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AMPHIBIAN HULL

The present invention relates to an amphibian hull and, in particular, to a high speed amphibian hull.

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In the past, designers of amphibians have focussed their efforts on optimising either on-water or on-land performance. As a result, either on-water performance has been sacrificed in order to give satisfactory on-land performance, or on-land performance sacrificed to give satisfactory on-water performance. The resulting amphibians are compromised to one degree or another.

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To enable an amphibian to attain greater speed on water, it is desirable for the amphibian to be provided with a planing hull. Such a hull can be powered from standing where it is fully displaced to a speed where it can generate sufficient hydrodynamic lift to rise up out of the water and plane across the surface of the water.

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Generally, for optimal performance, the surface of a planing hull should contain as few discontinuities as possible, as disruptions to the surface of the hull will increase drag and compromise both the hydrodynamic lift achievable and handling on water. However, the nature of an amphibian is such that it can require the surface of the hull to contain discontinuities, such as recesses within which components, for example, wheel and suspension assemblies, are located. When attempting to optimise on-water performance, designers of amphibians with retractable wheel and suspension assemblies have expended great effort in providing movable cover mechanisms for wheel arch cut outs to re-establish the smooth uninterrupted lines of a conventional marine hull when the wheels are retracted. Movable covers and plates are known in amphibians, for example from US patents

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US4958584 (Williamson), US3421472 (Oberg), and US3280785 (Oberg). The sliding and/or hinging mechanisms of movable covers or plates are liable to seize up through corrosion, and/or through ingress of mud, sand, silt, salt, or other marine debris. They may also be damaged through collision with objects

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such as rocks during vehicle mode conversion or off-road use.
An amphibious vehicle which cannot change mode may be
immobilized; either on land, or even worse, on water.
Furthermore, the necessity of maintaining and scrupulously
5 cleaning sliding and/or hinging mechanisms may not likely be
acceptable to the vehicle owner, who will be accustomed to the
less onerous demands of modern cars and boats. Although movable
covers or plates have been proposed in several amphibians
patents as noted above, these have not made it to series
10 production.

Furthermore, the designers of planing hulls for watercraft
usually adopt a dead rise angle of between 10 and 25 degrees.
However, to date, designers of amphibians have found it
15 desirable to reduce as far as possible the dead rise angle in
order to provide for adequate ground clearance when an amphibian
is used on land. Such a low dead rise angle can detrimentally
affect the ride of the hull when planing on water.

20 In addressing the above problems in the more recent past,
the applicant has retained wheel arches in the hull but
developed hydrodynamic aids such as planing plates to help
recover at least part of the hull form (as disclosed in the
applicant's UK patent no. GB2401832B) and strakes to improve
25 directional stability of the hull when on the plane (as
disclosed in the applicant's UK patent no. GB2401833B).

The applicant has now developed a high speed amphibian
with a V hull having optimised on-land and on-water performance.
30 The amphibian can plane on water, yet has on-road, off-road and
utilitarian capability and is operable in two and/or four-wheel
drive. This type of high speed amphibian further compounds the
problems identified above since a greater ground clearance is
required for off-road use and a bigger mass must be propelled up
35 onto the plane. Surprisingly, this new amphibian capability has
been achieved using a V hull according to the present invention.
To this end, the applicant has gone against conventional
thinking and overcome previous technical prejudices in arriving
at the hull configuration according to the present invention.

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In particular, the applicant has developed the shape and configuration of the front bow section of a hull to arrive at an optimised hull form for high speed amphibian use.

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Accordingly, the present invention provides, in a first aspect, an amphibian operable in land and marine modes, the amphibian comprising:

- a hull;
- 10 at least one discontinuity provided in the hull; and
- at least one retractable wheel or track drive assembly at least partially located in the at least one discontinuity, wherein:
 - a wheel or track drive of the at least one retractable
 - 15 wheel or track drive assembly is retracted above the lowest point of the hull when operating in marine mode, and at least part of the wheel or track drive is protracted below the lowest point of the hull when operating in land mode,
 - the hull is a planing V hull;
 - 20 the hull has a forward bow section defining a frontal bow surface/area across a beam of the hull;
 - the at least one discontinuity is provided in the forward bow section of the hull; and
 - at least a portion of the wheel or track drive of the at
 - 25 least one retractable wheel or track drive assembly is located ahead of and in front of at least a portion of the frontal bow surface/area when protracted.

