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(54) **A MARINE DRIVE UNIT**

(57) The present disclosure relates to a marine drive unit (1) for a marine vessel (100), comprising a shaft housing (2) having a housing face (3), a rotatable shaft (4) having an outer shaft face (5), the rotatable shaft (4) being rotatable arranged within the shaft housing (2) whereby an annulus (A) is defined between the housing

face (3) and the outer shaft face (5), the shaft housing (2) comprising an inlet (6) being in fluid communication with the annulus (A) so that a lubrication can be introduced in the annulus, wherein one or more spacer element(s) (7) is/are arranged at the inlet (6) for at least dividing the annulus up in several parts around the inlet.

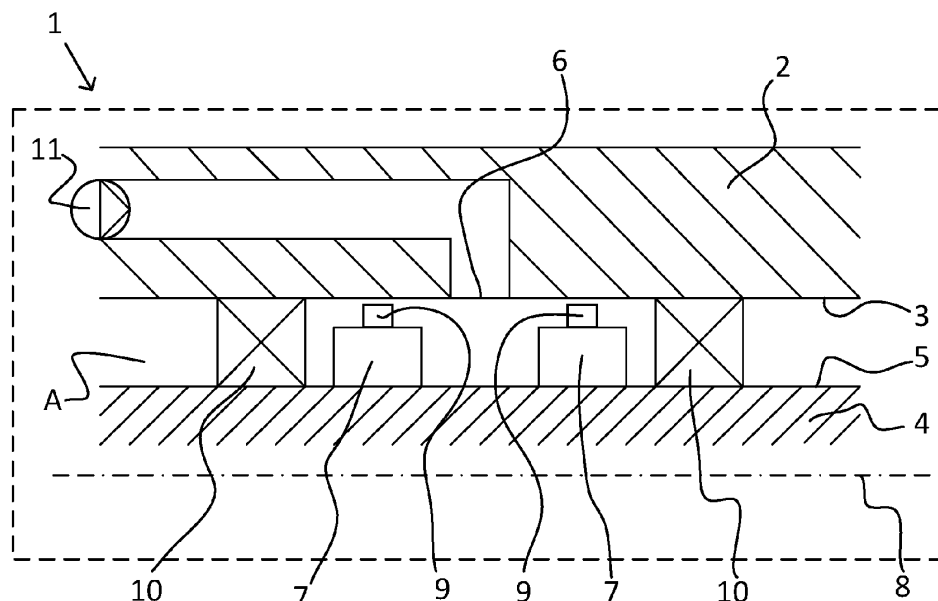


FIG. 1

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Description

TECHNICAL FIELD

[0001] The disclosure relates generally to marine propulsion systems. In particular aspects, the disclosure relates to a marine drive unit. The disclosure can be applied to marine vessels, such as water crafts, motor-boats, work boats, sport vessels, boats, ships, among other vessel types. Although the disclosure may be described with respect to a particular marine vessel, the disclosure is not restricted to any particular marine vessel.

BACKGROUND

[0002] In the field of marine applications, particularly those concerning the propulsion systems of marine vessels, the lubrication of rotating shafts presents a significant technical challenge. Effective lubrication is crucial for maintaining the operational integrity and efficiency of marine driveline systems. These systems typically involve complex dynamics with rotating and counter-rotating shafts operating under high loads and in harsh marine environments.

[0003] Hence, there exists a need for an improved lubrication approach in marine driveline systems that ensures even distribution of lubricating oil.

SUMMARY

[0004] According to a first aspect of the disclosure, a marine drive unit for a marine vessel, comprising a shaft housing having a housing face, a rotatable shaft having an outer shaft face, the rotatable shaft being rotatable arranged within the shaft housing whereby an annulus is defined between the housing face and the outer shaft face, the shaft housing comprising an inlet being in fluid communication with the annulus so that a lubrication can be introduced in the annulus, wherein one or more spacer element(s) is/are arranged at the inlet for at least dividing the annulus up in several parts around the inlet. The first aspect of the disclosure may seek to enhance the lubrication of the rotating shaft(s) in a marine drive unit. A technical benefit may include improved distribution and management of lubrication, ensuring consistent lubrication throughout the shaft system to prevent wear and maintain efficiency. In addition, the spacer element takes advantage of both the viscosity and surface tension of the lubrication, which work together to form a kind of barrier or wall within this confined space. The result is an increase in pressure within the space created by the spacer element(s).

[0005] Optionally in some examples, including in at least one preferred example, the spacer element is arranged around the rotatable shaft. A technical benefit may include the stabilizing effect of the spacer, which can help maintain the alignment of the shaft and reduce

vibrations during operation. In addition, during rotation of the shaft, the lubrication is forced outwards by the centrifugal forces so that the lubrication is pressurized.

[0006] Optionally in some examples, including in at least one preferred example, the spacer element is projecting from the outer shaft face. A technical benefit may include the enhancement of lubrication flow control, helping to direct lubricant more effectively to needed areas, and to take further advantage of both the viscosity and surface tension of the lubrication, which work together to form a kind of barrier or wall within this confined area.

[0007] Optionally in some examples, including in at least one preferred example, a first spacer element is arranged on a first side of the inlet and a second spacer element is arranged on a second side of the inlet. A technical benefit may include the ability to create multiple lubrication zones, which can be individually optimized for specific lubrication needs.

[0008] Optionally in some examples, including in at least one preferred example, the spacer element comprises a first ring arranged on the first side of the inlet and a second ring arranged on the second side of the inlet. A technical benefit may include the facilitation of a more organized and directed flow of lubrication, reducing the risk of leakage and ensuring that essential areas receive adequate lubrication.

[0009] Optionally in some examples, including in at least one preferred example, the spacer element comprises a ring, a ridge, a protrusion or similar. A technical benefit may include increased flexibility in designing the lubrication system to accommodate specific operational conditions or requirements. In addition, the ring, ridge or protrusion also takes the advantage of both the viscosity and surface tension of the lubrication, which work together to form a kind of barrier or wall within this confined space

[0010] Optionally in some examples, including in at least one preferred example, the rotatable shaft is hollow and has an inner shaft face and a shaft wall extending between the outer shaft face and the inner shaft face. A technical benefit may include additional space for routing lubrication or other systems internally, which can enhance the overall compactness and efficiency of the design. In addition, by having the rotatable shaft hollow it is possible to arranged another rotatable shaft inside the hollow shaft.

[0011] Optionally in some examples, including in at least one preferred example, a second rotatable shaft is arranged inside the hollow rotatable shaft, whereby a second annulus is defined between the inner shaft face and a second outer face of the second rotatable shaft. A technical benefit may include the ability to support complex drive configurations within a single unit, enhancing power transmission and operational flexibility. For instance, it is possible to have two rotating propellers each being rotated by its own shaft.

[0012] Optionally in some examples, including in at least one preferred example, the shaft wall comprising

a second inlet, the second inlet being arranged between the spacer elements, the second inlet being in fluid communication with the second annulus so that the lubrication can be introduced in the second annulus. A technical benefit may include improved lubrication delivery to the internal components, ensuring optimal performance and longevity.

[0013] Optionally in some examples, including in at least one preferred example, a plurality of second inlets is arranged around a circumference of the rotatable shaft between the spacer elements. A technical benefit may include a more uniform distribution of lubrication within the second annulus, enhancing the effectiveness of the lubrication system.

[0014] Optionally in some examples, including in at least one preferred example, one or more spacer element(s) is/are arranged at the second inlet for at least dividing the second annulus up in several parts around the second inlet. A technical benefit may include targeted lubrication control within the second annulus, improving the precision and efficiency of lubrication delivery.

