

Submersible

The invention relates to a submersible having a hull, wherein a flow channel is accommodated in the hull at least sectionally or wherein a flow channel is assigned to the hull, wherein the flow channel comprises a flow outlet in the area of the stern, wherein a water acceleration device, in particular a propeller, which can be driven directly or indirectly by an electric motor via a drive shaft, is disposed in the flow channel, wherein the axis of rotation of the drive shaft forms a virtual thrust axis, wherein the electric motor is connected to one or several rechargeable batteries for the supply of electrical energy.

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 the electric motor used to drive the propeller in the flow channel. Preferably, submersibles in the context of the invention can be such that they are driven at a speed of less than 4000rpm, particularly preferably at a speed of less than 3000rpm at the drive shaft, to be able to achieve a suitable drive power for both surface and underwater travel.

Preferably, in submersibles according to the invention, the handles can be disposed in the front part of the watercraft, in particular in the bow area of the submersible.

Furthermore, a submersible according to the invention may comprise 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.

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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.

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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. In the floating position of the watercraft at rest, i.e. not in driving mode, the axis of rotation of the drive shaft, which drives the propeller in the flow channel, is oriented horizontally.

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The invention addresses the problem of providing a compact and efficient submersible of the type mentioned above, which offers a stable floating position both during surface travel and during submerged travel.

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This problem is solved by the volume occupied by the at least one rechargeable battery being arranged for the most part, preferably completely, above the thrust axis.

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The mounting area for the voluminous rechargeable battery or batteries is offset from the thrust axis in the direction of the top of the submersible. This allows the submersible to be generously dimensioned and flow-optimized in the area of its underside, particularly in the area of the flow channel and the inflow area to the flow channel. In this way it becomes possible to design a powerful yet compact submersible.

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If the submersible according to the invention is in the floating position and in the rest position, the thrust axis lies deep in the water and the dead load of the rechargeable batteries stabilize this floating position in conjunction with the electric motor as a further large mass component. During surface travel of the , the hull rises slightly out of the water, resulting in a waterline that is positioned lower on the hull than in the "standstill"

position. Due to the dynamic water forces acting on the hull and the weight of the rechargeable battery or batteries, the submersible stabilizes autonomously. This supports a sporty and dynamic driving style. When the submersible is doing underwater travel, the position of the rechargeable battery in the hull has little or no effect on the driving characteristics, i.e., good driving characteristics can also be achieved in this operating mode.

A submersible according to the invention may be designed such that two rechargeable batteries are accommodated in the hull, which rechargeable batteries are arranged on both sides of the thrust axis, preferably symmetrically on both sides of the thrust axis, and that the volume occupied by both rechargeable batteries is arranged for the most part, preferably completely, above the thrust axis. The double-sided arrangement above the thrust axis ensures a stable vehicle position, especially when cornering on water.

According to a preferred variant of the invention, provision may be made for the hull to comprise a bottom hull in the area of its underside, wherein the flow channel is arranged at least sectionally inside a flow channel mount, in particular a bulge, protruding from the bottom hull, wherein downwards directed sliding surfaces, which end above the thrust axis in the stern area of the vehicle and extend in the direction towards the bow, bilaterally adjoin the flow channel mount, in particular to the bulge at the bottom hull, and for the rechargeable batteries to be disposed at least sectionally in an area above the sliding surfaces in the hull. The sliding surfaces are designed and arranged to glide on the surface of the water during fast surface travel. This adjusts the waterline in the area of the sliding surfaces accordingly. The protruding flow channel on the bottom hull (in particular in the form of a bulge) allows for generous flow channel dimensioning.

A possible variant of the invention is such that a bow tip section of the hull is formed, which, starting from the bow tip in the direction of the stern of the vehicle, extends along a length of 10%, preferably 5%, particularly preferably 2.5%, of the vehicle length measured from the bow tip to the stern end, and in that the virtual thrust axis, which is inclined downwards in the direction from the bow to the stern, intersects the bow tip section.

As a result of the thrust axis being set at an angle downwards to the rear, a water jet is generated, which is directed diagonally downwards during surface travel. This results in a thrust component that acts vertically downwards. This thrust component aims to righten the submersible at the stern section. However, this is counteracted by the frontal inflow of the submersible, which attempts to raise the hull at the bow. As a result, the water position of the submersible is stabilized and the flow resistance is kept low.

