dock.

However, this vessel has the disadvantage that the water flow generated by the first (second) thruster means interferes with said keels, reducing the power generated by the second (first) thruster means. In particular, the water flow is first obstructed by the keels and, despite a quantity of water of said water flow is dispersed into the surrounding environment as a result of the impact with the keels themselves, the greater water quantity of said water flow reaches said second (first) thruster means, interfering with said thruster means.

~~Object~~ Embodiments of the present invention ~~is~~ seek to overcome said disadvantages by providing an improved hull of a tugboat for towing/assisting a vessel, configured in such a way that, when a water flow is generated by first (second) thruster means of the hull, this water flow is channeled within the keel of the hull in such a way that the greater quantity of water of said water flow ~~is~~ may be dispersed into the surrounding environment, below the keels, and only a minimal amount of water of said water flow may reach~~es~~ second (first) thruster means. In this way, it ~~is~~ may be avoided that the thruster means towards which the water flow is directed (i.e. underflow thruster means) lose power. Consequently the efficiency of said thruster means ~~is~~ may be improved.

~~A second object~~ Embodiments of the invention ~~is~~ also seek to provide an improved hull configured in such a way to allow each component of the hull to participate in the overall structural strength of the hull itself.

~~A third object~~ Embodiments of the invention ~~is~~ further seek to provide an improved hull configured in such a way as to allow the tugboat to have a higher directional stability, to oppose side dragging during the towing of a vessel or an escort service of a vessel, have a greater maneuverability, independently of the dimensions of the water spaces, making it suitable for navigation both in open sea and in protected waters.

~~Another object~~ Embodiments of the invention ~~is~~ also seek to provide an improved hull of a tugboat configured in such a way as to allow the tugboat to transfer to said vessel a greater power, both towing and pushing.

~~A further object~~ Embodiments of the invention ~~is~~ also seek to provide a tugboat comprising

said hull.

In the following it will be indicated with water plane the surface of separation between the submersed part of the hull or underbody and the emerged part of the hull which defines the level of the fluid on which the vessel floats, with base line the parallel to the water plane which passes through the keel point, wherein the keel point is the intersection between the profile of the hull within the outer surface (shell plating) of the the hull itself and the perpendicular to the hull, with water lines the lines between the hull and the planes parallel to the water plane, and with main section the section which encloses the largest submerged area.

~~The objects above mentioned are achieved by~~ There is disclosed a hull that has a monolithic structure, wherein the keels are integral with the hull itself and form a tunnel with a portion of the bottom of the hull, and wherein first thruster means and second thruster means, arranged respectively at bow and stern, are aligned along the same axis.

~~It is the object of the invention an improved hull of a tugboat for towing/assisting a vessel, wherein said hull has a water plane, a base line, a main section, as well as a longitudinal axis which divides said hull in a first lateral part and a second lateral part, and wherein said hull comprises a bottom, a bow, a stern, a underbody, said underbody comprising a first keel and a second keel, wherein said first keel is parallel to and facing said second keel, as well as first thruster means and second thruster means. In particular, each keel is arranged on a respective side of said underbody, in a substantially central position, and is connected to said underbody respectively in correspondence of the bow and the stern of said hull, said two keels extending in depth perpendicularly or in a substantially perpendicular manner so as to have a draft equal to or greater than that of said first and second thruster means. Said first thruster means and said second thruster means are positioned respectively at the bow and stern of the hull, and are substantially aligned along said longitudinal axis.~~

~~Furthermore, said two keels are integral with said hull and are configured in such a way that they form a tunnel with at least a portion of said bottom of said hull. Said hull has a first airfoil which extends from said~~

~~first thruster means to said main section, and a second airfoil which extends from said second thruster means to said main section; wherein said two airfoils are substantially symmetrical with respect to said main section. In particular, each airfoil comprises respectively a first portion, external said tunnel, which extends from the respective thruster means to the keels, and a second portion, internal to said tunnel, which extends from the keels to the main section, wherein said first and second thruster means are arranged in said first portion, external to said tunnel, of a respective airfoil. With a such a configuration of the hull, when a water flow is generated by said first thruster means or by said second thruster means, said water flow is channeled within said tunnel, following a respective airfoil, and only a minimal amount of water of said water flow reaches respectively said second thruster means or said first thruster means.~~