[0015] Optionally in some examples, including in at least one preferred example, the inlet is in fluid communication with the second annulus via the second inlet. A technical benefit may include streamlined lubrication pathways, which simplify the overall design and maintenance of the lubrication system.

[0016] Optionally in some examples, including in at least one preferred example, the rotatable shaft is connected with a propeller and is providing rotation to the propeller. A technical benefit may include direct transmission of rotational force to the propeller, enhancing the propulsion efficiency of the marine vessel.

[0017] According to a second aspect of the disclosure, a marine vessel comprising the marine drive unit as described above. The second aspect of the disclosure may seek to enhance the lubrication of the rotating shaft(s) in a marine drive unit. A technical benefit may include the integration of a highly efficient marine drive unit, improving the overall performance and reliability of the vessel.

[0018] According to a third aspect of the disclosure, a lubrication method for lubricating a marine drive unit as described above, comprising providing one or more spacer elements at the inlet for dividing the annulus up in several parts around the inlet, supplying a lubrication to the inlet, building up a pressure in the lubrication at the inlet by the one or more spacer elements function as a barrier, utilizing the pressure to drive the lubrication towards any components being in fluid communication with the inlet. The third aspect of the disclosure may seek to enhance the lubrication of the rotating shaft(s) in a marine drive unit. A technical benefit may include a more effective and controlled lubrication process, which enhances the lifespan and functionality of the marine drive unit components by ensuring thorough lubrication under varying operational conditions.

[0019] The disclosed aspects, examples (including

any preferred examples), and/or accompanying claims may be suitably combined with each other as would be apparent to anyone of ordinary skill in the art. Additional features and advantages are disclosed in the following description, claims, and drawings, and in part will be readily apparent therefrom to those skilled in the art or recognized by practicing the disclosure as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Examples are described in more detail below with reference to the appended drawings.

FIG. 1 is an exemplary marine drive unit according to an example.

FIG. 2 is another exemplary marine drive unit according to an example.

FIG. 3 is yet another exemplary marine drive unit according to an example.

FIG. 4 is an enlarged view of a part of a spacer element.

FIG. 5 is yet another exemplary marine drive unit according to an example.

FIG. 6 shows partly a marine vessel with a marine drive unit.

FIG. 7 is another view of **FIG. 1**, according to an example.

DETAILED DESCRIPTION

[0021] The detailed description set forth below provides information and examples of the disclosed technology with sufficient detail to enable those skilled in the art to practice the disclosure.

[0022] In the field of marine applications, particularly those concerning the propulsion systems of marine vessels, the lubrication of rotating shafts presents a significant technical challenge. Effective lubrication is crucial for maintaining the operational integrity and efficiency of marine driveline systems. These systems typically involve complex dynamics with rotating and counter-rotating shafts operating under high loads and in harsh marine environments.

[0023] Traditional approaches to lubricating marine driveline systems often involve the use of ball bearings or other bearings but the distribution of lubrication along and through shafts are often complicated and it is difficult to effectively manage the pressure of the lubrication or ensure that the lubrication penetrates into deeper recesses or cavities within the system.

[0024] The present disclosure is using that the centrifugal forces generated by the rotation of the shafts tend to push the lubricating oil radially outward and the creation of a pressure differential within the lubrication channel, which is essential for forcing oil into narrow or hard-to-reach areas that are critical for the smooth operation of the shafts. Moreover, the present disclosure utilizes the

physical properties of the lubricating oil, such as viscosity and surface tension, to create a barrier or wall that can enhance the pressure within the lubrication system. Hereby is obtained that protection against wear and corrosion, leading to decreased efficiency and increased maintenance requirements is avoided.

[0025] FIG. 1 is an exemplary marine drive unit 1 for a marine vessel according to an example. The marine drive unit 1 is shown in a cross-sectional view and comprises a shaft housing 2 having a housing face 3. In addition, a rotatable shaft 4 having an outer shaft face 5 is arranged, the rotatable shaft 4 being rotatable arranged within the shaft housing 2 whereby an annulus A is defined between the housing face 3 and the outer shaft face 5. The shaft housing 2 comprising an inlet 6 being in fluid communication with the annulus A so that a lubrication can be introduced in the annulus A. In addition, one or more spacer element(s) 7 is/are arranged at the inlet 6 for at least dividing the annulus A up in several parts around the inlet 6. Hereby is obtained, that a higher pressure in the oil is developed whereby the oil may be pushed to shafts for enhanced lubrication. The rotatable shaft 4 is rotating around an axis 8. In FIG. 1, the different components are shown on one side of the axis, however, it is to be understood that similar components are present of the opposite side of the axis 8.

[0026] The present disclosure relates to positioning one or more spacer elements 7 at the inlet 6 so as to divide the annulus A up in several parts. Thereby a higher pressure in the lubrication may be obtained. The arrangement of spacer elements at the inlet 6 takes advantage of both the viscosity and surface tension of the lubrication, which work together to form a kind of barrier or wall within this confined area. The result is an increase in pressure within the area created by the space elements 7.

[0027] This elevated pressure can then be harnessed to drive the lubrication into any gaps, crevices, or holes within the drive unit, ensuring effective lubrication of the various components. The inherent viscous forces of the lubricant from escaping the drive unit, thus creating a pressure differential within the channel.

[0028] In FIG. 1, a first spacer element 7 is arranged on a first side of the inlet 6 and a second spacer element 7 is arranged on a second side of the inlet 6. In addition, the spacer elements 7 are arranged around the rotatable shaft 4. A technical benefit may include the facilitation of a uniform distribution of lubricant around the shaft, ensuring consistent lubrication and reducing the risk of overheating or damage due to uneven lubrication coverage. Moreover, the spacer elements 7 are projecting from the outer shaft face 5. A technical benefit may include the enhancement of lubricant retention and pressure build-up within the annulus, which can be critical for ensuring deep penetration of lubricant into essential parts of the marine drive unit 1.

[0029] The spacer elements 7 may comprise a ring, a ridge, a protrusion 9 or similar. A technical benefit may include the ability to modify the flow and distribution of

lubricant within the annulus in a controlled manner, potentially improving the lifespan and reliability of the marine drive unit.

[0030] The spacer elements 7 may be made of a metal, a composite, a polymeric, or any combination thereof. A technical benefit may include the flexibility in material choice, which allows for optimization based on specific operational needs and environmental conditions.

[0031] The ring, the ridge, the protrusion 9 may be made of a polymeric material. A technical benefit may include reduced wear and friction at the contact points, which can significantly enhance the operational efficiency and reduce maintenance needs.

[0032] One or more bearings 10 is/are arranged in the annulus A. A technical benefit may include improved support and stabilization of the rotatable shaft 4, enhancing the overall mechanical efficiency and reducing vibrations. The bearings 10 are arranged on the opposite sides of the spacer elements 7 compared to the inlet 6.

[0033] Furthermore, the lubrication may be oil. A technical benefit may include the use of a widely available and well-understood lubricant, which can help in reducing operational costs and simplifying maintenance.

[0034] Also, a pump 11 may be in fluid communication with the inlet 6. A technical benefit may include the ability to actively manage the flow and pressure of the lubricant, which can be crucial for maintaining optimal conditions within the marine drive unit. The pump 11 may be configured to supply a constant flow of lubrication to inlet 6, and/or a variable flow of lubrication to the inlet 6. A technical benefit may include flexible lubrication management, allowing for adjustments based on operational needs or environmental conditions. Furthermore, the marine drive unit 1 may comprise a lubrication reservoir. A technical benefit may include increased lubrication capacity, which can extend operational periods between maintenance sessions and enhance the overall reliability of the system.

