April 28, 1970 T. E. HANNAN 3,508,517

NOZZLES OR SHROUDS FOR SHIPS' PROPELLERS

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Fig. 1a.

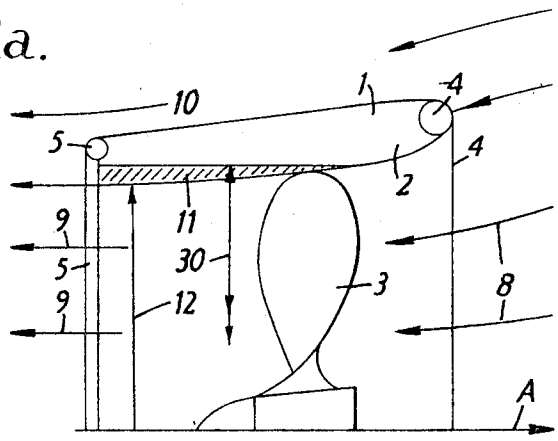


Fig. 1b.

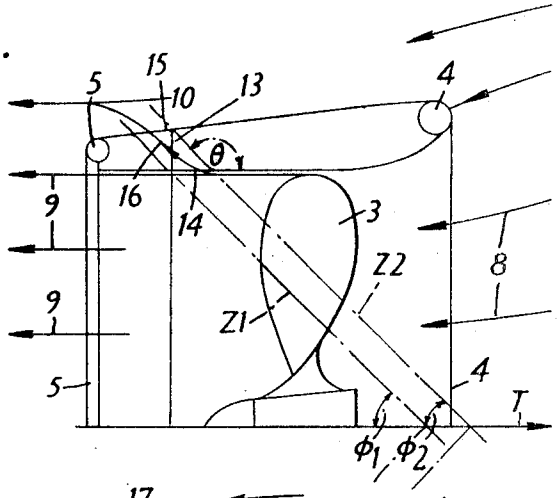
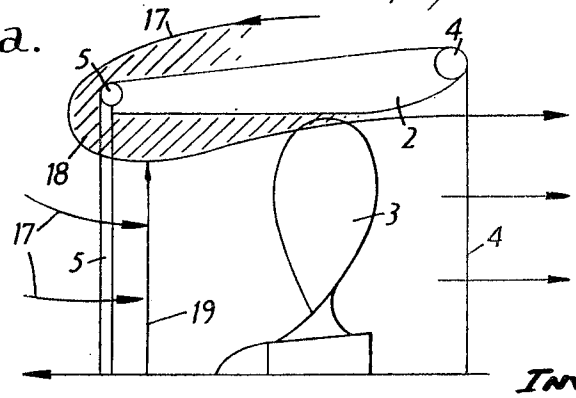


Fig. 2a.



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Fig. 2b.

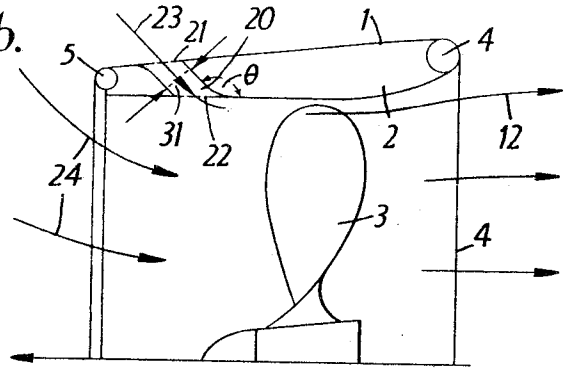


Fig. 3a.

