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(54) Semi-submersible vehicles

(57) A semi-submersible vehicle 1 comprising a vehicle housing 2, a propelling device 3 connected to the housing 2 to move the vessel, a strut 4 extending from the top of the housing 2, and optionally an engine 6 at the top of the strut 4 above the water surface. The engine 6 is connected to drive the propelling device 3. The vehicle 1 is adapted to be sufficiently buoyant such that it maintains the vessel housing 2 substantially at a predetermined level under the water with the strut 4 extending out of the water.

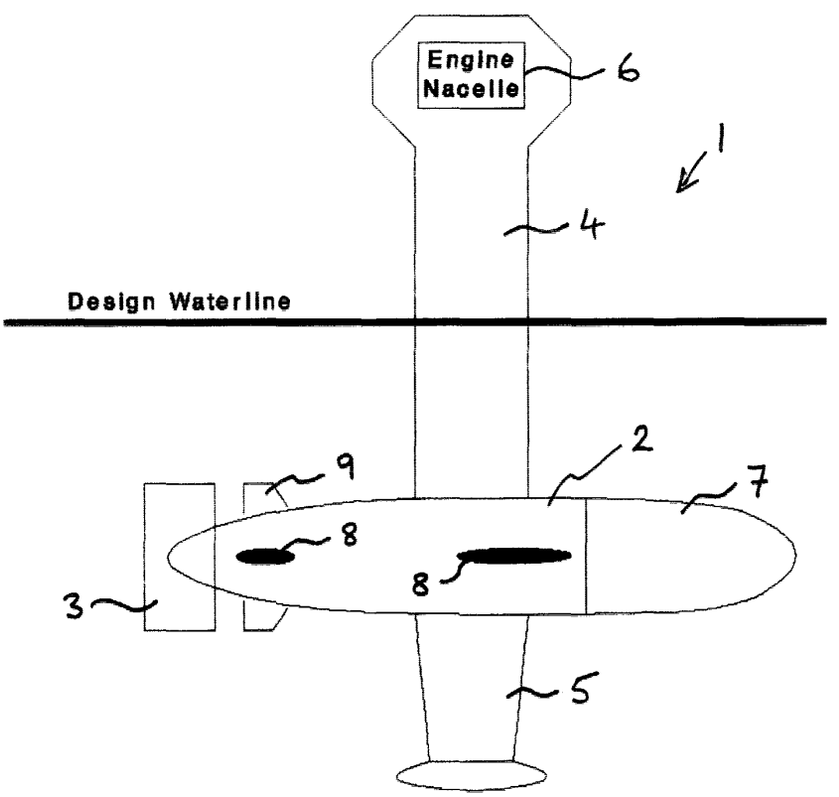

FIGURE 1

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Description

[0001] The present invention relates to autonomous semi-submersible vehicles.

[0002] Autonomous air breathing submersible vehicles are known and are used for a number of ocean survey tasks such as seismic surveys of the sea bed, monitoring of depths, sea floor topology and water pollution. Such vehicles normally consist of a tubular vessel housing, inter alia, a diesel engine, fuel and sensor equipment to perform a desired task. A breather tube normally extends from the top of the vessel to provide air for the engine. Such vessels float on the surface when stationary but include hydrofoils which maintain the vessel just under the surface of the water, below the waves, when the vessel is moving forward so as to provide a stable platform for the sensors.

[0003] These known vessels have a number of disadvantages. For example they cannot be used when stationary; they are difficult to recover from the water; the noise of the engine can interfere with the sensitivity of the equipment; and the vessel needs to be designed to accommodate the engine which need not lead to the best hydrodynamic shape. An increased range of ocean survey tasks can also be performed by fully-submerged autonomous vehicles. These have some major disadvantages; because they cannot use air breathing engines their propulsion systems are inefficient and lack speed and endurance; because they cannot use radio waves their communication systems are limited in range and bandwidth unless they interrupt their survey task to come to the surface; it is difficult to determine their position with accuracy; and
they are expensive to build and operate.

[0004] By providing a semi-submersible vehicle the invention seeks to avoid most of these disadvantages. The invention may replicate the sensor suite of a survey or research ship at a lower cost and may undertake tasks not currently possible with autonomous vehicles

[0005] According to the present invention there is provided a semi-submersible vehicle comprising:

a) a vehicle housing,
b) a propelling device connected to the housing to move the vessel,
c) a strut extending from the top of the housing,

said vehicle being adapted to be sufficiently buoyant such that it maintains the vessel housing substantially at a predetermined level under the water with the strut extending out of the water.

[0006] Preferably a keel is provided to maintain the strut substantially vertical

[0007] Preferably the strut is adapted to lift the vehicle to assist in recovering the vehicle

[0008] In one embodiment an engine is mounted on the top of the strut. The engine may be a diesel, or any air breathing engine or an electric generator. The engine may be used to drive the propelling device.