[0035] FIG. 2 shows another example of the marine drive unit in a cross-sectional view. The rotatable shaft 4 is hollow and has an inner shaft face 12 and a shaft wall 13 extending between the outer shaft face 5 and the inner shaft face 12. A second rotatable shaft 14 is arranged inside the hollow rotatable shaft 4, whereby a second annulus A2 is defined between the inner shaft face 12 and a second outer face 15 of the second rotatable shaft 14. A technical benefit may include the ability to handle multiple rotational components within a single compact unit, increasing the efficiency and power output of the marine drive unit 1.

[0036] The shaft wall 13 may comprise a second inlet 16, the second inlet 16 being arranged between the spacer elements 7, the second inlet 16 being in fluid communication with the second annulus A2 so that the lubrication can be introduced in the second annulus A2. A technical benefit may include improved lubrication management for multiple shaft systems, ensuring that all components receive adequate lubrication without exces-

sive use of space or resources. A plurality of second inlets **16** may be arranged around a circumference of the second rotatable shaft **14** between the spacer elements **7**. A technical benefit may include a more even and effective distribution of lubricant to the second annulus **A2**, particularly beneficial for complex or high-performance marine drive systems. In addition, one or more bearings **10** may be arranged between the rotatable shaft **4** and the second rotatable shaft **14** in the second annulus **A2**.

[0037] Moreover, one or more spacer element(s) may be arranged at the second inlet **16** for at least dividing the second annulus **A2** up in several parts around the second inlet. A technical benefit may include enhanced control and precision in lubrication delivery to critical areas of the second annulus **A2**, crucial for maintaining operational reliability and efficiency.

[0038] In addition, a fluid channel **17** may be arranged in the shaft wall **13** along an extension of the rotatable shaft **4**. A technical benefit may include enhanced fluid management capabilities, allowing for more precise control over the flow and distribution of lubricants or other fluids within the marine drive unit. The fluid channel **17** may be in fluid communication with the second inlet **16**. A technical benefit may include increased efficiency and reliability in lubricant delivery, ensuring that all parts of the system are adequately lubricated even under varying operational conditions. The fluid channel **17** may be used to distribute lubrication to other components in the marine drive unit **1**.

[0039] In **FIG. 3**, another example of the marine drive unit **1** is shown in a cross-sectional view. In the shown example, the spacer element **7** comprises a base part **18** connecting the first ring **19** and the second ring **20**, the base part is **18** extending along and around the rotatable shaft **4**. A technical benefit may include increased structural integrity and stability of the spacer element **7**, which ensures consistent performance even under varying operational stresses.

[0040] In **FIG. 4**, an enlarged part of the spacer element **7** is shown in a cross-sectional view. A distance **d** between the housing face **3** and the spacer element **7** is smaller than 1 cm, preferably smaller than 0,5 cm, more preferably smaller than 0,3 cm. A technical benefit may include the ability to maintain a high lubrication pressure within the annulus, which is crucial for ensuring effective lubrication under high-load conditions. The distance **d** between spacer element **7** and the outer housing peripheral wall **3** is deliberately minimal. This design takes advantage of both the viscosity and surface tension of the oil, which work together to form a kind of barrier or wall within this confined space. The result is an increase in pressure within the space created by spacer element(s) **7**.

[0041] In **FIG. 5**, yet another exemplary marine drive unit **1** according to an example is shown in a cross-section view. The marine drive unit **1** may comprise a shaft housing **2** having a housing face **3**. In addition, a

rotatable shaft **4** having an outer shaft face **5** is arranged, the rotatable shaft **4** being rotatable arranged within the shaft housing **2** whereby an annulus **A** is defined between the housing face **3** and the outer shaft face **5**. The shaft housing **2** comprising an inlet **6** being in fluid communication with the annulus **A** so that a lubrication can be introduced in the annulus **A**. In addition, one or more spacer element(s) **7** is/are arranged at the inlet **6** for at least dividing the annulus **A** up in several parts around the inlet **6**. Hereby is obtained, that a higher pressure in the oil is developed whereby the oil may be pushed to shafts for enhanced lubrication. The rotatable shaft **4** is rotating around an axis **8**. Furthermore, a plurality of bearings may be arranged between the shaft housing and the rotatable shaft **4**.

[0042] The rotatable shaft **4** is hollow and has an inner shaft face **12** and a shaft wall **13** extending between the outer shaft face **5** and the inner shaft face **12**. A second rotatable shaft **14** is arranged inside the hollow rotatable shaft **4**, whereby a second annulus **A2** is defined between the inner shaft face **12** and a second outer face **15** of the second rotatable shaft **14**.

[0043] The shaft wall **13** may comprise a second inlet **16**, the second inlet **16** being arranged between the spacer elements **7**, the second inlet **16** being in fluid communication with the second annulus **A2** so that the lubrication can be introduced in the second annulus **A2**. A plurality of second inlets **16** may be arranged around a circumference of the second rotatable shaft **14** between the spacer elements **7**. In addition, one or more bearings **10** may be arranged between the rotatable shaft **4** and the second rotatable shaft **14** in the second annulus **A2**. Moreover, one or more spacer element(s) may be arranged at the second inlet **16** for at least dividing the second annulus **A2** up in several parts around the second inlet. A technical benefit may include enhanced control and precision in lubrication delivery to critical areas of the second annulus **A2**, crucial for maintaining operational reliability and efficiency.

[0044] In addition, a fluid channel **17** may be arranged in the shaft wall **13** along an extension of the rotatable shaft **4**. The fluid channel **17** may be in fluid communication with the second inlet **16**. A technical benefit may include increased efficiency and reliability in lubricant delivery, ensuring that all parts of the system are adequately lubricated even under varying operational conditions. The fluid channel **17** may be used to distribute lubrication to other components in the marine drive unit **1**.

[0045] Furthermore, an outlet **21** may be arranged for leading the lubrication away from the shaft(s).

[0046] In addition, the second rotatable shaft may be hollow and has a second inner shaft face and a second shaft wall extending between the second outer shaft face and the second inner shaft face. A technical benefit may include additional structural options for further mechanical components or fluid systems, enhancing the versatility and functionality of the marine drive unit. A third rotatable shaft is arranged inside the hollow second

rotatable shaft, whereby a third annulus is defined between the second inner shaft face and a third outer shaft face of the third rotatable shaft. A technical benefit may include the capability to handle additional rotational components within a single unit, which can significantly increase the power density and efficiency of the system. The second shaft wall comprising a third inlet, the third inlet being in fluid communication with the third annulus so that the lubrication can be introduced in the third annulus. A technical benefit may include improved lubrication management for complex multi-shaft systems, ensuring that all components receive adequate lubrication without excessive use of resources or space. Furthermore, one or more bearings may be arranged in the third annulus. A technical benefit may include better support and stabilization for the third rotatable shaft, enhancing the mechanical efficiency and reducing vibrations within the marine drive unit. The inlet is in fluid communication with the third annulus via the second inlet and the third inlet. A technical benefit may include a more integrated and efficient lubrication system, which simplifies the overall design and reduces potential points of failure.

[0047] Moreover, a second fluid channel may be arranged in the second shaft wall along an extension of the second rotatable shaft. A technical benefit may include enhanced options for managing fluids within the system, allowing for more precise control and distribution of lubricants or other fluids. The second fluid channel is in fluid communication with the third inlet. A technical benefit may include increased efficiency and reliability in fluid delivery, ensuring that all parts of the system are adequately serviced even under varying operational conditions.

