This invention relates to a bow bulb for ships designed to improve a ship's seaworthiness especially in head sea. In ships having only a small local freeboard at the bow, the forecastle is liable to be washed by the head sea. Particularly disagreeable are such phases in which the diving of the forecastle coincides with a wave crest at the bow. As is known, a dry forecastle in a head sea can be attained by appropriate configuration, such as:

1. A high local freeboard at the bow;
2. Heavily sloping forecastle ribs;
3. A large coefficient of fineness of the displacement and of the water lines. Making the local freeboard higher means in most cases a larger ship. Providing more heavily sloping ribs often is not efficient enough as a sole measure and results in an increased sea resistance. Augmenting the coefficients of fineness of the displacement and of the water lines also involves an increase in resistance which makes itself felt even in a smooth sea and to an increased extent in a rough sea. The hitherto known measures thus involve disadvantages.

In a known bow bulb, the rib shape has a curved limitation. Such a bow bulb favourably influences the displacement current. A disadvantage consists in the occurrence of slamming effects in a rough sea. Similar to normal forecastle shapes, the known bow bulb opposes only insignificant hydrodynamic resistance to pitching. Finally, pitch damping surfaces, similar to the front hydroplanes in a submarine, have become known in ships which, however, will cause very disagreeable slamming effects when they emerge in a heavy sea. The present invention provides a bow bulb for ships comprising lateral limitations forming a breaking edge located in the region of the largest width of said bow bulb.

Due to this feature, the advantageous influence on the displacement current is maintained. Moreover, the following advantages not present in the standard bow bulb can be attained thereby:

1. Damping of the pitch vibrations due to increased hydrodynamic vertical resistance. With the oblique approach flow produced by the pitching the thread of stream can break away at the edge. The breaking edges influence the pitching motion in the same way as a bilge keel influences the rolling motion.
2. Reduced slamming effects. The underside of the bulb below the breaking edge may be cuneiformly tapered, thereby to obtain reduced slamming effects as compared with a rounded underside.
3. Further reduction of resistance by bilge action. The flanks of the breaking edges exert a kind of bilge action influencing the wave pattern and thus providing a reduction of resistance beyond the rate given by the displacement current.
4. Additional reduction of resistance due to the position of the bulb close to the water level. As is known, the influence of the bulb on the wave pattern is most effective if the bulb is positioned close below the water level. With a standard bulb, the advantage of the resistance is not utilized to avoid the slamming effects which may be produced in this position. But since a bow bulb with a breaking edge can be constructed more slamming-proof, the advantage of the position close to the water level can be utilized in this case.
5. Cheaper construction. The bow bulb with a breaking edge (beak) can be so designed that the underside is constituted for the most part of plates bent in one direction only, whereas the top of the bulb may even be plane. The breaking edges may be arranged to extend in the direction of the thread of stream with a smooth water surface.

Also, an arrangement is possible in which the breaking edges of the bow bulb deviate from the direction of the thread of stream with a smooth water surface, which enables the damping effect to be increased. The wave pattern, furthermore, can be so influenced that there will result a reduced resistance. The orientation of the breaking edges influences the flow direction from the position of the bow bulb up to the water level so as to obtain a reduced wave formation and thus a reduced resistance.

In accordance with another feature of the present invention, the breaking edge may be rounded, whereby it is achieved that the current is not be broken away only with the occurrence of heavier pitching. Above the breaking edge, the flanks of the bow bulb may be straight, convex or concave, in order to influence the damping action and the reduction of resistance as desired.

The present invention also provides for the subsequent attachment of breaking edges or breaking edge bodies to a known bow bulb or a standard bow. In such case the breaking edge then constitutes a separate part to be attached to the existing bow in the way adopted with wedge-shaped bilge keels.

Three embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic side elevation of a bow bulb with a breaking edge having arcuate upper and lower flanks;

FIG. 2 is a diagrammatic representation of horizontal longitudinal sections through the bow bulb of FIG. 1;

FIG. 3 is a diagram showing rib cross sections of the bow bulb of FIG. 1;

FIG. 4 is a diagram showing rib cross sections of a bow bulb with a breaking edge having a plane top surface and a lower flake bent in one direction only, and

FIG. 5 is a diagram showing a standard bow bulb provided with an attached breaking edge.

With reference now to FIGS. 1 to 3, a bow bulb 1 has a base 2 and a breaking edge 3. The bow bulb 1 is represented in the region of ribs 19, 19½, 19¾, 19¾, 19½ and 20¾. The exact shape of the bow bulb 1 results from water lines WL 1¼, WL 1½, WL 1¾, WL 1¾, WL 1½, WL 2¼ and WL 3. The ship's centre line is referenced 4.

