wheels. The magnets can be turned in an inactive state due to the connection of the magnets with a cylinder fixed to the chassis, which is able to move the magnets to the inactive state. Due to the specific configuration of the wheels in relation to the magnets and the cleaning mechanism, the robot is suited for flat surfaces instead of surfaces that are curved in three dimensions.

EP 1 216 761 discloses a device for hydrodynamic cleaning of surfaces. The device comprises a collector, a stator, a rotor comprising radial piping and high pressure-flow generators. The housing appears as a hollow shaped disk with at least one lower shaped surface and partially filled with a shifting ballast.

Relating to the attachment of a device to a surface, GB1270117 discloses a carriage or trolley for travel along an upright wall of magnetisable material. The device comprises magnetic means for attachment to the surface, that is kept at a fixed distance from the surface due to the runner wheels on the device.

~~The~~ Embodiments of the present invention ~~has for its object~~ seek to obviate or at least reduce the above stated problems.

~~The present invention provides for this purpose~~ According to a first aspect of the present invention, there is provided a cleaning head for cleaning a surface, such as a ship's hull, the cleaning head comprising:

- a frame comprising a nozzle shaft;
- one or more nozzles for cleaning the surface that are directly or indirectly connected to the nozzle shaft of the frame for providing a fluid to the surface to be cleaned;
- magnetic positioning means for positioning the head relative to the surface that are provided or attached to the frame; and

- an activating element for manipulating the distance between the surface and the positioning means, the activating element being connected to the positioning means,

wherein the magnetic positioning means are movable between at least a first state wherein the head moves freely, and an active second state wherein the head is movable connected to the surface, and

further comprising rotating means such that the nozzles are rotatable around the magnetic positioning means.

By providing magnetic positioning means, including both ferromagnetic and electromagnetic positioning means, a cleaning head can be positioned relative to the surface to be cleaned. This surface to be cleaned can be above or below water and may comprise a ships's hull, a tank surface, doors or gates for ships lock, and relatively static constructions in the offshore industry. The fouling on these structures increases drag forces on the structure and deterioration of the coating and construction. Cleaning involves removal of fouling, paint, surface layers, etc. Regular cleaning according to embodiments of the present invention would decrease environmental loads and the need for maintenance of the parts of the construction being exposed to the environment.

By providing an activating element the distance between the surface and the positioning means can be manipulated. The activating element moves the positioning means between at least two different states. In a first state, the cleaning head moves freely from the surface and can be positioned at a surface location requiring cleaning for example. In an active second state the actual cleaning of the surface is performed, wherein the cleaning head can be put to operation. In this second state the magnetic

positioning means are magnetically attached to the surface to be cleaned.

The activating means manipulate the distance or gap between the (permanent) magnetic positioning means and the surface to be cleaned. A small gap may provides a relatively strong connection between the head and the surface to be cleaned, and enables moving the device over the surface to be cleaned. In case the alternative electromagnets are used the level of the supplied electrical power determines the strength of the attachment of the device according to embodiments of the invention with the surface to be cleaned.

Optionally, intermediate states could be arranged. For example, in such intermediate state some connection between the cleaning head and the surface to be cleaned is still maintained, however, this connection is less strong as compared to the second state wherein the actual cleaning is performed. Such intermediate state would enable a more easy movement of the cleaning head over the surface without completely disconnecting the cleaning head from the surface.

The cleaning head is provided with one or more nozzles that channel the pressurized fluid on to the surface.

The nozzles are directly or indirectly connected to the nozzle shaft. For example, in a presently preferred embodiment the nozzles are attached to nozzle arms that are connected to a rotatable housing that is capable of rotating around the nozzle shaft.

This fluid may comprise water and/or air. Additionally, the fluid may comprise abrasives and/or other components. The pressurized fluid removes the fouling and/or paint and/or other components from the surface to be cleaned. Preferably, the nozzles are provided on a rotating ring that rotates the nozzles around the nozzle shaft of the frame corresponding to an axis of the cleaning head. This

may increases the surface area that can be cleaned in one position of the cleaning head.

The cleaning head further comprises rotating means such that the nozzles are rotatable around the magnetic positioning means. By having the nozzles rotated when the cleaning head is in use a larger surface area can be cleaned. Preferably the nozzles are provided on a ring that rotates around these magnetic positioning means.

Preferably, the cleaning head is integrally provided with the positioning means. By integrally providing the magnetic positioning means may provides the capability to follow the curvature of the surface. For example, such curvature is relevant for a ship's hull. This may significantly improves the applicability of the cleaning head according to the invention.

According to embodiments of the invention the functions of cleaning curved surfaces and the attachment of the device to the surface are combined. Due to the integration of cleaning technology with magnetic attachment means, embodiments of the present invention may provides a solution for the specific requirements when cleaning surfaces, especially including curved surfaces, while the device ~~is~~ may be able to achieve high cleaning speeds and may optionally be optimized to capture the removed debris as well.