Furthermore, the inclined thrust axis simplifies the transition to submerged travel or a descent, as the aforementioned vertical thrust force component then supports the descent behavior after the bow is tilted downwards. During submerged travel, the user can tilt the submersible to stabilize it in its underwater position and then take up the desired direction of travel. During submerged travel, the sliding surfaces have little or no effect on the driving characteristics, so that this driving mode is also optimized.

To guarantee stable surface travel, in particular sliding travel, provision is made according to a variant of the invention for the central longitudinal plane to intersect the boundary rim of the flow outlet at an upper boundary point, for a boundary line intersecting the bow tip and the upper boundary point to be provided, for the boundary line to lie in a horizontal plane, wherein two vectors spanning the horizontal plane are disposed such that the first vector extends in the direction of the boundary line and the second vector extends perpendicular thereto between the port and starboard sides in parallel to the thrust plane, and for the volume occupied by the at least one rechargeable battery to be disposed for the most part, preferably completely, above the horizontal plane.

In particular, provision may be made for the stern ends of the sliding surfaces to intersect the horizontal plane, or for the stern ends of the sliding surfaces to be spaced apart from the horizontal plane at a maximum distance of $M = 0.2 \cdot X$, preferably $M = 0.1 \cdot X$, and are disposed below the horizontal plane, wherein X is the maximum clear opening dimension of the flow outlet, to achieve a high thrust performance.

A particularly preferred variant of the invention is such that the thrust axis intersects the horizontal plane in the bow area, preferably in the bow tip section.

5 For improved weight distribution provision may be made for the electric motor including most of the volume it occupies to be disposed below the horizontal plane in the hull.

10 A further variant of the invention provides that the rechargeable battery or batteries are disposed in a flooding chamber, wherein the flooding chamber is disposed in the hull of the submersible and is spatially connected via water passage openings, wherein preferably provision is made for the water passage openings to form at least one water inlet opening and at least one water outlet opening, which are disposed to generate a water flow through the flooding chamber during underwater travel of the submersible and/or during surface travel of the submersible. In the flooding chamber, the ambient water can be used to cool the rechargeable batteries effectively and continuously.

15 Preferably, the at least one water inlet opening is arranged in the bow area and the at least one water outlet opening is arranged in the stern area to achieve an effective flow.

20 In accordance with the invention, provision may also be made for the rechargeable battery to comprise a tubular section inside which a plurality of rechargeable battery cells are disposed, and for the tubular section to be closed in a watertight manner at its longitudinal ends by means of covers, wherein preferably provision is made for electronics for monitoring and/or for controlling the rechargeable battery cells to be accommodated in the water-protected area in the tubular section. This provides a

25 simple design that is also characterized by high compressive strength for underwater applications.

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

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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,

5 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,

10 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,

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

20 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.

25 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.

30 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.

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

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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.

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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.

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

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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.

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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.

- 5 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.
10 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.

15 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.

20 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
25 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
30 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.

- 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,
10 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
15 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
20 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.

25 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.

30 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.

- 5 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.

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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
15 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.

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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,
25 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.

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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.

- 5 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.

10 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
15 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
20 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
25 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.

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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 at a maximum distance of $M = 0.2 \cdot X$, preferably $M = 0.1 \cdot X$, 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° .

5 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.

10 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.

15 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.

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

25 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 tubular section in a watertight manner. Preferably, electronics for monitoring and/or controlling the rechargeable battery cells is/are provided and accommodated inside the sealed area of the tubular section.

30 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 arranged 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.

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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.

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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.

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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 arranged such that equal proportions of the surface parts of the sliding surface 37 extend above and below this mean virtual sliding surface plane.

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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°.

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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 $\alpha=0^\circ$ to the thrust plane FE. However, this angle of inclination may also be $\alpha > 0^\circ$, wherein the angle of inclination α preferably opens towards the starboard or port side.

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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° .

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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.

15 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
20 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, in the direction from the stern to the bow. The guide element 33 may at its bow end facing away from
25 the stern 27 merge into a 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 preferably extends from the guide element 33 to the bow tip 21.

