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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Apparatus for Manoeuvring on a Submerged Surface

We, ESSO RESEARCH AND ENGINEERING COMPANY, a Corporation duly organised and existing under the laws of the State of Delaware, United States of America, of Elizabeth, New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus which can be manoeuvred on a submerged surface. Thus, it can be used as a machine for cleaning the hull of a ship while it is in the water, or for cleaning the inside of tanks or it can be used as an underwater survey platform.

The apparatus of this invention comprises a chamber having an open side, a pressure reducing device capable of continuously maintaining a reduced pressure inside the chamber relative to the pressure outside the chamber, a steerable wheel mounted so that the apparatus can be driven along a submerged surface with the open side of the chamber adjacent to the surface and also mounted so that the wheel is capable of being swivelled through an angle of at least 90°, a motor for driving the apparatus along a submerged surface, and a steering device for steering the steerable wheel.

The chamber open at one side, is preferably box-like in shape. The chamber may also have an outlet which can be a cylindrical tube attached to a wall of the chamber opposite to the open side of the chamber.

The pressure reducing device may be a suction pump arranged so that liquid is removed from the interior of the chamber faster than it enters the chamber round the periphery of the open side. Alternatively, it may be a propeller pump and the propeller blades may be conveniently located inside the outlet, or it may be a centrifugal pump. One may use any other pressure reducing device which reduces the internal pressure in the chamber

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in the face of liquid entering the chamber, so that the external hydrostatic pressure forces the steerable wheel into contact with the submerged surface. Thus, the inside of the chamber could be continuously vented to a zone of lower pressure.

The steerable wheel (by which term we include any other rotatably mounted circular member capable of driving the apparatus, e.g. a roller or drum) is preferably mounted within the chamber so that its running surface projects through the open side of the chamber. This means that the chamber is supported a small distance, e.g. 5 to 10 cm., off the submerged surface. If desired however this wheel could be mounted outside the chamber. In order to facilitate the manoeuvrability of the apparatus, it is preferable if in addition to the steerable wheel, there are two or more supporting wheels, which may be idle or may be driven. These wheels are also preferably mounted within the chamber, so as to project through the open side by about the same distance as the steerable wheel.

The steerable wheel must be free to swivel through a wide angle, i.e. at least 90°. In practice this angle will often be greater, e.g. between 100° and 180°, or even 360°. Preferably, the wheel is free to swivel by a substantially equal angle either side of the position which results in the apparatus being steered in a straight line. With this wide angle of swivel, the steerable wheel can steer the device very easily and the device can be manoeuvred over any part of the submerged surface.

The apparatus is provided with a motor so that it can be driven along a submerged surface. This motor may be arranged so as to drive the steerable wheel, or, where other wheels are provided, one or more of these wheels may be driven. There is also a steering device for steering the steerable wheel, and this device may be an electric motor remotely controlled, e.g. from the land or a ship. Either or both the motor and steering device are

preferably mounted in the chamber in a water-tight compartment, or alternatively they may be of such a design that they are suitable for operating in submerged conditions.

5 When the apparatus is used for cleaning a submerged surface, there should be one or more cleaning devices, e.g. rotatable brushes. These brushes project beyond the open side of the chamber so as to clean the submerged surface. The cleaning devices may be operated by a separate motor, or may be operated by the motor of the suction device or by the driving motor.

10 The apparatus may also have a sensing device and/or instruments for sending back information to the surface, e.g. a gravity controlled potentiometer for information on the orientation of the apparatus, or a pressure gauge for information on the hydrostatic pressures.

20 The apparatus may also have mounted on the top of the chamber, a television camera directed towards the front of the apparatus for navigation and survey purposes.

25 All the cables for supplying current to the electrical equipment in the apparatus may pass through a gland in the wall of the chamber. These electrical cables may act as hoists for lowering and raising the apparatus into and out of the water, or if desired there may be separate cables for the purpose.

30 The apparatus is particularly suited for cleaning the hull of a ship, or as a platform for attaching to the hull of a ship for an underwater survey, or as a stable platform for carrying out mechanical operations underwater.