In an advantageous preferred embodiment according to the present invention the activating element comprises a hydraulic or pneumatic control cylinder wherein the positioning means is movable between the at least first and second state.

By providing a pneumatic or hydraulic cylinder the air gap between the magnetic element of the positioning means and the surface to be cleaned can be controlled. In the first state, the air gap is relatively large such that the

cleaning head can be moved freely from the surface, while in the second state the air gap is relatively small such that the cleaning head is more or less fixed to the surface to be cleaned. In both states the air gap can ensures that the surface to be cleaned is not damaged by a cleaning head. This may maintains the protective performances of coatings and the fouling layers, for example.

Preferably, the positioning means comprises a permanent magnet. The use of a permanent magnet can guarantees that the cleaning head stays connected to the ship's hull both above and under water even in case of malfunctioning of the electric supply. Furthermore, permanent magnets have a high attachment force/magnet weight or size ratio as compared to electromagnets. In addition, in a presently preferred embodiment a metal strip ~~is~~ provided on at least one side of the permanent magnet ~~to~~ may increase the magnetic field and thereby enhance the capabilities of handling the cleaning head relative to the surface. This may reduces the number of magnets that are required thereby making handling of the cleaning head more easy and reducing the costs associated with the cleaning head according to embodiments of the invention.

Preferably, the positioning means is provided at or around a shaft of the cleaning head. As mentioned before, providing a cleaning head integrated with the positioning means may improves the capability of cleaning surfaces with a relatively large curvature. In a presently preferred embodiment the shaft is positioned at or close to the central axis of the cleaning head. Preferably, one or more of the supplies for the activating element are positioned in the internal of the shaft. This may prevents additional pipes or hoses to be used.

In an advantageous preferred embodiment according to the present invention the rotating means comprise a

rotatable housing with arms to which the nozzles are attached.

By providing a rotatable housing with arms with nozzles attached to these arms in use a larger surface area can be cleaned. As mentioned before, the nozzles are preferably provided on a type of ring, or other circular shape, that rotates around these magnetic positioning means.

Preferably, the nozzles are provided at a non-perpendicular angle to the surface such that a rotating movement is achieved when the cleaning head is in use. By providing the nozzles with an inclination relative to a perpendicular line of the surface to be cleaned, the nozzles power the rotational movement of the ring such that no external drive, or at least a reduced drive, is required.

In a further advantageous preferred embodiment according to the present invention the cleaning head comprises three support-and-moving means.

By providing three support-and-moving means a stable construction ~~is~~ may be achieved. Preferably, these means involve wheels and/or rollers that enable moving the cleaning head over the surface to be cleaned.

In a presently preferred embodiment the support-and-moving means are attached or connected to the shaft such that the nozzles may rotate around the shaft and the support-and-moving means. In this embodiment the positioning means, preferably comprising a permanent magnet, is also connected to the shaft such that the nozzles may also rotate around the positioning means.

Optionally, the support-and-moving means comprise connecting means for connecting to a power source for driving the cleaning head. When the nozzles rotate around the shaft and the support-and-moving means at the same time,

the cleaning head substantially moves over a clean surface when in use.

Preferably, the cleaning head comprises suction means. The suction means remove loose parts from the surface. Such parts may relate to fouling and/or paint that is removed by the nozzles. By providing suction means it ~~is~~ can be prevented that such parts enter the environment. Preferably, the suction means is incorporated in a housing of the cleaning device. This housing involves a double-walled housing with the suction means provided between the inner and outer wall.

~~The present invention further relates to~~ According to a second aspect of the present invention, there is provided a cleaning device for cleaning a surface, such as a ship's hull, comprising:

- a frame with one or more cleaning heads as described above; and
- a drive for moving the device.

Such a cleaning device may provide~~s~~ the same effects and advantages as described for the cleaning head. The cleaning device can be used for cleaning a surface that is partly above and partly under water by providing relevant parts with a water tight casing.

Applying more than one cleaning head for a device may significantly improve~~s~~ the cleaning performance due to the multiple head configuration as compared to a circumferential cleaning, for example.

Preferably, the cleaning device comprises one or more units that each are provided with one or more cleaning heads. Providing the one or more units with more than one cleaning head may enable~~s~~ the use of a central suspension that provides more balance to the device according to embodiments of the invention.

