 relative to that of vessel 11 will still be permitted. It will be apparent that the dimensioning of the coupling members, i.e. as to their relative projecting and receiving formations will be such as to allow such pivoting. As best seen with reference to FIG. 10, the vertical disposition of the wedge shaped recesses 37 permits a plurality of relative draft engagements of vessels 10 and 11. The embodiments shown in FIGS. 6 and 7, will permit vertical pivoting of the two vessels around the couplings 12 and 13. However, because of the size and shape of the interengaged formations which go to make up the couplings 12 and 13, vessels 10 and 11 will be prevented from any substantial degree of relative roll. In order to prevent substantial relative yawing of vessels 10 and 11, the bumper or fendering means 23 and 24 are employed. In FIGS. 8 and 9, a detailed showing of bumper 23 is depicted, it being understood that bumper 24 is substantially the same. Bumper 23 comprises a mounting plate 38 secured to the side 17 of vessel 11. In order to take into account the curvature of the hull of vessel 10 and maintain the substantially vertical alignment of bumper 23, a spacer bracket 39 is disposed between mounting plate 38 and side 17 of vessel 10, spacer bracket 39 having a shape conforming to the curvature of the hull of vessel 10 and being secured thereto. Secured to the surface of plate 38 are a series of resilient pads 40 which, when vessels 10 and 11 are mated and the pivot coupling 12 or 13 is engaged, abut the inside surface of the wing 22 of vessel 11. While the pads 40 have been described as being resilient, it is to be understood that they are of sufficient hardness so as to not be compressed excessively when vessel 10 and 11 are mated. As best seen in FIG. 9, bumper 23 is secured to vessel 11 and abuts the inside surface of the wing wall of vessel 10 closely adjacent the rearwardmost portion thereof. While the bumper 23 is shown as being secured to the powered vessel 10, it is possible and in some cases desirable, that bumper 23 be secured to vessel 11. As best seen in FIG. 8, the bumpers, as exemplified by bumper 23, being disposed adjacent the side of vessel 10 and the inside surface of the wing walls of vessel 11, prevent any substantial relative yawing of vessels 10 and 11.

Although pads 40 are resilient, they are of a material possessing sufficient rigidity and resistance to compression so as to prevent any substantial yawing of vessel 10 when the latter is received within the stern notch 20 of vessel 11 and the pivot couplings are engaged. The material chosen for the construction of the pads 40 can, of course, vary depending upon the relative sizes of the vessels, the environment in which the articulated vessel is to be employed and other such factors. However, in general the pads 40 will be comprised of a polymeric material, either in pure or composed form, which possesses sufficient resiliency and elasticity to allow snug engagement of vessel 10 in stern notch 20 but yet will not be hard enough to result in damage to the wings of vessel 11 or to result in a wedging of vessel 10 in the stern notch 20.

The combined effect of either of the couplings 12 or 13 with the bumper pads 23 and 24 serves to permit vertical pivoting of vessels 10 and 11 but precludes substantial relative rolling or yawing of same. Other forms of bumpers or fendering devices can be employed other than the resilient pads described above. For example, it would be possible to employ resiliently biased roller as
assemblies disposed between the sides of the vessel 10 and the wing walls of the vessel 11 which would accomplish the same purpose. Likewise, other structures can be employed which, in conjunction with the couplings 12 and 13, serve to prevent relative yaw and roll of vessels 10 and 11. It should be noted that in the embodiments shown in FIGS. 6 and 7, the shape of the interengaging formations is such as to, per se, restrain any substantial rolling of the two vessels. A further point with regard to the embodiment shown in FIG. 7 is that the side walls of recess 31 serve to prevent any substantial port or starboard movement of vessel 10 relative to vessel 11 thus further confining the relative movement of the two vessels. As observed heretofore, other similar provisions can be made to prevent relative starboard and port movement in the coupling arrangement shown in FIG. 6.