[0009] The propelling device may be in the form of one or more propellers or water jets.

[0010] Preferably the front of the vehicle housing includes a nose cone (or other compartment) to accommodate sensing or other equipment. The nose cone may be detachable

[0011] The strut and/or housing may further house or support equipment to control the vehicle.

[0012] The strut may be designed to add buoyancy to the vessel housing. In this respect it has been found that the strut water plane area (WPA, in metres ^ 2) to vehicle displacement (DISP, in metres ^ 3) ratio is best designed such that WPA ^ 3/2 / DISP equals a value of between 0.002 and 0.2.

[0013] The invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows a schematic side view of a semi-submersible vehicle, and
Figure 2 shows an end view of the vehicle of Figure 1.

[0014] Referring to the drawing there is shown a semi-submersible vehicle 1 having a vehicle housing or hull 2, a propelling device in the form of a propeller 3 connected to and at one end of the housing to move the vessel, and a strut 4 extending from the top of the housing 2. A ballast keel 5 is provided to maintain strut substantially vertical. As explained in more detail below, the vehicle is adapted to be sufficiently buoyant such that it maintains the vessel housing substantially at a predetermined level under the water with the strut extending out of the water.

[0015] An engine 6 is mounted on the top of the strut. The engine may be of any suitable type such as a diesel engine or an electric generator. The engine may be used to drive the propeller 3 e.g. through a suitable form of mechanical, hydraulic or electric linkage.

[0016] The front of the vehicle includes a detachable nose cone or compartment 7 to accommodate sensing or other equipment.

[0017] Central and rear control fins 8, which may be active or passive, provide stability by dynamic lift. Rudders 9 are provided to steer the vehicle. Instead of rudders one or more propulsor nozzles may be used to steer the vehicle.

[0018] As mentioned above, the vehicle is adapted to be sufficiently buoyant such that it maintains the vessel housing substantially at a predetermined level under the water with the strut extending out of the water. If the strut 4 is too large in water plane area (WPA), the strut will provide a high degree of buoyancy such that, when waves are present, this will tend to oscillate the vehicle. If, on the other hand, the WPA of the strut is too low, it will only provide a low degree of buoyancy making use of the vehicle impractical, e.g. if forces other than those from waves are applied, the vessel motion amplitude

may be too great. It has been found that a WPA (in metres ^ 2) to vehicle displacement (DISP, in metres ^ 3) ratio is best designed such that WPA ^ 3/2 / DISP equals a value of between 0.002 and 0.2.

[0019] With the engine at the top of the strut, there is less noise in the vehicle housing to interfere with any sensors or other equipment in the nose cone. Also the shape of the housing can be designed around an optimum hydrodynamic shape without need for it to accommodate the engine.

[0020] The vehicle of the invention may include other features to that mentioned above. The strut may be adapted to lift the vehicle to assist in recovering the vehicle. For example the top of the strut may include a "lifting point" to engage with a crane hoist.

[0021] The propelling device may be in a form other than a single propeller, such as a number or propellers or contra-rotating propellers , or one or more water jets.

[0022] The engine could be mounted in the housing rather than on top of the strut.

[0023] The strut and/or housing may further house or support equipment to control the vehicle. If the control equipment is located above the water level, it is possible to communicate with the vehicle through a medium other than acoustic signals, e.g. radio waves. This can lead to economies with and/or enhanced function of control equipment. A platform may be provided on the top of the strut for such control equipment and/or for other equipment such as cameras.

[0024] More than one strut may be provided on the vehicle.

[0025] The vehicle could have more than one housing, e.g. twin housings or hulls. The housings could be joined by a horizontal connection above or below the waterline.

[0026] The vehicle could be formed of any suitable material such as metal or GRP. The vehicle can be made in any desired size other than shown in the drawing. A typical size range could be from three to eight metres in length.

[0027] Further modifications will be apparent to those skilled in the art without departing from the scope of the present invention.

Claims

1. A semi-submersible vehicle comprising:

a) a vehicle housing,
b) a propelling device connected to the housing to move the vessel,
c) a strut extending from the top of the housing,

said vehicle being adapted to be sufficiently buoyant such that it maintains the vessel housing substantially at a predetermined level under the water with the strut extending out of the water.

2. A semi-submersible vehicle according to claim 1 having at least one engine mounted on the top of the strut above the water surface, the or each engine being connected to drive the propelling device.

3. A semi-submersible vehicle according to claim 1 or 2 wherein the housing is formed from two or more housings or hulls joined together above or below the waterline.

4. A semi-submersible vehicle according to any preceding claim further comprising a keel to maintain the strut substantially vertical and/or at least one active or passive control fin.

5. A semi-submersible vehicle according to any preceding claim further comprising at least one additional strut.

6. A semi-submersible vehicle according to any preceding claim wherein the or one strut is adapted to lift the vehicle to assist in recovering the vehicle.