As shown in Figure 5, the submersible advantageously has a flooding chamber 70 in
30 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 is directed towards the topside O and is formed integrally 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 stern of the vehicle, 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), wherein a flow channel (39.2) is accommodated in the hull (10) at least sectionally or wherein a flow channel (39.2) is assigned to the hull (10), wherein the flow channel (39.2) comprises a flow outlet (39) in the area of the stern, wherein a water acceleration device, in particular a propeller (36), which can be driven indirectly or directly by an electric motor (61) via a drive shaft (62), is disposed in the flow channel (39.2), wherein the axis of rotation (D) of the drive shaft (62) forms a virtual thrust axis (53), wherein the electric motor (61) is connected to one or several rechargeable batteries (60) for the supply of electrical energy, characterized in that the volume occupied by the at least one rechargeable battery (60) is arranged for the most part, preferably completely, above the thrust axis (53).
2. The submersible according to claim 1, characterized in that two rechargeable batteries (60) are accommodated in the hull (10), which rechargeable batteries are arranged on both sides of the thrust axis (53), preferably symmetrically on both sides of the thrust axis (53), and in that the volume occupied by both rechargeable batteries (60) is disposed for the most part, preferably completely, above the thrust axis (53).
3. The submersible according to claim 1 or 2, characterized in that the hull (10) comprises a bottom hull (30) in the area of its underside, wherein the flow channel (39.2) is arranged at least sectionally inside a flow channel mount (38), in particular a bulge (39.3), protruding from the bottom hull (30), wherein downwards directed sliding surfaces (37), which end above the thrust axis (53) in the stern area of the vehicle and extend in the direction towards the bow, bilaterally adjoin the flow channel mount (38), in particular the bulge (39.3) at the bottom hull (30), and in that the rechargeable batteries (60) are disposed at least sectionally in an area above the sliding surfaces (37) in the hull.
4. The submersible according to any of claims 1 to 3, characterized in that a bow tip section (B1-B3) of the hull (10) is formed, which, starting from the bow tip (21) in the direction of the stern of the vehicle, extends along a length of 10%, preferably 5%, particularly preferably 2.5%, of the vehicle length (L) measured from the bow tip to the

stern end, and in that 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).

5. The submersible according to any of claims 1 to 4, characterized in that the
5 central longitudinal plane (ME) of the submersible intersects the boundary rim (39.1) of the flow outlet (39) at an upper boundary point (P), in that a boundary line (52) intersecting the bow tip (21) and the upper boundary point (P) is provided. in that 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
10 the boundary line (52) and the second vector extends perpendicular thereto between the port and starboard sides (11, 12) in parallel to the thrust plane (FE), and in that the volume occupied by the at least one rechargeable battery (60) is disposed for the most part, preferably completely, above the horizontal plane (HE).

15 6. The submersible according to claim 5, characterized in that the stern ends of the sliding surfaces (37) intersect the horizontal plane (HE), or in that the stern ends of the sliding surfaces (37) are spaced apart from the horizontal plane (HE) at a maximum distance of $M = 0.2 \cdot X$, preferably $M = 0.1 \cdot X$ and are disposed below the horizontal plane (HE), wherein X is the maximum clear opening dimension
20 of the flow outlet (39).

7. The submersible according to any of claims 1 to 6, characterized in that the thrust axis (53) intersects the horizontal plane (HE) in the bow area, preferably in the bow tip section (B1-B3).

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8. The submersible according to any of the preceding claims, characterized in that the electric motor (61) including most of the volume it occupies is disposed below the horizontal plan (HE) in the hull (10).

30 9. The submersible, according to any of claims 1 to 8, characterized in that the thrust axis (53) and the boundary line (52) intersect in the bow area (22), wherein preferably the intersection point is arranged in the bow tip area (B1-B3).

10. The submersible, according to any of claims 1 to 9, characterized in that the rechargeable battery or batteries (60) are disposed in a flooding space (70), wherein the flooding chamber (70) is disposed in the hull (10) of the submersible and is spatially connected via water passage openings, wherein preferably provision is made for the water passage openings to form at least one water inlet opening (71) and at least one water outlet opening (72), which are disposed to generate a water flow through the flooding space (70) during submerged travel of the submersible and/or during surface travel of the submersible.
11. The submersible according to any of claims 1 to 10, characterized in that the at least one sliding surface (37) and the horizontal plane (HE) diverge in the direction from the stern to the bow.
12. The submersible according to any of claims 1 to 11, characterized in that the rechargeable battery (60) comprises a tube section inside which a plurality of rechargeable battery cells are disposed, and in that the tube section is closed in a watertight manner at its longitudinal ends by means of covers (64, 65), wherein preferably provision is made for electronics for monitoring and/or for controlling the rechargeable battery cells to be accommodated in the water-protected area in the tubular section.