According to a first aspect of the present invention, there is provided an improved tunnel-hull of a tugboat for towing/assisting a vessel, said tunnel-hull having a water plane, a base line, a main section, as well as a longitudinal axis dividing said tunnel-hull in a first lateral part and a second lateral part, said tunnel-hull comprising a bottom, a bow, a stern, and further comprising: a underbody, said underbody comprising a first keel and a second keel, wherein said first keel is parallel to and faces said second keel, first thruster means and second thruster means, wherein each keel is arranged on a respective side of said underbody, in a substantially central position, and is connected to said underbody respectively in correspondence of the bow and the stern of said tunnel-hull, said two keels extending in depth perpendicularly or in a substantially perpendicular manner so as to have a draft equal to or greater than that of said first and second thruster means, and wherein said first thruster means and said second thruster means are positioned respectively at the bow and stern of the tunnel-hull, and are substantially aligned along said longitudinal axis of said tunnel-hull; and wherein said two keels are integral with said tunnel-hull and are configured in such a way that they form a tunnel with at least a portion of said bottom of said tunnel-hull, and

wherein said tunnel-hull has a longitudinal section having a concave bow portion, a concave stern portion and a convex intermediate portion, positioned between said bow portion and said stern portion, and has a first concave bottom portion which extends from said first thruster means to said main section, and a second concave bottom portion which extends from said second thruster means to said main section; said two concave bottom portions being substantially symmetrical with respect to said main section; each concave bottom portion comprising a respective first portion, externally to said tunnel, which extends from the respective thruster means to the keels, and a second portion, internal to said tunnel, which extends from the keels to the main section, said first and second thruster means being arranged in said first portion, externally to said tunnel, of a respective concave bottom portion, so that, when a water flow is generated by said first thruster means or by said second thruster means, said water flow is channeled within said tunnel, following a respective concave bottom portion, and only a minimal amount of water of said water flow reaches respectively said second thruster means or said first thruster means.

It is preferable that said two keels are in a position shifted toward the bow of said hull.

According to embodiments of the invention, said first thruster means and said second thruster means can have a respective center and said first thruster means and said second thruster means are arranged so that said base line of said hull passes from each center or above each center.

Advantageously, said hull can comprise a fin centrally arranged on the bottom of said hull, at the stern of the hull itself; wherein said fin is preferably integral with said hull.

Again according to embodiments of the invention, said hull can comprise a first pushing fender and a second pushing fender, each of which is externally arranged to the hull, on a respective lateral part, so as to be below said water plane. Particularly, said pushing fenders are positioned on the hull so as to be in correspondence with said base line of said hull.

Furtehrthermore, said hull can comprise a third pushing fender, arranged externally to the hull so as to be above said water plane.

Particularly, said first thruster means and said second thruster means can respectively comprise at least one azimuth propulsor.

~~It is a further object of the invention a tugboat for towing/assisting a~~

~~vessel, which comprises said hull, wherein said first thruster means can be driven by a first engine, said first engine being positioned at the bow of said hull and connected to said first thruster means by a first shaft, and wherein said second thruster means can be driven by a second engine, said second engine being positioned at the stern of said hull and connected to said second thruster means by a second shaft. Said engines can have a respective longitudinal axis and can be arranged within the hull in a respective lateral part of it, in such a way that the longitudinal axis of each engine forms a respective angle with the longitudinal axis of said hull.~~

According to a second aspect of the present invention, there is provided tugboat for towing/assisting a vessel, wherein it comprises a tunnel-hull according to the first aspect, and wherein said first thruster means are driven by a first engine, said first engine being positioned at the bow of said tunnel-hull and connected to said first thruster means by a first shaft, and wherein said second thruster means are driven by a second engine, said second engine being positioned at the stern of said tunnel-hull and connected to said second thruster means by a second shaft; said engines having a respective longitudinal axis and being arranged within the tunnel-hull, in a respective lateral part of it, in such a way that the longitudinal axis of each engine forms with the longitudinal axis of said tunnel-hull a respective angle.

It is preferable that the value of each angle is between 0° and 90°.

