Submersible

The invention relates to a submersible having a hull, which comprises a flow channel mount or wherein a flow channel mount is assigned to the hull, wherein a flow channel is disposed or formed at least sectionally in the flow channel mount, wherein the flow channel has a flow inlet and a stern-end flow outlet, wherein a propeller is disposed in the flow channel and can be driven directly or indirectly by a motor via a drive shaft, wherein the flow channel mount is delimited on its underside by a connecting section, wherein a guide element is disposed at a connection point of the connecting section, wherein a guide element is fastened to a connection point of the connecting section, and wherein the area of the guide element facing away from the connection point extends in the direction of the bow and is coupled directly or indirectly to the hull.

Submersibles according to the invention are, for instance, swimming and diving aids. They can be used to pull a user, wherein the submersible is capable of switching between surface travel and submerged travel. In particular, the submersible can be designed to switch between surface travel and submerged travel solely by shifting weight.

A submersible according to the invention may, for instance, be such that it has a support surface on its topside, on which support surface a user can rest part of the user’s body.

For instance, the submersible according to the invention may comprise a handle each on the starboard side and on the port side, which handle a user can hold on to during travel. In particular, the handle may also be equipped with operating elements that can be used to control the functions of the submersible.

For instance, one or several control elements may be used to vary the speed of an electric motor used to drive the propeller in the flow channel.

Preferably, the handles are disposed in the front part of the watercraft, in particular in the bow area of the submersible.

Furthermore, a submersible according to the invention comprises a display, which is disposed in the user's field of vision and which is designed to display functions and/or operating states of the submersible.

DE 10 2013 100 544 A1 describes a swimming and diving aid, in which a flow channel is incorporated in the hull. A propeller is disposed in the flow channel, which propeller is driven by an electric motor via a drive shaft. The electric motor is powered by rechargeable batteries, which are also located in the hull. A guide element in the form of a fin is fitted into the flow channel upstream of the flow inlet.

Another submersible that can be used as a swimming and diving aid is known from US 2015/0217847 A1. A drive unit comprising a flow channel is attached to the bottom hull of the submersible.

The invention addresses the problem of providing a submersible of the type mentioned at the beginning, which features improved efficiency.

This problem is solved by the features of claim 1. According to the invention, provision is made for the guide element to extend in the direction towards the stern, past the edge of the connecting section facing the inlet opening and into the flow channel in the area of the connection point, and for the guide element to delimit two feed areas from each other downstream of this connection point in the flow channel. As the guide element is now routed into the flow channel, it can guide the flowing water to the propeller in an improved manner. Any swirl components in the supplied water jet can be reduced. Overall, the efficiency and thrust performance of the submersible can be significantly improved.

Preferably, the connection point of the connecting section is the point that lies at least sectionally in the central transverse plane of the submersible. Furthermore, the connection point is preferably located in an area of the connecting section of the flow channel mount that forms the lowest point at the inlet opening in the direction of the underside of the submersible.

According to a preferred variant of the invention, provision may be made for the axis of rotation of the drive shaft to form a thrust axis, wherein the thrust axis lies in a thrust plane, wherein two vectors spanning the thrust plane are disposed such that the first vector extends in the direction of the thrust axis and the second vector extends horizontally perpendicularly thereto between the port side and the starboard side in the floating position and in the rest position of the submersible, wherein a central transverse plane perpendicular to the thrust plane and incorporating the thrust axis is provided, and for the guide element to extend into the flow channel in the direction of the central transverse plane in a direction perpendicular to the thrust axis past the connection point.

Preferably, according to the invention, provision may be made for the projection of the connection point perpendicular to the axis of rotation of the drive shaft in the thrust plane of the submersible to result in a projected connection point and for the guide element to extend beyond this projected connection point into the flow channel. In this way, the supplied water jet can be reliably guided in the flow channel.

Accordingly, the guide element extends through the inlet opening of the flow channel into the flow channel. There it divides the flow channel into two feed areas in the flow area upstream of the propeller.

According to the invention, the flow inlet can preferably be disposed in the center area of the lower hull between the bow and stern or at least be disposed sectionally in the bow area.

According to the invention, the motor can be designed as an electric motor, which is supplied with power from rechargeable batteries. The rechargeable batteries can be housed in the hull.

If provision is made for the guide element to extend past the drive shaft towards the topside of the submersible and perpendicular to the axis of rotation of the drive shaft into the flow channel and to comprise a coupling section opposite from the connection point, by means of which the guide element is directly or indirectly coupled to the flow

channel mount or a component defining the flow channel, then the guide element is held in a stable manner in the flow channel.

According to the invention, the guide element may be integrally made or multi-part.

A particularly preferred embodiment of the invention is such that the guide element forms a feed-through, through which the drive shaft or a sheathing tube accommodating the drive shaft is routed upstream of the propeller. In this way, the flow of the water is no longer adversely affected by these components in the area of the flow channel, in which the sheathing tube or the drive shaft is accommodated by the guide element, which results in a further improvement in efficiency.

