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A FLOW GUIDE SURFACE FOR THE
STERN OF A PROPELLER SHIP

The invention relates to a flow guide surface for the
5 stern of a propeller ship to be fixed to the ship in front
of the propeller.

An arrangement of this general type is known from the
United States Patent Specification 4,309,172, in which a
nozzle is disposed coaxially or approximately coaxially with
10 the propeller axis slightly in front of the propeller.
This arrangement requires relatively large dimensions with
corresponding constructional costs, and moreover there is an
additional frictional resistance from the nozzle. In
addition the British publication "Motor Ship", of April 1982
15 on pages 36 and 37 discloses a guide surface system disposed
around the propeller shaft approximately in the shape of a
star and a combination of this guide surface system with a
ring nozzle limiting this guide surface.

The asymmetry of this system relates to the radial or
20 approximately radial guide surfaces, in which the nozzle is
disposed in a centrally symmetrical manner with respect to
the shaft. Although in the case of this arrangement the
initial twist of the propeller is taken into account by the
guide surfaces, the potential flow direction determined by
25 the shape of the ship which rises slightly in most cases
towards the stern is not taken into account.

In the case of ships' screw propellers which are in
most cases disposed on the stern as single propellers, it is
known that the flow to the propeller rises towards the stern
30 in accordance with the shape of the ship and that the pro-
peller flow therefore includes an upwardly directed com-
ponent. As a result of the converging shape of a ship
towards its stern the flow also converges at this point with
respect to the midships plane. In addition the propeller
35 does not only produce a twist in the wash but also in the

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area in front of itself. This means, in the case of a propeller rotating clockwise - seen from behind - that in the upper area on the portside the upward component of the oncoming flow is further amplified. On the starboard side
5 the upwardly directed oncoming flow component acts against the propeller.

The flow component in the direction of the propeller rotation effects a pressure relief on the propeller on the portside. The counterflow component on the starboard side
10 causes additional loading of the propeller. The centre of pressure of the propeller is disposed on the starboard side of the propeller in the case of a propeller rotating clockwise when seen from behind.

The flow to the propeller is also very non-uniform in
15 terms of speed as a result of the boundary layer flowing towards the propeller and as a result of cavitation effects. This effect is particularly marked in the upper halves of the propellers in the case of full afterbodies. The mean speed of flow to the propeller is, in the case of single-
20 screw merchant ships, approximately 20% to 40% lower than the speed of the ship. This wash has a favourable effect on the power requirement. However an extremely non-uniform wash distribution has an unfavourable effect on the efficiency of the propeller. In conventional merchant ships
25 the oncoming flow speed via the propeller surface may vary from 95% to 30% of the ship's speed. Even greater differences may be encountered in the case of loaded tankers.

In order to compensate the speed of flow to the propeller the afterbody may be correspondingly formed. The
30 so-called stern seams are for example suitable in the first instance for this purpose. It is also known to dispose substantially horizontal flow guide surfaces in front of the propeller. These guide surfaces cause a more axial flow to the propeller and can also serve to compensate the oncoming
35 flow speed. If a carrier or guide surface which is inclined

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between the direction of flow and horizontal is disposed in this flow which moves obliquely upwardly, this carrier surface is subject to lifting with a forwardly directed force component, i.e. it produces an additional forward drive. The flow behind the carrier surface is forced downwardly by the carrier surface and then moves in a more horizontal manner. These carrier surfaces therefore modify the direction of flow in the desired manner and the speed of flow to the propeller is simultaneously compensated. A carrier surface of this type may improve the propulsion efficiency of a ship, i.e. in this way it is possible to reduce the propulsion power required for achieving a specific speed or to achieve a higher speed with the same power. The following effects may be differentiated in this respect:

- (1) The production of a propulsive force directly on the carrier surface. The additional viscous resistance of the guide surface is slight and may be partially recovered in the propeller.
- (2) The increase in efficiency of the propeller as a result of the direction of the oncoming flow being more horizontal.
- (3) The increase in efficiency of the propeller as a result of the compensation of the speed of the oncoming flow over the propeller disc surface.
- (4) The flow compensation reducing the vibrational stimulus. This effect may be used for a reduction of vibration at the stern or for the purpose of increasing the propeller diameter in conjunction with a reduction of the upper propeller blade tip spacing from the counter.

A further improvement in efficiency of the propeller may be achieved with a diameter increase in accordance in each case with the speed.

These facts are widely known. Attempts have been made to utilize their concept by providing carrier surfaces in

front of the propeller on both sides of the propeller post. As carrier surfaces of this type lead to additional construction costs they have been used only infrequently up to now even when the additional cost is lower than that which would have been required for the savings in propulsion power in terms of capital and operation.