7. A semi-submersible vehicle according to any preceding claim wherein the front of the vehicle housing includes an optionally detachable nose cone (or other compartment) to accommodate sensing or other equipment.

8. A semi-submersible vehicle according to any preceding claim wherein the or one strut and/or housing may further house or support equipment to control the vehicle.

9. A semi-submersible vehicle according to any preceding claim wherein the or each strut may be designed to add buoyancy to the vessel housing, and the strut or struts water plane area (WPA, in metres ^ 2) to vehicle displacement (DISP, in metres ^ 3) ratio is best designed such that WPA ^ 3/2 / DISP equals a value of between 0.002 and 0.2.

10. A semi-submersible vehicle substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

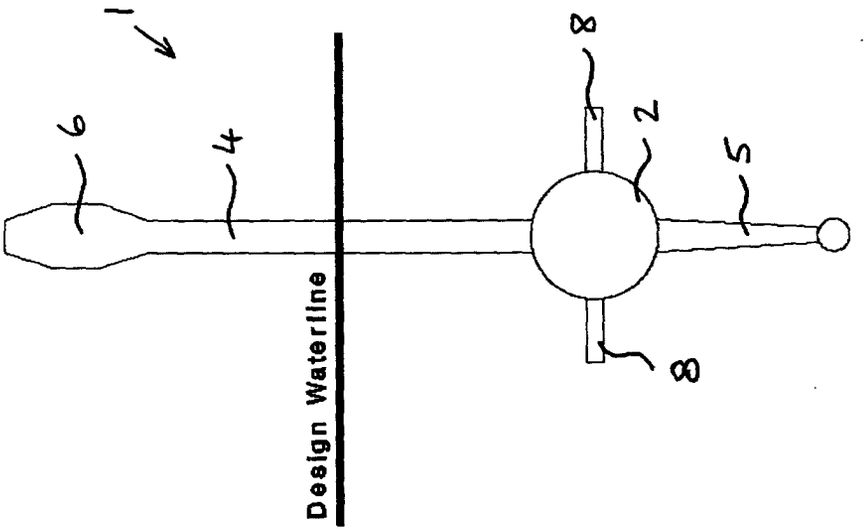

FIGURE 2

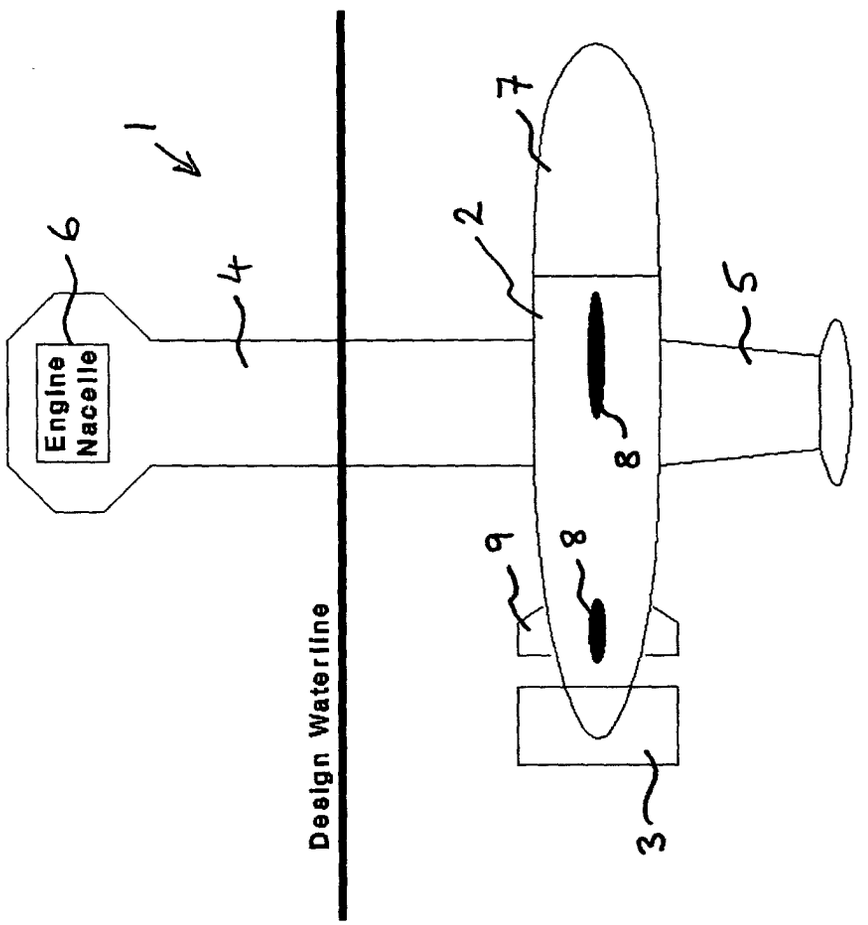

FIGURE 1