It is further preferable that said longitudinal axes of said motors are parallel and said angles are equal.

According to embodiments of the invention, said tugboat can comprise a winch arranged at the bow of said hull, in the proximity or in correspondence of said first thruster means, and/or a winch arranged at the stern of said hull, in proximity or in correspondence of said second thruster means. A respective tow cable can be wind/unwind on each winch in such a way that the force for towing/assisting said vessel, exerted by a winch at the bow or stern, is applied on a respective point of said bow or said stern.

In particular, said tugboat can comprise a central control bridge and at least one corresponding chock for each winch, in such a way that:

- said winch is arranged between said control bridge and said bow, and the corresponding chock is arranged between said winch and said bow; and/or

- said winch is arranged between said control bridge and said stern, and the corresponding chock is arranged between said winch and said stern.

Again according to embodiments of the invention, said engines can be positioned externally to said control bridge, wherein said control bridge has preferably a substantially circular section.

In a first embodiment, the tugboat can comprise an engine room, whcih comprises said two engines.

In a ~~second~~ further embodiment, the tugboat can comprise two engine rooms, each of which is respectively arranged at bow and stern of said hull and comprises a respective engine.

Furthermore, said tugboat can comprise steering and controlling means for steering and controlling said first and second thruster means, said steering and controlling means being aligned along an axis which coincides with said longitudinal axis.

The present invention will be now described, for illustrative, but not limitative purposes, according to an embodiment, making particular reference to the enclosed drawings, wherein:

Figure 1 is a perspective view of the hull of a tugboat according to the present invention,

Figure 2A is a three dimensional view of the longitudinal section of the hull of Fig. 1, without a keel, thruster means and fenders;

Figure 2B is a side view of the hull of Fig. 1;

la figura 3 è una sezione dello scafo di fig. 1 che mostra i primi ed i secondi mezzi di spinta, nonché i rispettivi motori di detti mezzi di spinta, disposti all'interno dello scafo stesso, dove le chiglie sono state asportate;

Figure 3 is a section of the hull of Fig. 1 showing the first and second thruster means, as well as the respective engines of said thruster means, arranged inside the hull itself, wherein the keels have been cut away;

Figures 4A-4B are respectively a first view and a second top view of the hull of Fig. 1;

Figures 5A-5B are respectively a view of the rear and front of the hull of Fig. 1;

Figure 5C is a side view of the bow part of the hull of Fig. 1;

Figure 5D shows the water lines of the hull of Fig. 1 seen from the stern;

Figure 5E shows the water lines of the hull of Fig. 1 seen from the bow;

Figure 5F shows a comparison between the water lines of the hull of Fig. 1 seen from the bow and the water lines of the hull of Fig. 1 seen from the stern;

CLAIMS

1. Improved tunnel-hull ~~(1)~~ of a tugboat ~~(R)~~ for towing/assisting a vessel ~~(N)~~, said tunnel-hull having a water plane ~~(G)~~, a base line ~~(B)~~, a main section, as well as a longitudinal axis ~~(L)~~ dividing said tunnel-hull ~~(1)~~ in a first lateral part ~~(L1)~~ and a second lateral part ~~(L2)~~, said tunnel-hull ~~(1)~~ comprising a bottom ~~(1A)~~, a bow, a stern, and further comprising:

- a underbody ~~(2)~~, said underbody comprising a first keel ~~(11)~~ and a second keel ~~(12)~~, wherein said first keel ~~(11)~~ is parallel to and faces said second keel ~~(12)~~,

- first thruster means ~~(3)~~ and second thruster means ~~(4)~~,

wherein each keel ~~(11, 12)~~ is arranged on a respective side of said underbody ~~(2)~~, in a substantially central position, and is connected to said underbody ~~(2)~~ respectively in correspondence of the bow and the stern of said tunnel-hull ~~(1)~~, said two keels ~~(11, 12)~~ extending in depth perpendicularly or in a substantially perpendicular manner so as to have a draft equal to or greater than that of said first and second thruster means ~~(3, 4)~~, and wherein said first thruster means ~~(3)~~ and said second thruster means ~~(4)~~ are positioned respectively at the bow and stern of the tunnel-hull ~~(1)~~, and are substantially aligned along said longitudinal axis ~~(L)~~ of said tunnel-hull ~~(1)~~;