More preferably, the cleaning head is provided with three cleaning heads, that are connected to a triangular sub

frame. In a presently preferred embodiment according to the invention the cleaning heads are capable of rotating relative to the sub frame. The sub frame is connected to the frame that houses the drive for moving the device, using a cylinder or other suspension~~, thus~~ that may result~~ing~~ in a flexible suspension for the three cleaning heads. This can ensure~~s~~ that the cleaning heads will perfectly follow curved surfaces. In addition, the unit comprising the three cleaning heads will exert a force on the cleaning heads away from the surface to be cleaned. Due to the magnetic positioning means in the cleaning heads, in their active state, the frame that is attached to the unit comprising the cleaning heads will stay connected to the surface to be cleaned. Optionally, extra magnetic positioning means can be attached to the frame thereby creating an even higher attachment force to the surface.

In a presently preferred embodiment of the cleaning device the device comprises inspection means and/or paint spray means. This may enable~~s~~ inspection of the surface. The inspection means may comprise a camera or sensor to measure the thickness of the surface, coating thickness, and corrosion inspection, for example. The paint spray means enable providing a coating or other layer on the surface.

~~The present invention further also relates to~~ According to a third aspect of the present invention, there is provided a method for cleaning a surface, such as a ship's hull, the method comprising the steps of:

- providing a cleaning device as described above;
- positioning the device on the surface; and
- cleaning the surface.

Such a method may provide~~s~~ the same effects and advantages as described for the cleaning device and/or the cleaning head.

CLAIMS

1. Cleaning head ~~(22)~~ for cleaning a surface, such as a ship's hull, the cleaning head comprising:

- a frame comprising a nozzle shaft ~~(32)~~;
- one or more nozzles ~~(44)~~ for cleaning the surface that are directly or indirectly connected to the nozzle shaft of the frame for providing a fluid to the surface to be cleaned;
- magnetic positioning means ~~(46,42)~~ for positioning the head ~~(22)~~ relative to the surface that are provided or attached to the frame; and
- an activating element for manipulating the distance between the surface and the positioning means, the activating element being connected to the positioning means ~~(46,42)~~,

wherein the magnetic positioning means ~~(46,42)~~ are movable between at least a first state wherein the head ~~(22)~~ moves freely, and an active second state wherein the head ~~(22)~~ is movable connected to the surface, and further comprising rotating means ~~(60)~~ such that the nozzles ~~(44)~~ are rotatable around the magnetic positioning means ~~(46,42)~~.

2. Cleaning head ~~(22)~~ according to claim 1, wherein the cleaning head is integrally provided with the positioning means ~~(46,42)~~.

3. Cleaning head ~~(22)~~ according to claim 1 or 2, wherein the activating element comprises a hydraulic or pneumatic controlled cylinder for moving the positioning means ~~(46,42)~~ between the at least first and second state.

4. Cleaning head ~~(22)~~ according to claim 1, 2 or 3, wherein the positioning means ~~(46,42)~~ comprises a permanent magnet and wherein at least one side of the magnet is provided with a metal strip ~~(56)~~.

5. Cleaning head ~~(22)~~ according to any of the foregoing claims, wherein the positioning means is provided at or around a shaft ~~(32)~~.

6. Cleaning head ~~(22)~~ according to claim 5, wherein a supply ~~(78,80,82)~~ for the activating element is positioned in the internal of the shaft ~~(32)~~.

7. Cleaning head ~~(22)~~ according to one or more of the foregoing claims, wherein the rotating means comprise a rotatable housing ~~(60)~~ with arms ~~(58)~~ to which the nozzles ~~(44)~~ are attached.

8. Cleaning head ~~(22)~~ according to claim 7, wherein the spray nozzles ~~(44)~~ are provided at a non-perpendicular angle to the surface such that in operation a rotating movement is achieved when the cleaning head is in use.

9. Cleaning head ~~(22)~~ according to one or more of the foregoing claims, further comprising three support-and-moving means ~~(48)~~ with the three support-and-moving means ~~(48)~~ optionally comprising connecting means to connect to a power source.

10. Cleaning head ~~(22)~~ according to one or more of the foregoing claims, further comprising suction means ~~(64,66,68,70)~~ to remove loose parts.

11. Cleaning device ~~(8)~~ for cleaning a surface, such as a ship's hull, comprising:

- a frame ~~(18)~~ with one or more cleaning heads ~~(22)~~ according to one or more of the foregoing claims; and
- a drive for moving the device.

12. Cleaning device ~~(8)~~ according to claim 10, further comprising a unit which is provided with one or more cleaning heads ~~(22)~~ and comprising a combined suspension.

13. Cleaning device ~~(8)~~ according to claim 10 or 11, further comprising inspection means and/or paint spray means.

14. Cleaning device ~~(8)~~ according to claim 13, wherein the suction means is incorporated in a housing.

15. Method for cleaning a surface, such as a ship's hull, comprising the steps of:

- providing a cleaning device ~~(8)~~ according to one or more of the foregoing claims 11-14;
- positioning the device ~~(8)~~ on the surface; and
- cleaning the surface.