United States Patent

Pool

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[54] **METHODS OF AND APPARATUS FOR REDUCING RESISTANCE TO THE HULL OF A VESSEL**

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[52] **U.S. Cl.** .....**114/67 A**
[51] **Int. Cl.** **B63b 1/38**
[58] **Field of Search** .....114/67 A, 67 R

[56] **References Cited**

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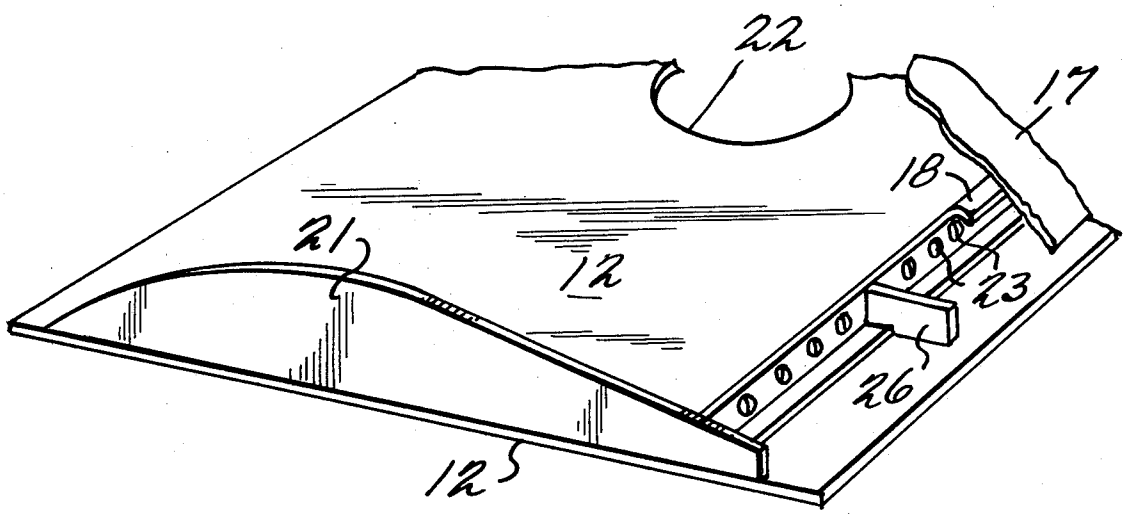
[57] **ABSTRACT**

In order to reduce resistance to motion of a hull through water and/or to counteract marine growth on the hull pressurized air is discharged from a duct extending transversely of the hull into a diffuser chamber from which it is discharged through a slot in the form of a film flowing rearwardly over the submerged hull.

8 Claims, 8 Drawing Figures



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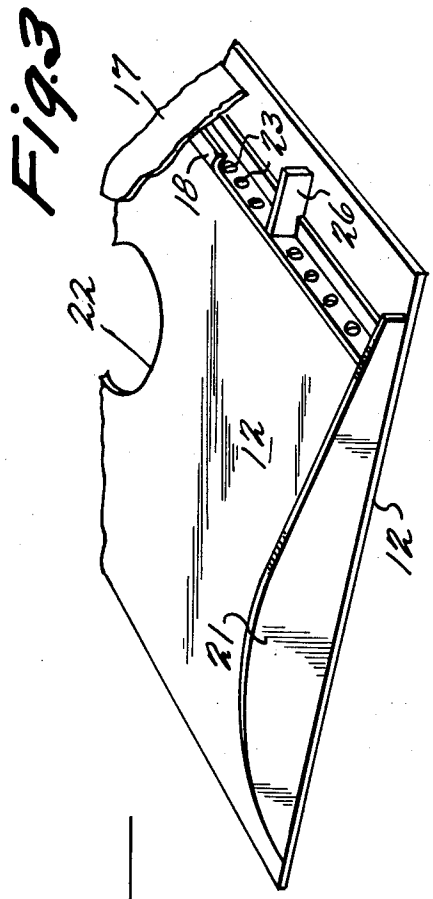

