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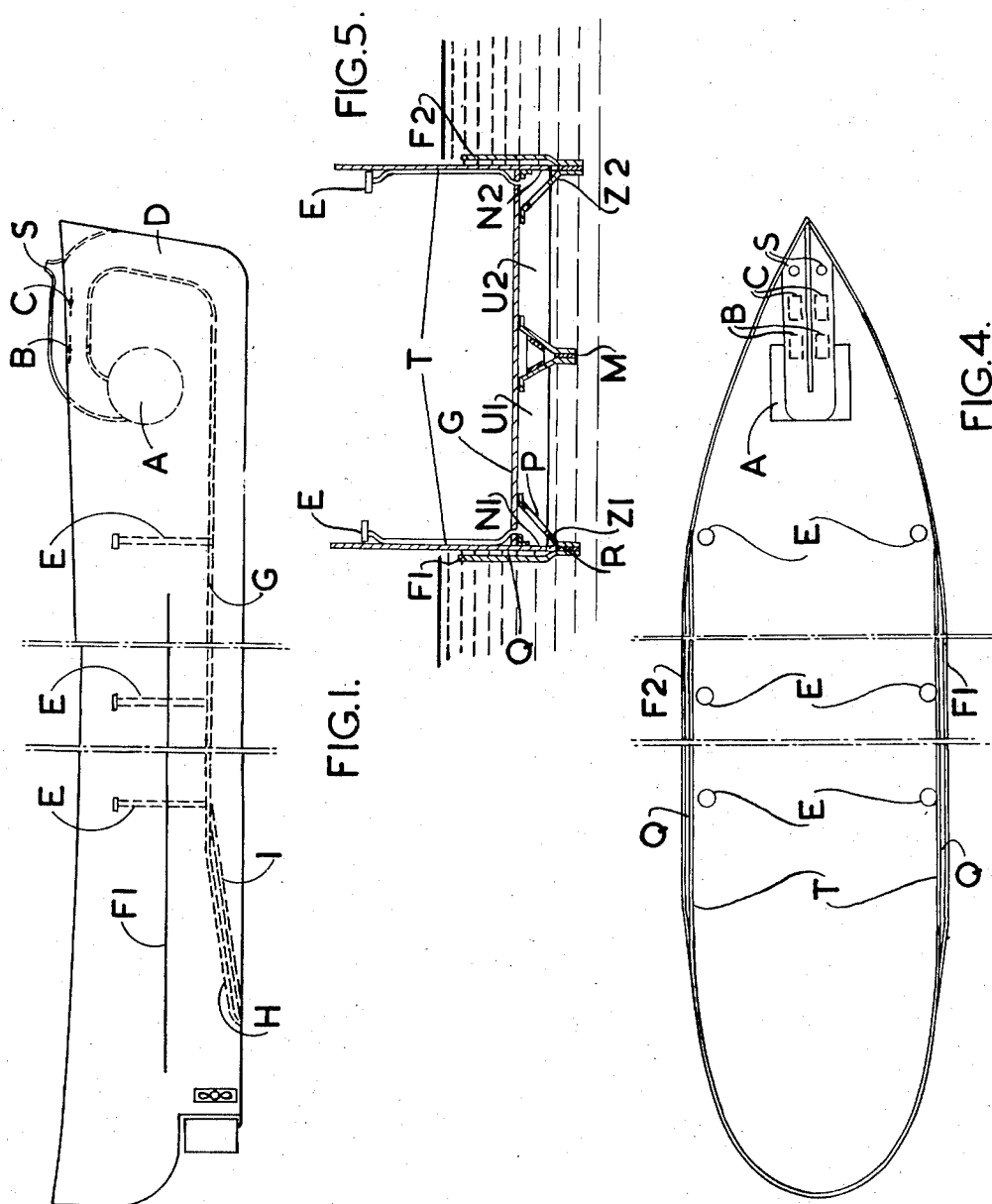
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SHIP'S HULL CONSTRUCTION

