Summary of the Invention

In accordance with a first aspect of the present invention, there is provided a cleaning head for cleaning a submerged surface, the cleaning head comprising:

a body portion;

a skirt portion extending around a periphery of the body portion, the skirt portion performing a sealing function between the body portion and a submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use;

at least one cleaning member for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface during use and the cleaning member moves relative to the submerged surface; and

at least one suction aperture in fluid communication with a space defined between the body portion and the submerged surface during use;

wherein during use when the cleaning head is disposed on the submerged surface and the at least one suction aperture is connected in fluid communication with a device for generating a negative pressure, material separated from the submerged surface by the at least one cleaning member is drawn away from the cleaning head through the suction aperture;

wherein at least one cleaning member comprises at least one cleaning element arranged to generate a fluid current adjacent the submerged surface when the cleaning element moves relative to but substantially does not touch the submerged surface during use, the fluid current causing material to separate from the submerged surface.~~cleaning system for cleaning a submerged surface, the cleaning system comprising:~~

~~a cleaning head having:~~

~~a body portion;~~

~~a skirt portion extending around a periphery of the body portion, the skirt portion performing a sealing~~

~~function between the body portion and a submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use; and~~

~~at least one cleaning member for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface during use;~~

~~a device for generating a negative pressure; and~~

~~a suction pipe extending between said device and the cleaning head, the suction pipe being in fluid communication with a space defined between the body portion and the submerged surface during use;~~

~~wherein during use when the cleaning head is disposed on the submerged surface, material separated from the submerged surface is drawn away from the cleaning head through the suction pipe.~~

In an embodiment, the body portion comprises a plurality of body portion sections moveably connected together.

In an embodiment, the body portion comprises first and second body portions moveably connected together.

In an embodiment, the first and second body portions are moveably connected together using a hinge.

rotatable blade arranged to scrape material from the submerged surface during use.

~~In an embodiment, at least one cleaning member comprises at least one cleaning element arranged to generate a fluid current adjacent the submerged surface when the cleaning element moves relative to the submerged surface during use, the fluid current causing material to be released from the submerged surface.~~

In an embodiment, at least one cleaning element includes a foot portion disposed at a first side of the cleaning element facing towards the direction of movement of the cleaning element during use, and a cut out portion disposed at a second side of the cleaning element facing away from the direction of movement of the cleaning element during use.

In an embodiment, the foot portion is substantially wedge shaped.

In an embodiment, the wedge shape tapers at an angle of approximately 45°.

In an embodiment, the shape of the cut out portion is substantially the same as the shape of the foot portion.

In an embodiment, each cleaning element is arranged to rotate such that the cut out portion follows the rotational path defined by the foot portion.

In an embodiment, the cleaning head comprises at least one motor arranged to cause the or each cleaning member to rotate.

In an embodiment, the at least one motor comprises at least one hydraulic motor.

In an embodiment, the disc portion includes a central aperture and the hollow raised section is disposed adjacent and in fluid communication with the central aperture.

In an embodiment, the impeller is resiliently connected to the cleaning member.

In an embodiment, the cleaning head comprises a safety mechanism arranged to cease operation of the cleaning head if an operator becomes incapacitated or is otherwise unable to operate the cleaning head.

~~In accordance with a second aspect of the present invention, there is provided~~Also disclosed is a cleaning system for cleaning a submerged surface, the cleaning system comprising:

a cleaning head according to the first aspect of the invention;

a device for generating a negative pressure; and

a suction pipe extending between said device and the cleaning head, the suction pipe being in fluid communication with a space defined between the body portion and the submerged surface during use;

wherein during use when the cleaning head is disposed on the submerged surface, material separated from the submerged surface is drawn away from the cleaning head through the suction pipe.

In an embodiment, the device for generating a negative pressure comprises a suction pump.

In an embodiment, the cleaning system comprises an auxiliary cleaning head connectable to the suction pump and manually operable by an operator.

In an embodiment, the system comprises a separation device arranged to receive a slurry of water and material separated from the submerged surface and to separate the water and material from the slurry.

In an embodiment, the system comprises a disinfection device arranged to substantially disinfect water that has been separated from the slurry.

In an embodiment, the system comprises a cleaning enclosure including at least one transparent wall portion, at least one aperture, a sealing device associated with each aperture, and a suction aperture in fluid communication with a space defined by the enclosure, wherein a cleaning device is disposable through the aperture and the sealing device such that the cleaning device forms a substantially sealed relationship with the aperture.