It will be apparent that other interfitting or interengaging formations other than those specifically shown in FIGS. 6 and 7 can be employed. For example, a ball and socket arrangement such as shown in FIG. 5 could be employed. Referring then to FIG. 5, the cargo vessel 10 is seen to have a rearwardly projecting coupling member 110, projecting member 110 having a substantially hemispherical socket 11 and being secured to the apex wall 28 of stern notch 20. Secured to bulwark 25 of cargo vessel 10 is coupling member 112, having a forwardly projecting male member 113, male member 113 having a portion which is generally spherical shaped so as to form a complementary fit with socket 111 of coupling member 110. As in the case of the embodiment shown in FIGS. 6 or 7, there can be provided a plurality of coupling members 100 and/or 112 to provide for relative draft engagements of the two vessels. While the ball and socket arrangement per se will not restrain relative rolling of the vessels as would the couplings of FIGS. 6 and 7, the ball and socket arrangement, in combination with a bumper or fendering means as described above, would prevent substantial relative rolling and would prevent such roll but would still allow freedom for the two vessels to pivot vertically around the ball and socket coupling. Because of the configuration of the substantially spherical ball and socket arrangement of the embodiment shown in FIGS. 7, relative port and starboard drift of vessels 10 and 11 is substantially precluded without the necessity for side anti-drift plates.

It will be apparent that in all of the various couplings shown in FIGS. 5, 6 and 7, when the vessels are mated and the couplings are engaged and further when the vessels are secured together, as for example in a manner hereafter described, the mated, coupled vessels will be allowed vertical pivoting about the coupling point, i.e. between the bow of one vessel and the stern of the other vessel, but will be prevented from any degree of substantial relative yawing, rolling or heaving.

The interengaged or interfitting formations depicted above are merely exemplary of numerous types of configurations and formations which can be employed and which will accomplish the desired results of allowing engagement by substantially horizontal relative movement of the vessels and will, in combination with the bumper or fendering means described above, permit vertical pivoting of the two vessels about the coupling point but will prevent substantial relative heaving, rolling or yawing of such vessels.

Turning now to FIGS. 12 and 13, there is depicted one method of securing vessels 10 and 11 together when the vessels have been mated and the couplings engaged. The coupling is substantially that as shown in FIG. 6, there being a plurality of vertically disposed coupling means 29 allowing the plurality of relative draft engagement of vessels 10 and 11. Protruding rearwardly from wall 28 of vessel 10 on opposing sides of coupling member 29 are support brackets 41 and 42. Support bracket 41 is spaced from coupling 29 by upper and lower support plates 41a and 41b respectively, support bracket 42 being likewise spaced by suitable support plates. The support plates are secured to apex wall 28, the support brackets and coupling 29. Clevis connections 45 and 46 are attached to support brackets 41 and 42, respectively. Pins 43 and 44 or supporting clevises 45 and 46 extend through openings in brackets 41 and 42 and are substantially co-axial with the long axis of projection 30 of coupling 29. Hawser lines 47 and 48 are attached to clevises 45 and 46 via links 49 and 50, respectively.

Hawser lines 47 and 48 extend through openings 51 and 52, respectively, in bulwark 25 and are fastened to a common shackle 53. Shackle 53 is releasably held in pelican hook 54 having movable jaw 55, the latter controlled hydraulically by a mechanism not shown. Pelican hook 54 is slidably movable fore and aft on rails 56 mounted on rail support housing 57 fastened to the deck 58 of vessel 11. Pelican hook 54 is affixed to modified eye-bolt 59 by nut and bolt assembly 60. Eye-bolt 59 has a threaded end portion 61 loosely journelled in a bracket 62 also secured to the deck 58 of vessel 11. The threaded portion 61 of eye-bolt 59 is received in a threaded nut portion 65 of handwheel 63, nut portion 65 engaging upwardly projecting abutment 64 forming part of support housing 57.

To mate vessels 10 and 11 together, the coupling members are first engaged, shackle 53 being free and pelican hook 54 being moved fore of vessel 11. Shackle 53 is then placed in pelican hook 54 and jaw 55 hydraulically closed. Handwheel 63 is then rotated in a direction to drive eye-bolt 59 aft of vessel 11. The aft movement of eye-bolt 59 retracts pelican hook 54 which pulls hawser lines 47 and 48 taut thus securing vessels 10 and 11 together. It is to be understood, that the means for securing vessels 10 and 11 together shown in FIGS. 12 and 13 is merely exemplary of numerous other techniques which, once the vessels are mated and the coupling means engaged, can be used to secure and prevent the vessels from relative fore and aft movement and maintain the horizontally engageable couplings together.