Preferably, the drive shaft or a sheathing tube accommodating the drive shaft is fitted or routed through the feed-through upstream of the propeller in a sealed manner. Negative pressure is created in the flow channel upstream of the propeller during operation. The sealed or fitted feed-through prevents or reduces the risk of air being sucked into the flow channel from the hull, in particular from a flooding chamber formed separately from the flow channel in the hull, to the extent necessary.

For optimized flow guidance, provision may be made for the guide element to comprise at least one guide section, which extends past the connection point towards the stern and there projects into the flow channel and which delimits the feed areas in the flow channel from each other on opposite sides, wherein the central transverse plane of the submersible preferably extends through the guide element and the feed areas extend on both sides of the central transverse plane. The guide element(s) can be used to guide the flow well.

According to the invention, provision may also be made for the guide element to have bulging, preferably convexly curved, boundary surfaces in the area of the feed-through on opposite sides of the drive shaft, wherein guide element sections of the guide element preferably adjoin the boundary surfaces, and for the guide element sections to extend towards the edge of the flow channel. The boundary surfaces are used to encompass the area through which the sheathing tube or drive shaft passes. The bulged, in particular curved, geometry is designed to optimize flow.

If guide element sections are connected to the boundary surfaces and routed to the edge of the flow channel, the area of the feed-through can be kept stable inside the flow channel.

Particularly preferably guide element sections of the guide element directly or indirectly adjoin the boundary surfaces on opposite sides, and the guide element sections extend in opposite directions towards the edge of the flow channel.

One conceivable variant of the invention is such that a centering unit is disposed in the flow channel upstream of the propeller, which centering unit holds the free end of the drive shaft or the sheathing tube at the end by means of a hub, and that the guide element is routed up to the centering unit, wherein preferably provision is made for the centering unit to be supported relative to the guide element and/or connected to the latter, particularly preferably at least one component of the centering unit to be connected to the guide element.

According to one variant of the invention, the centering unit can be part of the guide element, in particular at least partially integrally connected to the guide element. This reduces the amount of parts and assembly work required.

The centering unit is used to hold and position the sheathing tube or drive shaft in the flow channel.

If the guide element is guided up to the centering unit, this results in a compact design. Surfaces of the guide element may also be connected to surfaces of the centering unit in the flow channel to achieve a flow-optimized design.

It is preferably also conceivable for a flow-optimized design that the centering unit comprises at least two centering blades, which hold the hub at a distance from the inner wall of the flow channel, and that at least one of the centering blades is aligned with the guide element in the direction of the axis of rotation of the drive shaft, wherein the guide element preferably adjoins the centering blade directly or separately via a gap area.

A possible variant of the invention can be such that the width of the guide element extending perpendicular to the central transverse plane increases, preferably continuously expands, in the direction from stern to bow. This extension creates an area on the inside of the hull, in which components of the submersible, in particular part of the drive train (e.g. at least part of the engine), can be accommodated in a space-saving manner. A continuous extension proves to be particularly streamlined.

A streamlined design is preferably achieved if provision is made for the guide element at its bow end facing away from the stern to merge into a curved rounded area of the bottom hull that is curved outwards towards the underside of the submersible, wherein the rounded area is disposed in the bow area and extends further, preferably from the guide element to the bow tip.

A preferred variant of the invention can be such that, in addition to the flow channel, a flooding chamber is disposed in the hull, which flooding chamber is connected to the environment via one or several inlet openings and one or several outlet openings. The flooding chamber offers a variable mass component, which facilitates switching between surface travel and submerged travel.

Furthermore, the flooding chamber can be designed such that water from the surroundings flows into the flooding chamber during surface travel of the submersible, passes through the flooding chamber at least sectionally and is then discharged from the flooding chamber through the outlet openings.

Preferably, the at least one inlet opening and/or the at least one outlet opening is disposed such that the flow occurs at least during submerged travel of the submersible. For instance, provision may be made for at least one inlet opening to be disposed in the area of an integrally formed or multi-part upper shell of the submersible directed towards the topside.

Preferably, at least one electrical component is disposed, at least sectionally, for cooling purposes in the flooding chamber. It is conceivable that the motor, at least one

control unit and/or at least one rechargeable battery is/are disposed in the flooding chamber.

In the context of the invention, provision may also be made for a flow stator to be disposed downstream of the propeller in the flow channel, wherein the flow stator comprises one or several stator blades, which preferably extend in the direction of the axis of rotation of the drive shaft. In particular, the stator blades can extend radially in the flow channel. The flow stator is used to at least partially reduce the swirl generated by the propeller in the water jet. This improves thrust performance.

If provision is made for at least one of the stator blades to be at least sectionally aligned with the guide element and/or with the centering blade of the/a centering unit in the direction of the axis of rotation of the drive shaft, then the flow-optimized design is further improved.

For improved stability, provision may be made for the guide element to comprise a fastening section adjacent to the edge-end connection point of the connecting section, which fastening section extends into the flow channel in the direction of the stern, and for the fastening section adjacent to the connection point to be attached, preferably integrally formed, to the inside of the flow channel mount.