- Preferably, at least a portion of the wheel or track drive
- 30 of the at least one retractable wheel or track drive assembly is located ahead of and in front of at least a portion of the frontal bow surface/area when retracted.

- Preferably, the forward bow section is formed by a central
- 35 bow portion and port and starboard bow portions, each of central bow portion and port and starboard bow portions contributing to the frontal bow surface/area across a beam of the hull.

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Preferably, at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions is spaced laterally from and to the rear of the frontal bow surface/areas contributed by the central bow portion.

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Preferably, the portion of the wheel or track drive of the at least one retractable wheel or track drive assembly located ahead of and in front of the portion of the frontal bow surface/area when protracted is located ahead of and in front of the portion of the frontal bow surface/area contributed by the port or starboard bow portion.

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Preferably, at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions are contoured such that the plane of each area/surface varies in at least one axis of that plane.

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More preferably, at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions are contoured such that the plane of each area/surface varies in at least two non coincident axes of that plane.

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In a second aspect, the present invention provides an amphibian operable in land and marine modes, the amphibian comprising:

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a hull;
at least one discontinuity provided in the hull; and
at least one retractable wheel or track drive assembly at least partially located in the at least one discontinuity,
wherein:

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a wheel or track drive of the at least one retractable wheel or track drive assembly is retracted above the lowest point of the hull when operating in marine mode, and at least part of the wheel or track drive is protracted below the lowest point of the hull when operating in land mode,

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the hull is a planing V hull;
the hull has a forward bow section defining a frontal bow surface/area across a beam of the hull;

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the at least one discontinuity is provided in the forward bow section of the hull;

the forward bow section is formed by a central bow portion and port and starboard bow portions, each of central bow portion
5 and port and starboard bow portions contributing to the frontal bow surface/area across a beam of the hull;

at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions is spaced laterally from and to the rear of the frontal bow
10 surface/areas contributed by the central bow portion; and

at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions are contoured such that the plane of each area/surface varies in
15 at least one axis of that plane.

Preferably, the portions of each of the frontal bow surface/areas contributed by the port and starboard bow portions are contoured such that the plane of each area/surface varies in
20 at least two non coincident axes of that plane.

Preferably, at least a portion of the wheel or track drive of the at least one retractable wheel or track drive assembly is located ahead of and in front of at least a portion of the
25 frontal bow surface/area when protracted.

Preferably, the portion of the wheel or track drive of the at least one retractable wheel or track drive assembly located ahead of and in front of the portion of the frontal bow
30 surface/area when protracted is located ahead of and in front of the portion of the frontal bow surface/area contributed by the port or starboard bow portion.

Preferably, the frontal bow surface/areas FP or FS contributed by the port and starboard bow portions P, S is/are
35 located behind the at least one discontinuity provided in the forward bow section of the hull.

Preferably, no part of the frontal bow surface/areas FP or FS contributed by the port and starboard bow portions P, S

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is/are located ahead of the at least one discontinuity provided in the forward bow section of the hull.

5 Preferably, more than 50% of the length of the hull has a deadrise angle in the range of 5 to 70 degrees, more preferably in the range of 10 to 50 degrees, and even more preferably in the range of 15 to 35 degrees.

10 Yet more preferably, more than 50% of the length of the hull has a deadrise angle of substantially 20 degrees.

Preferably, one or more jet drives or propellers are provided as a marine propulsion means.

15 Preferably, the one or more jet drives or propellers can propel the amphibian to a speed where sufficient hydrodynamic lift is generated to enable the vehicle to plane.

20 Preferably, the amphibian further comprises a four wheel drive or track drive powertrain which can be driven in two or four wheel drive or track drive.

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

Figure 1 is a schematic plan view from below of an amphibian hull according to the present invention;

Figure 2 is an enlarged detail view of the front bow section of the amphibian hull of Figure 1;

30 Figure 3 is an enlarged detail view of the front bow section of the amphibian hull of Figure 1 with front wheels shown schematically in a protracted position;

Figure 4 is a schematic front elevation view of the bow section of the amphibian hull of Figure 1;

35 Figure 5 is a schematic front elevation view of the bow section of the amphibian hull of Figure 1 with front wheels shown schematically in a protracted position;

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Figure 6 is a schematic front elevation view of the bow section of the amphibian hull of Figure 1 with front wheels shown schematically in a retracted position;

Figure 7 is a schematic perspective view from below and one side of the front bow section of the amphibian hull of Figure 1;

Figure 8 is a schematic side elevation view of the front bow section of the amphibian hull of Figure 1;

Figure 9 is a schematic side elevation view of the amphibian hull of Figure 1;

Figure 10 is a schematic perspective view from below and one side of the amphibian hull form of Figure 1; and

Figure 11 is a further schematic perspective view from below and one side of the amphibian hull form of Figure 1.