FIG. 4 illustrates a different embodiment of a bow bulb with a breaking edge. The bow bulb referenced 1' is represented in the region of ribs 17¼, 18, 18½, 19, 19½ and 19¾. The shape of the bulb results from water lines WL 1¼, WL 1½, WL 2, WL 3, WL 4 and WL 5.

In FIG. 5, a bow bulb 1″ is provided with a breaking edge 3' formed by an attached part 5 adapted to be subsequently mounted on existing ships' bows of any shape. Briefly in review, constructions are known in which the configuration at the bow of a ship is such that it forms a hollow and outer edge extending in the longitudinal direction of the ship.

In the known constructions the edge increases the amount of flow resistance in vertical direction, when a vertical flow component is caused by the orbital motion of a rough sea or by the pitching motion of the ship.
A vertical force occurs which tends to adjust the motion of the bow to the vertical motion of a rough sea. When the ship pitches in a rough sea in such a manner that the water flows alongside the edge, then the pitching vibrations are not influenced otherwise than in accordance with the normal configuration of the ship. In such a case, a rough sea is relatively harmless.

The present invention provides a combination of longitudinal edges which damp the pitching vibrations and a bow bulb which projects beyond the front vertical line. The invention consists in the combination of the following features:

(a) The bow bulb projects beyond the front vertical line below the construction water line;
(b) its two lateral faces are bent in such a way that they form on each side of the ship an edge which is positioned in the region of the largest width of the bow bulb;
(c) the edge slopes backwards in the region behind the front vertical line and has an angle of 6° to 18° relative to the horizontal line in the entire region or in a part thereof;
(d) in the region behind the rear vertical line the edge diverges backwards relative to the midships plane, extends parallel or converges slightly backwards but not more than by 10°.

This arrangement not only combines the resistance-decreasing effect of a bow bulb projecting beyond the vertical line with the pitching-vibration damping effect of longitudinal edges, but it also increases the effectiveness of the edge in comparison with the known arrangements in the following way:

(1) The lever arm between the front edge portion and the center of the pitching vibrations is enlarged.

(2) Insofar as the bulb is not overlapped by the forecastle, it may be provided with a relatively flat upper side which has the effect of a "pitching-vibration damping surface."

In accordance with another feature of the present invention, the edge may be rounded, whereby it is achieved that the current will be broken away only with the occurrence of heavier pitching. Above the edge the flanks of the bow bulb may be straight, convex or concave in order to influence the damping action and the reduction of resistance as desired.

Below the bulb the flanks in the plane of the ribs may be straight or convexly bent.

The present invention also provides for the subsequent attachment of edges or edge bodies to a known bulb bow which projects beyond the front vertical line. In such a case the edge constitutes a separate structural part to be attached to the existing bow in the way adopted with wedge-shaped bilge keels.

We claim:

1. In a ship hull comprising a vertical edge at the forward portion of the bow, a base and a normal water line, the improvement comprising a bow-bulb projecting beyond said hull vertical edge and disposed below the normal water line, said bow-bulb including lateral faces forming a longitudinal edge extending substantially from the forwardmost portion of said bow-bulb and rearwardly and angularly toward the base of said hull, said longitudinal edge being disposed at the maximum transverse width of said bow-bulb and extending substantially the entire length of said bow bulb.

2. In a hull for a ship comprising in combination: a hull having a forward vertical edge, characterized by said bow-bulb projecting beyond the forward vertical edge and below the normal water line of said hull, said bow-bulb comprising two lateral faces curved in such a way and forming on each side of the hull a longitudinal edge which is located in the region of the largest transverse width of the bow-bulb, said longitudinal edge sloping rearwardly from said vertical edge in the region behind the forward vertical edge of said hull and having an angle ranging from 6° to 18° relative to a horizontal plane and extending substantially the entire extent of said bow-bulb, the portion of the bow-bulb behind the rear vertical edge of said forward edge diverging rearwardly relative to a medial plane of said bow-bulb and extending parallel and converging slightly rearwardly not more than 10°.

3. The structure as claimed in claim 2 wherein the longitudinal edge of said bow-bulb is arcuate, the radius of the arcuate edges being less than 0.2°F wherein F designates the rib surface below the normal water line.

4. The structure as claimed in claim 2 wherein several longitudinal edges are provided on said bow-bulb.

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