The guide element proves to be particularly effective if provision is made for the projection of the connection point perpendicular to the axis of rotation of the drive shaft in the thrust plane of the submersible to result in a projected connection point, and for the guide element to extend beyond this projected connection point into the flow channel.

The invention is explained in greater detail below based on an exemplary embodiment shown in the drawings. In the figures,

Figure 1 shows a perspective view of a submersible in the form of a swimming and diving aid from behind and diagonally above,

Figure 2 shows a perspective view of the submersible shown in Figure 1 from the front and diagonally below,

Figure 3 shows a side view of the submersible from the left,

Figure 4 shows another perspective view of the submersible of Figures 1 to 3 from behind and diagonally below,

Figure 5a shows a schematic detailed representation along the section marked V-V in Figure 5,

Figure 5 shows the submersible according to the representation of Figure 3, but in a schematized full sectional view,

Figure 6 shows the submersible of Figures 1 to 5 viewed from behind and in a floating position when stationary, and

Figure 7 shows the watercraft shown in Figures 1 to 6 from the front.

Figures 1 and 2 show a submersible designed as a swimming and diving aid. The submersible has a hull 10.

For instance, as Figure 1 shows, the hull 10 may comprise an upper shell 20. The upper shell 20 may be integrally made or multi-part.

A bow tip 21 is formed in the bow area 22 of the submersible. The bow tip 21 forms the front end of the submersible. For instance, the bow tip 21 may be formed by the upper shell 22. However, it is also conceivable that the bow tip 21 is formed by the bottom hull 30. The bottom hull 30 may, for instance, be formed by a lower shell that is connected to the upper shell 20. The lower shell can be designed to be integrally made or multi-part.

A handle 24 is attached to the upper shell 20 on both the starboard and port sides. At least one control element 25 can be attached to one or both handles 24. The control

element(s) 25 can be used to control the functions of the submersible. As can be seen from the illustrations, the handles 24 are preferably attached in the bow area 22 of the submersible.

A display 23 is disposed centrally, preferably in the area between the two handles 24, in the area of the upper shell 20. Information about the operating status of the submersible can be shown on the display 23 and read by a user.

The handles 24 are adjoined by arm rests 26 in the direction towards the stern 27 of the watercraft. The armrests 26 extend on the port or starboard side.

Figure 1 also shows that a charging connection 28 may be provided in the area of the upper shell 20. A cover cap covers the charging connection 28. It can be removed to expose the electrical contacts of the charging connection 28. The submersible can be connected to a power supply via the charging connection 28 to charge at least one rechargeable battery 60, which is housed in the hull 10 of the submersible.

Figs. 1 and 2 show that, adjacent to the bow tip 21, the upper shell 20 can be spherical, in particular biconvex. This results in a streamlined shape that is optimized for underwater travel.

The bottom hull 30 can be designed such that it comprises a rounded area 31 adjacent to the bow tip 21, which can be spherical, in particular biconvex. Such a design is flow-optimized for both surface travel and underwater travel.

As Figures 1 and 5 show, there may be a bulge 32 in the rounded area 31, which bulge delimits a space disposed in the hull 10. A component of the submersible can be accommodated therein. For instance, an electric motor 61 and/or a control unit 63, which is installed in the hull 10 in the bow area 22, may be accommodated in the area of the bulge 32 in the hull 10, as shown in Figure 5. In this way, a compact design is supported.

Figures 2 and 4 illustrate that the bottom hull 30 comprises sliding surfaces 37, preferably immediately adjacent to the rounded area 31. The sliding surfaces 37 preferably extend on the port and starboard sides.

The sliding surfaces 37 can preferably be routed up to the stern 27 of the submersible, where they then form end sections 37.3.

The sliding surfaces 37 can be designed as surfaces formed in the three-dimensional space. The sliding surfaces 37 can also be designed as plane surfaces or have at least one such plane surface.

Figures 1 and 4 illustrate that the sliding surfaces 37 extend on both sides of a flow channel mount 38. The flow channel mount 38 protrudes from the bottom of the bottom hull 30. In this case, the flow channel mount 38 may comprise two side walls 38.1 spaced apart from each other, which are directly or indirectly connected to the sliding surfaces 37, for instance via, preferably concave, rounded transitions 38.3 on the port and starboard sides.

The two side walls 38.1 can be interconnected via a connecting section 38.2, wherein the connecting section 38.2 is preferably convex.

Preferably, the spherically curved rounded area 32 merges into the sliding surfaces 37, wherein the bow tip 21 is disposed above the sliding surfaces 37. During surface travel of the submersible, the water is then directed under the sliding surfaces 37 to achieve an optimized flow to these areas. In addition, annoying water spray is avoided or prevented.

The flow channel mount 38 forms or encloses a partial area of the hull 10, inside which a flow channel 39.2 is accommodated. The flow channel 39.2 forms a flow inlet, approximately in the central area of the submersible. The flow channel 39.2 forms a flow outlet 39 in the area of the stern 27.

