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WATERLINE BULB ON HIGH SPEED BOATS

THE AUTHOR

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SYSTEMATIC tests with different bow appendages fitted onto the models of a tanker and a motorboat, carried out in Turkish Tank,* have served to explain the characteristic function of the ship bulb as a resistance-reducing means. From the various means used to abate the bow wave, only the streamlined body of revolution, the nearest geometrical bow appendage to the existing ship bulb will be taken as the subject of this article.

Pressure measurements on naked ship models by various investigators have indicated that a pressure maxima occurs near station 19½, in the vicinity of designed waterline, and that the bow wave is principally responsible for the greater part of ship wave resistance.

Measurements of local pressures around the model hull confirms that the excess pressure at fore body responsible for wave making is more pronounced in the vicinity of load waterline than down near the keel. As the design and positioning of the conventional bulbs has not been based upon any

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* A contribution made by the author to the 9th symposium of Naval hydrodynamics, held in Bergen, Sept. 1964.

specific theory or hydrodynamic reasoning, it invites suspicion as to its present shape and place. A need was therefore felt to study the performance of the bulb alone and then in conjunction with ship's bow in interaction.

A bulb, of streamlined body of revolution form, fitted onto the tanker model is shown in Figure 1a and the same, capped with a segmental hydrofoil suppressor, in Figure 1b. In Figures 1c and 1d the wave formations without and with the bulb are compared, where, in the latter, the bow wave is sucked down to the original calm waterline. The thus reduced total resistance amounted to 17.5 per cent.

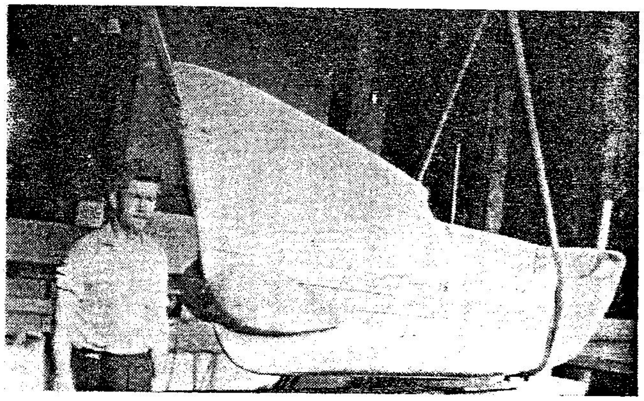


Figure 1a.

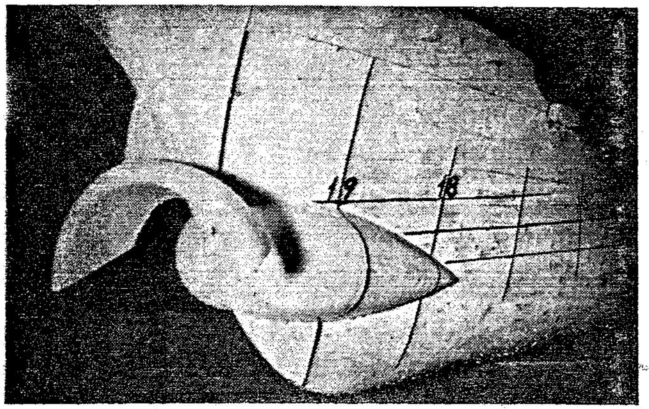


Figure 1b.

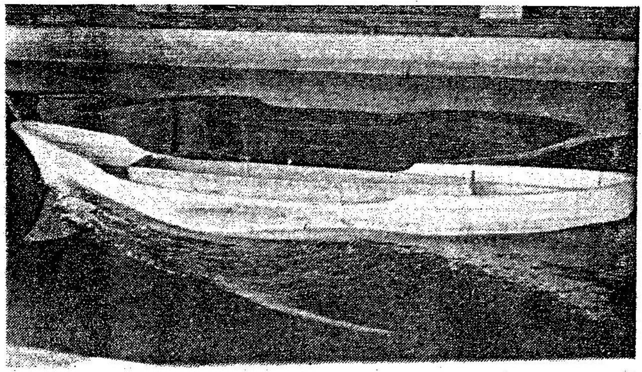


Figure 1c.

