Claims

1. A device (60) for cleaning of surfaces submerged in water, comprising a disk member (80) rotatably supported by a spindle (67) and configured for rotation about a rotational axis (r) by drive means (63); said disk member having a first side (80a) which is facing said surface when the device is in use, and a second side (80b) facing away from the surface, and where the disk member further comprises a plurality of nozzles (82) for discharging liquid under pressure against the surface to be cleaned; said nozzles being fluidly connected to a liquid reservoir via a first conduit (81) in the disk member and a second conduit (69) in the spindle (67), **characterized in that**
the disk member (80) comprises a plurality of through holes (83), spaced at regular intervals and arranged symmetrically with respect to the rotational axis.

2. The device of claim 1, further comprising a plurality of ridges (84) arranged at regular intervals on the first side (80a) and extending radially.

3. The device of claim 2, wherein successive ridges (84) alternating extend to a respective one of said through holes (83) and between adjacent through holes.

4. The device of claim 2 or 3, wherein the height of each ridge is decreasing radially, from a maximum height near the disk central portion, to a minimum height in a disk peripheral portion.

5. The device of any one of the preceding claims, wherein the first side (80a) comprises a concave portion (85), symmetrically with the rotational axis.

6. The device of any one of the preceding claims, wherein the through holes (83) are circular and have bores that are substantially parallel with the disk rotational axis.

7. The device of any one of claims 1 – 5, wherein the through holes (88) are circular and have bores that are slant with respect to the disk rotational axis.

8. The device of any one of claims 1 – 6 or claim 7, wherein each through hole (83; 88) further comprises a vane (87) rotatably supported in the hole and arranged radially in the disk member.

9. The device of any one of the preceding claims, wherein the nozzles (82) are arranged at regular intervals around the disk member periphery and arranged for discharging liquid in a radial direction and towards said surface to be cleaned.

10. The device of any one of the preceding claims, wherein the second conduit (69) in the spindle (67) is concentric with the rotational axis (r).

11. The device of any one of the preceding claims, wherein the disk member (80) is rotatably supported in a housing (62), thus defining a cavity (70) between the second side (80b) and the housing interior.

12. The device of claim 11, wherein the housing (62) further comprises at least one liquid discharge opening (65).

13. The device of any one of the preceding claims, wherein the drive means is configured for rotating the disk member at a speed in the range 200 rpm to 800 rpm.

14. The device of any one of the preceding claims, wherein, when the device is in operation, liquid is supplied to the nozzles (82) at a pressure in the range of 50 bar to 450 bar.

15. A cleaning apparatus (40), **characterized by** a plurality of cleaning devices (60) as set out by any one of claims 1 – 14; each cleaning device (60) being connected to a central unit (41) comprising at least one liquid intake opening (45) and a liquid return opening (42); each liquid intake opening (45) being fluidly connected to a respective liquid discharge opening (65); and the liquid return opening being fluidly connected to liquid reservoir.

16. The cleaning apparatus of claim 15, wherein the cleaning devices are connected via hinge means (64) to respective side faces of the central unit (41), and the central unit further comprises a pump means which is fluidly connected to the at least one liquid intake openings (45) and to the liquid return opening (42).

17. The cleaning apparatus of claim 15 or claim 16, wherein each of the cleaning devices (60) comprise rotatable support means (61) arranged and configured for supporting each of the cleaning devices a distance from the surface to be cleaned.

18. The cleaning device of claim 17, wherein the distance is approximately 12 millimetres.

19. An underwater vehicle (1), having a roll axis (x), a pitch axis (y), and a yaw axis (z), all of said axes intersecting the vehicle's centre of gravity (CG); the vehicle comprising propulsion means (2, 3) and buoyancy means (9, 11), **characterized by**
at least one pair of trimming means (10a,b; 12a,b), where the elements of each pair are arranged on opposite sides of the centre of gravity (CG); each said trimming means (10a,b, 12a,b) comprising a movable mass (15) and a displacement region (19) into which the mass can move, whereby the trimming means' individual centre of gravity is automatically shifted when the vehicle is accelerating or changes its orientation in the water.

20. The underwater vehicle of claim 19, wherein the trimming means of the first pair (10a,b) are arranged in a plane which is parallel with the vehicle's y-z plane, and a distance away from the centre of gravity (CG); and the trimming means of the second pair (12a,b) are arranged in the x-y plane and along the x axis.

21. The underwater vehicle of claim 19 or claim 20, wherein first buoyancy means (9) are arranged on a first external side (5a) of the vehicle and second buoyancy means (11) are arranged on a second external side (5b) of the vehicle, on the opposite side of side first side.

22. The underwater vehicle of any one of claims 19 – 21, wherein each of the trimming means (10a,b, 12a,b) comprise closed and mutually isolated compartments, each such compartment being partly filled with a substance (15) having a specific gravity greater than one.

23. The underwater vehicle of claim 22, wherein the substance comprises a liquid, such as mercury.

24. The underwater vehicle of claim 22, wherein the substance comprises a powder.

25. The underwater vehicle of any one of claims 20 – 24, wherein the first trimming means (10a,b) comprise tubular elements (10a,b), each element extending substantially the width of the vehicle.