[0048] In **FIG. 5**, the marine drive unit **1** is arranged on a marine vessel **100**. The rotatable shaft **4** is connected with a propeller **22** and is providing rotation to the propeller **22**. A technical benefit may include direct transmission of power to the propeller, which can improve the efficiency and responsiveness of the marine vessel. The second rotatable shaft **14** is connected with a second propeller **23** and is providing rotation to the second propeller **23**. A technical benefit may include the capability to manage multiple propulsion systems within a single unit, increasing the power and control available to the marine vessel. The propeller **22** and the second propeller **23** are arranged adjacent to each other. A technical benefit may include compact design, which can help in reducing the overall size and weight of the propulsion system. Furthermore, the propeller **22** and the second propeller **23** may be counter-rotating. A technical benefit may include enhanced stability and maneuverability of the marine vessel, which can be crucial for operations in challenging marine environments. In **FIG. 5**, the one or more propellers **22, 23** are configured to pull the marine vessel **100** in a forward motion of the marine vessel **100**. In another example, the one or more propellers may be configured to push the marine vessel in a

forward motion of the marine vessel.

[0049] In addition, the third rotatable shaft may be connected with a third propeller and is providing rotation to the third propeller. The propeller, the second propeller and the third propeller are arranged adjacent to each other. The propeller, the second propeller and the third propeller are counter-rotating. A technical benefit may include improved stability and control, which can be essential for maintaining safety and efficiency in marine operations.

[0050] The present disclosure also relates to a marine vessel **100** comprising the marine drive unit **1** as described above.

[0051] The present disclosure also relates to a lubrication method for lubricating a marine drive unit **1** as described above. The lubrication method comprising

providing one or more spacer elements **7** at the inlet **6** for dividing the annulus **A** up in several parts around the inlet,

supplying a lubrication to the inlet **6**,
building up a pressure in the lubrication at the inlet **6** by the one or more spacer elements **7** function as a barrier, utilizing the pressure to drive the lubrication towards any components being in fluid communication with the inlet **6**. A technical benefit may include a systematic approach to lubrication that ensures optimal distribution and use of lubricant, which can significantly enhance the longevity and performance of the marine drive unit.

[0052] **FIG. 7** is another view of **FIG. 1**, according to an example. A marine drive unit **1** for a marine vessel **100** is shown in a cross-sectional view. The marine drive unit **1** comprises a shaft housing **2** having a housing face **3**, a rotatable shaft **4** having an outer shaft face **5**, the rotatable shaft **5** being rotatable arranged within the shaft housing **2** whereby an annulus **A** is defined between the housing face **3** and the outer shaft face **5**, the shaft housing **2** comprising an inlet **6** being in fluid communication with the annulus **A** so that a lubrication can be introduced in the annulus **A**, wherein one or more spacer element(s) **7** is/are arranged at the inlet **6** for at least dividing the annulus **A** up in several parts around the inlet **6**.

[0053] Certain aspects and variants of the disclosure are set forth in the following examples numbered consecutive below.

[0054] Example 1: A marine drive unit (**1**) for a marine vessel (**100**), comprising a shaft housing (**2**) having a housing face (**3**), a rotatable shaft (**4**) having an outer shaft face (**5**), the rotatable shaft (**4**) being rotatable arranged within the shaft housing (**2**) whereby an annulus (**A**) is defined between the housing face (**3**) and the outer shaft face (**5**), the shaft housing (**2**) comprising an inlet (**6**) being in fluid communication with the annulus (**A**) so that a lubrication can be introduced in the annulus, wherein one or more spacer element(s) (**7**) is/are arranged at the

inlet (6) for at least dividing the annulus up in several parts around the inlet.

[0055] Example 2: The marine drive unit (1) of example 1, wherein the spacer element (7) is arranged around the rotatable shaft (4).

[0056] Example 3: The marine drive unit (1) of example 1 or 2, wherein the spacer element (7) is projecting from the outer shaft face (5).

[0057] Example 4: The marine drive unit (1) of any of examples 1-3, wherein a first spacer element (7) is arranged on a first side of the inlet (6) and a second spacer element (7) is arranged on a second side of the inlet (6).

[0058] Example 5: The marine drive unit (1) of any of examples 1-4, wherein the spacer element (7) comprises a first ring (19) arranged on the first side of the inlet and a second ring (20) arranged on the second side of the inlet.

[0059] Example 6: The marine drive unit (1) of example 5, wherein the spacer element (7) comprises a base part (18) connecting the first ring and the second ring, the base part (18) is extending along and around the rotatable shaft (4).

[0060] Example 7: The marine drive unit of any of examples 1-6, wherein the spacer element (7) comprises a ring, a ridge, a protrusion (9) or similar.

[0061] Example 8: The marine drive unit (1) of any of examples 1-7, wherein the spacer element (7) is made of a metal, a composite, a polymeric, or any combination thereof.

[0062] Example 9: The marine drive unit (1) of example 7, wherein the ring, the ridge, the protrusion (9) is made of a polymeric material.

[0063] Example 10: The marine drive unit (1) of any of the examples 1-9, wherein a distance (d) between the housing face (3) and the spacer element (7) is smaller than 1 cm, preferably smaller than 0,5 cm, more preferably smaller than 0,3 cm.

[0064] Example 11: The marine drive unit (1) of any of the examples 1-10, wherein one or more bearings (10) is/are arranged in the annulus (A).

[0065] Example 12: The marine drive unit (1) of any of the examples 1-11, wherein the rotatable shaft (4) is hollow and has an inner shaft face (12) and a shaft wall (13) extending between the outer shaft face (5) and the inner shaft face (12).

[0066] Example 13: The marine drive unit (1) of example 12, wherein a second rotatable shaft (14) is arranged inside the hollow rotatable shaft (4), whereby a second annulus (A2) is defined between the inner shaft face (12) and a second outer face (15) of the second rotatable shaft.

[0067] Example 14: The marine drive unit (1) of example 13, wherein the shaft wall (13) comprising a second inlet (16), the second inlet (16) being arranged between the spacer elements (7), the second inlet (16) being in fluid communication with the second annulus (A2) so that the lubrication can be introduced in the second annulus.

[0068] Example 15: The marine drive unit (1) of example 14, wherein a plurality of second inlets (16) is ar-

ranged around a circumference of the rotatable shaft (4) between the spacer elements (7).

[0069] Example 16: The marine drive unit (1) of example 14 and/or 15, wherein one or more spacer element(s) (7) is/are arranged at the second inlet (16) for at least dividing the second annulus up in several parts around the second inlet.

[0070] Example 17: The marine drive unit (1) of any of the examples 13-16, wherein one or more bearings (10) is/are arranged in the second annulus (A2).

[0071] Example 18: The marine drive unit (1) of any of the examples 13-17, wherein the inlet (6) is in fluid communication with the second annulus (A2) via the second inlet (16).

[0072] Example 19: The marine drive unit (1) of any of the examples 12-18, wherein a fluid channel (17) is arranged in the shaft wall along an extension of the rotatable shaft (4).

[0073] Example 20: The marine drive unit (1) of example 19, wherein the fluid channel (17) is in fluid communication with the second inlet (16).

[0074] Example 21: The marine drive unit (1) of any of the examples 13-20, wherein the second rotatable shaft (14) is hollow and has a second inner shaft face and a second shaft wall extending between the second outer shaft face and the second inner shaft face.