The above-mentioned effect is however quite different on the two sides, even when it is ensured that the angle of incidence of the carrier surfaces is separately optimised for each side. On the starboard side two effects combine together in the case of propellers rotating clockwise as seen from behind, these effects supplying the propeller in most cases with a substantially horizontal flow, i.e. the displacement flow of the ship's body having an upwardly directed flow component and the initial twist of the propeller with a downwardly directed flow component. These vertical components, which oppose one another on the starboard side, act in the same direction of the portside, i.e. they reinforce one another on this side. It is therefore often suitable to restrict the arrangement of carrier surfaces to one side. This is normally the side with the propeller blade which beats upwardly in the forward direction, i.e. the portside in the case of propellers rotating clockwise. The carrier surface may in this respect comprise a symmetrical profile or a non-symmetrical profile, in which the suction side is disposed at the top.

In heavy seas the carrier surface may be subject to conditions in which it is temporarily in or out of the water. The immersion is then accompanied by a slamming effect which subjects the structure to high static stresses. In order to avoid water shock effects of this type the carrier surface may be disposed at a somewhat deeper location than is optimum from a hydrodynamic point of view.

In addition it is known to arrange Kort nozzles as an annular casing of the propeller with a carrier surface

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cross-section. These Kort nozzles produce a propulsion which reinforces the propeller action. However a propulsive benefit occurs only with relatively large propeller loads as otherwise the nozzle resistance is
5 predominant. Kort nozzles of this type effect both a compensation of the oncoming flow with respect to direction and a speed distribution.

If nozzles of the Kort type are disposed concentrically in front of the propeller, it is possible
10 to achieve some of the advantages which maybe achieved for cased propellers. Kort nozzles disposed in front of the propeller and having an external diameter which is about as large as the propeller diameter are known.

The object of the invention is to provide an improved
15 guide surface nozzle of the Kort ring type disposed in front of the propeller.

According to the invention there is provided a flow guide surface mounted on the stern of a ship in front of a propeller less than one propeller diameter therefrom, the
20 guide surface forming a nozzle having a cross-sectional area which is smaller than half the area of the propeller blade tip circle and having the centroid of the cross-section lying above the propeller axis by at least 10% of the propeller diameter.

25 In order to achieve a further improvement of the propulsion efficiency, the axis of the guide surface or ring nozzle is preferably disposed such that it rises slightly to the rear. In this way an additional propulsion effect is achieved in the same way as for guide
30 surfaces of the carrier surface type. The optimum angle of incidence of the axis is in most cases smaller than the flow thread angle without

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the nozzle ring with respect to the horizontal.

As the optimum angle of incidence of the annular nozzle is different on the two sides of the ship, it is proposed to form the ring nozzle of half shells with a dividing surface
5 interposed therebetween and to associate one half shell in each case with the sides of the ship with different axial directions. The lateral angle of the half shell axes can produce a back twist to the propeller flow and be additionally used to produce a control moment in order thereby to
10 compensate different control effects of the propeller. In this case the rudder can be disposed amidships for sailing in a straight line.

For the case in which the horizontal distance between the propeller post and the propeller is small, it is proposed for the half shells to form a closed ring in each case
15 with the outer skin of the ship. In this way the flow is also accelerated laterally with respect to the centre.

An alternative embodiment of the invention is provided in that a guide surface formed as a closed ring is only
20 disposed on one side of the ship.

The further advantageous features of the invention are the result of the following:

In contrast to Kort nozzles which actually surround the propeller, it is possible in the case of front nozzles to
25 select their diameter at will and to position the nozzle stream cross-sectional area and to make it of a size such that the compensation of the flow to the propeller is as extensive as possible.

The wash is particularly heavy in the upper area of
30 flow to the propeller and in the vicinity of the midships plane. The nozzle effect is also concentrated at this area.

In this area the flow separation is also strongest on the outer skin of the ship as a result of an angle of in-
35 cidence with respect to the longitudinal axis of the ship

which is large or too large. In this respect the nozzle may cause improved contacting of the flow with the ship's body. At this point the angle of flow is in most cases particularly large with respect to horizontal, i.e. it is 5 easiest at this point to achieve a propulsion component in the case of deflection of the flow in a more horizontal direction using a guide surface.

If the size and arrangement of the front nozzle is limited to this area, it has considerably lower resistance 10 than conventional front nozzles having an inner diameter of approximately the propeller diameter and is simpler from a constructional point of view.