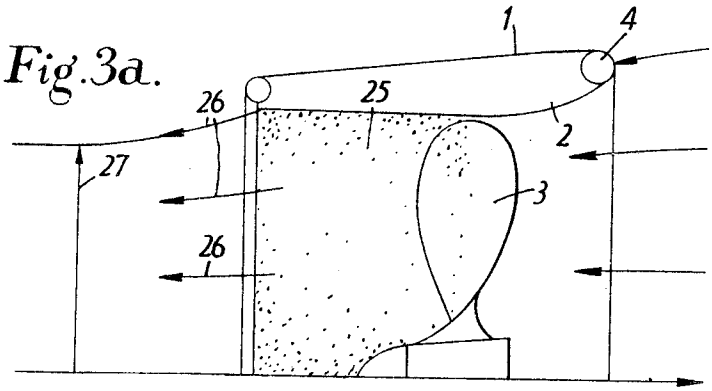
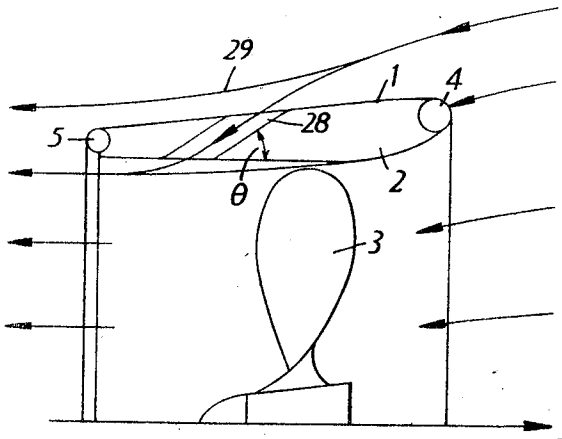


Fig. 3b.



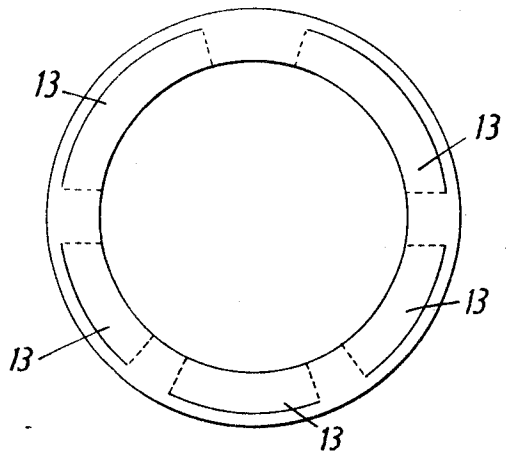
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NOZZLES OR SHROUDS FOR SHIPS' PROPELLERS

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Fig.4.



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NOZZLES OR SHROUDS FOR SHIPS' PROPELLERS

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Int. Cl. F04d 3/00; B63h 1/14, 11/00
U.S. Cl. 115—42 4 Claims

ABSTRACT OF THE DISCLOSURE

A nozzle of the Kort type for propelling a ship, the nozzle having inclined ducts to eliminate or reduce any zone of stagnant water that forms aft of the propeller, and the ducts form supplemental inlets into the nozzle on the reverse motion.

The present invention relates to the propulsion of ships by means of at least one propeller shrouded by a nozzle which is well known in the art as a "Kort" nozzle, and which acts to increase the degree of propulsive efficiency of the propeller. The nozzle may either be fixed or turnable so as to act as a rudder.

Such a nozzle is of aerofoil section, the inlet or forward end of the nozzle widening from about the position of the propeller tip in the nozzle towards the front of the nozzle. On reversing the direction of rotation of the propeller, the inlet opening becomes the outlet opening.

A nozzle as briefly described above is designed primarily for the ahead motion of the ship and thus is not suited to the astern condition, in which condition the nozzle does not function efficiently.

The object of the present invention therefore, is to overcome the above-mentioned disadvantage, and to this end the invention consists in an improved fixed or turnable nozzle of the "Kort" type for use on ships, wherein arcuate, circumferentially-spaced through-slots are provided in the wall of the nozzle aft of the tip of the propeller relative to the ahead motion of the ship so as to provide through-ducts which establish communication between the interior and the exterior of the nozzle, the ducts being inclined in such a direction relative to the longitudinal axis of the nozzle that the flow of water through the ducts takes place either from the interior of the nozzle outwards or, alternatively, from the outside of the nozzle inwards according to requirements.