[0075] Example 22: The marine drive unit (1) of example 21, wherein a third rotatable shaft is arranged inside the hollow second rotatable shaft, whereby a third annulus is defined between the second inner shaft face and a third outer shaft face of the third rotatable shaft.

[0076] Example 23: The marine drive unit (1) of example 22, wherein the second shaft wall comprising a third inlet, the third inlet being in fluid communication with the third annulus so that the lubrication can be introduced in the third annulus.

[0077] Example 24: The marine drive unit (1) of example 22, wherein one or more bearings is/are arranged in the third annulus.

[0078] Example 25: The marine drive unit (1) of any of the examples 22-24, wherein the inlet is in fluid communication with the third annulus via the second inlet and the third inlet.

[0079] Example 26: The marine drive unit (1) of any of the examples 21-25, wherein a second fluid channel is arranged in the second shaft wall along an extension of the second rotatable shaft.

[0080] Example 27: The marine drive unit (1) of example 26, wherein the second fluid channel is in fluid communication with the third inlet.

[0081] Example 28: The marine drive unit (1) of any of the examples 1-27, wherein the lubrication is oil.

[0082] Example 29: The marine drive unit (1) of any of the examples 1-28, wherein a pump (11) is in fluid communication with the inlet (6).

[0083] Example 30: The marine drive unit of example 29, wherein the pump is configured to supply a constant flow of lubrication to inlet, and/or a variable flow of lubri-

cation to the inlet.

[0084] Example 31: The marine drive unit **(1)** of any of the examples 1-30, further comprising a lubrication reservoir.

[0085] Example 32: The marine drive unit **(1)** of any of the examples 1-31, wherein the rotatable shaft **(4)** is connected with a propeller **(22)** and is providing rotation to the propeller **(22)**.

[0086] Example 33: The marine drive unit **(1)** of any of the examples 13-32, wherein the second rotatable shaft **(14)** is connected with a second propeller **(23)** and is providing rotation to the second propeller **(23)**.

[0087] Example 34: The marine drive unit **(1)** of example 33, wherein the propeller **(22)** and the second propeller **(23)** are arranged adjacent to each other.

[0088] Example 35: The marine drive unit **(1)** of example 33 or 34, wherein the propeller **(22)** and the second propeller **(23)** are counter-rotating.

[0089] Example 36: The marine drive unit **(1)** of any of the examples 22-35, wherein the third rotatable shaft is connected with a third propeller and is providing rotation to the third propeller.

[0090] Example 37: The marine drive unit **(1)** of example 36, wherein the propeller, the second propeller and the third propeller are arranged adjacent to each other.

[0091] Example 38: The marine drive unit **(1)** of example 36 or 37, wherein the propeller, the second propeller and the third propeller are counter-rotating.

[0092] Example 39: The marine drive unit **(1)** of any of the examples 32-38, wherein the one or more propellers **(22, 23)** are configured to push the marine vessel **(100)** in a forward motion of the marine vessel.

[0093] Example 40: The marine drive unit **(1)** of any of the examples 32-38, wherein the one or more propellers **(22, 23)** are configured to pull the marine vessel **(100)** in a forward motion of the marine vessel.

[0094] Example 41: A marine vessel **(100)** comprising the marine drive unit **(1)** of any of the examples 1-40.

[0095] Example 42: A lubrication method for lubricating a marine drive unit **(1)** of any of the examples 1-40, comprising

providing one or more spacer elements **(7)** at the inlet **(6)** for dividing the annulus **(A)** up in several parts around the inlet,
supplying a lubrication to the inlet,
building up a pressure in the lubrication at the inlet **(6)** by the one or more spacer elements function as a barrier,
utilizing the pressure to drive the lubrication towards any components being in fluid communication with the inlet **(6)**.

[0096] The terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting of the disclosure. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly in-

dicates otherwise. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including" when used herein specify the presence of stated features, integers, actions, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, actions, steps, operations, elements, components, and/or groups thereof.

[0097] It will be understood that, although the terms first, second, etc., may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element without departing from the scope of the present disclosure.

[0098] Relative terms such as "below" or "above" or "upper" or "lower" or "horizontal" or "vertical" may be used herein to describe a relationship of one element to another element as illustrated in the Figures. It will be understood that these terms and those discussed above are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element, or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

[0099] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. It will be further understood that terms used herein should be interpreted as having a meaning consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0100] It is to be understood that the present disclosure is not limited to the aspects described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the present disclosure and appended claims. In the drawings and specification, there have been disclosed aspects for purposes of illustration only and not for purposes of limitation, the scope of the disclosure being set forth in the following claims.

Claims

1. A marine drive unit **(1)** for a marine vessel **(100)**, comprising

a shaft housing **(2)** having a housing face **(3)**,

- a rotatable shaft (4) having an outer shaft face (5), the rotatable shaft (4) being rotatable arranged within the shaft housing (2) whereby an annulus (A) is defined between the housing face (3) and the outer shaft face (5),
the shaft housing (2) comprising an inlet (6) being in fluid communication with the annulus (A) so that a lubrication can be introduced in the annulus,
wherein one or more spacer element(s) (7) is/are arranged at the inlet (6) for at least dividing the annulus up in several parts around the inlet.
2. The marine drive unit (1) of claim 1, wherein the spacer element (7) is arranged around the rotatable shaft (4).
 3. The marine drive unit (1) of claim 1 or 2, wherein the spacer element (7) is projecting from the outer shaft face (5).
 4. The marine drive unit (1) of any of claims 1-3, wherein a first spacer element (7) is arranged on a first side of the inlet (6) and a second spacer element (7) is arranged on a second side of the inlet (6).
 5. The marine drive unit (1) of any of claims 1-4, wherein the spacer element (7) comprises a first ring (19) arranged on the first side of the inlet and a second ring (20) arranged on the second side of the inlet.
 6. The marine drive unit (1) of any of the claims 1-5, wherein the rotatable shaft (4) is hollow and has an inner shaft face (12) and a shaft wall (13) extending between the outer shaft face (5) and the inner shaft face (12).
 7. The marine drive unit (1) of claim 6, wherein a second rotatable shaft (14) is arranged inside the hollow rotatable shaft (4), whereby a second annulus (A2) is defined between the inner shaft face (12) and a second outer face (15) of the second rotatable shaft.
 8. The marine drive unit (1) of claim 7, wherein the shaft wall (13) comprising a second inlet (16), the second inlet (16) being arranged between the spacer elements (7), the second inlet (16) being in fluid communication with the second annulus (A2) so that the lubrication can be introduced in the second annulus.
 9. The marine drive unit (1) of claim 8, wherein a plurality of second inlets (16) is arranged around a circumference of the rotatable shaft (4) between the spacer elements (7).
 10. The marine drive unit (1) of claim 8 and/or 9, wherein one or more spacer element(s) (7) is/are arranged at the second inlet (16) for at least dividing the second annulus up in several parts around the second inlet.
 11. The marine drive unit (1) of any of the claims 6-10, wherein the inlet (6) is in fluid communication with the second annulus (A2) via the second inlet (16).
 12. The marine drive unit (1) of any of the claims 1-11, wherein the rotatable shaft (4) is connected with a propeller (22) and is providing rotation to the propeller (22).
 13. The marine drive unit (1) of any of the claims 7-12, wherein the second rotatable shaft (14) is connected with a second propeller (23) and is providing rotation to the second propeller (23).
 14. A marine vessel (100) comprising the marine drive unit (1) of any of the claims 1-13.
 15. A lubrication method for lubricating a marine drive unit (1) of any of the claims 1-13, comprising providing one or more spacer elements (7) at the inlet (6) for dividing the annulus (A) up in several parts around the inlet, supplying a lubrication to the inlet, building up a pressure in the lubrication at the inlet (6) by the one or more spacer elements function as a barrier, utilizing the pressure to drive the lubrication towards any components being in fluid communication with the inlet (6).
- Amended claims in accordance with Rule 137(2) EPC.**
1. A marine drive unit (1) for a marine vessel (100), comprising a shaft housing (2) having a housing face (3),
a rotatable shaft (4) having an outer shaft face (5), the rotatable shaft (4) being rotatable arranged within the shaft housing (2) whereby an annulus (A) is defined between the housing face (3) and the outer shaft face (5),
the shaft housing (2) comprising an inlet (6) being in fluid communication with the annulus (A) so that a lubrication can be introduced in the annulus,
wherein one or more spacer element(s) (7) is/are arranged at the inlet (6) for at least dividing the annulus up in several parts around the inlet, the spacer element (7) comprises a protrusion (9) or similar.
 2. The marine drive unit (1) of claim 1, wherein the spacer element (7) is arranged around the rotatable

shaft (4).