In accordance with a second~~third~~ aspect of the present invention, there is provided method of cleaning a submerged surface, the method comprising:

providing a cleaning head having:

a body portion;

a skirt portion extending around a periphery of the body portion; and

at least one cleaning member having at least one cleaning element for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface and the at least one cleaning element moves relative to the submerged surface;

disposing the cleaning head on the submerged surface such that the skirt portion contacts the submerged surface and performs a sealing function between the body portion and the submerged surface;

connecting a space defined between the body portion and the submerged surface in fluid communication with a device for generating a negative pressure;

activating said device and the at least one cleaning member so that material is separated from the submerged surface and is drawn away from the cleaning head;

wherein the at least one cleaning element is arranged to generate a fluid current adjacent the submerged surface when the cleaning element moves relative to but substantially does not touch the submerged surface during use, the fluid current causing material to separate from the submerged surface.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of a marine cleaning system in accordance with an embodiment of the present invention;

Figure 2 is a diagrammatic upper perspective view of a cleaning head in accordance with an embodiment of the present invention;

Figure 3 is a diagrammatic lower perspective view of the cleaning head shown in Figure 2;

Figure 4 is a diagrammatic plan view of an alternative cleaning member of an alternative embodiment of a marine cleaning system;

Figures 5 to 8 are diagrammatic perspective, side, top and bottom views of a cleaning element of the cleaning member shown in Figure 4;

Figure 9 is a diagrammatic upper perspective view of a housing of a cleaning head in accordance with an alternative embodiment of the present invention;

Figure 10 is a diagrammatic lower perspective view of the housing shown in Figure 9;

Figure 11 is a diagrammatic exploded perspective view of a cleaning member assembly of the cleaning head in accordance with an alternative embodiment of the present invention;

Figure 12 is a diagrammatic perspective view of the cleaning member assembly shown in Figure 11; and

Figure 13 is a diagrammatic lower perspective view of the alternative cleaning head~~; and~~

~~Figure 14 is a diagrammatic representation of an enclosure of a cleaning system in accordance with an embodiment of the present invention~~.

Description of an Embodiment of the Invention

Referring to the drawings, in Figure 1 there is shown a marine cleaning system 10 for cleaning a submerged portion of a vessel or other structure in situ.

The present embodiment is described in relation to cleaning a vessel hull, although it will be understood that other applications are envisaged.

The system 10 includes a cleaning head 14, in this example arranged during use to be disposed on an underwater portion of a vessel hull 12 and configured so as to separate fouling material from the vessel hull 12.

The system 10 also includes a device for generating a negative pressure in a space defined between the cleaning head 14 and the vessel hull 12 so that material that is separated from the vessel hull by the cleaning head 14 is discouraged from passing into the surrounding marine environment and instead is drawn away from the cleaning head 14. In this example, the device for generating negative pressure is a conventional suction pump 16 of the type configured to operate in a marine environment. The suction pump 16 may be hydraulically or electrically powered.

In a marine environment, the fouling material present on a vessel hull 12 is typically predominantly of biological type, although other types of material may also be present.

cleaning head 14 shown in Figures 2 and 3 where appropriate. For example, the cleaning head 14 may incorporate an arrangement for generating negative pressure at the cleaning head 14, for example using an impeller configuration of the type shown in Figures 9 to 13 to generate suction generally centrally of the rotatable brushes 48.

The cleaning system 10 may also include an enclosure ~~106~~ that can be used to remove fouling on and adjacent appendages of a vessel, such as anodes, transducer housings, suction grates and recesses.

The enclosure ~~106~~ includes a frame member ~~107~~, a pair of support hoops ~~108~~ at longitudinal ends of the enclosure ~~106~~, and a pair of end plates ~~109~~. The frame member ~~107~~, the support hoops ~~108~~ and the end plates ~~109~~ provide structural integrity for transparent top ~~110~~, side ~~111~~ and end walls ~~112~~. In this embodiment, the transparent walls are formed of Perspex material, although it will be understood that other suitable materials are envisaged.

The top wall ~~110~~ includes a top support bar ~~114~~ in which elongate top apertures ~~116~~ are formed, and attached inwardly of the enclosure over the top apertures is a sealing strip ~~118~~. The sealing strip ~~118~~ is formed of resilient material, such as rubber, and includes a longitudinal slit ~~120~~.