The ducts may be curved in cross-section so as to provide easy flow paths for the water through the nozzle and the inflow and outflow ends of the ducts may be rounded. In order to control flow conditions the ducts may be arranged so as to run from the outer to the inner surface of the nozzle at any angle determined by the requirement of the particular design being undertaken.

In one embodiment of the invention as viewed from aft, the nozzle is formed with five circumferentially-spaced, arcuate ducts which need not necessarily be of the same circumferential length or spaced equidistantly from each other.

In a case in which ducts are directed forwardly towards the propeller and when the ship is travelling astern the ducts increase the inflow of water through the nozzle from aft towards the propeller, the water flowing downwards through the ducts.

In a case in which the propeller is heavily cavitating or super-cavitating the ducts are sloped in the opposite direction and when the ship is travelling ahead, the ducts increase the flow of water from the forward to the after

end of the nozzle by reason of the water drawn inwards through the ducts which augments the water flow from the propeller.

The effect of the rearwardly directed ducts according to the invention is to improve astern performance by increasing the supply of water to the propeller, the additional water being drawn in through the ducts. This improves the efficiency of the nozzle combination in this condition. The improvement is realized without reducing the ahead performance which on the contrary is increased by the action of the ducts drawing stagnant or dead water away from the periphery of the propeller race resulting in an increased flow of water to the propeller. This change in flow conditions permits subsidiary changes to the propeller and to the design of the nozzle to be made, and these further increase the overall efficiency of the nozzle and propulsion combination.

Reference is now made to the accompanying drawings in which three constructional embodiments of the invention are shown, by way of example, and in which:

FIGURE 1*a* is a diagrammatic half section through a Kort nozzle of usual construction, the ship to which the nozzle is fitted being assumed to be going ahead, and the propeller also going ahead;

FIGURE 1*b* is a diagrammatic half section of the nozzle shown in FIG. 1*a* but showing one of a plurality of rearwardly-inclined ducts which allow water to flow from the inside of the nozzle to the outside, the ship again being assumed to be travelling ahead and the propeller also going ahead;

FIGURE 2*a* is a diagrammatic half section of a Kort nozzle of usual construction showing a zone of pressure drop and flow separation which leads to a restricted inflow of the water into the nozzle, the propeller going astern;

FIGURE 2*b* shows a half section of a Kort nozzle as shown in FIGURE 2*a* but showing one of a plurality of rearwardly-inclined ducts through which the water can flow from the outside into the inside of the nozzle, the propeller going astern;

FIGURE 3*a* is a diagrammatic half section of a Kort nozzle of usual construction enclosing a heavily-cavitating or super-cavitating propeller and the cavitation zone or low pressure area formed in the nozzle by the propeller, the ship being assumed to be travelling ahead and the propeller going ahead;

FIGURE 3*b* is a diagrammatic half section of the Kort nozzle shown in FIGURE 3*a* but showing one of a plurality of circumferentially-spaced, forwardly-inclined ducts formed in the nozzle which allow an additional inflow of the water from the outside of the nozzle induced by the said low pressure area in the nozzle and which eliminates or reduces cavitation, the ship in this case being assumed to be travelling ahead and the propeller going ahead; and

FIGURE 4 is a diagrammatic view from aft showing, by way of example, how the ducts may be positioned in a nozzle.

Referring to the drawings:

In the following description the expression "forward end" of the nozzle means that end of the nozzle which is nearer to the forward end of the ship when the latter is travelling ahead, the expression "after end" thus meaning the opposite end of the nozzle.

FIGURE 1*a* shows diagrammatically a half section of a Kort nozzle **1** of known construction, the profile or section of which is indicated at **2**, a propeller **3** being arranged to turn in known manner within the nozzle between the forward and after ends **4** and **5** of the nozzle.