Fig. 3

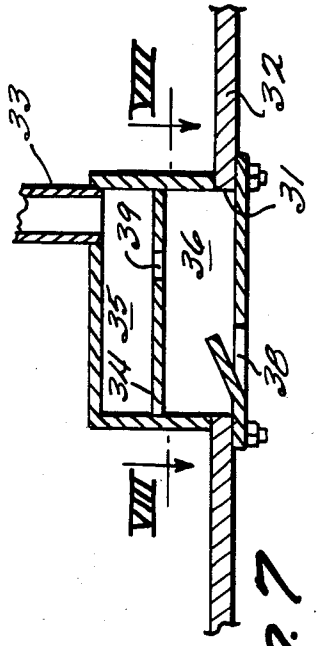

Fig. 7

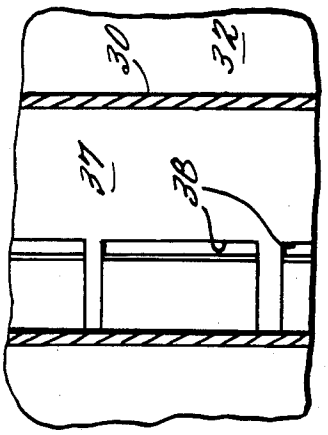

Fig. 8

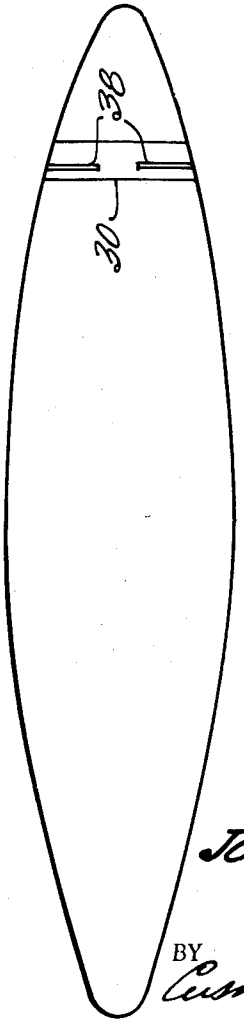

Fig. 6

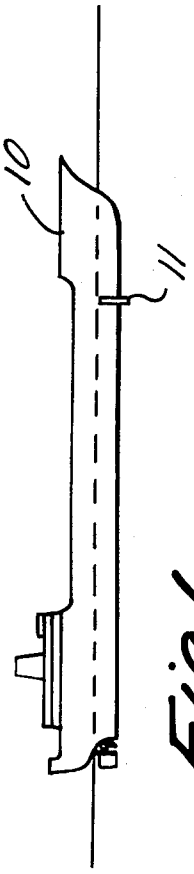

Fig. 1

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Fig. 2

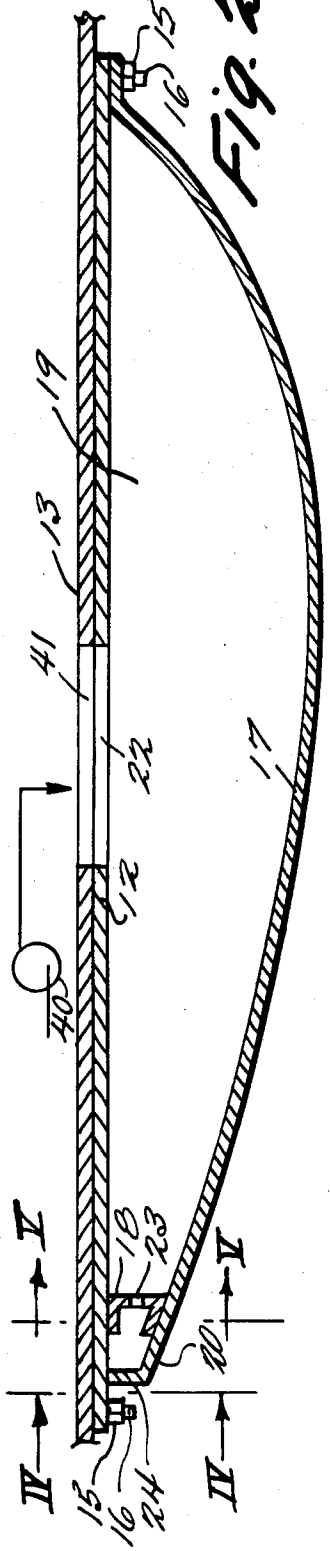


Fig. 4

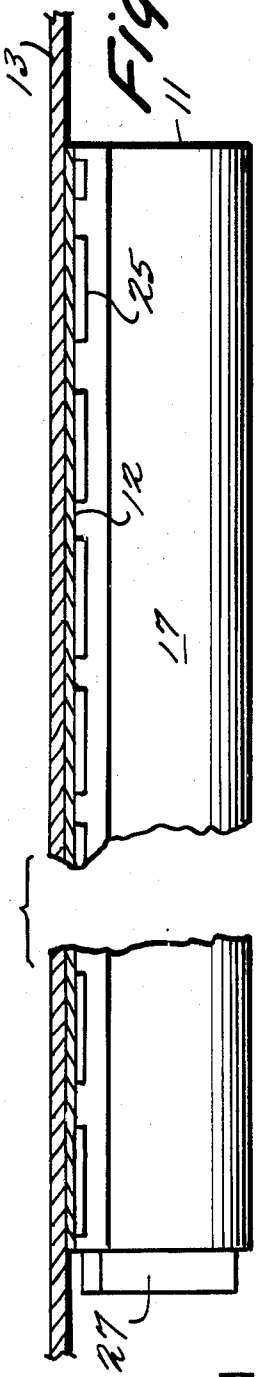
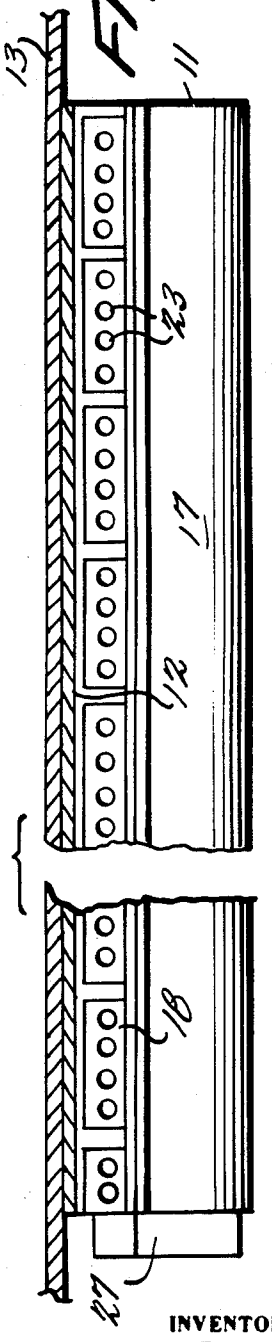


Fig. 5



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METHODS OF AND APPARATUS FOR REDUCING RESISTANCE TO THE HULL OF A VESSEL

The present invention relates to a method of reducing viscous resistance to motion of a hull through water and/or counteracting marine growth on the hull in which air or another fluid medium is discharged through a plurality of openings spaced transversely of the hull below the water-line. The invention further relates to apparatus for carrying out this method.

A considerable proportion of the propulsion power required to drive a ship through water is used to overcome viscous resistance exerted on the hull of the ship by the water. This viscous resistance is considerable increased by marine growth on the hull.

It is known to reduce the viscous resistance by discharging air or other fluid beneath the hull, but previous methods of doing this have the disadvantage that the fluid is not discharged sufficiently uniformly around the hull.

The present invention is based on the problem of discharging air or other fluid around a hull beneath the water-line as a thin layer or film discharged along the outer surface of the hull.

This problem is solved, according to the invention, in that the fluid medium is directed by the openings towards a diffuser surface in a diffuser chamber, and in that the fluid medium is discharged along the outer surface of the hull towards the stern from the diffuser chamber through at least one slot-shaped opening extending transversely of the hull.

Advantageously, the slot-shaped opening is arranged according to the pattern of flow of the fluid medium relative to the free-stream.