Filed Aug. 15, 1955

2 Sheets-Sheet 1



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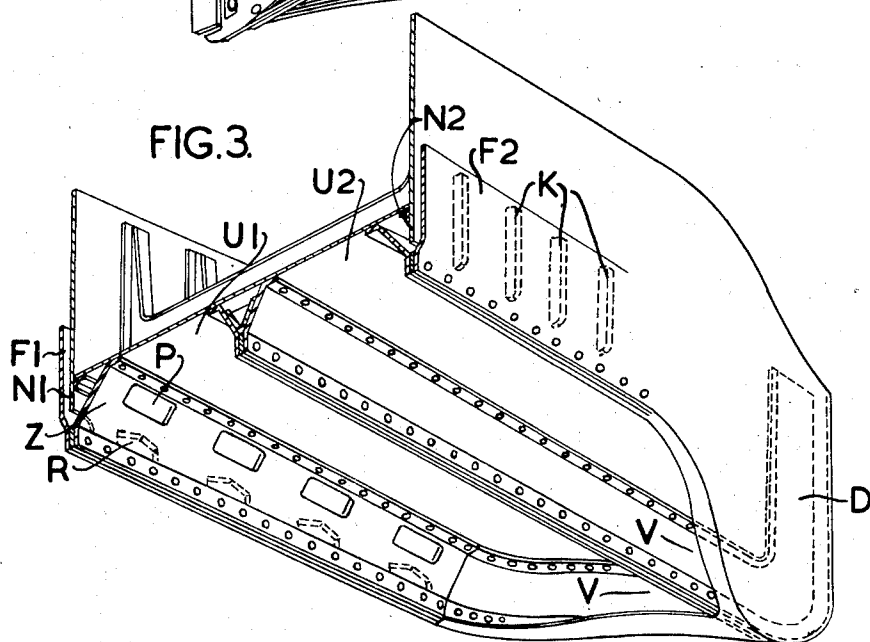
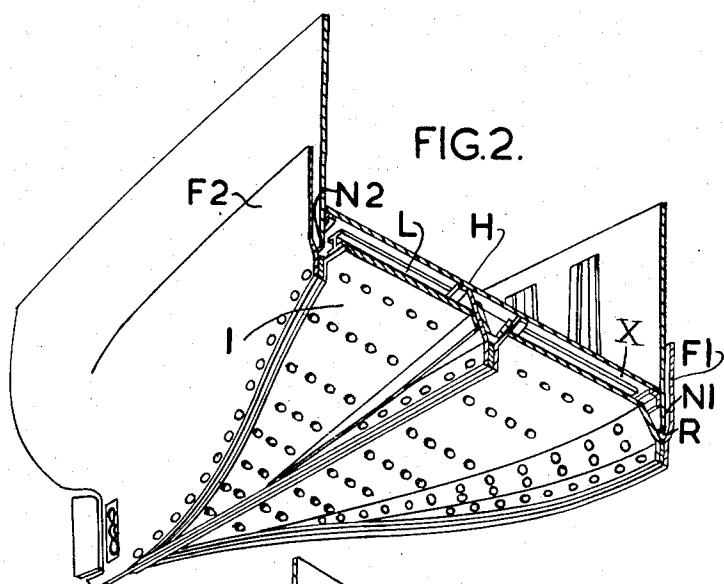
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## SHIP'S HULL CONSTRUCTION

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8 Claims. (Cl. 114—122)

This invention relates to ship's hull construction and has for its object to provide a ship's hull which will have reduced skin friction, as concerns a comparable ship's hull. The term "ship," as hereinafter used, is intended to include ocean-going vessels and smaller craft, such for example as motor launches.

According to the present invention, a hull of a ship includes a generally flat bottom beneath which are formed two air tunnels, said tunnels being formed by three downwardly extending projections or members, two of which are extensions of the sides of the hull, the other being arranged along the longitudinal centre line of the bottom, said tunnels extending over substantially the whole length of the hull, means being provided for maintaining a layer or cushion of air under pressure in each of said tunnels.

Preferably air is forced through inlets in the bottom of the hull at the bow, which air is directed into the tunnels in a direction substantially parallel with the bottom of the hull and towards the stern, means being provided at the stern of the ship for allowing a controlled exit of said air from the tunnels. Preferably also the supply of air under pressure to each tunnel is separately controlled, whereby a layer of air in the two tunnels along the bottom of the hull can be maintained and, if necessary, the air in one tunnel can be at a pressure different from that in the other tunnel, thereby providing means for counteracting rolling of the ship.

The means for supplying air under pressure may consist of a turbo-blower or the like, with a damper control, mounted within the ship adjacent the bow, which can supply air under pressure to two separate conduits leading downwardly to the bottom of the ship and terminating in an outlet directed aft, and at an angle such that air issuing therefrom into a tunnel is directed parallel, or substantially parallel, to and along the bottom of the ship; it will, of course, be appreciated that, if desired, two turbo-blowers may be provided, one for each tunnel. Pressure release valves may also be provided, leading off each tunnel.

The downwardly extending projections of the sides of the hull may be provided with exterior baffle plates extending substantially from bow to stern, and approximately from the water level to about the level of said projections, so as to form, in effect, a double skin along the sides of the hull. The arrangement is such that air release passages are provided so that when the ship rolls and air escapes from one or other of the tunnels under the respective projections, turbulence in the water along the sides of the ship is prevented and the air passes up through the release passages in the double skin. This escape of air reduces the pressure and volume of air in the respective tunnel, thereby tending to prevent further rolling motion of the ship.