The nozzle is shown driving ahead with the ship in the direction of the arrowed line A at speed or developing power at zero ahead speed. The propeller is assumed to be going ahead. The direction of the inflow of the water into the nozzle and that of the outflow of the water out of the nozzle are indicated respectively by the arrowed lines **8** and **9**, the flow of water through the nozzle taking place from the forward end **4** of the nozzle to the after end **5**.

Around the nozzle there is an area **10** of reduced pressure and within the outflow portion of the nozzle there is an annular zone **11** (shown hatched) approximately conical in longitudinal section, of stagnant water which restricts the outflow of water as shown by the arrowed line **12**. It will be obvious that the stagnant water restricts the flow of the water and thus the efficiency of the nozzle.

The aim of the present invention is to eliminate the stagnant zone **11** and one construction calculated to do this is shown in FIGURE 1*b* and diagrammatically in FIGURE 4 in which the ship is travelling ahead and the propeller is going ahead. It will be seen that the nozzle is formed with a plurality of circumferentially-spaced, arcuate through-ducts **13** which have parallel walls and which is this case are inclined rearwardly at an angle θ, greater than 90° to the inner surface of the nozzle. The inflow ends **14** of the ducts communicate with that part of the bore of the nozzle in which the said stagnant zone **11** was formed in the construction shown in FIGURE 1*a*. The outflow ends **15** of the ducts **13** are disposed relatively near to the after end **5** of the nozzle. The effect of the ducts is to ensure that the water in the said zone **11** (FIGURE 1*a*) of stagnant water shall be withdrawn outwardly and rearwardly through the ducts as shown by the arrowed line **16**. This is due to the pressure drop at the after end of the nozzle in way of the ducts **13** which draws the stagnant water out of the nozzle, thus increasing the outflow of water from the nozzle and thereby the total quantity passing through. The arrowed line T indicates the increase of thrust due to this arrangement.

In the case in which the propeller is operating astern with the ship still moving ahead (stopping or emergency stop) or with the ship stopped, the flow to the propeller is restricted due to the water having to pass around the after end **5** of the nozzle. This circumstance is shown in FIGURE 2*a*, the inflow of water, indicated by the arrowed lines **17**, into the nozzle being restricted because the water has to flow around the after end **5** of the nozzle. This circumstance causes the creation of a zone **18** (shown hatched) of pressure drop and flow separation partly outside and partly inside the nozzle. By comparison with the bore of the nozzle the arrowed line **19** indicates to what degree the inflow to the nozzle is restricted.

FIGURE 2*b* shows how the above-mentioned disadvantage is overcome. It will be seen that a plurality of circumferentially spaced, arcuate ducts **13A** (which are the same as the ducts **13** in FIGURE 1*b*) are formed in the wall of the nozzle, the walls of the ducts being parallel and arranged at an angle θ greater than 90° to the inner surface of the nozzle. The ducts are inclined from their mouths or inlet ends **21**, which are disposed relatively near to the after end **5** of the nozzle, forwardly to their outlet ends **22** which open out into the zone **18** (FIGURE 2*a*) of pressure drop and flow separation. The ducts **13A** act to allow some of the water outside the nozzle to flow into the nozzle through the latter as indicated by the arrowed line **23**. The arrowed lines **24** show that with this arrangement the inflow of water is less restricted. The result is that the thrust is increased for the same power.

FIGURE 3*a*, in which it is assumed that the ship is travelling ahead and the propeller is going ahead, shows

the case of a heavily-cavitating or super-cavitating propeller turning in a Kort nozzle of known construction, behind which propeller within the nozzle a cavitation or low pressure zone **25** is created, the restricted outflow being indicated by the arrowed lines **26** and the arrowed line **27** extending across the lines **26**.