The flow channel 39.2 can be formed and/or delimited at least sectionally by a one-piece or multi-part hollow body, wherein provision may be made for the hollow body to be held at least sectionally in the flow channel mount 38.

Figures 1 and 5 illustrate that the flow outlet 39 is delimited by a, preferably circumferential, boundary rim 39.1.

A guide element 33 is disposed in the area of the flow inlet. The guide element 33 can be formed, preferably integrally, with the lower shell forming the bottom hull 30. However, it is also conceivable that the guide element 33 is formed as a separate component, which is connected to the bottom hull 30. The guide element 33 can be designed such that it forms an underside edge 33.1 of a wall 33.3. The edge 33.1 and thus also the wall 33.3 extend in the direction from the bow to the stern 27.

Preferably, the wall 33.3 of the guide element 33 divides the area of the inlet opening into the flow channel 39.2 into two sub-areas. This forms two, preferably separated from each other, feed areas 34.1 and 34.2. The first feed area 34.1 extends on the port side and the second feed area 34.2 on the starboard side.

However, the wall 33.3 does not necessarily completely separate the two feed areas 34.1 and 34.2 from each other. In fact, provision may also be made for overflow areas to be formed between the two feed areas 34.1 and 34.2.

Furthermore, the guide element 33, preferably adjoining the edge 33.1, may be connected to the connecting section 38.2 of the flow channel mount 38.

As the drawings show, the guide element 33 can be coupled to a connection point 33.4 on the inflow-side edge of the flow channel mount 38. Subsequent to the connection point 33.4, the guide element forms a fastening section 33.5. This fastening section 33.5 is used to attach, for instance integrally mold, the guide element 33 to the inside of the connecting section 38.2 facing the flow channel 39.2.

Preferably, provision is made for the wall 33.3 to form a fastening section 33.4, which extends into the flow channel 39.2, such that the wall 33.3 is also connected to the

connecting section 38.2 on the inside of the connecting section 38.2 in the direction towards the stern 27 by means of a correspondingly designed fastening section 33.5, as shown in particular in Figure 5.

Preferably, the flow channel mount 38 is made integrally with the guide element 33.

The guide element 33 extends in the direction of the stern 27, past the edge of the connecting section 38.2 facing the inlet opening and into the flow channel 39.2 in the area of the connection point 33.4. The guide element 33 delimits two feed areas 34.1, 34.2 from each other downstream of this connection point 33.4 in the flow channel 39.2.

Figure 5 also illustrates that preferably the projection of the connection point 33.4 perpendicular to the axis of rotation D of the drive shaft 62 into the thrust plane FE of the submersible results in a projected connection point 33.4', and that the guide element 33 extends beyond this projected connection point 33.4' into the flow channel 39.2.

As the drawings show, the guide element 33 extends past a drive shaft 62 in the direction of the topside O of the submersible and perpendicular to the axis of rotation D of the drive shaft 63 into the flow channel 39.2. Opposite from the connection point 33.4, the guide element 33 is directly or indirectly coupled to the flow channel mount 38 or a component defining the flow channel 39.2 by means of a coupling section 33.6.

Preferably, the guide element 33 in the flow channel 39.2 comprises a feed-through 33.7 downstream of the inlet opening. A sheathing tube 64, which holds the drive shaft 62, is guided through this feed-through 33.7 into the flow channel 39.2. Preferably, the sheathing tube 64 is sealed against the feed-through 33.7.

As Figure 5a shows, the area of the guide element 33 that forms the feed-through is thickened in cross-section and bulges laterally, preferably in a convexly curved manner. Guide element sections 33.9 of the guide element 33 are preferably connected to the area forming the feed-through 33.7 on opposite ends of the boundary surfaces 33.8. As the drawings show, the guide element sections 33.9 may extend in

opposite directions towards the inner wall of the flow channel 39.2. There, the guide element sections can be connected to the flow channel or another component, e.g. the flow channel mount.

The guide element sections 33.9 are preferably wing-shaped.

Figure 5a illustrates that the guide element 33 can be divided in the area of the feed-through 33.7. The dividing plane 33.10 may extend through the feed-through 33.7, which simplifies the assembly of the sheathing tube 64.

The guide element 33 can preferably be designed such that it is guided into the rounded area 31 at the bow end, as illustrated in Figures 4 and 5 via a transition 33.2.

Further, the wall 33.3 may taper towards the front, i.e. towards the bow, while decreasing in height.

The wall 33.3 forms water guide surfaces on both ends, which extend from the bow area 22 towards the stern 27 and which guide the flowing water towards the assigned feed area 34.1 or 34.2.

Figure 5 illustrates that a motor 61, preferably an electric motor, is disposed in the interior of the hull 10, which motor drives a propeller 36 by means of a drive shaft 62. Preferably, the drive shaft 62 is guided inside a hollow tube 62.1, such that the rotating drive shaft 62 has little or no influence on the water flow guided in the feed area 34.1, 34.2.