The roof of each tunnel, a short distance from the stern, slopes downwardly to the level of the three downwardly extending projections. Extending across the width of

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each tunnel at the stern, and parallel to the downward sloping roof of each tunnel, is a perforated plate, which is curved at its end adjacent the stern of the ship so that it tends to merge with the downwardly sloping tunnel roof. It will be seen therefore that, when the ship is in motion, air, assisted by the flow of water, is carried along each of the tunnels, and at the stern is directed by the downward sloping roof and perforated plate through ports in the side projections adjacent the stern and then escapes up the release passages in the double skin.

Due to the downwardly sloping roof of each tunnel, there might be a tendency for the air being carried along by the water to build up to form a "bulge," but this tendency is prevented by the perforated plates which break up any eddying currents in the air.

The downwardly extending projections of the sides of the hull adjacent the bow do not require exterior baffle plates or air release passages but may be curved to follow substantially conventional hull lines.

An example of the present invention is now described with reference to the accompanying diagrammatic drawings in which:

Figure 1 is a side view of a hull of a ship.

Figure 2 is a part sectional, perspective view showing the bottom and stern of the hull.

Figure 3 is a part sectional perspective view showing the bottom and bow of the hull.

Figure 4 is a plan view of the hull, and

Figure 5 is a mid-ships section of the hull.

Referring to the drawings, the hull of a ship includes a flat bottom G from which downwardly extend three projections M, N1 and N2, of which projections N1 and N2 are extensions of the sides T of the hull, and at their lower edges are provided with ports R, the third projection M being arranged along the longitudinal centre line of the bottom. There are thus formed two tunnels generally indicated by U1 and U2 which extend over substantially the whole length of the hull and which are adapted to maintain two air layers or cushions under the hull. Air in the two tunnels U1 and U2 is forced through inlets V, in the bottom G adjacent the bow, to enter the tunnels in a direction along the bottom and is released from the stern through controlled exits to be fully described hereinafter. Air is supplied to the inlets V under pressure by means of a turbo-blower A and connected thereto by two conduits D, in each of which is provided two control dampers B and C and a relief valve S. Each tunnel U1, U2 adjacent the stern communicates through a perforated plate I with an air chamber X, the roof H of which is inclined downwardly towards the stern to terminate at the level of the lower edge of the two projections N1 and N2. The perforated plate I is spaced away from the roof H by distance pieces L (only one shown), and its edge adjacent the stern is curved and shaped to merge with the roof H.

Extending along each side of the hull substantially from bow to stern, and substantially from water level to the level of the projections N1 and N2, are exterior baffle plates F1 and F2 respectively, which define air release passages Q up each side of the hull. Plates F1 and F2 are spaced from the sides T by distance pieces K. Bracing members Z1 and Z2 are secured to the projections N1, N2 respectively, in turn secured to the baffles F1 and F2, which members Z1, Z2 are inclined inwardly and upwardly, and secured to the flat bottom G of the hull. A series of spaced apart air escape ports P are provided in the bracing members Z1 and Z2. These ports, together with the ports R, are shaped and positioned so as to allow for the controlled release of air from the tunnels when the ship rolls. As the ship rolls, air will escape through the ports P and R, and up the respective

air release passage Q to atmosphere. It is imperative that air should not escape under the baffles F1 and F2 and up the outside of the hull as this could cause undesirable turbulence in the water. This escape of air can be avoided by making the head of air escaping through the ports P and R, and passage Q, less than the head of water between the top edge of the ports R and the bottom edge of the projections N1, N2 (see Figure 5). The efficiency of the two series of ports is improved by making the upper edge of the series of ports R in the form of an inverted shallow V; this allows a small release of air before the main discharge. This small release of air or initial discharge has the effect of increasing the rapidity of discharge and allows the ship to return more smoothly to its normal level position.

It should be understood that when the ship is stationary air cannot escape from the tunnels until a layer or cushion has been formed therein of such depth that it would overflow through the ports R in the projections N1 and N2 into the release passages Q from whence it would escape to atmosphere. On the other hand, when the vessel is in motion, the air in the tunnels in contact with water is carried along the tunnels towards the stern, exit of the air at the stern being controlled by being directed by the inclined roof H and perforated plates I downwards and through the ports R adjacent the stern and into air release passages Q from whence the air escapes to atmosphere. It will be seen, therefore, that all escaping air at the stern passes through air release passages Q and no air escapes up the outside of the vessel.