Referring now to the Figures, there is shown an amphibian hull 10 comprising a forward bow section 40 and a rearward stern section 80. A midships section 70 extends between the forward bow section 40 and the rearward stern section 80. The respective lengths and/or proportions of the forward bow section 40, midships section 70 and the rearward stern section 80 shown in the context of the length of the hull 10 are indicative only and may be varied as appropriate. Provided on the underside of the hull 10 in the forward bow section 40 are a pair of discontinuities 48, 49 which serve as forward wheel arches. In the rear stern section 80 are provided a pair of discontinuities 90, 91 which serve as rear wheel arches. The wheel arches 48, 49, 90 and 91 do not form complete wheel arches which envelop the entire upper periphery of a wheel in the normal sense of a wheel arch for a road only going vehicle, but each does provide space to receive a retractable wheel assembly (shown schematically in Figure 3, for example, by wheels 110, 112) which preferably includes a retractable suspension assembly. The wheels 110, 112 can each be moved between a protracted position, for use of the amphibian on land (including entry into and egress from the water), and a retracted position for use of the amphibian on water. The wheels 110, 112 may moved into the retracted position to reduce drag when the amphibian is operated in water.

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One or more jet drives or propellers (not shown) may be located in recesses 100, 101 at the rear of the hull 10, either in the centre of or offset from the centre line of the hull 10.

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The hull 10 takes the form of a deep V planing hull. Such a hull 10 can be powered from standing where it is fully displaced to a speed where it can generate sufficient hydrodynamic lift to rise up out of the water and plane across the surface of the water. The hull 10 comprises a planing surface 20. The forward bow section 40 has a bespoke design to address the problems described above and experienced by introducing discontinuities (disruptions) in the hull 10 to accommodate the front wheel and suspension assemblies. With particular reference to Figures 2, 4 and 7, it can be seen that the forward bow section 40 of the hull 10 comprises a central bow portion C and port and starboard bow portions P, S. An indicative line B (shown for reference only in Figures 4 and 8) is used to illustrate the difference and transition in beam of the hull 10 at this line B between the bow 14 and the midships section 70. The central bow portion C extends further forward towards the bow 14 at the line B than the port and starboard bow portions P, S. The beam of the hull 10 at the line B increases between the bow 14 towards the midships section 70. Indeed, the developing beam of the hull 10 at the line B is such that the port and starboard bow portions P, S are provided behind the discontinuities 48, 49 which serve as forward wheel arches. The central bow portion C and port and starboard bow portions P, S are thus the frontal areas/surfaces of the hull which interface and interact with the water at the water line in the static, displacement and planing modes of operation, even on turning of the amphibian. The respective frontal areas/surfaces FC, FP and FS of each of the central bow portion C and port and the starboard bow portions P, S are contoured such that the plane of each area/surface varies in at least one axis of the plane. However, it is especially preferred that the plane of each area/surface varies in at least two non coincident axes of that plane. In particular, it is to be noted that there are no surface features in the frontal areas/surfaces FP and FS of each

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of the port and the starboard bow portions P, S which serve to cause drag when in contact with the water.

5 The hull 10 begins with very a steep dead rise angle at the bow 14 and this dead rise angle transitions through the length of the forward bow section 40 to a dead rise angle of some 20 degrees along a substantial part of the rest of the hull 10 towards the stern 18. Alternative dead rise angles may be employed. For example, a significant portion (more than 50%) of
10 the length of the hull 10 will have a dead rise angle in the range of 5 to 70 degrees, more preferably in the range of 10 to 50 degrees, and even more preferably in the range of 15 to 35 degrees.

15 With particular reference to Figure 1, there is shown a schematic plan view from below of the hull 10 according to the present invention. For reasons of clarity, no wheels, suspension, powertrain or marine propulsion is shown. Figure 2 is an enlarged detail view of the front bow section 40 of the
20 hull 10, again with no wheels, suspension, powertrain or marine propulsion shown. Figure 3 differs from Figure 2 in that front wheels 110, 112 are shown schematically in a protracted position in discontinuities 48, 49 which serve as forward wheel arches. Figure 4 is a schematic front elevation view of the bow section
25 of the hull 10 and illustrates the central bow portion C and port and starboard bow portions P, S and their respective frontal areas/surfaces FC, FP and FP which interface and interact with the water at the water line in the static, displacement and planing modes of operation. Figure 5 differs
30 from Figure 4 in that front wheels 110, 112 are shown schematically in a protracted position in discontinuities 48, 49. Figure 6 shows the front wheels 110, 112 schematically in a protracted position in discontinuities 48, 49. Figure 7 is a schematic perspective view from below and one side of the front
35 bow section 40 of the hull 10, while Figure 8 is a schematic side elevation view of the front bow section 40. Figures 9 and 10 schematically illustrate the surface hull form.