Similarly, the side and end walls ~~111, 112~~ also include side apertures ~~122~~ formed in side bars ~~125~~, end apertures ~~124~~, and associated sealing strips ~~126, 128~~ and longitudinal slits ~~131, 132~~.

The frame member ~~107~~ may also be provided with one or more sealing members, for example formed of rubber material, which assist in providing a good seal between the

enclosure ~~106~~ and a vessel during use.

The purpose of the apertures ~~116, 122, 124~~ and sealing strips ~~118, 126, 128~~ is to enable a cleaning nozzle (not shown) to be disposed in the space defined by the enclosure ~~106~~ without overly compromising the relative negative pressure environment in the space.

The enclosure ~~106~~ also includes a pipe stub ~~130~~ in communication with the space inside the enclosure, the pipe stub ~~130~~ disposed on one of the side support bars ~~125~~ and facilitating connection to a suction hose of the cleaning system ~~106~~.

In this example, the frame member ~~107~~, the support hoops ~~108~~, the side plates ~~109~~ and the support bars ~~114, 125~~ are formed of aluminium material, although it will be understood that other suitable materials are envisaged.

During use, the enclosure ~~106~~ is disposed over an appendage that is desired to be cleaned and a suction hose (not shown) is attached to the pipe stub ~~130~~ so as to create a relative negative pressure environment inside the enclosure. A suitable high pressure cleaning nozzle is then inserted through one of the apertures ~~116, 122, 124~~ and used to clean fouling from at and around the appendage(s). Fouling material that is separated from the vessel is drawn out of the enclosure, and for example caused to move up to the separation device 18 through the extraction conduit 19.

It will be appreciated that the transparent walls ~~109, 110, 111~~ provide a user with good vision during a cleaning operation, and the configuration of the enclosure ~~106~~ allows regions of a vessel hull adjacent appendages to be cleaned whilst minimising egression of fouling material into the surrounding marine environment outside of the

CLAIMS:

1. A cleaning head for cleaning a submerged surface, the cleaning head comprising:

a body portion;

a skirt portion extending around a periphery of the body portion, the skirt portion performing a sealing function between the body portion and a submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use;

at least one cleaning member for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface during use; and

at least one suction aperture in fluid communication with a space defined between the body portion and the submerged surface during use;

wherein during use when the cleaning head is disposed on the submerged surface and the at least one suction aperture is connected in fluid communication with a device for generating a negative pressure, material separated from the submerged surface by the at least one cleaning member is drawn away from the cleaning head through the suction aperture.

2. A cleaning head as claimed in claim 1, wherein the body portion comprises a plurality of body portion sections moveably connected together.

3. A cleaning head as claimed in claim 2, wherein the body portion comprises first and second body portions moveably connected together.

4. A cleaning head as claimed in claim 3, wherein the first and second body portions are moveably connected together using a hinge.

members.

12. A cleaning head as claimed in any one of the preceding claims, wherein at least one cleaning member comprises a rotatable brush.

13. A cleaning head as claimed in any one of the preceding claims, wherein at least one cleaning member comprises a rotatable blade arranged to scrape material from the submerged surface during use.

14. A cleaning head as claimed in any one of the preceding claims, wherein at least one cleaning member comprises at least one cleaning element arranged to generate a fluid current adjacent the submerged surface when the cleaning element moves relative to but substantially does not touch the submerged surface during use, the fluid current causing material to be released from the submerged surface.

15. A cleaning head as claimed in claim 14, wherein at least one cleaning element includes a foot portion disposed at a first side of the cleaning element facing towards the direction of movement of the cleaning element during use, and a cut out portion disposed at a second side of the cleaning element facing away from the direction of movement of the cleaning element during use.

16. A cleaning head as claimed in claim 15, wherein the foot portion is substantially wedge shaped.

17. A cleaning head as claimed in claim 16, wherein the wedge shape tapers at an angle of approximately 45°.

18. A cleaning head as claimed in any one of claims 15 to 17, wherein the shape of the cut out portion is substantially the same as the shape of the foot portion.

27. A cleaning head as claimed in claim 26 when dependent on claim 20, wherein the motor is arranged to effect rotation of the impeller.