26. The underwater vehicle of claim 25, wherein each first trimming means comprises two slanted regions (17) interconnected by a level central region (16).

27. The underwater vehicle of claim 26, wherein the displacement region (19) is in the slanted region (17).

28. The underwater vehicle of any one of claims 20 – 27, wherein the first trimming means (10a,b) are arranged in region of the second buoyancy means (11).

29. The underwater vehicle of any one of claims 20 – 27, wherein the second trimming means (12a,b) are arranged on opposite sides of the centre of gravity, and concentric with the x axis.

30. The underwater vehicle of any one of claims 19 – 29, wherein the vehicle is a neutrally buoyant ROV.

31. The underwater vehicle of any one of claims 19 – 30, further comprising at least one cleaning device (60) as set out by any one of claims 1 – 14.

32. The underwater vehicle of any one of claims 19 – 30, further comprising a cleaning apparatus (40) as set out by any one of claims 15 – 18.

Claims

1. A remotely operated underwater vehicle (1) for carrying cleaning devices for cleaning of surfaces submerged in water,
the underwater vehicle (1) having
a roll axis (x), a pitch axis (y) and a yaw axis (z),
all of said axes intersecting the vehicle's centre of gravity (CG);
characterized in that
the underwater vehicle (1) comprising a first side (5a), a second side (5b), propulsion means (2, 3), at least one pair of trimming means (10a,b; 12a,b), a first buoyancy means (9) attached to the first side (5a) and a second buoyancy means (11) attached to the second side (5b),
wherein the elements of each pair are arranged on opposite sides of the centre of gravity (CG) and each said trimming means (10a,b, 12a,b) comprising a movable mass (15) and a displacement region (19) into which the mass can move, whereby the trimming means' individual centre of gravity is automatically shifted due to gravity and inertia when the vehicle is accelerating or changes its orientation in the water, and
wherein the first buoyancy means (9) provides more buoyancy than the second buoyancy means (11) such that the centre of buoyancy is located above the centre of gravity (CG) irrespective of the orientation and attitude of the underwater vehicle (1).

2. The underwater vehicle of claim 1, wherein the trimming means of the first pair (10a,b) are arranged in a plane which is parallel with the vehicle's y-z plane, and a distance away from the centre of gravity (CG); and the trimming means of the second pair (12a,b) are arranged in the x-y plane and along the x axis.

3. The underwater vehicle of claim 1 or claim 2, wherein first buoyancy means (9) are arranged on a first external side (5a) of the vehicle and second buoyancy means (11) are arranged on a second external side (5b) of the vehicle, on the opposite side of side first side.

4. The underwater vehicle of any one of claims 1 – 3, wherein each of the trimming means (10a,b, 12a,b) comprise closed and mutually isolated

compartments, each such compartment being partly filled with a substance (15) having a specific gravity greater than one.

5. The underwater vehicle of claim 4, wherein the substance comprises a liquid, such as mercury.

6. The underwater vehicle of claim 4, wherein the substance comprises a powder.

7. The underwater vehicle of any one of claims 2 – 6, wherein the first trimming means (10a,b) comprise tubular elements (10a,b), each element extending substantially the width of the vehicle.

8. The underwater vehicle of claim 7, wherein each first trimming means comprises two slanted regions (17) interconnected by a level central region (16).

9. The underwater vehicle of claim 8, wherein the displacement region (19) is in the slanted region (17).

10. The underwater vehicle of any one of claims 2 – 9, wherein the first trimming means (10a,b) are arranged in region of the second buoyancy means (11).

11. The underwater vehicle of any one of claims 2 – 9, wherein the second trimming means (12a,b) are arranged on opposite sides of the centre of gravity, and concentric with the x axis.

12. The underwater vehicle of any one of claims 1 – 11, wherein the vehicle is a neutrally buoyant ROV.

13. The underwater vehicle of any one of claims 1-12, wherein the first and second buoyancy means (9,11) is configured to make the underwater vehicle (1) neutrally buoyant in water during use.

14. The underwater vehicle of any one of claims 1 – 13, further comprising at least one cleaning device (60) for cleaning surfaced submerged in water, the device comprising a disk member (80) rotatably supported by a spindle (67) and configured for rotation about a rotational axis (r) by drive means (63);

said disk member having a first side (80a) which is facing said surface when the device is in use, and a second side (80b) facing away from the surface, wherein the disk member further comprises

a plurality of nozzles (82) for discharging liquid under pressure against the surface to be cleaned; said nozzles being fluidly connected to a liquid reservoir via a first conduit (81) in the disk member and a second conduit (69) in the spindle (67) and

a plurality of through holes (83), spaced at regular intervals and arranged symmetrically with respect to the rotational axis.

15. The underwater vehicle of any one of claims 14, further comprising a cleaning apparatus (40) having a plurality devices (60); each cleaning device (60) being connected to a central unit (41) comprising at least one liquid intake opening (45) and a liquid return opening (42); each liquid intake opening (45) being fluidly connected to a respective liquid discharge opening (65); and the liquid return opening being fluidly connected to liquid reservoir.