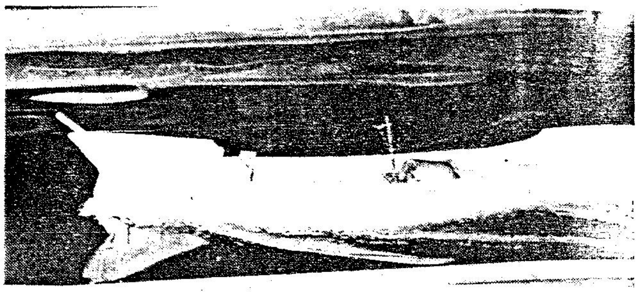


Figure 1d.

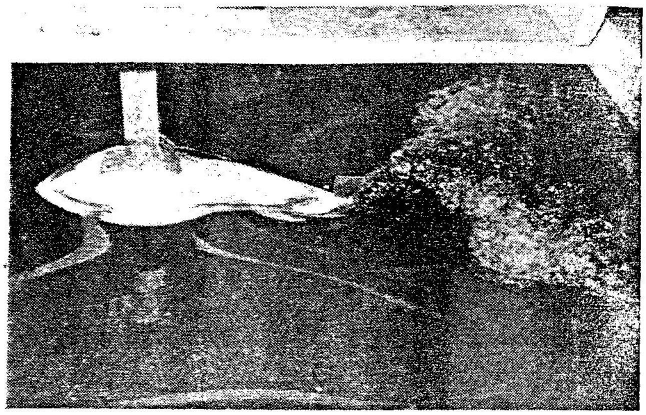


Figure 2a.

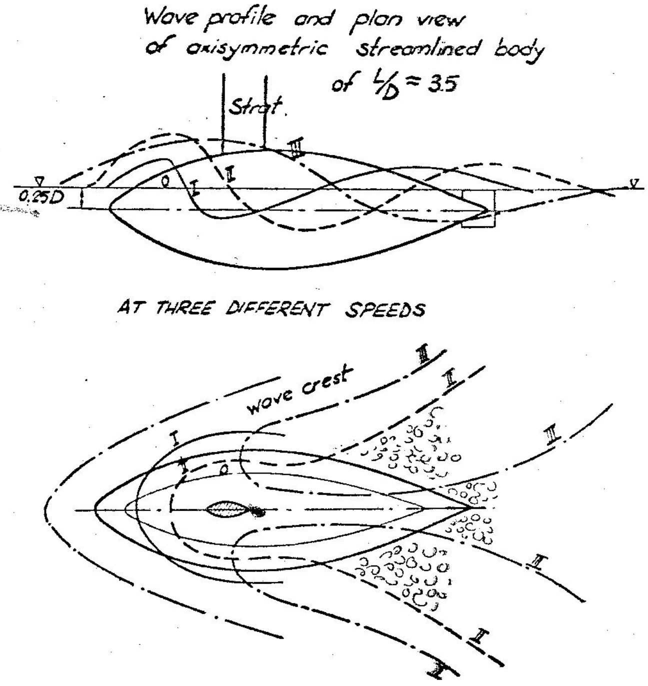


Figure 2b.

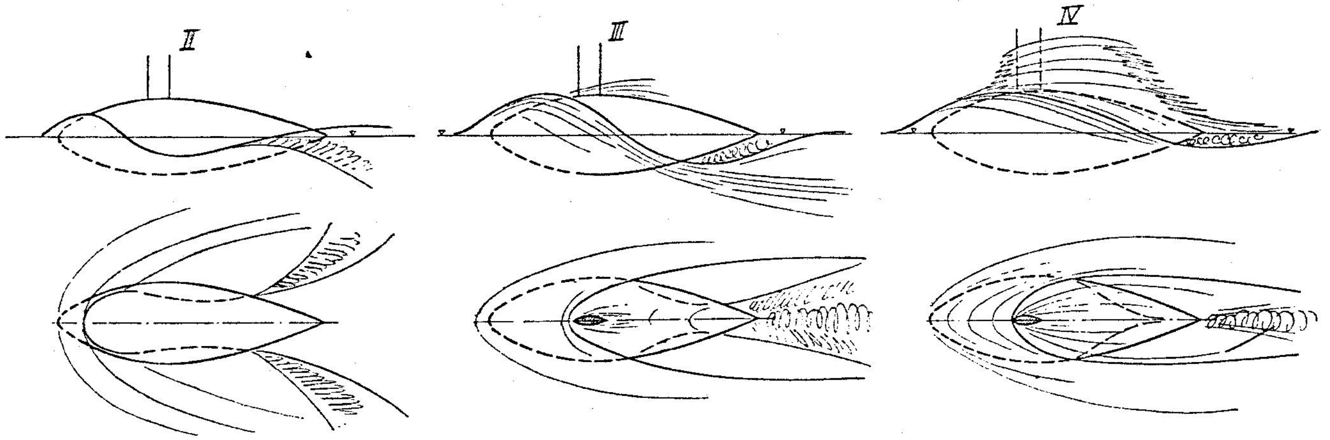
These observations have necessitated a program of testing to study the performance of the body of revolution, in calm water and in wave crest, to determine its resistance and flow patterns at different Froude numbers both speed and depth. A streamlined body of revolution model having a L/D=3.50 was towed by a strut, at different depths and speeds and yaw angles. The resistance, distribution of pressure (and suction) around the body were determined as could also be inferred from its wave formations. The critical Froude numbers were noted as demonstrated by peaks in resistance curves, however, the latter includes the resistance of the strut as well.