28. A cleaning head as claimed in claim 27, comprising a housing arranged to rotatably receive the impeller, the housing including a housing skirt portion arranged to perform a sealing function between the housing and the submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use.

29. A cleaning head as claimed in claim 27 or claim 28, wherein the impeller comprises a hollow raised section having alternately circumferentially disposed wall portions and wall apertures, and at least one impeller blade extending outwardly of a respective wall portion, the hollow raised section defining an impeller aperture in fluid communication with the wall apertures, wherein rotation of the impeller causes a reduction in pressure in the hollow raised section.

30. A cleaning head as claimed in claim 29 when dependent on claim 22, wherein the disc portion includes a central aperture and the hollow raised section is disposed adjacent and in fluid communication with the central aperture.

31. A cleaning head as claimed in claim 30, wherein the impeller is resiliently connected to the cleaning member.

32. A cleaning head as claimed in any one of the preceding claims, comprising a safety mechanism arranged to cease operation of the cleaning head if an operator becomes incapacitated or is otherwise unable to operate the cleaning head.

33. A cleaning system for cleaning a submerged surface,

defined by the enclosure, wherein a cleaning device is disposable through the aperture and the sealing device such that the cleaning device forms a substantially sealed relationship with the aperture.

39. A method of cleaning a submerged surface, the method comprising:

providing a cleaning head having:

a body portion;

a skirt portion extending around a periphery of the body portion; and

at least one cleaning member for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface;

disposing the cleaning head on the submerged surface such that the skirt portion contacts the submerged surface and performs a sealing function between the body portion and the submerged surface;

connecting a space defined between the body portion and the submerged surface in fluid communication with a device for generating a negative pressure;

activating said device and the at least one cleaning member so that material is separated from the submerged surface and is drawn away from the cleaning head.

40. A method as claimed in claim 39, wherein the body portion comprises first and second body portions moveably connected together.

41. A method as claimed in claim 39 or claim 40, comprising facilitating adjustment of the distance between the body portion and the submerged surface to be cleaned, and thereby adjustment of the degree of compression of the skirt portion during use, and adjustment of the efficacy of the seal formed between the skirt portion and the submerged surface.

shape tapers at an angle of approximately 45°.

50. A cleaning head as claimed in any one of claims 47 to 49, wherein the shape of the cut out portion is substantially the same as the shape of the foot portion.

51. A method as claimed in any one of claims 47 to 50, comprising rotating the cleaning member such that the cut out portion follows the rotational path defined by the foot portion.

52. A method as claimed in any one of claims 39 to 50, comprising providing the cleaning head with a device for reducing pressure at the cleaning head in a region between the cleaning head and a submerged surface during use.

53. A method as claimed in claim 52, comprising reducing pressure at the cleaning head at a location substantially centrally of the cleaning member.

54. A method as claimed in claim 52 or claim 53, wherein the device for reducing pressure comprises an impeller.

55. A method as claimed in claim 54 when dependent on claim 44, comprising rotating the impeller using one or more hydraulic motors.

56. A method as claimed in claim 54 or claim 55, comprising rotatably receiving the impeller in a housing, the housing including a housing skirt portion arranged to perform a sealing function between the housing and the submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use.

57. A method as claimed in any one of claims 54 to 56, wherein the impeller comprises a hollow raised section having alternately circumferentially disposed wall

through the aperture and the sealing device such that the cleaning device forms a substantially sealed relationship with the aperture.

CLAIMS:

1. A cleaning head for cleaning a submerged surface, the cleaning head comprising:

a body portion;

a skirt portion extending around a periphery of the body portion, the skirt portion performing a sealing function between the body portion and a submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use;

at least one cleaning member for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface during use and the cleaning member moves relative to the submerged surface; and

at least one suction aperture in fluid communication with a space defined between the body portion and the submerged surface during use;

wherein during use when the cleaning head is disposed on the submerged surface and the at least one suction aperture is connected in fluid communication with a device for generating a negative pressure, material separated from the submerged surface by the at least one cleaning member is drawn away from the cleaning head through the suction aperture;

wherein at least one cleaning member comprises at least one cleaning element arranged to generate a fluid current adjacent the submerged surface when the cleaning element moves relative to but substantially does not touch the submerged surface during use, the fluid current causing material to separate from the submerged surface.

2. A cleaning head as claimed in claim 1, wherein the body portion comprises a plurality of body portion sections moveably connected together.