The marine combination of the present invention can include other features such as for example resilient fenders or bumpers, other than those described above, for preventing damage to the vessels when mating and unmating of same. For example, with reference to the embodiment shown in FIG. 12, fender or bumper 120 can be secured to vessel 11 to cushion the forward motion of vessel 11 into notch 20 thereby preventing damage to apex wall 28 of stern notch 20. It will be apparent that fender 120 can extend substantially around the bow and sides of the vessel 11 providing a continuous resilient bumper. It is to be understood that the resilient bumper or fender 120 is of a different nature and for a different purpose than the bumpers or fenders 23 and 24 described above, the latter serving, in cooperation with the coupling means, to limit the relative various movements of the two vessels.

I claim:
A marine transportation combination comprising a first vessel having a bow portion and sides, and a second vessel having a notch at one end, said notch having a pair of oppositely disposed wings, coupling means coupling said bow portion of said first vessel to said second vessel at generally the apex of said notch when said first vessel is received in the notch of said second vessel between said wings, said coupling means preventing substantial relative bobbing of said first and second vessels about said coupling means, said coupling means defining interengaging formations respectively projecting as to one and receiving as to the other of said first and second vessels in a direction generally parallel to the longitudinal axes of said first and second vessels, said formations being engaged by relative forward movement of said first vessel to said second vessel and disengaged by relative rearward movement of said first vessel to said second vessel, and means disposed between opposite sides of said first vessel and the wings of said notch and closely adjacent the rearwardmost portion of said wings for preventing substantial relative yawing and rolling of said first and second vessels while permitting said vertical pivoting.

2. The combination of claim 1 wherein said means preventing said yawing are on said second vessel.

3. The combination of claim 1 wherein said means preventing said yawing comprises bumper means comprised of a resilient material.

4. The combination of claim 1 wherein said means including means permitting a plurality of relative draft engagements of said first and second vessels.

5. The combination of claim 5 wherein said projecting formation is on said second vessel and said receiving formation is on said first vessel.

6. The combination of claim 5 wherein said projecting formation is on said second vessel and said receiving formation is on said first vessel.

7. The combination of claim 7 wherein said receiving formation comprises a generally U-shaped socket, and said projecting formation is disposed generally at the apex of said notch, said projecting formation comprising a generally cylindrical portion, having smoothly chamfered end surfaces, and a reduced neck portion disposed between said cylindrical portion and said second vessel, said socket being sized and shaped so as to permit smooth, partial rotation of said projecting formation about a generally horizontal axis.

8. The combination of claim 8 wherein there are a plurality of vertically disposed U-shaped sockets.

9. The combination of claim 10 wherein securing means comprises hawser line means secured to said second vessel and means on said first vessel for engaging said hawser line means and adjustably drawing said hawser line means taut.

10. The combination of claim 1 wherein means securing said first and second vessels together in the coupled position.

11. The combination of claim 10 wherein securing means comprises hawser line means secured to said second vessel and means on said first vessel for engaging said hawser line means and adjustably drawing said hawser line means taut.

12. The combination of claim 1 wherein at least one of said interengaging formations is disposed at substantially the forwardmost part of said bow portion of said first vessel.

13. The combination of claim 1 wherein said means preventing said yawing comprises bumper means secured to each side of said first vessel, said bumper means providing substantially planar vertical surfaces facing said wings and wherein the walls of said wings adjacent said surfaces of said bumper means, when said first and second vessels are coupled, are substantially planar and vertical.

14. The combination of claim 1 wherein said projecting formation is pivotally mounted on the bow portion of said first vessel.

15. The combination of claim 14 wherein said projecting member is recessed in a generally vertical channel in the bow of said first vessel, said receiving formation being formed in a rearwardly extending member generally at the apex of said notch, said rearwardly extending member being received into said vertical channel when said first and second vessels are mated.

16. The combination of claim 14 wherein said projecting formation and said receiving formation have a forwardly converging tapered configuration.

17. The combination of claim 16 wherein said formations are substantially wedge shaped.

18. The combination of claim 14 wherein there are a plurality of vertically disposed receiving formations.

19. The combination of claim 1 wherein said interengaging formations substantially define a ball and socket arrangement.
UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO.: 3,922,993
DATED: December 2, 1975
INVENTOR(S): ROBERT A. BLUDWORTH

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

(page 1 of 2)

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Signed and Sealed this twenty-second Day of June 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks