minimum gap size which depends on the dimensions of the particular propeller nozzle should be adhered to for safety reasons.

Embodiments~~It is the object~~ of the present invention seek to provide a propeller nozzle in which the losses of performance caused by turbulences of the marginal flow during flow around the propeller blade end regions may be~~are~~ kept as low as possible.

There is disclosed~~This object is solved according to the present invention in that~~ flow guiding means for guiding at least a part of the marginal flow onto the propeller area being~~are~~ provided on the propeller nozzle.

According to a first aspect of the present invention, there is provided a propeller nozzle, in particular for watercraft, comprising a nozzle and a propeller having at least one propeller blade, preferably a plurality of propeller blades, said at least one propeller blade being rotatable about a propeller axis, wherein the at least one propeller blade spans a propeller area through rotation about the propeller axis, wherein the at least one propeller blade comprises a propeller blade end region, wherein the propeller is disposed inside the nozzle in such a manner that a circumferential gap in the circumferential direction of the propeller nozzle is formed between the propeller end region and the inner wall of the nozzle, wherein the gap allows for passage of a marginal flow, said marginal flow flowing in the area of the inner wall of the nozzle, wherein flow guiding means are provided for guiding at least part of the marginal flow onto the propeller area, wherein the flow guiding means are disposed on the inner wall of the nozzle, wherein the nozzle is configured to be pivotable about the propeller, wherein the flow guiding means and the propeller blade end region are configured in such a manner and matched to one another that the gap is substantially constant up to a pivot angle of the nozzle of 10°, and wherein the flow guiding means are configured in such a manner that they act as a labyrinth seal in cooperation with the propeller blade end region.

The flow guiding means are configured in such a manner that they deflect at least a part of the marginal flow away from the normal flow path from the gap and onto the propeller area. In other words, the flow means can guide at least a part of the marginal flow away from the region of the inner wall of the nozzle and onto the propeller surface. By this means it is achieved that a part of the marginal flow which normally flows around the propeller blade end regions is instead guided onto the propeller area where it is grasped by the propeller blades and flows out from the propeller nozzle again as propeller nozzle back-wash and may thereby reduces the formation of turbulence in the propeller nozzle. Accordingly, the flow guiding means are configured in such a manner that they deflect at least a part of the marginal flow from its normal flow path along the inner wall of the nozzle and guide it onto the propeller area, i.e. the propeller itself. In other words, at least a part of the marginal flow is deflected by the flow guiding means from the marginal or nozzle inner wall region. Overall the flow rate of the marginal flow flowing through the gap may beis reduced by this means. This may leads to reduced turbulence in the region downstream of the propeller blade end region when viewed in the direction of flow and as a result leads to an improvement in the overall performance of the propeller nozzle. The flow guiding means may therefore reduces the amount of water flowing through the gap between propeller blade end region and nozzle inner wall in a defined time interval.

The flow guiding means can have any structural configuration which is suitable for deflecting a part of the marginal flow away from the normal flow path from the gap and onto the propeller blade end region surface. In particular, the flow guiding means are preferably formed by a suitable configuration of the contour of the nozzle inner wall.

The flow guiding means are expediently configured in such a manner that they guide a reasonable proportion of the marginal flow, for example, more than half, more than 60% or more than 75% of the marginal flow onto the propeller surface.

The flow guiding means usually do not influence the dimensions of the gap or the gap size. In particular, in embodiments of the present invention the gap expediently always has at least the minimum gap dimension required for the respective size of the propeller nozzle. In particular, the gap has a thickness, i.e. a distance between propeller blade end region and inner wall of the nozzle, of 1% to 2% of the propeller diameter, preferably of 1.2% to 1.8%. Since the individual propeller blades are usually inclined with respect to the direction of flow of the propeller nozzle, the gap runs in the direction of flow over the entire depth of the inclined propeller blade.

The present propeller nozzle according to embodiments of the invention can be designed both as a controllable variant (rudder nozzle) and as a fixed variant with fixed, non-swivellable nozzle. The controllable propeller nozzle can be configured, for example, as a controllable Kort nozzle or as a rudder nozzle which can be pivoted by 360°. The advantages according to embodiments of the invention of the lower circulation losses may beare obtained in both variants. In the propeller nozzle according to embodiments of the invention, the propeller is preferably arranged between the centre of the nozzle and the flow outlet region of the nozzle when viewed in the direction of flow. An arrangement of the propeller between 50% and 70% of the nozzle length relative to the inlet edge of the nozzle in the flow inlet region is particularly preferred. In particular, in rotationally symmetrical nozzles, the propeller is dis-

posed with its propeller axis concentrically to the nozzle axis so that a circumferential gap of constant width is obtained.

