

Claims

- 5 1. A catheter device (1), comprising:
- a rotor (2,2') located at the distal end region (8) of the catheter device (1);
 - a drive shaft (4) extending from a driving region (16) of the catheter device (1) to the distal end region (8) of the catheter device (1);
 - distally of the rotor, a distal bearing (9) for bearing a distal end of the drive shaft (4), the distal bearing (9) comprising a polymer end part (10); and
- 10 wherein
- the distal bearing (9) comprises a heat conducting part (13) configured to enable heat transfer away from the distal bearing (9) and/or wherein the distal bearing (9) comprises a spiral sleeve (14) with a winding, configured for rotatably mounting the distal end of the drive shaft (4) inside the spiral sleeve (14).
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- 20 2. A catheter device according to claim 1, characterized in that the heat conducting part (13) extends out of the polymer end part.
3. A catheter device according to one of claims 1 or 2, characterized in that the heat conducting part (13) is designed as a tube surrounding the drive shaft.
- 25 4. A catheter device (1) according to one of claims 1 to 3, characterized in that the drive shaft (4) comprises a cavity extending axially with the drive shaft and wherein the drive shaft comprises a plurality of coaxial windings which run spirally around the cavity of the drive shaft, the windings within different coaxial layers having opposite winding directions and in that the outer diameter of the drive shaft lies in a range of 0.4 mm to 2 mm, preferably comprising a reinforcement element
- 30 which is provided sectionally in the cavity of the drive shaft (4) in the distal end region.

5. A catheter device (1) according to one of claims 1 to 4, characterized in that the heat conducting part (13) extends out of the distal bearing (9), into an area which is configured to be brought in contact with a fluid, enabling heat transfer from the distal bearing (9) to the fluid.
- 5 6. A catheter device (1) according to one of claims 1 to 5, characterized in that the distal bearing (9) comprises the polymer end part, the polymer end part (10) comprising a region which is designed as a pigtail (10.2).
- 10 7. A catheter device (1) according to one of claims 1 to 6, characterized in that the heat conducting part (13) is made of a medical grade stainless steel, preferably made of 1.4441 stainless steel.
- 15 8. A catheter device (1) according to one of claims 1 to 7, characterized in that an inner diameter of the heat conducting part (13) designed as a tube is between 0.5 mm and 2.6 mm and/or in that the heat conducting part (13) has a thickness between 0.05 mm and 0.5 mm.
- 20 9. A catheter device (1) according to one of claims 1 to 8, characterized in that the spiral sleeve (14) with a winding is arranged within the distal bearing (9), for rotatably mounting the distal end of the drive shaft (4) inside the spiral sleeve (14), such that the spiral sleeve (14) lies at least in part inside the heat conducting part (13) designed as a tube and/or such that a portion of the spiral sleeve (14) is in direct contact with a portion of the inner side (13') of the heat conducting part (13)
- 25 10. A catheter device (1) according to one of claims 1 to 9, characterized in that a spiral sleeve (14) with a winding is arranged within the distal bearing (9), for rotatably mounting the distal end of the drive shaft (4) inside the spiral sleeve (14), such that a portion of the spiral sleeve (14) and a portion of the heat conducting part (13) are only separated by a thin flexible tube (12,12') which is provided around a portion of the outside of the spiral sleeve, wherein the flexible tube (12,12') is preferably designed as a shrink hose.
- 30 11. A catheter device (1) according to claim 1 to 10, characterized in that

the spiral sleeve (14) is made of flat tape (14.1).

12. A catheter device (1) according to one of claims 1 to 11, characterized in that a portion of the outer side (13'') of the heat conducting part (13) which is configured to be brought in contact with the fluid is smooth, preferably with a ten-point mean roughness of $R_z \leq 1.2 \mu\text{m}$, and in that an inner side (13') of the heat conducting part (13) is rough to facilitate gluing the spiral sleeve (14) to the inner side (13') of the heat conducting part (13), the inner side (13') of the heat conducting part or tube (13) preferably having an arithmetic average surface roughness of $R_a \geq 0.8 \mu\text{m}$.
13. A catheter device (1) according to claim 12, characterized in that a further portion of the outer side (13'') of the heat conducting part or tube (13), which is configured to lie inside the polymer end part (10), is roughened, preferably having an arithmetic average surface roughness of $R_a \geq 0.8 \mu\text{m}$.
14. A catheter device (1) according to one of claims 1 to 13, characterized in that both ends of the spiral sleeve (14) are face ground and all edges of both ends are rounded and smooth, preferably with a ten-point mean roughness of $R_z \leq 2 \mu\text{m}$.
15. A catheter device (1) according to one of claims 1 to 14, characterized in that an inner diameter of the spiral sleeve (14) is between 0.4 mm and 2.1 mm, and in that the spiral sleeve has a thickness between 0.05 mm to 0.4 mm.
16. A catheter device (1) according to one of claims 1 to 15, wherein the rotor (2) and the drive shaft (4) are configured to rotate in a rotating direction (4.1) such that a flow of fluid in a proximal direction is effected, if the catheter device (1) is brought in contact with a fluid, characterized in that, when looking along the drive shaft towards a distal end of the drive shaft, the winding direction of the spiral sleeve (14) from a proximal end of the spiral sleeve (14) to a distal end of the spiral sleeve (14), is the opposite direction of the rotating direction (4.1) of the ro-

tor (2) and the drive shaft (4), when looking along the drive shaft (4) towards a distal end of the drive shaft (4).

- 5 17. A catheter device (1) according to one of claims 1 to 16, characterized in that the spiral sleeve (14) is made out of MP35N®, 35NLT®, or ceramics.
- 10 18. A catheter device (1) according to one of claims 1 to 17, designed as an expandable pump, characterized in that a cannula (15) is provided around a portion of the drive shaft which lies in the vicinity of the rotor (2) and in that the rotor (2) is located in a housing (3), the housing (3) and the rotor (2) being configured to be transferred at least in part into the cannula (15), wherein the housing (3) and the rotor (2) are compressed at least along a radial direction extending transversely to a longitudinal direction, from an expanded state into a compressed state.
- 15 19. A catheter device (1) according to claim 18, wherein, upon application of a force at the proximal end of the catheter and/or compression of the housing (3) and the rotor (2), a relative motion of the drive shaft (4) with respect to the distal bearing (9) is effected, and wherein the drive shaft (4) and the distal bearing (9) are configured such that the distal end of the drive shaft (4) remains within the distal bearing (9) or within the heat conducting part (13) designed as a tube or within the spiral sleeve (14) when the housing (3) and the rotor (2) are compressed.

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- 25 20. A catheter (1) device according to one of claims 1 to 19, characterized in that a hub (2.1) pertaining to the rotor (2) extends less than 0.5 mm past the rotor blades (2.2) towards the distal end of the catheter device, preferably less than 0.1 mm.
- 30 21. A catheter device according to one of claims 1 to 20, characterized in that a flexible tube (12, 12') is provided around a portion of the outside of the spiral sleeve, wherein the flexible tube is preferably designed as a shrink hose.

22. A catheter device (1) according to one of claims 1 to 21, characterized in that the spiral sleeve (14) and/or the flexible tube (12,12') according to claim 20 is at least in part in contact with a heat conducting part (13), the heat conducting part (13) being configured to enable heat transfer away from the distal bearing (9) and/or the spiral sleeve (14).
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