~~said tunnel-hull (1) being characterized that~~ and wherein

said two keels ~~(11, 12)~~ are integral with said tunnel-hull ~~(1)~~ and are configured in such a way that they form a tunnel ~~(14)~~ with at least a portion of said bottom ~~(1A)~~ of said tunnel-hull ~~(1)~~,

and ~~in that~~ wherein

said tunnel-hull ~~(1)~~ has a longitudinal section having a concave bow portion, a concave stern portion and a convex intermediate portion, positioned between said bow portion and said stern portion, and has a first concave bottom portion ~~(W1)~~ which extends from said first thruster means ~~(3)~~ to said main section ~~(SM)~~, and a second concave bottom portion ~~(W2)~~ which extends from said second thruster means ~~(4)~~ to said main section ~~(SM)~~; said two concave bottom portions ~~(W1, W2)~~ being substantially symmetrical with respect to said main section ~~(SM)~~; each concave bottom

portion ~~(W1, W2)~~ comprising a respective first portion, externally to said tunnel ~~(14)~~, which extends from the respective thruster means ~~(3, 4)~~ to the keels ~~(11,12)~~, and a second portion, internal to said tunnel ~~(14)~~, which extends from the keels ~~(11,12)~~ to the main section ~~(SM)~~, said first and second thruster means ~~(3, 4)~~ being arranged in said first portion, externally to said tunnel ~~(14)~~, of a respective concave bottom portion ~~(W1, W2)~~, so that, when a water flow is generated by said first thruster means ~~(3)~~ or by said second thruster means ~~(4)~~, said water flow is channeled within said tunnel ~~(14)~~, following a respective concave bottom portion ~~(W1, W2)~~, and only a minimal amount of water of said water flow reaches respectively said second thruster means ~~(4)~~ or said first thruster means ~~(3)~~.

2. Improved tunnel-hull ~~(1)~~ according to the previous claim, ~~characterized in that~~ wherein said two keels ~~(11, 12)~~ are in a position shifted toward the bow of said tunnel-hull ~~(1)~~.

3. Improved tunnel-hull ~~(1)~~ according to any one of the preceding claims, ~~characterized in that~~ wherein said first thruster means ~~(3)~~ and said second thruster means ~~(4)~~ have a respective center and in that said first thruster means ~~(3)~~ and said second thruster means ~~(4)~~ are arranged such that said base line ~~(B)~~ of said tunnel-hull ~~(1)~~ passes from each center or above each center.

4. Improved tunnel-hull ~~(1)~~ according to any one of the preceding claims, ~~characterized in that~~ wherein said tunnel-hull ~~(1)~~ comprises a fin ~~(13)~~ centrally arranged on the bottom ~~(1A)~~ of said tunnel-hull ~~(1)~~, at the stern of the tunnel-hull ~~(1)~~ itself; said fin being preferably integral with said tunnel-hull ~~(1)~~.

5. Improved tunnel-hull ~~(1)~~ according to any one of the preceding claims, ~~characterized in that~~ wherein it comprises a first pushing fender ~~(10A)~~ and a second pushing fender ~~(10B)~~, each of which is externally arranged to the tunnel-hull ~~(1)~~, on a respective lateral part ~~(L1, L2)~~, so as to be below said water plane ~~(G)~~.

6. Improved tunnel-hull ~~(1)~~ according to the preceding claim, ~~characterized in that~~ wherein said pushing fenders ~~(10A, 10B)~~ are positioned on the tunel-hull ~~(1)~~ so as to be in correspondence with said base line ~~(B)~~ of

said tunnel-hull ~~(1)~~.

7. Improved tunnel-hull ~~(1)~~ according to any one of the preceding claims, ~~characterized in that~~ wherein it comprises a third pushing fender ~~(11)~~, arranged externally to the tunnel-hull ~~(1)~~ so as to be above said water plane ~~(G)~~.

8. Improved tunnel-hull ~~(1)~~ according to any one of the preceding claims, ~~characterized in that~~ wherein said first thruster means ~~(3)~~ and said second thruster means ~~(4)~~ comprise respectively at least one azimuth propulsor ~~(31, 41)~~.