3. The marine drive unit (1) of claim 1 or 2, wherein the spacer element (7) is projecting from the outer shaft face (5). 5
4. The marine drive unit (1) of any of claims 1-3, wherein a first spacer element (7) is arranged on a first side of the inlet (6) and a second spacer element (7) is arranged on a second side of the inlet (6). 10
5. The marine drive unit (1) of any of claims 1-4, wherein the spacer element (7) comprises a first ring (19) arranged on the first side of the inlet and a second ring (20) arranged on the second side of the inlet. 15
6. The marine drive unit (1) of any of the claims 1-5, wherein the rotatable shaft (4) is hollow and has an inner shaft face (12) and a shaft wall (13) extending between the outer shaft face (5) and the inner shaft face (12). 20
7. The marine drive unit (1) of claim 6, wherein a second rotatable shaft (14) is arranged inside the hollow rotatable shaft (4), whereby a second annulus (A2) is defined between the inner shaft face (12) and a second outer face (15) of the second rotatable shaft. 25
8. The marine drive unit (1) of claim 7, wherein the shaft wall (13) comprising a second inlet (16), the second inlet (16) being arranged between the spacer elements (7), the second inlet (16) being in fluid communication with the second annulus (A2) so that the lubrication can be introduced in the second annulus. 30 35
9. The marine drive unit (1) of claim 8, wherein a plurality of second inlets (16) is arranged around a circumference of the rotatable shaft (4) between the spacer elements (7). 40
10. The marine drive unit (1) of claim 8 and/or 9, wherein one or more spacer element(s) (7) is/are arranged at the second inlet (16) for at least dividing the second annulus up in several parts around the second inlet. 45
11. The marine drive unit (1) of any of the claims 6-10, wherein the inlet (6) is in fluid communication with the second annulus (A2) via the second inlet (16). 50
12. The marine drive unit (1) of any of the claims 1-11, wherein the rotatable shaft (4) is connected with a propeller (22) and is providing rotation to the propeller (22). 55
13. The marine drive unit (1) of any of the claims 7-12, wherein the second rotatable shaft (14) is connected with a second propeller (23) and is providing rotation

to the second propeller (23).

14. A marine vessel (100) comprising the marine drive unit (1) of any of the claims 1-13.
15. A lubrication method for lubricating a marine drive unit (1) of any of the claims 1-13, comprising
 - providing one or more spacer elements (7) at the inlet (6) for dividing the annulus (A) up in several parts around the inlet,
 - supplying a lubrication to the inlet,
 - building up a pressure in the lubrication at the inlet (6) by the one or more spacer elements function as a barrier,
 - utilizing the pressure to drive the lubrication towards any components being in fluid communication with the inlet (6).