The disadvantage due to cavitation or super-cavitation can be overcome in the manner shown in FIGURE 3*b* in which the ship and the propeller are assumed to be going ahead and which shows that the nozzle is provided with a plurality of circumferentially-spaced, arcuate, forwardly-inclined through-ducts **28**, the walls of which are parallel and inclined at an angle θ of less than 90° to the inner surface of the nozzle. Such an arrangement causes an additional inflow of water through the ducts into the nozzle from the outside of the latter induced by the cavitation or low pressure zone **25** (FIGURE 3*a*), which additional inflow eliminates or reduces the cavitation. The direction of such additional inflow is indicated by the arrowed flow line **29**.

In each construction described above the walls of the ducts are formed by part of the surface of parallel cones having an axis coincident with the longitudinal axis of the nozzle.

The chain dotted lines **Z1** and **Z2** in FIGURE 1*b* for instance show, for parallel ducts, the surface of two cones coincident with the nozzle axis, the duct walls being part of this surface and the angles φ_1 and φ_2 being equal. For non-parallel ducts the angles φ_1 and φ_2 are unequal. For a smaller area at the outlet **14** than at the inlet **15** than as given by $\varphi_1=\varphi_2$ then φ_2 is greater than φ_1.

It is necessary that the area of the ducts in the outer surface of the nozzle shall be greater than the area in the inner surface so as to induce an increase in fluid velocity through the slots toward the inside of the nozzle, this condition being satisfied with the angles φ_1 and φ_2 equal as shown in FIGURE 1*b* and FIGURE 4. However, in order still further to increase the fluid velocity, if required the walls of the ducts may be non-parallel so as to increase the difference between the areas **14** and **15**.

The total circumferential area through the ducts advantageously should represent about 25% of the area of the throat of the nozzle, the throat being indicated at **30** in FIG. 1*a* and the line for calculating the duct area being indicated at **31** in FIG. 2*b*.

The angles θ and φ at which the ducts of either type are set depend upon the particular application. In ships of relatively slow speed, the angle θ may be about 135° as indicated in FIGURE 1*b*. An angle θ suitable for faster ships is shown in FIGURE 3*b*. This applies to forwardly or rearwardly directed slots.

The normal operation of Kort nozzles of known construction gives rise to stable zones of stagnant water adjacent to the walls of the nozzle. The slots through the nozzle act by causing these zones to be wholly or partially removed, thus increasing the flow of water through the nozzle and thereby the performance of the nozzle/propeller combination.

I claim:

1. In a propelling device for propelling a ship through water with forward or reverse motion, an improved hollow nozzle of the Kort type formed of a generally ring-shaped side wall defining an aerofoil in axial cross section, a screw propeller in said nozzle intermediate its length, said nozzle widening from a throat at about the position of the propeller tip outwardly toward the front of the nozzle, a plurality of arcuate circumferentially spaced through-ducts passing through the thickness of said wall in each case aft of the tip of the propeller relatively to the ahead motion of a ship, said ducts having inlet and outlet ends disposed on the opposite side surfaces of the nozzle wall, and in each case aft of the propeller,

establishing unrestricted communication between the interior and the exterior of the nozzle, said ducts being substantially smooth and inclined rearwardly from the inner surface of the nozzle up to the outer surface of the latter relative to the longitudinal axis of the nozzle whereby flow over the outer surface of the nozzle on the forward motion thereof induces flow through the ducts from the interior to the exterior to eliminate or reduce any zone of stagnant water which forms aft of the propeller within the nozzle and on the reversal of the motion of said nozzle and the flow, flow is induced from the exterior into the interior of the nozzle through said ducts to increase the fluid flow through the nozzle.

2. A propelling device as claimed in claim 1, wherein the said ducts are straight in cross section and are provided with substantially parallel fore and aft walls.

3. A propelling device as claimed in claim 1, wherein the area of the forward end of the duct at the outer surface of the nozzle is greater than the area at the inner surface in order to induce an increase in fluid velocity through the ducts towards the inside of the nozzle.

4. A propelling device as claimed in claim 1, in which the total circumferential area of the through-ducts, taken normal to the sides, is approximately 25% of the throat area of the nozzle.

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U.S. Cl. X.R.

60—221, 271; 115—34