Embodiments of the~~The~~ present invention can be applied both to propeller nozzles having fixed propeller blades and also to those having adjustable propeller blades.

It is further preferred that the propeller nozzle is used in watercraft, for example, ships. In principle, however, the propeller nozzle according to embodiments of the invention is not restricted to this application and other areas of application such as, for example, in air travel are also possible.

The propeller nozzle has at least one propeller blade. In principle, however, variants with several propeller blades, for example with 3, 4 or 5 propeller blades, are preferred.

In some embodiments the flow guiding means are configured in such a manner that they either guide the marginal flow away from the inner wall of the nozzle in the direction of the nozzle centre and therefore onto the propeller area or that they allow the propeller area to be inserted or introduced into the region of the marginal flow. In the last-mentioned alternative, the flow guiding means enable the propeller blade end regions to be extended further outwards compared with the propeller nozzles of the same dimensions known from the prior art, i.e. to use a larger propeller (diameter). By shifting the propeller or the propeller surface further outwards, a part of the marginal flow that would normally flow through the gap in propeller nozzles known from the prior art is guided into the propeller surface without the marginal flow needing to be deflected from its normal flow path or its normal flow track. Furthermore the performance of the propeller nozzle may be~~is~~ further increased by enlarging the propeller. The deflection of the flow from the inner wall of the nozzle by the flow guiding means according to the first previously described alternative should be understood in such a manner that the flow is in particular deflected obliquely away from the edge.

In a preferred embodiment of the invention the flow guiding means are disposed in the region of the propeller blade end regions or in the immediate vicinity of the gap or the propeller blade end regions. The term "immediate vicinity of the gap" is understood in the present case in such a manner that the flow guiding means can be disposed in the gap, in the direction of flow upstream of the gap and/or in the direction of flow downstream of the gap. That is, the flow guiding means can fundamentally extend from a position immediately or directly upstream of the gap, through the gap as far as a position directly or immediately downstream of the gap. If the flow means are disposed upstream and/or downstream of the gap, they should be arranged in such a manner adjacently or in such a spacing that they can influence the marginal flow in such a manner that they are guided at least partially onto the propeller area.

Since the flow means are configured for guiding the marginal flow which flows along the inner wall of the nozzle, it is expedient to also arrange or configure the flow guiding means on the inner wall of the nozzle. The flow guiding means can in principle be attached as separate components to the inner wall of the nozzle or they can be formed in the wall or inner wall of the nozzle (in one piece).

In principle, the flow guiding means can be disposed only in one region or several separate regions of the nozzle when viewed in the circumferential direction of the nozzle. It is preferred however that the flow guiding means are configured circumferentially in the sense of a ring in the circumferential direction of the nozzle. It is thereby ensured that the entire marginal flow in each region of the nozzle is influenced by flow guiding means. As a result, the performance of the propeller nozzle may be~~is~~ further improved. Alternatively to the circumferential arrangement of the flow guiding means, these can be formed, in particular in controllable propeller nozzles, only in the two stern-side or starboard-side lateral regions of the propeller nozzle, since the gap is enlarged in these regions by the swivelling of the propeller axis and thus intensified turbulence can occur there.

quired in each case is ensured. The recess is expediently disposed directly upstream of or in the region of the propeller blade end regions or the gap.

As a result of the recess, the inner wall of the nozzle in the region of the recess runs relatively rapidly outwards in relation to the nozzle in a profile view. That is, the profile thickness of the nozzle is reduced relatively rapidly in the region of the recess. It may be~~is thereby~~ achieved that only a part of the marginal flow follows this inwardly directed profile and consequently the flow rate in the region of the gap may be~~is~~ significantly reduced. Overall a sealing effect of the marginal region of the nozzle or the gap may be~~is thus~~ obtained as a result of the recess. Furthermore, compared with the prior art, it is furthermore possible to use a propeller having a somewhat larger diameter with the result that the performance of the propeller nozzle may be~~is~~ further improved.