The propeller 36 is connected to the drive shaft 62 for co-rotation and disposed in the flow channel 39.2. This is illustrated in Figure 5. A centering unit 35, preferably in the form of a centering star, is held in the flow channel 39.2 upstream of the propeller 36.

The centering unit 35 may comprise a hub 35.1. Centering blades 35.2 are connected to the hub 35.1. The centering blades 35.2 can preferably be connected to the inner wall of the flow channel 39.2 at the ends facing away from the hub 35.1, preferably be integrally connected thereto.

The drive shaft 62 is guided through a mount of the hub 35.1 of the centering unit 35 and preferably held centered in the flow channel 39.2.

Preferably, at least three centering blades 35.2 can be used, which are disposed offset from one another in the circumferential direction of the drive shaft 62, preferably spaced equidistantly.

Particularly preferably, provision may be made for the wall 33.3 of the guide element 33 to be connected, preferably integrally connected, to the centering unit 35 at least sectionally. For instance, provision may be made for the wall 33 to be connected to the hub 35.1 and/or to at least one of the centering blades 35.2. Preferably, the wall 33.3 is integrally connected to the centering unit 35. This reduces the amount of parts required and improves production accuracy. This also results in improved flow behavior in the flow channel 39.2, as the design can then be more compact.

A flow stator 40 can preferably be disposed downstream of the propeller 36 in the flow channel 39.2. Preferably, the flow stator 40 is disposed in the area of the stern end of the flow channel 39.2. The flow stator 40 has a plurality of stator blades 41, which preferably extend radially to a thrust axis 53, which coincides with the axis of rotation D of the drive shaft 62.

The arrangement of the stator blades 41 can be clearly gathered from Figures 4 and 6. As these drawings illustrate, a stator tip 42 can be used to interconnect the stator blades 41 in the center of the flow channel 39.2.

The propeller 36 generates a rotating water jet in the flow channel 39.2. The flow stator 40 is used to reduce the rotation in the water jet or, ideally, to direct it without swirling. This results in an improved thrust power.

As Figures 4 and 6 illustrate, the axis of rotation D of the drive shaft 62 forms a thrust axis 53. The thrust axis 53 lies in a thrust plane FE, wherein two vectors spanning the thrust plane FE are disposed such that the first vector extends in the direction of the thrust axis 53 and the second vector extends perpendicular thereto, horizontally

between the port and starboard sides in the floating position and in the rest position of the submersible, i.e. perpendicular to the image plane in Figure 5. A central longitudinal plane ME perpendicular to the thrust plane FE and accommodating the thrust axis 53 extends between the port and starboard sides, as shown in Figure 6 (i.e. in the image plane in Figure 5). The central longitudinal plane ME can be disposed such that it intersects the boundary rim 39.1 of the flow outlet 39 at an upper boundary point P as shown in the drawings.

Provision may be made for a boundary line 52 intersecting the bow tip 21 and the upper boundary point P to form an angle γ with the thrust plane FE, preferably in the range between 2° and 7°.

Preferably, the boundary line 52 lies in a horizontal plane HE, wherein two vectors spanning the horizontal plane HE are disposed such that the first vector extends in the direction of the boundary line 52 and the second vector extends perpendicular thereto between the port and starboard sides in parallel to the thrust plane FE, as illustrated in Figure 5. The stern ends of the sliding surfaces 37 intersect the horizontal plane HE and pierce it from bottom to top in the direction from bow to stern, as shown in Fig. 5.

Figure 5 further illustrates that the stern ends of the sliding surfaces 37 may end above the flow outlet 39. Consequently, the entire flow outlet 39 is disposed completely below the horizontal plane HE and/or below the stern ends of the sliding surfaces 37.

However, it is also conceivable that the stern ends of the sliding surfaces 37 end below the horizontal plane HE. For instance, the stern ends of the sliding surfaces 37 may be spaced apart from the horizontal plane HE by a maximum dimension M= 0.2 * X, preferably M= 0.1 * X, and end below the horizontal plane HE, wherein X is the maximum clear opening dimension of the flow outlet 39. In this exemplary embodiment, the maximum clear opening dimension X is the diameter of the circular flow outlet 39 (see Figure 6).

Figure 5 further illustrates that the boundary rim 39.1, which delimits the flow outlet 39, forms a surface at the stern, this surface is inclined at an angle μ to the horizontal plane 52. This angle μ is preferably selected in the range greater than 84° and further

preferably in the range from 84° to less than 110°, particularly preferably in the range from greater than 90° to less than 110°.

If the angle μ is selected to be greater than 90°, the flow direction slopes downwards towards the rear such that the water jet does not or no longer strongly hit the part of the user lying in the water behind the stern of the watercraft.

As Figure 5 further illustrates, at least one, preferably two, rechargeable batteries 60 may be accommodated inside the hull 10. If two rechargeable batteries 60 are used, these can be positioned on either side of the central longitudinal plane ME. Preferably, the two rechargeable batteries 60 are disposed symmetrically to the central longitudinal plane ME.

Preferably, the rechargeable batteries 60 can be disposed completely above the thrust plane FE.