Coupled to the relief valves S and to the dampers B is a level control relay (not shown) operated by a simple pendulum device which automatically controls the air pressure in the tunnels to counteract rolling in the ship; if the ship is rolling to port the air pressure in the port tunnel is increased and the air pressure in the starboard tunnel decreases, and vice versa. The level control relay is situated amidships on the longitudinal centre line of the hull and at such a height that the axis about which the pendulum swings coincides with the roll centre of the vessel. By positioning the control relay amidships it is subjected to a minimum amount of pitching motion of the vessel. In each tunnel and spaced along the length of the hull, are three detector units E, which may be of the electronic or float type, to give an indication of the presence of air in each tunnel and to control the operation of the respective dampers C to increase or decrease the air pressure. The sequence of operation of the damper units is as follows: Assuming that the tunnels U1 and U2 are free from air, the turbo-blower is brought into operation introducing air into the tunnels adjacent the bow, which air tends to creep along the tunnels towards the stern. As the air reaches the detector unit adjacent the bow, it closes the damper C slightly and thus reduces the flow of air into the tunnels. The second and third detector units come into operation as the layers of air are built-up in the tunnels and as each unit comes into operation the flow of air is reduced until the layers of air are built-up along the length of both tunnels. The two detector units adjacent the bow serve a dual purpose, because when air is absent from the portions of the tunnels adjacent the bow, and although air may be in the tunnels amidship and adjacent the stern, these forward units open the dampers C fully so that air under maximum pressure is forced into the tunnels. This operation of the forward units is independent of the position of the other two units.

It will be realised that, as the air layers are built up, the ship will rise out of the water and that air initially will have to be supplied to the tunnels at a pressure greater than that that will be in the tunnels when filled. This is because work has to be done by the air being forced into the tunnels to displace water from the tunnels

and consequently to lift the ship. It is desirable, as the tunnels are filled with air, gradually to decrease the inlet pressure to that which will be in the tunnel when filled. This decrease in inlet pressure is controlled by the detector units.

The level of the projections, M, N1 and N2 are not proportional to the draught of the vessel but must be such as to retain a layer or cushion of air within the tunnels when the ship is rolling to at least an angle of 6°. The angle of roll at which air is discharged from through the ports R should preferably be only a fraction of a degree. The centre projection M may terminate short of the bottom of the projections N1 and N2 but should be such that air from one tunnel does not enter the other tunnel when the vessel is rolling to an angle of 6°. For example, the depth of M may be  $\frac{7}{10}$  of the depth of the projections N1 and N2.

A full sequence of operation will now be described commencing with the ship at rest and no air in either of the tunnels. The turbo-blower is brought into operation and air is pumped into the two tunnels until each tunnel has been fully charged with air. As the vessel moves forward air in contact with the water is carried towards the stern and is discharged through the air release passages adjacent the stern. If the vessel should roll the level control relay is actuated, causing the respective dampers B and relief valves S to operate to reduce the pressure in one tunnel and increase it in the other to counteract the rolling of the vessel, as hereinbefore described. When the vessel comes to rest, air may be released from the tunnels by opening the relief valve S. Although small pockets of air may be left in the tunnels this is of no consequence.

What is claimed is:

1. A ship construction comprising a hull including a generally flat bottom, three projections extending downwardly from said bottom, two of which projections are extensions of the sides of the hull, the other being arranged along the longitudinal centre line of the bottom, thereby defining two tunnels beneath said bottom extending along substantially the whole length of the hull, exterior baffle plates mounted on the outside of said hull and extending alongside and spaced from the hull sides respectively substantially from the bow to stern and substantially from water level down to approximately the level of said projections, thereby forming a double skin along the sides of the hull, air blowing means mounted on said hull, inlets in the bottom of the hull adjacent the bow in communication with said air blowing means and said tunnels, whereby air is introduced into the tunnels and directed substantially parallel with the bottom of the hull to the stern, and means for providing communication between said tunnels and the spaces between the hull sides and the respectively associated baffle plates for controlling exit of air from said tunnels.

2. A ship's hull according to claim 1, wherein the roof of each tunnel, a short distance from the stern, slopes downwardly to substantially the level of the three downwardly extending projections, a perforated plate being provided spaced below but parallel to the downward sloping roof.

3. A ship's hull according to claim 2 in which said perforated plate is curved at its edge adjacent the stern and merges with the downwardly sloping tunnel roof.

4. A ship's hull according to claim 1 in which said spaces between the hull sides and the respectively associated baffle plates constitute air release passages open at their tops for enabling escape of air from the tunnel at the higher side of the hull when the ship rolls.

5. A ship construction according to claim 1 including means for varying the air pressure in one tunnel with respect to that in the other.

6. A ship construction according to claim 2 including

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means for varying the air pressure in one tunnel with respect to that in the other.

7. A ship construction as set forth in claim 3 including dampers for variably controlling the air pressure in one tunnel with respect to that in the other to counteract tendency of the ship to roll, and means responsive to rolling of the ship for automatically operating said dampers.

8. A ship construction as set forth in claim 7 including pressure release valves operable by said responsive

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means for automatically releasing air from either of said tunnels, according to the roll of the ship.

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