In principle, the recess can have any shape as long as the nozzle profile is thereby reduced in the region of the recess. The recess preferably has a step-shaped profile, a sloping profile or a curved profile in a longitudinal sectional view of the nozzle. In particular, in pivotably configured propeller nozzles or when using adjusting propellers, the formation of the recess with curved profile line can be appropriate since the profile of the recess can be adapted to the pivoting path of the nozzle in such a manner that the distance between nozzle inner wall and propeller blade end region remains as constant (small) as possible, at least up to a certain pivot angle.

When viewed in the flow direction of the nozzle downstream of the gap or downstream of the propeller blade end region, the recess can again go over into the normal profile behaviour of the nozzle or run further in another manner, for example, rectilinearly towards the nozzle end. If the nozzle profile is enlarged again downstream of the gap or the propeller blade end regions when viewed in the direction of flow, i.e. the nozzle wall thickness increases again or the nozzle inside diameter decreases, the recess is configured as an indentation. The formation of such an indentation is particularly advantageous in the case of swivellable propeller nozzles, since the gap is kept as small as possible by this means

in each of the two pivoting directions. This applies to those pivot angles in which the propeller blade end region is still located in the region of the indentation. An improved sealing effect may be~~is also~~ produced by the indentation since the indentation seals the gap region in the sense of a labyrinth seal and only an extremely small amount of flow flows through the gap. This sealing effect is particularly intensified when the propeller is configured and arranged in such a manner that only the minimum distance exists between propeller blade end region and inner wall (at the lowest point of the indentation), i.e. the propeller blade end region is introduced into the region of the indentation. Furthermore, the indentation has the result that compared to the propeller nozzle according to the prior art, the profile of the nozzle wall is only narrower in certain areas and consequently no weakening or only a slight weakening of the nozzle structure occurs. When viewed in the circumferential direction of the nozzle, the indentation can be formed in certain areas or circumferentially, with a type of closed or circumferential annular groove being formed with a circumferential configuration.

The profile of the indentation preferably runs as a circular arc having the same curvature in a longitudinal sectional view of the nozzle. The curvature should advantageously be matched to the swivelling of the nozzle in such a manner that the gap or distance between propeller blade end region and inner wall is always substantially constant inside the indentation. In individual cases it can also be desirable that the curvature is not configured to be constant but in particular runs flat towards the flow outlet side of the propeller nozzle since during assembly the propeller must frequently be inserted from this side into the nozzle and it must be ensured that sufficient space remains in the nozzle for insertion of the propeller.

In particular in this embodiment it is expedient if the indentation is configured as a spherical ball or spherical. This is particularly advantageous in view of the fact that the propeller blades are usually inclined and therefore swivel over a certain length with respect to the indentation.

It is furthermore expedient in this case that the propeller blade end regions have a shape corresponding to the shape of the flow guiding means or the indentation. Accordingly, in this exemplary embodiment the propeller blade end region is to be provided with a spherical shape where the sphere of the propeller blade end region should have the same curvature as the sphere of the indentation so that the gap size remains constant up to a certain predefined pivot angle. If an adjusting propeller is used in the propeller nozzle, the propeller blade end regions or the recesses should be configured to correspond to one another or be matched to one another in such a manner that during adjustment of the propeller blades (adjustment of the angle of incidence), a corresponding configuration is ensured or the gap dimension is constant.

In a further preferred exemplary embodiment, the flow guiding means comprise one or more projection bodies projecting from the inner wall of the nozzle. The projection body or bodies should expediently be disposed in the immediate vicinity of the gap. In particular, the projecting body is at least disposed upstream of the gap when viewed in the flow direction. The one or more projecting bodies are configured in such a manner that they deflect the marginal flow or at least a part of the marginal flow away from the nozzle wall in the direction of the nozzle centre or propeller area. For example, the projection bodies can be configured as a circumferential bulge in the circumferential direction of the nozzle. Such a bulge should be aligned approximately parallel to the gap. In addition, an additional bulge can be disposed downstream of the gap. Alternatively the contour of the nozzle inner wall can run straight or without projection bodies downstream of the gap when viewed in the longitudinal direction of the nozzle. This may results in an intensified sealing effect in the sense of a labyrinth seal. The projection bodies can also be provided with a curvature so that the gap remains as constant (small) as possible up to a certain pivot angle when swivelling the nozzle. The configuration of the projection body is preferably adapted to the flow in such a manner that no turbulence or only a small amount of turbulence is produced by the projection body. The projection bodies project into the interior of the nozzle and are configured to guide the marginal flow.