3. A cleaning head as claimed in claim 1, wherein the skirt portion is of bristle like configuration.

4. A cleaning head as claimed in claim 1, comprising a height adjustment system arranged to facilitate adjustment of the distance between the body portion and the submerged surface to be cleaned, and thereby adjustment of the degree of compression of the skirt portion during use, and adjustment of the efficacy of the seal formed between the skirt portion and the submerged surface.

5. A cleaning head as claimed in claim 1, comprising a drive mechanism arranged to urge the cleaning head to move relative to the submerged surface during use.

6. A cleaning head as claimed in claim 5, comprising a height adjustment system arranged to facilitate adjustment of the distance between the body portion and the submerged surface to be cleaned, and thereby adjustment of the degree of compression of the skirt portion during use, and adjustment of the efficacy of the seal formed between the skirt portion and the submerged surface, wherein the height adjustment system is arranged to facilitate adjustment of the distance between one or more of the drive shafts and the body portion.

7. A cleaning head as claimed in claim 1, comprising a plurality of cleaning members.

8. A cleaning head as claimed in claim 1, wherein at least one cleaning element includes a foot portion disposed at a first side of the cleaning element facing towards the direction of movement of the cleaning element during use, and a cut out portion disposed at a second side of the cleaning element facing away from the direction of movement of the cleaning element during use.

9. A cleaning head as claimed in claim 8, wherein the foot portion is substantially wedge shaped.

10. A cleaning head as claimed in claim 9, wherein the wedge shape tapers at an angle of approximately 45°.

11. A cleaning head as claimed in claim 8, wherein the shape of the cut out portion is substantially the same as the shape of the foot portion.

12. A cleaning head as claimed in claim 8, wherein each cleaning element is arranged to rotate such that the cut out portion follows the rotational path defined by the foot portion.

13. A cleaning head as claimed in claim 1, wherein the cleaning member comprises at least one rotatable disc portion, each disc portion including at least one cleaning element.

14. A cleaning head as claimed in claim 1, wherein the cleaning head comprises at least one buoyancy member.

15. A cleaning head as claimed in claim 1, comprising an impeller for reducing pressure at the cleaning head in a region between the cleaning head and a submerged surface during use.

16. A cleaning head as claimed in claim 15, comprising a housing arranged to rotatably receive the impeller, the housing including a housing skirt portion arranged to perform a sealing function between the housing and the submerged surface desired to be cleaned when the cleaning head is disposed on the submerged surface during use.

17. A cleaning head as claimed in claim 15, wherein the impeller comprises a hollow raised section having alternately circumferentially disposed wall portions and wall apertures, and at least one impeller blade extending outwardly of a respective wall portion, the hollow raised section defining an impeller aperture in fluid communication with the wall apertures, wherein rotation of the impeller causes a reduction in pressure in the hollow raised section.

18. A cleaning head as claimed in claim 17, wherein the disc portion includes a central aperture and the hollow raised section is disposed adjacent and in fluid communication with the central aperture.

19. A cleaning head as claimed in claim 18, wherein the impeller is resiliently connected to the cleaning member.

20. A method of cleaning a submerged surface, the method comprising:

providing a cleaning head having:

a body portion;

a skirt portion extending around a periphery of the body portion; and

at least one cleaning member having at least one cleaning element for causing material on the submerged surface to separate from the submerged surface when the cleaning head is disposed on the submerged surface and the at least one cleaning element moves relative to the submerged surface;

disposing the cleaning head on the submerged surface such that the skirt portion contacts the submerged surface and performs a sealing function between the body portion and the submerged surface;

connecting a space defined between the body portion and the submerged surface in fluid communication with a device for generating a negative pressure; and

activating said device and the at least one cleaning member so that material is separated from the submerged surface and is drawn away from the cleaning head;

wherein the at least one cleaning element is arranged to generate a fluid current adjacent the submerged surface when the cleaning element moves relative to but substantially does not touch the submerged surface during use, the fluid current causing material to separate from the submerged surface.

21. A method as claimed in claim 20, comprising rotating each cleaning member using one or more hydraulic motors.

22. A cleaning head as claimed in claim 20, comprising providing at least one cleaning element with a foot portion disposed at a first side of the cleaning element facing towards the direction of movement of the cleaning element during use, and a cut out portion disposed at a second side of the cleaning element facing away from the direction of movement of the cleaning element during use.