40 One method of operating the apparatus of the invention comprises allowing the apparatus to enter the water near the hull of a ship to a suitable depth, activating the pressure reducing device whereby the chamber attaches itself to the hull, and operating the driving motor whereby the apparatus moves over the surface of the hull. If it is desired to clean the sides of the ship the cleaning device is activated when the chamber has attached itself to the hull. To remove the apparatus from the water, the activation of the pressure reducing device is stopped, and the apparatus is recovered, e.g. by allowing it to float to the surface, or by raising it by means of cables attached to the apparatus.

50 An apparatus of this invention is now described with reference to the accompanying drawings in which:

Fig. 1 shows a side elevation of the apparatus.

60 Fig. 2 shows a plan view along the line II—II of Fig. 1.

and Fig. 3 shows a perspective view of the apparatus with some of the internal parts of the apparatus shown in dotted lines.

Referring to the drawings, the chamber 1 having an open side 12, has an outlet 2. Inside

the chamber there is a water-tight casing 10 which houses a driving motor 6, a steering motor 7, a cleaning motor 8, and a pump motor 9. Cables 14 supplying current to these motors pass through a gland 17 on the chamber 1 and a gland 18 in the casing 10.

Attached to the casing 10 are brushes 25 which are driven by the motor 8. The steerable wheel 4 is driven by the driving motor 6 and steered by the steering motor 7. This wheel is free to swivel through 360° as indicated in Fig. 2. There are also supporting wheels 3 which are idle and not free to swivel. The pump motor 9 drives a propeller 5 which continuously removes water from inside chamber 1 and discharges it through the outlet 2, thereby lowering the pressure inside the chamber 1 relative to the external hydrostatic pressure. The apparatus is then forced against the submerged surface.

The casing 10 also contains transducers 21, which send back to the surface information regarding the orientation of the apparatus, and the hydrostatic pressures inside and outside the chamber.

Mounted on the top of the chamber 1 is a television camera 20 which is directed towards the front of the apparatus for navigation and survey purposes.

WHAT WE CLAIM IS:—

1. An apparatus capable of being driven along a submerged surface comprising a chamber having an open side, a pressure reducing device capable of continuously maintaining a reduced pressure inside the chamber relative to the pressure outside the chamber, a steerable wheel mounted so that the apparatus can be driven along the submerged surface with the open side of the chamber adjacent to the surface, and also mounted so that the wheel is capable of being swivelled through an angle of at least 90°, a motor for driving the apparatus along the submerged surface, and a steering device for steering the steerable wheel.

2. An apparatus as claimed in claim 1 wherein the steerable wheel is mounted within the chamber so that its running surface projects through the open surface of the chamber.

3. An apparatus as claimed in either of claims 1 and 2 wherein in addition to the steerable wheel there are two or more supporting wheels.

4. An apparatus as claimed in any one of the preceding claims wherein the driving motor drives the steerable wheel.

5. An apparatus as claimed in any one of the preceding claims wherein the steering device is an electric motor.

6. An apparatus as claimed in any one of the preceding claims which also has a cleaning device.

7. An apparatus as claimed in claim 6



preferably mounted in the chamber in a water-tight compartment, or alternatively they may be of such a design that they are suitable for operating in submerged conditions.

- 5 When the apparatus is used for cleaning a submerged surface, there should be one or more cleaning devices, e.g. rotatable brushes. These brushes project beyond the open side of the chamber so as to clean the submerged surface. The cleaning devices may be operated by a separate motor, or may be operated by the motor of the suction device or by the driving motor.

- 10 The apparatus may also have a sensing device and/or instruments for sending back information to the surface, e.g. a gravity controlled potentiometer for information on the orientation of the apparatus, or a pressure gauge for information on the hydrostatic pressures.

20 The apparatus may also have mounted on the top of the chamber, a television camera directed towards the front of the apparatus for navigation and survey purposes.

- 25 All the cables for supplying current to the electrical equipment in the apparatus may pass through a gland in the wall of the chamber. These electrical cables may act as hoists for lowering and raising the apparatus into and out of the water, or if desired there may be separate cables for the purpose.

- 30 The apparatus is particularly suited for cleaning the hull of a ship, or as a platform for attaching to the hull of a ship for an underwater survey, or as a stable platform for carrying out mechanical operations underwater.