To take into account differences in the pressure of the water at different depths, the mass flow of the fluid medium from the slot-shaped opening preferably varies from the lowermost portion of the hull to the shallower portions of the hull in accordance with the depth of the water at said portions.

To avoid turbulence in the free stream, the fluid medium is advantageously discharged from the slot-shaped opening at the same velocity as that of the hull relative to the water.

The invention will now be described in greater detail with reference to the accompanying drawings, which are given by way of example only, and in which:

FIG. 1 shows a side view of a ship provided with fluid discharge apparatus embodying the present invention;

FIG. 2 shows a view taken in section through the plating of the hull of the ship of FIG. 1 and the fluid discharge apparatus attached thereto;

FIG. 3 shows a broken-away view taken in perspective of the fluid discharge apparatus of FIG. 1;

FIG. 4 shows a view taken in section along the line IV — IV of FIG. 2;

FIG. 5 shows a view taken in section along the line V — V of FIG. 2;

FIG. 6 shows diagrammatically a view taken in horizontal section below the water-line of the hull of a ship provided with a modified fluid discharge apparatus;

FIG. 7 shows a vertical section through a portion of the plating of the hull of the ship of FIG. 6 and the modified fluid discharge apparatus; and

FIG. 8 shows a broken-away view taken in section along the line VIII — VIII of FIG. 7.

As shown in FIG. 1, a ship 10 is provided near its bows with a fluid discharge apparatus indicated generally by reference numeral 11, which is secured to the underside of the hull of the ship 10 and extends transversely of the hull. When the ship is in motion, air is discharged rearwardly from the apparatus 11 and, as described in greater detail below, forms a film under a major portion of the wetted area of the hull for reducing the drag exerted on the ship by the viscous resistance of the water in which the ship 10 floats.

The fluid discharge apparatus is shown in greater detail in FIGS. 2 to 5 of the drawings. As shown the apparatus 11 comprises a flat plate portion 12 which is secured to the exterior of a portion of the plating 13 of the hull of the ship 10, e.g., by nuts 15 threaded on to pins 16 projecting from the plating 13. A cover member 17 is secured to the flat plate portion 12, and has a substantially streamlined or aerofoil shape in order to reduce the drag caused by the fluid discharge apparatus 11 as the ship 10 travels through the water.

The space between the cover member 17 and the flat plate portion 12 is separated by an apertured wall member 18 to form a duct 19 and a diffuser chamber 20.

Referring FIG. 3, the cover member 17 and the plate portion 12 are enclosed by end plates 21, of which only one is shown, and the flat plate portion 12 is formed with an air inlet opening 22 through which air can be supplied under pressure from a compressor (not shown) within the ship 10 through an opening (not shown) in the plate 13 into the duct 19. The wall member 18 is formed with a plurality of outlet openings 23 through which the air can escape from the duct 19 into the diffuser chamber 20.

Referring again to FIG. 2, the rear most end of the cover member 17 is formed with a vertical wall portion 24, against which the air escaping through the outlet openings 23 impinges. This causes the air to be uniformly distributed along the length of the diffuser chamber 20. The air is then discharged from the diffuser chamber 20 through slots 25 in the vertical wall portion 24 as a film along the outer surface of the hull towards the stern of the ship 10.

The spacing of the outlet openings 23 is varied so that the number of outlet openings 23 per unit length of the wall member 18 increases from the ends of the duct towards the middle, i.e., lowermost, part of the duct. The air is supplied to the duct at a rate such that the flow is throttled by the outlet openings 23, and the varying spacing of the openings ensures that the quantity of discharged air is distributed according to the depth and pressure of the water. The diffuser chamber 20 is divided along its length by transverse baffles 26 into regions of different pressure. In this way, allowance is made for the increase in the pressure of the surrounding water towards the lowermost part of the apparatus.

The air is discharged past the aftermost edge of the plate 12 at a velocity at least as high as the velocity of the hull relative to the water.

To facilitate manufacture and assembly, the plate 12 and the cover member 17 are formed in sections which are joined end-to-end by means of a spigot portion 27, projecting from one end of each section of the cover member 17 for engagement in the adjacent section.