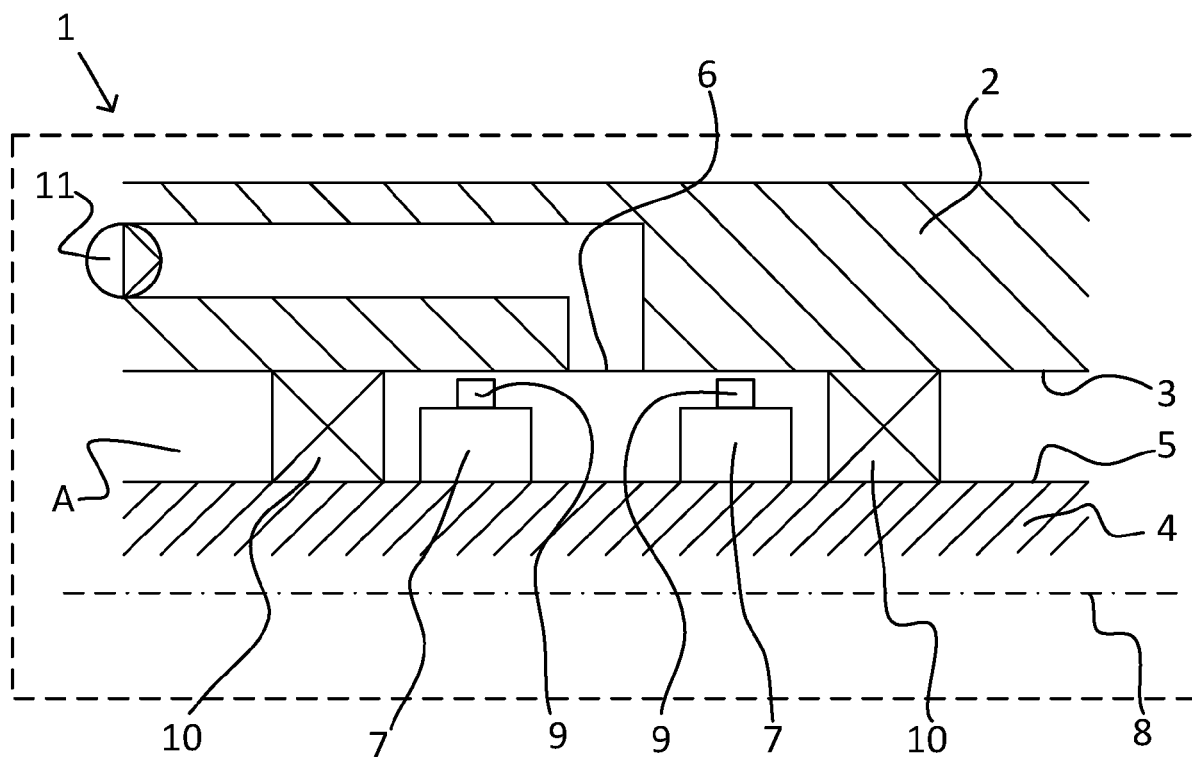


FIG. 1

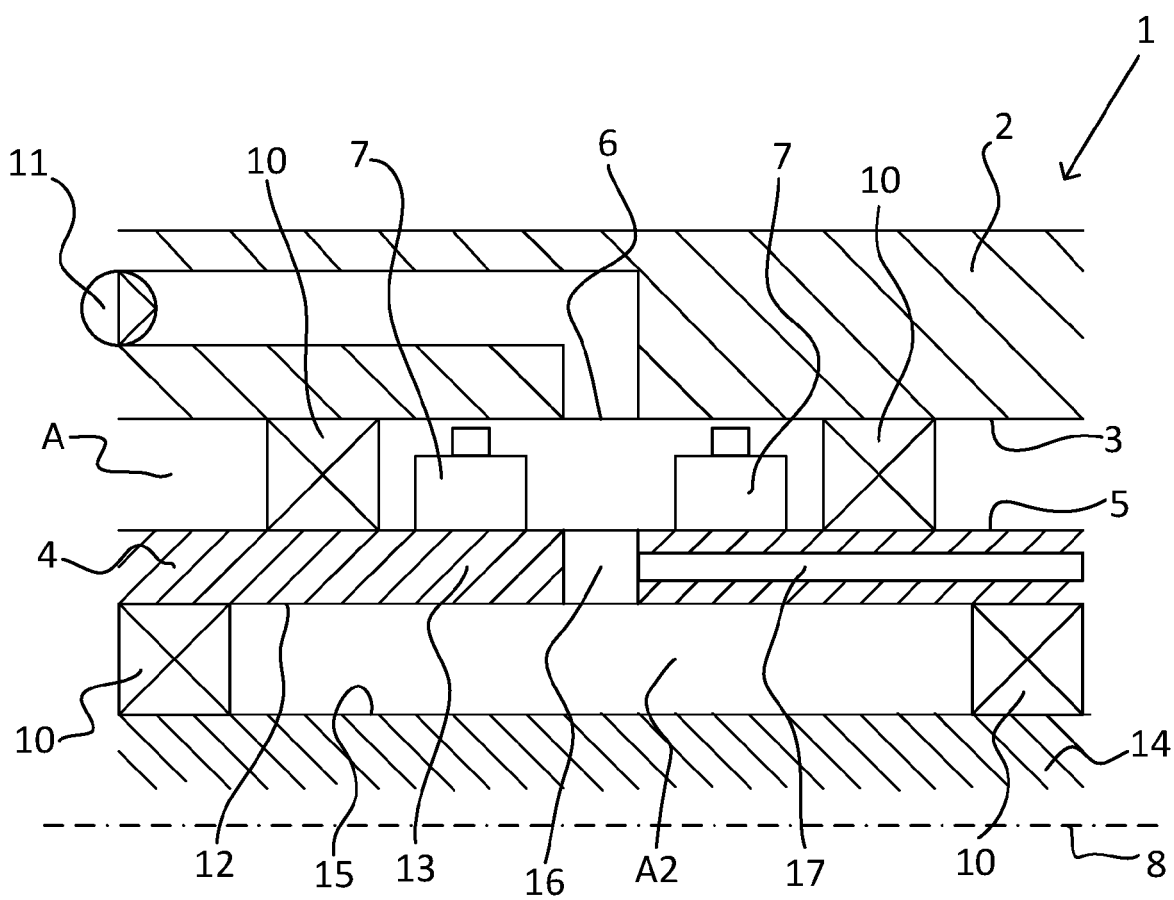


FIG. 2

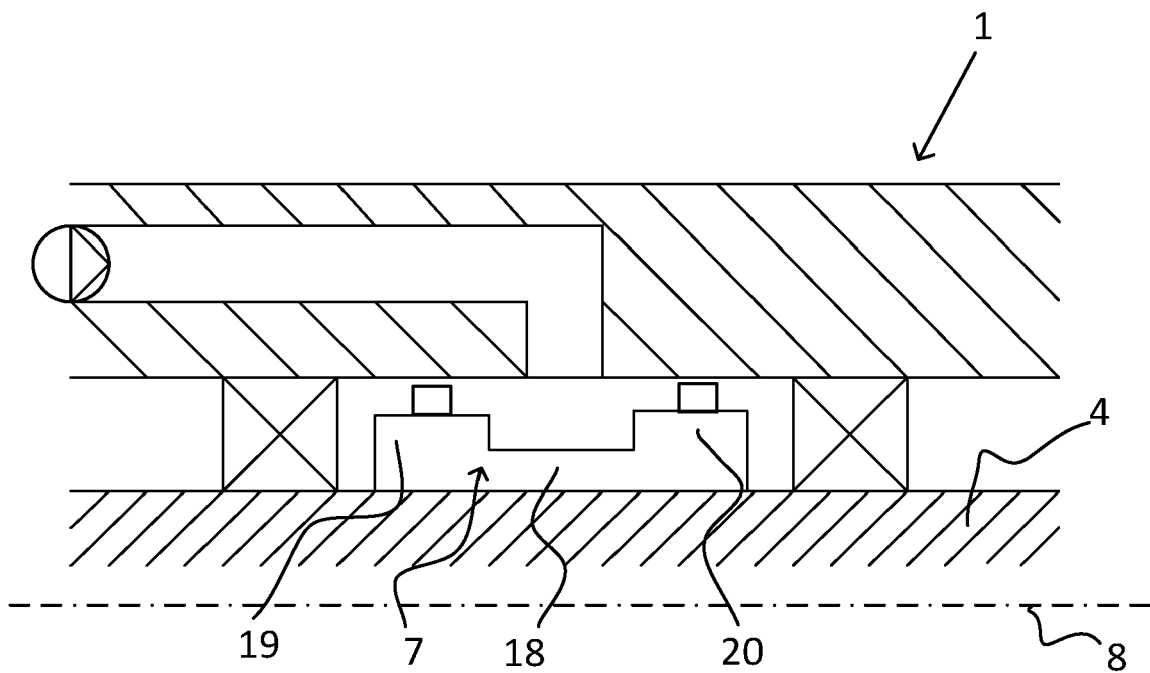


FIG. 3

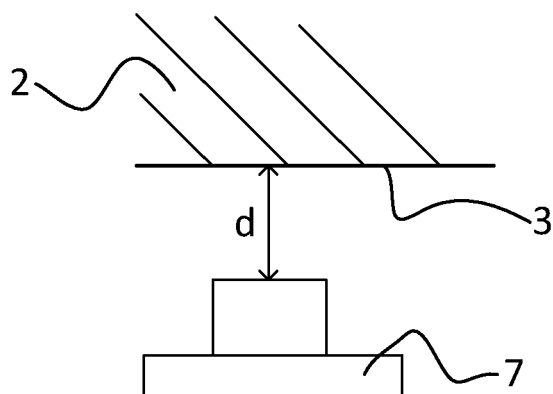


FIG. 4

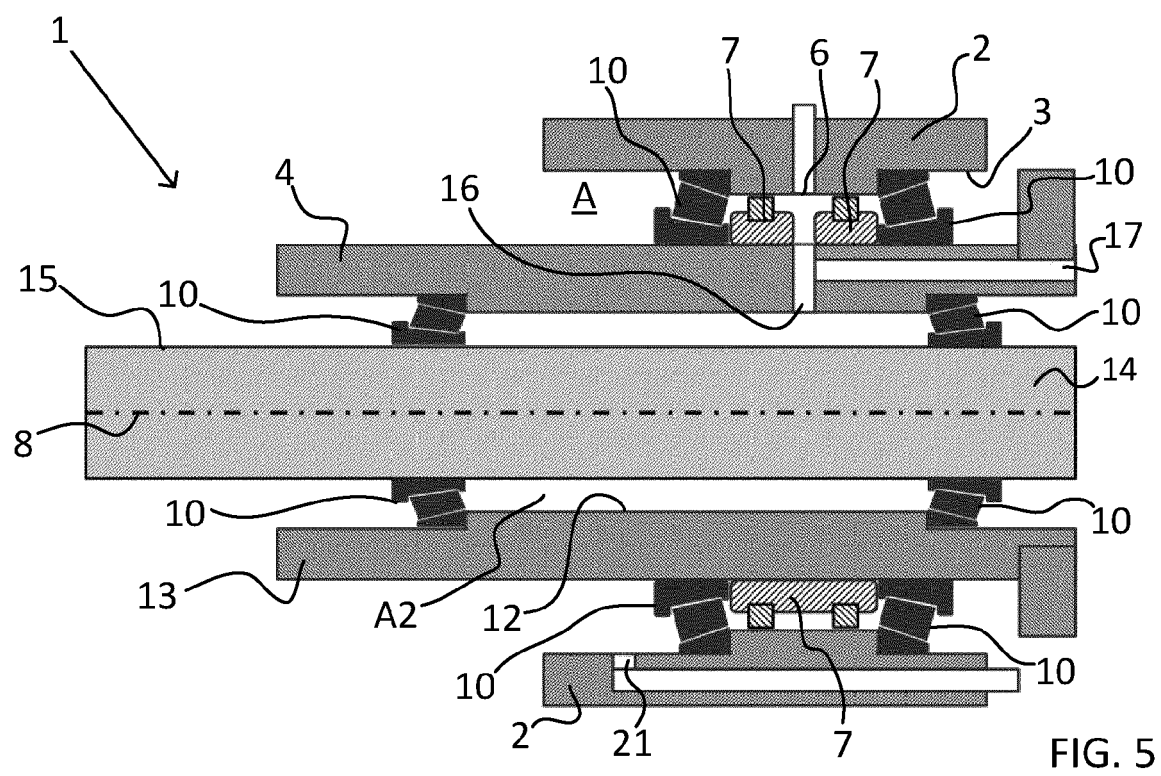


FIG. 5

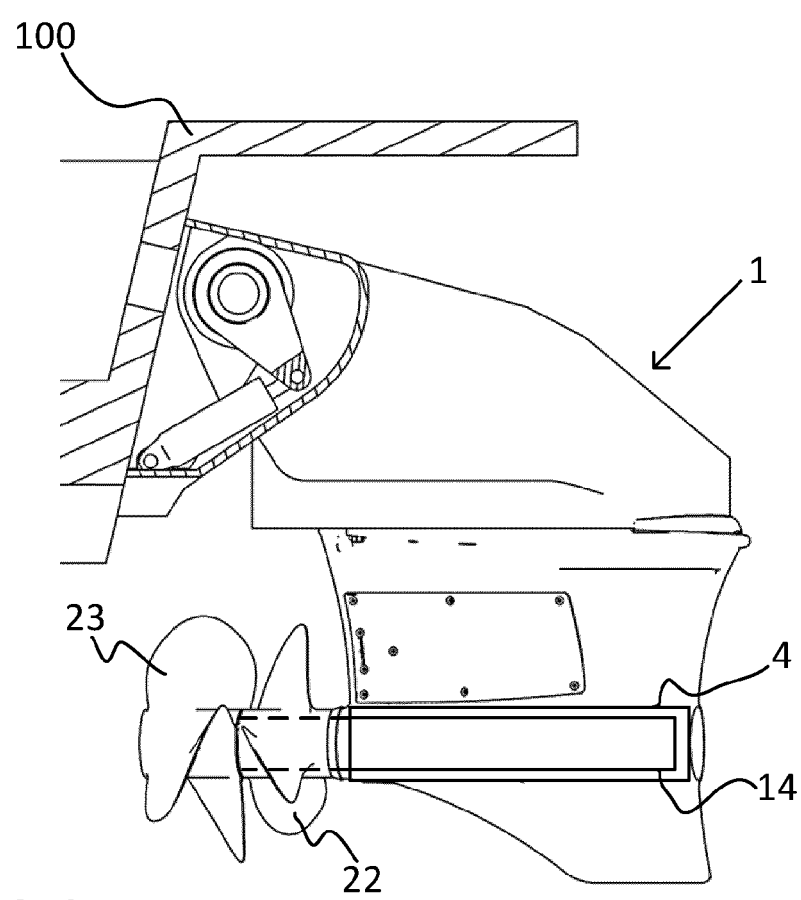