Some of the results measured from model tests are given in Figures 2b, 2c. The wave formations at three ranges of speed are as given in Figure 2a for an immersion of OD (centre line=WL). The wave crest at the nose climbs over the body as the speed is increased and a deep wave trough is produced in the middle, which moves aft as the speed is increased and eddies are formed below the tail. The body is sheathed by its wave at higher speeds.

The photograph in Figure 3a shows the body at critical Froude number with its wake bound to it.

The wave formations of the same body towed at 0.25D draft and at three different speeds are as shown in Figure 3b. The body of revolution when

STREAMLINED BODY OF REVOLUTION
WAVE FORMATIONS AND FLOW PATTERNS
AT DIFFERENT SPEEDS



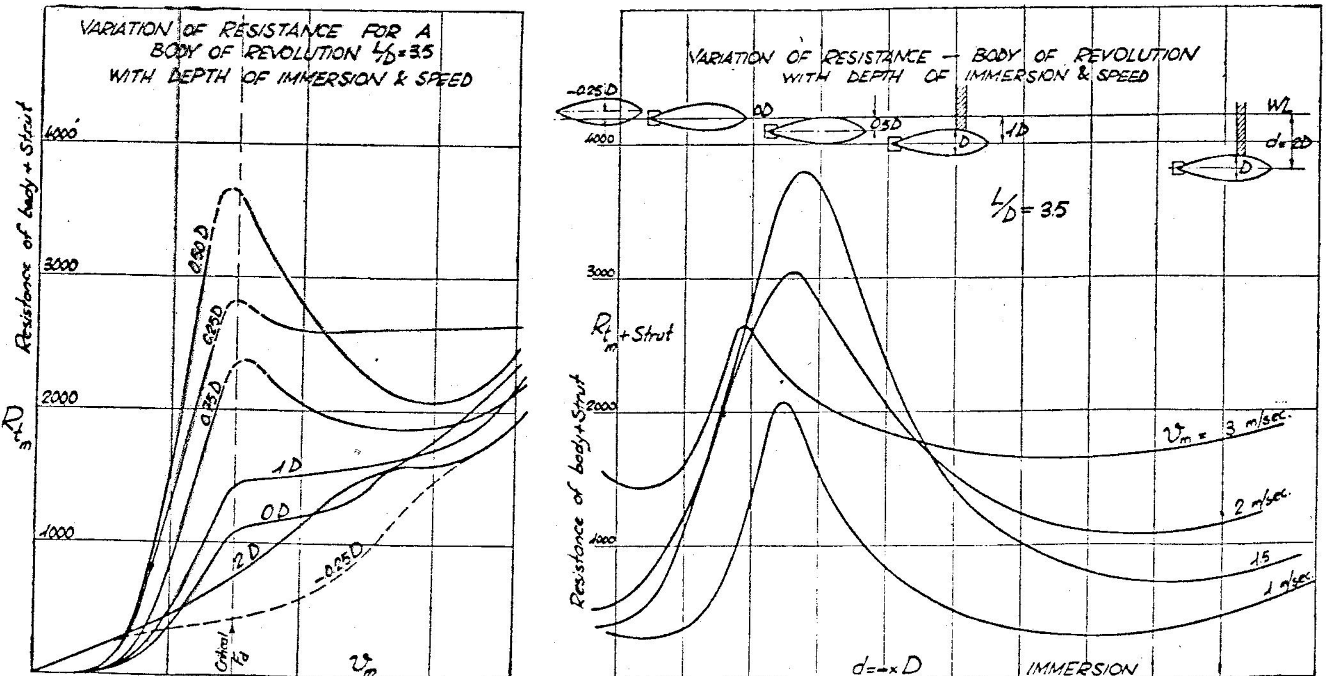


Figure 2c.

towed in different positions of a wave crest has been instructive in the design of bulbs. for determining the proper size and positioning in order to be effective in its function of interference to anihilate a ship's bow wave.