Preferably, the volume of the rechargeable batteries 60 can extend for the most part above the horizontal plane HE.

These measures achieve a good weight distribution in a watercraft according to the invention, which results in a stable floating position.

The rechargeable battery or batteries 60 may comprise a tubular section in the form of a sheathing tube 64, inside which a plurality of rechargeable battery cells are disposed. At its longitudinal ends, covers 65, 66 seal the pipe section in a watertight manner. Preferably, electronics for monitoring and/or controlling the rechargeable battery cells are housed inside the sealed area of the tube section.

As Figure 5 shows, a flooding chamber 70 can be formed inside the hull 10. The flooding chamber 70 is connected to the surrounding area via water passage openings. At least one water inlet opening 71 may be present in the bow area and at least one water outlet opening 72 may be present in the stern section of the submersible. The water inlet opening 71 and/or the water outlet opening 72 may penetrate the hull shell, e.g. is/are formed by the lower and/or upper shell of the submersible.

When the submersible is placed on the water, the flooding chamber 70 is filled with the surrounding water via the water passage openings. During water travel, in particular during submerged travel, a water flow from the water inlet opening 71 to the water outlet opening 72 occurs in the flooding chamber 70, such that continuous cooling of the electrical components, in particular of the rechargeable batteries 60, is performed in the flooding chamber 70. In addition, the flooding chamber 70 offers the option of taking in water as a variable mass component by (partially) filling it with water or emptying it. If the flooding chamber 70 is filled or partially filled, it simplifies the transition from surface travel to underwater travel. When the submersible is lifted out of the water, the flooding chamber is emptied via the water passage openings. Preferably, an additional water passage opening can also be provided on the starboard side 11 and/or on the port side 12, via which additional water passage opening the water can be emptied from the flooding chamber 70 when the submersible is lifted out of the water.

Figure 5 also illustrates that, for instance, a control unit 63 may be disposed in the hull 10, by means of which all or at least some of the functions of the submersible can be electrically controlled. The control unit 63 can be assigned to the motor 61 and connected electrically and/or mechanically thereto.

According to one design variant, the control unit 63 may be disposed in the flooding chamber 70 in addition to or as an alternative to the rechargeable battery or batteries 60.

Figure 5 also shows, for instance, that most of the motor's 61 volume can be disposed below the horizontal plane HE to optimize the weight distribution.

According to one design variant, the electric motor 61 may be disposed in the flooding chamber 70 in addition to or as an alternative to the rechargeable battery or batteries 60 and in addition to or as an alternative to the control unit 63.

Figures 2 and 7 show that the sliding surfaces 37 are present on both ends of the flow channel mount 38 on the bottom hull 30 and are disposed facing downwards. The

sliding surfaces 37 may be formed at least sectionally by plane surfaces, by surfaces shaped in a three-dimensional space or by a combination of a three-dimensionally shaped surface and at least one plane surface. In this exemplary embodiment, the sliding surfaces 37 are formed in part, preferably for the most part, by plane surfaces.

As Figure 2 shows, the end sections 37.3 of the sliding surfaces 37 adjoin the center section of 37.2 in the direction of the bow. The center sections 37.2 also extend on the port side and starboard side, respectively, laterally next to the flow channel mount 38. Facing away from the end sections 37.3, the center sections 37.2 each merge into a sliding surface front section 37.1. The sliding surface front section 37.1 is routed past the inlet opening of the flow channel mount 38 and preferably extends into the bow area 22. The sliding surface front sections 37.1 are preferably used to continuously transition the sliding surfaces 37 directly or indirectly into the rounding area 31 in the bow area 22.

The drawings show that the sliding surfaces 37 form a sliding plane 51. The sliding plane 51 can be formed by the sliding surfaces 37 themselves if these are designed as plane surfaces or for the most part as plane surfaces.

If the sliding surfaces 37 are not designed as plane surfaces or are not completely designed as plane surfaces, the sliding plane 51 is formed by a mean virtual sliding surface plane, wherein this mean virtual sliding surface plane is disposed such that equal proportions of the surface parts of the sliding surface 37 extend above and below this mean virtual sliding surface plane.

The drawings illustrate that a reference longitudinal line of the plane surface or of the mean virtual sliding surface plane extending in the direction from the bow to the stern 27 or the mean virtual planar surface plane, which extends through the center of gravity of the planar surface or the mean virtual planar surface plane, forms a sliding angle β with the thrust plane FE. In this exemplary embodiment, the sliding angle β can be selected in the range from 2°to 20°, preferably in the range from 4° to 15°, particularly preferably in the range from 8° to 14°, especially preferably in the range from 11° to 14°.

Figure 6 illustrates that the plane surface of the sliding surfaces 37 or the mean virtual sliding surface plane is set at an angle of inclination α=0° to the thrust plane FE. However, this angle of inclination may also be α > 0°, wherein the angle of inclination α preferably opens towards the starboard or port side.