FIG. 6

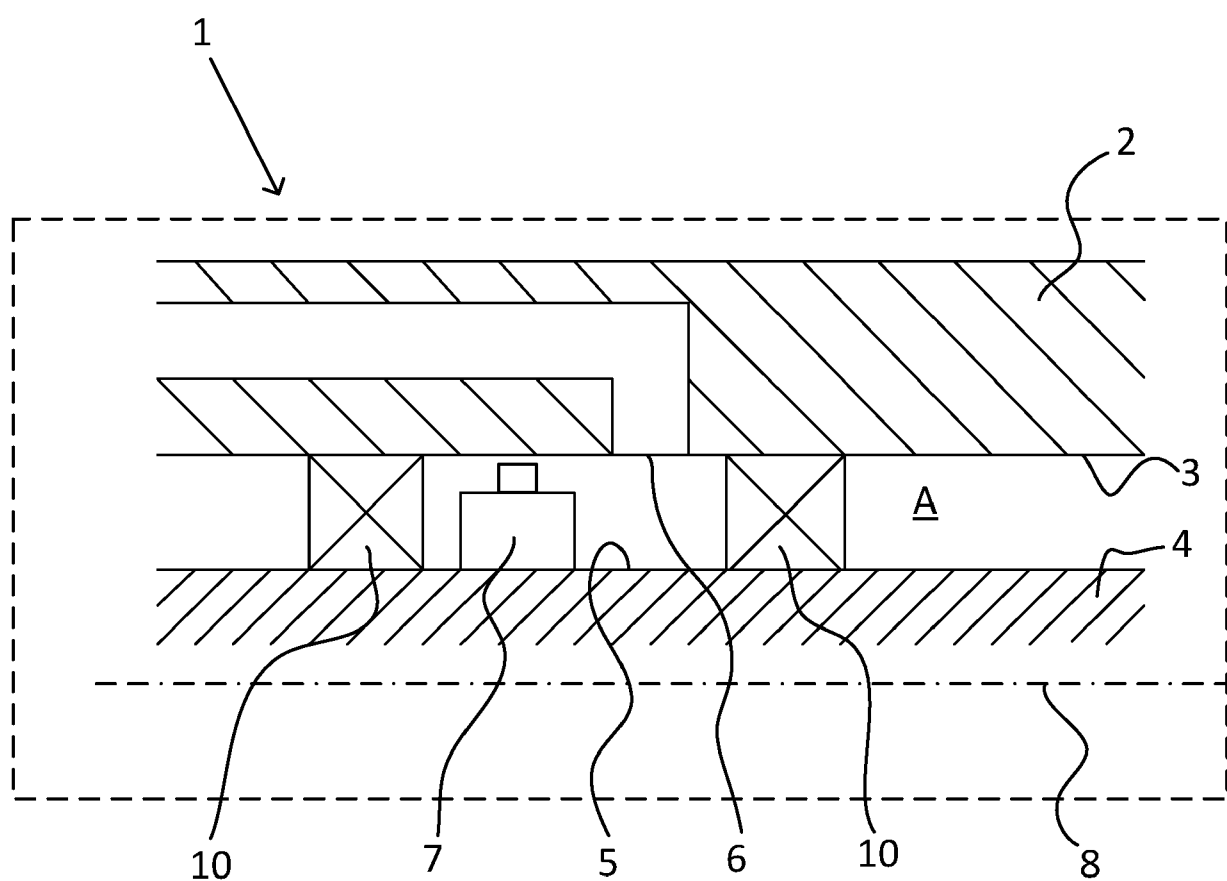


FIG. 7



EUROPEAN SEARCH REPORT

Application Number

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The Hague		30 January 2025	Harder, Sebastian
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