The plate **12**, the cover member **17** and the wall member **18** are made of polyester resin laminate.

FIGS. **6** and **7** show a modified fluid discharge apparatus which, as shown in FIG. **6**, has a rectangular housing **30**. This housing is disposed within the hull of the ship over a rectangular opening **31** (FIG. **7**) in the plating **32** of the hull of the ship. An air inlet pipe **33** communicates through the top of the housing **30** with the interior thereof, which is divided by a nozzle plate **34** into an air duct portion **35** and a diffuser chamber **36**. The opening **31** is covered by a cover plate **37** in which slots **38** are formed by cutting and bending inwardly a portion of the cover plate. The upper face of the cover plate **37** acts as a diffuser surface for air discharged through a plurality of air outlet openings **39** which are formed in the nozzle plate **34** and of which only one is shown. The air flows from the diffuser chamber **36** through the slots **38** to the exterior of the hull, along which it flows towards the stern of the ship.

I claim:

1. A method of reducing viscous resistance to motion of a hull through water and/or counteracting marine growth on the hull, which comprises the steps of discharging a pressurized gaseous medium from a high pressure chamber through a plurality of outlet openings into a lower pressure diffuser chamber towards a diffuser surface, and discharging the gaseous medium from the diffuser chamber along the outer surface of said hull towards the stern thereof from said diffuser chamber through at least one slot-shaped opening extending transversely of said hull.

2. A method as set forth in claim **1**, and further comprising arranging said slot-shaped opening according to the pattern of flow of fluid medium relative to the free-stream.

3. A method as set forth in claim **1**, and further comprising varying the mass flow of said gaseous medium from said slot-shaped opening from the lowermost position of said hull to the shallower portions of said hull in accordance with the depth of the water at said portions.

4. A method as set forth in claim **1**, and further comprising discharging said gaseous medium from said slot-shaped opening at a velocity at least as high as that of the hull relative to the water level.

5. Apparatus for reducing viscous resistance to motion of the hull through water and/or counteracting marine growth on said hull by means of a gas discharged beneath said hull, said apparatus comprising ducting extending transversely of said hull and provided with at least one gas inlet aperture; means for introducing pressurized gas into said ducting, means defining a diffuser chamber, a diffuser surface in said chamber, means defining a plurality of outlet openings communicating said ducting with said diffuser chamber, and means defining at least one slot-shaped outlet in said diffuser chamber directed towards the stern of said hull and extending transversely of said hull beneath the water-line for discharging gaseous medium in the form of a film along the outer surface of said hull.

6. Apparatus as set forth in claim **5**, wherein said ducting and said diffuser chamber are secured to the exterior of said hull.

7. Apparatus for reducing viscous resistance to motion of a hull through water and/or counteracting marine growth on the hull by means of a gas discharged beneath the hull, said apparatus comprising: ducting extending transversely of the hull; means defining a diffuser chamber; means defining a diffuser surface in said diffuser chamber; means defining a plurality of outlet openings communicating said ducting with said diffuser chamber, at least one of the size and spacing of said openings varying along said ducting in accordance with the depth of the water adjacent the hull; a plurality of baffles extending transversely of said diffuser chamber for segregating the fluid in said chamber into regions of different pressure; and means defining at least one slot-shaped outlet in said diffuser chamber directed toward the stern of the hull and extending transversely of the hull beneath the water-line for discharging gaseous medium in the form of a film along the outer surface of the hull.

8. Apparatus for reducing viscous resistance to motion of a hull through water and/or counteracting marine growth on the hull by means of a gas discharged beneath the hull, said apparatus comprising: ducting extending transversely of the hull; means defining a diffuser chamber; means defining a diffuser surface in said diffuser chamber; means defining a plurality of outlet openings communicating said ducting with said diffuser chamber; means defining at least one slot-shaped outlet in said diffuser chamber directed toward the stern of the hull and extending transversely of the hull beneath the water-line for discharging gaseous medium in the form of a film along the outer surface of the hull; and a cover member extending around said ducting and said diffuser chamber and having a streamlined shape to reduce drag.

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