- 35 One method of operating the apparatus of the invention comprises allowing the apparatus to enter the water near the hull of a ship to a suitable depth, activating the pressure reducing device whereby the chamber attaches itself to the hull, and operating the driving motor whereby the apparatus moves over the surface of the hull. If it is desired to clean the sides of the ship the cleaning device is activated when the chamber has attached itself to the hull. To remove the apparatus from the water, the activation of the pressure reducing device is stopped, and the apparatus is recovered, e.g. by allowing it to float to the surface, or by raising it by means of cables attached to the apparatus.

- 50 An apparatus of this invention is now described with reference to the accompanying drawings in which:

Fig. 1 shows a side elevation of the apparatus.

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the chamber there is a water-tight casing 10 which houses a driving motor 6, a steering motor 7, a cleaning motor 8, and a pump motor 9. Cables 14 supplying current to these motors pass through a gland 17 on the chamber 1 and a gland 18 in the casing 10.

Attached to the casing 10 are brushes 25 which are driven by the motor 8. The steerable wheel 4 is driven by the driving motor 6 and steered by the steering motor 7. This wheel is free to swivel through 360° as indicated in Fig. 2. There are also supporting wheels 3 which are idle and not free to swivel. The pump motor 9 drives a propeller 5 which continuously removes water from inside chamber 1 and discharges it through the outlet 2, thereby lowering the pressure inside the chamber 1 relative to the external hydrostatic pressure. The apparatus is then forced against the submerged surface.

The casing 10 also contains transducers 21, which send back to the surface information regarding the orientation of the apparatus, and the hydrostatic pressures inside and outside the chamber.

Mounted on the top of the chamber 1 is a television camera 20 which is directed towards the front of the apparatus for navigation and survey purposes.

WHAT WE CLAIM IS:—

1. An apparatus capable of being driven along a submerged surface comprising a chamber having an open side, a pressure reducing device capable of continuously maintaining a reduced pressure inside the chamber relative to the pressure outside the chamber, a steerable wheel mounted so that the apparatus can be driven along the submerged surface with the open side of the chamber adjacent to the surface, and also mounted so that the wheel is capable of being swivelled through an angle of at least 90°, a motor for driving the apparatus along the submerged surface, and a steering device for steering the steerable wheel.

2. An apparatus as claimed in claim 1 wherein the steerable wheel is mounted within the chamber so that its running surface projects through the open surface of the chamber.

3. An apparatus as claimed in either of claims 1 and 2 wherein in addition to the steerable wheel there are two or more supporting wheels.

4. An apparatus as claimed in any one of the preceding claims wherein the driving motor drives the steerable wheel.

5. An apparatus as claimed in any one of the preceding claims wherein the steering device is an electric motor.

6. An apparatus as claimed in any one of the preceding claims which also has a cleaning device.

7. An apparatus as claimed in claim 6

wherein the cleaning device comprises rotatable brushes.

8. An apparatus as claimed in any one of the preceding claims which also has a sensing device.

9. An apparatus as claimed in any one of the preceding claims wherein the pressure reducing device is a propeller pump.

10. An apparatus as claimed in any one of the preceding claims wherein the chamber also has an outlet.

11. An apparatus as claimed in claim 10 wherein the pressure reducing device is a propeller pump and the propeller blades are located inside the outlet.

12. An apparatus as claimed in any one of the preceding claims wherein the steerable wheel is free to swivel through 360°.

13. An apparatus as claimed in any one of claims 1 to 11 wherein the steerable wheel is free to swivel through an angle between 100° and 180°.

14. An apparatus as claimed in any one of claims 1 to 8, 10, 12 and 13 wherein the pressure reducing device is a centrifugal pump.

15. An apparatus as claimed in any one of the preceding claims wherein a television

camera is mounted on the top of the chamber and directed towards the front of the apparatus.

16. An apparatus substantially as hereinbefore described with reference to the drawings.

17. A method of operating the apparatus as claimed in any one of the preceding claims which comprises allowing the apparatus to enter the water near the hull of a ship to a suitable depth, activating the pressure reducing device, thereafter operating the driving motor, and recovering the apparatus by stopping the activation of the pressure reducing device.

18. A method as claimed in claim 17 wherein the apparatus as claimed in any one of claims 6 to 16 is employed, and wherein after the chamber has attached itself to the side of the ship, the cleaning device is activated.

19. A method as claimed in either of claims 17 and 18 wherein the apparatus is recovered by raising it by means of cables attached thereto.

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