Finally, Figure 5 also illustrates that an angle δ is formed between the sliding plane 51 and the horizontal plane 52, which angle opens towards the bow end. This angle δ is preferably selected in the range from 3° to 14°, preferably from 5° to 12°, particularly preferably from 5° to 10°.

Figure 5a illustrates that the centering unit 35 can be disposed in the central longitudinal plane ME and can preferably be designed symmetrically to the central longitudinal plane ME.

The centering unit 35 preferably has at least two centering blades 35.2, which keep the area of the feed-through (hub 35.1) at a distance from the inner wall of the flow channel 39.2. Preferably, at least one of the centering blades 35.2 is disposed in alignment with the guide element 33 in the direction of the axis of rotation D of the drive shaft 62. The guide element 33 can be connected directly or separately to the centering blade 35.2 via a narrow gap area.

Figure 1 illustrates that the width of the guide element 33 extending perpendicular to the central transverse plane ME increases, preferably continuously expands, in the direction from the stern to the bow. The guide element 33 may at its bow end facing away from the stern 27 merge into a curved rounded area 31 of the bottom hull 30 curved towards the underside U, wherein the rounded area 31 is disposed in the bow area 22 and extends further, preferably from the guide element 33 to the bow tip 21.

As shown in Figure 5, the submersible advantageously has a flooding chamber 70 in the hull 10 in addition to the flow channel 39, which flooding chamber is connected to the environment via one or several inlet openings 71 and one or several outlet openings 72. Preferably, at least one inlet opening 71 is disposed in the area of an upper shell 20 of the submersible, which upper shell is directed towards the topside O and is integrally made or multi-part.

In the submersible shown in the drawings, the axis of rotation D of the drive shaft 62 forms a virtual thrust axis 53, wherein the sliding surfaces 37 directed downwards adjoin the flow channel mount 38, in particular the bulge 39.3, on both sides of the bottom hull 30. Figure 5 illustrates that a bow tip section B1-B3 of the hull (10) is formed, which bow tip section, starting from the bow tip 21 in the direction of the vehicle stern, extends along a length of 10%, preferably 5%, particularly preferably 2.5%, of the vehicle length L measured from the bow tip 21 to the stern end. In so doing, the virtual thrust axis 53, which is inclined downwards in the direction from the bow to the stern, intersects the bow tip section B1-B3.

Figures 3 and 5 illustrate that the sliding surfaces 37 preferably extend, starting from the stern end of the sliding surfaces 37, at least along 30%, preferably at least along 40%, particularly preferably at least along 50%, of the vehicle length L laterally next to the flow channel 39.2 and in particular preferably above the thrust plane FE in the direction of the bow (22).

In particular, the sliding surfaces 37 may intersect the thrust plane FE.

Figures 3 and 6 show that the virtual thrust axis 53 lies in a thrust plane FE, wherein two vectors spanning the thrust plane FE are disposed such that the first vector extends in the direction of the thrust axis 53 and the second vector extends perpendicular thereto horizontally from the port side to the starboard side 11, 12 in the floating position and in the rest position of the submersible (perpendicular to the image plane in Figure 5). Furthermore, a central longitudinal plane ME is provided that is perpendicular to the thrust plane FE and incorporates the thrust axis 53. As Fig. 5 shows, the sliding surfaces 37 may intersect the thrust plane FE in the area of the vehicle hull, wherein preferably the sliding surfaces 37 intersect the thrust plane FE in an area that is spaced apart from the bow end and/or the stern end by 25% of the vehicle length L, respectively.

Preferably, as Fig. 5 shows, the sliding surfaces 37 intersect the thrust plane FE in an area that is spaced apart from the stern end by 25%.

Claims

1. A submersible having a hull (10), which comprises a flow channel mount (38) or wherein a flow channel mount (38) is assigned to the hull (10), wherein a flow channel (39.2) is disposed or formed at least sectionally in the flow channel mount (38), wherein the flow channel (39.2) has a stern-end flow inlet and a flow outlet (39) each, wherein a propeller (36) is disposed in the flow channel (39.2) and can be driven indirectly or directly by a motor (61) via a drive shaft (62), wherein the flow channel mount (38) is delimited on its underside by a connecting section (38.2), wherein a guide element (33) is fastened to a connection point (33.4) of the connecting section (38.2) in the area of the inlet opening, and wherein the area of the guide element (33) facing away from the connection point (33.4) extends in the direction of the bow and is coupled directly or indirectly to the hull (10),

characterized

in that the guide element (33) extends in the direction towards the stern (27), past the edge of the connecting section (38.2) facing the inlet opening and into the flow channel (39.2) in the area of the connection point (33.4) and in that the guide element (33) delimits two feed areas (34.1, 34.2) from each other downstream of this connection point (33.4) in the flow channel.

2. The submersible according to claim 1, characterized in that the axis of rotation (D) of the drive shaft (62) forms a thrust axis (53), wherein the thrust axis (53) lies in a thrust plane (FE), wherein two vectors spanning the thrust plane (FE) are disposed such that the first vector extends in the direction of the thrust axis (53) and the second vector extends perpendicularly thereto in the floating position and in the rest position of the submersible horizontally between the port and starboard sides, wherein a central transverse plane (ME), which is perpendicular to the thrust plane (FE) and incorporates the thrust axis (53) is provided, and in that adjoining the connection point (33.4) the guide element (33) extends in the direction of the central transverse plane (ME) into the flow channel (39.2) in a direction perpendicular to the thrust axis (53).