These tests have proven that the function of a ship's bulb can be simulated and treated like that of a fish form body. It appears from the foregoing that any ship suffering from excessive wave resistance can benefit from a WL bulb. It will only suffice to know the bow wave profile of the particular ship in hand.

The size and proportions and the position of the bulb have to suit the requirements of the particular bow wave. The bow wave is known to be governed by the stagnation pressure, the angle of entrance and the angle of incidence of the U or V sections at the bow. With increase of speed (Froude Number) the wave will be elongated and its size will increase. With finer angle of entrance, the crest will lie closer to the ship's side, the stem cutting into it (Figure 3b); unlike the slow ship's wave, having blunter entrance, where the bow wave crest will spread out at a greater angle of divergence, its trough following suit.

The bulb tried in the tank had a curvilinear velocity distribution with a maximum velocity increase of about 12 per cent. the increase starting from about 0.08L to 0.75L from its nose. The velocity profile is coincident to a ship's bow wave profile. steeper at the bow, the maximum ordinate being at about 0.37L, in completely submerged condition.

The characteristics of the streamlined body of revolution at zero angle of incidence at various depths of submergence being known the successive steps are to determine the same in inclined state (or yaw angles) and in different types of waves, later at interaction with ship's sides. When the pressure distribution in the vicinity of the bow is known to the designer, a bulb can be found to suit the conditions.

A bulb to suit a large range of speed should be selected. An example of a bulb fitted on a high speed hull is given in Figures 3a to 3c. The photograph of the wave formation in bulbless condition may be seen in Figure 3b. The boat is a yacht adopted from the lines of the local fishing boats in Turkey.

A bulb having an L/D ratio of 5 having the form as shown in Figure 3c was selected and fitted at design waterline, with a slight slope to end into the

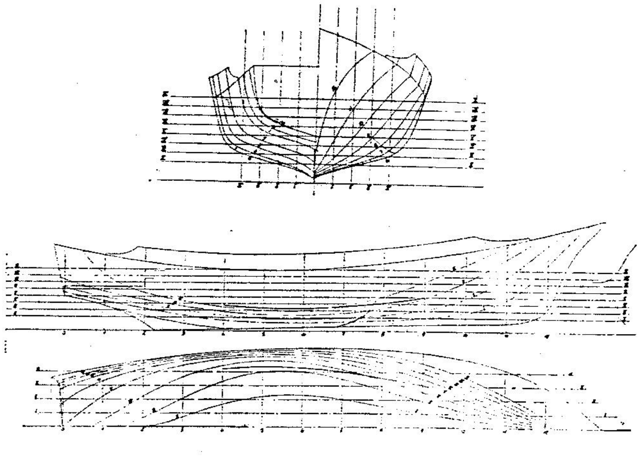


Figure 3a.

Figure 3b.

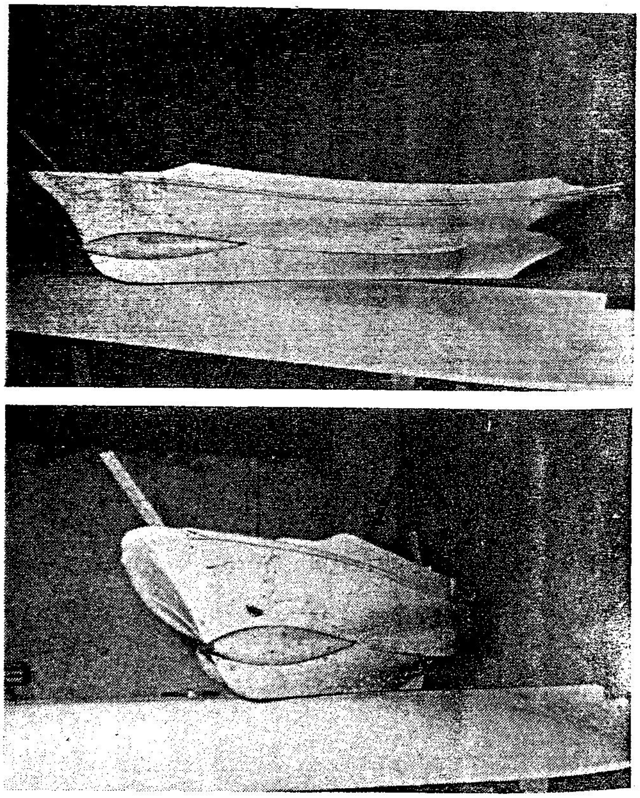


Figure 3c.