A good effect from the point of view of propulsion, which is achievable with a flow guide surface of the 15 invention, is the production of an initial whirl in the upper section of the propeller. This effect may be combined with a 'curved hull' in the lower sector. It is therefore proposed that the water lines of the hull below the propeller axis should lie outside of the 20 midships plane. As the water lines in the lower area extend in the midships plane at an angle which is more acute than in the upper region, there is less risk of flow separation in the lower area than in the upper area. This means that the hull connection below the shaft may be 25 limited to a small area in accordance with length.

For twin-screw ships it is proposed to form the guide surfaces as propeller brackets. Propeller brackets of this type are conveniently designed with rearwardly converging axes in the case of propellers beating upwardly 30 outwardly.

In the case of greater convergence of the propeller bracket axes this may increase manoeuvrability such that in the case of rotation the screw which is beating back acts on the spot on the propeller bracket such that a 35 transverse component amplifying the rotation is produced.

In the case of double screw arrangements the power saving is much greater than for single screw arrangements as the additional resistance and disturbing effect of the actual propeller bracket is not present.

5 The advantages of the guide surface are further increased in sea travel as the propeller flow behind a guide surface is subject to less considerable fluctuations than would be the case without this guide surface. The guide surface also causes a reduction in pitch
10 fluctuations, although this is low. In addition the guide surface contributes to course stability.

Guide surfaces are not only suitable for inclusion in new ship constructions. They may be installed in existing ships and may be used for the correction of defects, for
15 example in the following cases:

- (1) When the speed conditions are not satisfied during sea trials,
- (2) When the screw action has become too heavy over time,
- 20 (3) When course stability is in need of improvement,
- (4) When the afterbody is inclined to vibrate.

To help understanding of the invention a specific embodiment thereof will now be described with reference to the accompanying drawings in which:

25 Figure 1 shows a side view of a stern portion of a ship's hull incorporating a flow guide surface embodying the invention; and

Figure 2 is a horizontal cross-section of the arrangement shown in Figure 1, taken approximately half
30 way up the ring nozzle consisting of two half shells.

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The ship's hull portion 4 is provided with a propeller 5 which is driven via a shaft by means of a stern tube 9 and which has a blade tip circle 10. A rudder 6 is provided downstream of the propeller 5. Upstream of the propeller a ring nozzle is provided which comprises two half shells 1,2 which are separated by an optional dividing surface 3. The centroid of the cross-sectional surface enclosed in this way lies above the propeller axis 7. As may be seen in Figure 2 the two half shells 1, 2 differ and axes may in this respect assume different axial directions. The axes rise slightly towards the stern.

10 The ring nozzle 1, 2 is horizontally spaced from the propeller 5 by less than one propeller diameter. Also, the centroid of the cross-sectional area enclosed by the ring nozzle lies above the axis of the propeller 5 by at least 10 % of the propeller diameter and the cross-sectional area is less than half the area of the propeller blade tip circle.

15 With the above described flow guide surfaces, it will be appreciated that an increase in propulsion efficiency and a compensation in the speed of flow to the propellers can be simply provided. The arrangements enable fastening over a large area. In this respect slamming effects are less of a danger and the water shock effects are less concentrated as a result of
20 the vertical disposition of the guide surfaces.



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CLAIMS

1. A flow guide surface mounted on the stern of a ship
5 in front of a propeller less than one propeller diameter
therefrom, the guide surface forming a nozzle having a
cross-sectional area which is smaller than half the area
of the propeller blade tip circle and having the centroid
of the cross-section lying above the propeller axis by at
10 least 10% of the propeller diameter.
2. A flow guide surface as claimed in claim 1, wherein
the axis of the guide surface nozzle is disposed such that
it rises slightly towards the stern.
- 15 3. A flow guide surface as claimed in claim 1 or 2,
wherein the nozzle is a ring formed by two half shells,
each of the half shells being associated with its side of
the ship in different axial directions.
- 20 4. A flow guide surface as claimed in claim 3,
including a dividing surface between the two half shells.
5. A flow guide surface as claimed in claim 1 or 2,
25 wherein the guide surface nozzle is closed into a ring
with the ship's skin.
6. A flow guide surface as claimed in claim 1, wherein
the guide surface nozzle, formed as a closed ring, is
30 disposed on one side only of the ship.
7. A flow guide surface as claimed in any preceding
claim wherein, below the propeller axis, the extension of
the water lines aft of the hull, lie outside of the
35 midships plane.



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8. A flow guide surface substantially as hereinbefore described with reference to the accompanying drawings.

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