3. The submersible according to any of claims 1 or 2, characterized in that the guide element (33) extends past the drive shaft (62) towards the topside (O) of the

submersible and perpendicular to the axis of rotation (D) of the drive shaft (63) into the flow channel (39.2) and comprises a coupling section (33.6) opposite from the connection point (33.4), by means of which the guide element (33) is directly or indirectly coupled to the flow channel mount (38) or a component delimiting the flow channel (39.2).

4. The submersible according to any of claims 1 to 3, characterized in that the guide element (33) forms a feed-through(33.7), through which the drive shaft (62) or a sheathing tube (64) accommodating the drive shaft (62) is routed, preferably sealed or fitted.

5. The submersible according to any of claims 1 to 4, characterized in that the guide element (33) comprises at least one guide section (33.9) which extends past the connection point (33.4) towards the stern (27) and there projects into the flow channel (39.2) and which delimits the feed areas (34.1, 34.2) in the flow channel (39.2) from each other on opposite sides (34.1), wherein the central transverse plane (ME) of the submersible preferably extends through the guide element (33) and the feed areas (34.1, 34.2) extend on both sides of the central transverse plane (ME).

6. The submersible according to any of claims 1 to 5, characterized in that the guide element (33) has bulging, preferably convexly curved, boundary surfaces (33.8) in the area of the feed-through (33.7) on opposite sides of the drive shaft (62), wherein guide element sections (33.9) of the guide element (33) adjoin the boundary surfaces (33.8) on opposite sides, and in that the guide element sections (33.9) extend in opposite directions towards the edge of the flow channel (39.2).

7. The submersible according to any of claims 1 to 6, characterized in that a centering unit (35) is disposed in the flow channel (39.2) upstream of the propeller (36), which centering unit holds the free end of the drive shaft (62) or the sheathing tube (64) at the end by means of a hub (35.1), and in that the guide element (33) is routed up to the centering unit (35), wherein preferably provision is made for the centering unit (35) to be supported relative to the guide element (33) and/or to be connected to the latter, particularly preferably at least one component of the centering unit (35) to be connected to the guide element (33).

8. The submersible according to claim 7, characterized in that the centering unit (35) comprises at least two centering blades (35.2), which hold the hub (35.1) at a distance from the inner wall of the flow channel (39.2), and in that preferably at least one of the centering blades (35.2) is aligned with the guide element (33) in the direction of the axis of rotation (D) of the drive shaft (62), wherein preferably the guide element (33) adjoins the centering blade (35.2) directly or separately via a gap area.

9. The submersible according to any of claims 1 to 8, characterized in that the width of the guide element (33) extending perpendicular to the central transverse plane (ME) increases, preferably continuously expands, in the direction from the stern to the bow.

10. The submersible according to any of claims 1 to 9, characterized in that the guide element (33) at its bow end facing away from the stern (27) merges into a curved rounded area (31) of the bottom hull (30), wherein the rounded area (31) is disposed in the bow area (22) and extends further, preferably from the guide element (33) to the bow tip (21).

11. The submersible according to any of claims 1 to 9, characterized in that, in addition to the flow channel (39), a flooding chamber (70) is disposed in the hull (10), which flooding chamber is connected to the environment via one or several inlet openings (71) and one or several outlet openings (72), wherein preferably provision is made for at least one inlet opening (71) to be disposed in the area of an upper shell (20) of the submersible, which upper shell is directed towards the topside (O) and is integrally made or multi-part.

12. The submersible according to any of claims 1 to 11, characterized in that a flow stator (40) is disposed downstream of the propeller in the flow channel, wherein the flow stator comprises one or several stator blades (41), which preferably extend in the direction of the axis of rotation (D) of the drive shaft (62).

13. The submersible according to any of claims 1 to 12, characterized in that at least one of the stator blades (41) is aligned with the guide element (33) and/or with the

centering blade (35.2) of the/a centering unit (35) in the direction of the axis of rotation (D) of the drive shaft (62).

14. The submersible according to any of claims 1 to 13, characterized in that the guide element (33) comprises a fastening section (33.5) adjacent to the connection point (33.4) of the connecting section (38.2), which fastening section extends into the flow channel (33.9) in the direction of the stern (27), and in that the fastening section (33.5) adjacent to the connection point (33.4) is attached, preferably integrally formed, to the inside of the flow channel mount (38).

15. The submersible according to any of claims 1 to 14, characterized in that the projection of the connection point (33.4) perpendicular to the axis of rotation (D) of the drive shaft (62) in the thrust plane (FE) of the submersible results in a projected connection point (33.4'), and in that the guide element (33) extends beyond this projected connection point (33.4') into the flow channel (39.2).