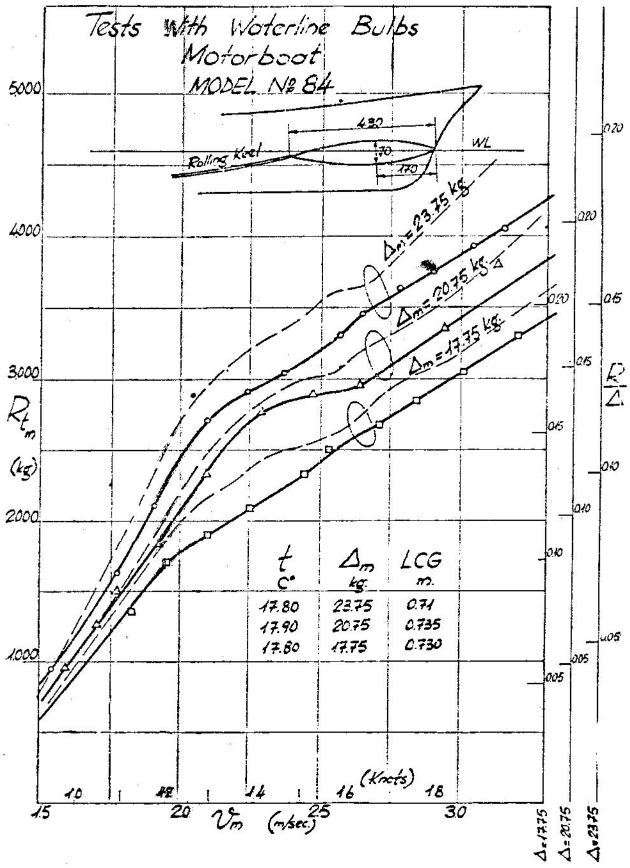


Figure 3d.

rolling keel. The bulb has reduced the bow wave considerably and partially emerged.

The results of resistance tests, for three different displacements are given in Figure 3d. The dotted lines being for original hull and full lines for the bulbed form. The gain, difference between the curves, covers the whole range of speeds, which is exceptional. The cause may be attributed also to the reduction of frictional resistance obtained by the abated bow wave. Further reduction in total resistance was attained when a segmented foil was additionally fitted on the bulb.

In an endeavor to explain the function of the surface bulb, it may be said that, the production of waves being a surface phenomena, a body of interference placed near the surface becomes more effective in the ensuing interaction. The tests have shown that the extra resistance of the bulb due to its proximity to the surface is negligible against the benefit brought by it. Furthermore, the condition of the bulb in a wave crest differs from that of its calm water performance.

The solid body of the bulb occupies the core of the bow wave and displacing it, turns it into a sheet wave of envelope, in medium speed range. At higher speeds, the bulb emerges, its lower surface acting alone.

However, although it has yet to be confirmed by tests, it appears that a surface bulb constitutes an effective contribution in a ship's seakeeping qualities, since it will reduce pitching.

SNAP-7E COMPLETES FIRST YEAR OF OPERATION

The U.S. Navy Underwater Sound Laboratory's (USL) underwater acoustic beacon, located approximately 100 miles southwest of Bermuda at a depth of about 13,000 feet, has completed one year of successful operation. The beacon, which uses an isotopic power source provided by the Atomic Energy Commission (AEC), is designated SNAP-7E. (The letters SNAP stand for Systems for Nuclear Auxiliary Power, a series of power devices for sea, space, and land use.)

The beacon was implanted in July 1964 and put into operation as a research tool for a two-year evaluation program to be conducted by USL. The energy source for the beacon is a 2,000-pound isotopic generator, developed for AEC by the Martin Company, Baltimore, Maryland, which also developed an energy storage system for the generator and a pressure housing for the electronic equipment.

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