9. Tugboat ~~(R)~~ for towing/assisting a vessel ~~(N)~~, ~~characterized in that~~ wherein it comprises a tunnel-hull ~~(1)~~ according to any one of the preceding claims, and ~~in that~~ wherein said first thruster means ~~(3)~~ are driven by a first engine ~~(33)~~, said first engine ~~(33)~~ being positioned at the bow of said tunnel-hull ~~(1)~~ and connected to said first thruster means ~~(3)~~ by a first shaft ~~(3A)~~, and ~~in that~~ wherein said second thruster means ~~(4)~~ are driven by a second engine ~~(44)~~, said second engine ~~(44)~~ being positioned at the stern of said tunnel-hull ~~(1)~~ and connected to said second thruster means ~~(4)~~ by a second shaft ~~(4B)~~; said engines ~~(33, 44)~~ having a respective longitudinal axis ~~(A33, A44)~~ and being arranged within the tunnel-hull ~~(1)~~, in a respective lateral part ~~(L1, L2)~~ of it, in such a way that the longitudinal axis ~~(A33, A44)~~ of each engine ~~(33, 44)~~ forms with the longitudinal axis ~~(L)~~ of said tunnel-hull ~~(1)~~ a respective angle ~~(α, β)~~.

10. Tugboat ~~(R)~~ according to the preceding claim, ~~characterized in that~~ wherein the value of each angle ~~(α, β)~~ is between 0° and 90°.

11. Tugboat ~~(R)~~ according to claim 9 or 10, ~~characterized in that~~ wherein said longitudinal axes ~~(A33, A44)~~ of said motors ~~(33, 44)~~ are parallel and said angles ~~(α, β)~~ are equal.

12. Tugboat ~~(R)~~ according to any of claims 9-11, ~~characterized in that~~ wherein it comprises a winch ~~(V)~~ arranged at the bow of said tunnel-hull, in the proximity or in correspondence of said first thruster means ~~(3)~~, and/or a winch ~~(V)~~ arranged at the stern of said tunnel-hull ~~(1)~~, in proximity or in correspondence of said second thruster means ~~(4)~~, a respective tow cable ~~(C)~~ being wind/unwind on each winch ~~(V)~~ in such a way that the force for

towing/assisting said vessel ~~(N)~~, exerted by a winch ~~(V)~~ at the bow or stern, is applied on a respective point of said bow or said stern.

13. Tugboat ~~(R)~~ according to the preceding claim, ~~characterized in that~~ wherein it comprises a central control bridge ~~(P)~~ and at least one corresponding chock ~~(F)~~ for each winch ~~(V)~~, in such a way that:

- said winch ~~(V)~~ is arranged between said control bridge ~~(P)~~ and said bow, and the corresponding chock ~~(F)~~ is arranged between said winch ~~(V)~~ and said bow; and/or

- said winch ~~(V)~~ is arranged between said control bridge ~~(P)~~ and said stern, and the corresponding chock ~~(F)~~ is arranged between said winch ~~(V)~~ and said stern.

14. Tugboat ~~(R)~~ according to the preceding claim, ~~characterized in that~~ wherein said engines ~~(33, 44)~~ are positioned externally to said control bridge ~~(P)~~; said control bridge ~~(P)~~ preferably having a substantially circular section.

15. Tugboat ~~(R)~~ according to any of claim 9-14, ~~characterized in that~~ wherein it comprises an engine room ~~(M)~~; said engine room ~~(M)~~ comprising said two engines ~~(33, 44)~~.

16. Tugboat ~~(R)~~ according to any of claim 9-14, ~~characterized in that~~ wherein it comprises two engine rooms ~~(M1, M2)~~, each of which is respectively arranged at bow and stern of said tunnel-hull ~~(1)~~ and comprises a respective engine ~~(33, 44)~~.

17. Tugboat ~~(R)~~ according to any of claim 9-16, ~~characterized in that~~ wherein it comprises steering and controlling means for steering and controlling said first and second thruster means ~~(3, 4)~~, said steering and controlling means being aligned along an axis which coincides with said longitudinal axis ~~(L)~~.