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In order for the amphibian to make the transition from its hull 10 being in displacement mode to one where it is planing, the through water speed of the amphibian must be increased to achieve the necessary hydrodynamic lift. The V hull and frontal
5 bow section 40 is key in reducing the drag of the hull 10 and facilitating the necessary gain in speed of the amphibian through the water. Once on the plane, the V of the hull 10 provides directional stability. However, the V of the hull may be supplemented with conventional strakes or strakes as
10 discussed in the applicant's UK patent no. GB2401833B.

Whilst wheels have been described throughout as the land propulsion means, track drives or individual track drives (i.e. to replace a single wheel) may be used as an alternative or in
15 combination with wheels.

Each feature disclosed in this specification (including the accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar
20 purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features. In addition, all of the features disclosed in this specification (including the accompanying claims, abstract and
25 drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. Accordingly, while different embodiments of the present invention have been described above,
30 any one or more or all of the features described, illustrated and/or claimed in the appended claims may be used in isolation or in various combinations in any embodiment. As such, any one or more feature may be removed, substituted and/or added to any of the feature combinations described, illustrated and/or
35 claimed. For the avoidance of doubt, any one or more of the features of any embodiment may be combined and/or used separately in a different embodiment with any other feature or features from any of the embodiments.

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Whereas the present invention has been described in
relation to what is presently considered to be the most
practical and preferred embodiments, it is to be understood that
the invention is not limited to the disclosed arrangements but
5 rather is intended to cover various modifications and equivalent
constructions included within the scope of the appended claims.

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CLAIMS

1. An amphibian operable in land and marine modes, the amphibian comprising:
- 5 a hull;
- at least one discontinuity provided in the hull; and
- at least one retractable wheel or track drive assembly at least partially located in the at least one discontinuity, wherein:
- 10 a wheel or track drive of the at least one retractable wheel or track drive assembly is retracted above the lowest point of the hull when operating in marine mode, and at least part of the wheel or track drive is protracted below the lowest point of the hull when operating in land mode,
- 15 the hull is a planing V hull;
- the hull has a forward bow section defining a frontal bow surface/area across a beam of the hull;
- the at least one discontinuity is provided in the forward bow section of the hull; and
- 20 at least a portion of the wheel or track drive of the at least one retractable wheel or track drive assembly is located ahead of and in front of at least a portion of the frontal bow surface/area when protracted.
- 25 2. An amphibian as claimed in claim 1 wherein at least a portion of the wheel or track drive of the at least one retractable wheel or track drive assembly is located ahead of and in front of at least a portion of the frontal bow surface/area when retracted.
- 30 3. An amphibian as claimed in claim 1 or claim 2 wherein the forward bow section is formed by a central bow portion and port and starboard bow portions, each of central bow portion and port and starboard bow portions contributing to the frontal bow
- 35 surface/area across a beam of the hull.
4. An amphibian as claimed in claim 3 wherein at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions is spaced laterally from and

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to the rear of the frontal bow surface/areas contributed by the central bow portion.

5. An amphibian as claimed in claim 3 or claim 4 wherein the
5 portion of the wheel or track drive of the at least one retractable wheel or track drive assembly located ahead of and in front of the portion of the frontal bow surface/area when protracted is located ahead of and in front of the portion of the frontal bow surface/area contributed by the port or
10 starboard bow portion.

6. An amphibian as claimed in any one of claims 3, 4 or 5 wherein at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions
15 are contoured such that the plane of each area/surface varies in at least one axis of that plane.

7. An amphibian as claimed in any one of claims 3, 4, 5 or 6 wherein at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions
20 are contoured such that the plane of each area/surface varies in at least two non coincident axes of that plane.

8. An amphibian operable in land and marine modes, the
25 amphibian comprising:
a hull;
at least one discontinuity provided in the hull; and
at least one retractable wheel or track drive assembly at least partially located in the at least one discontinuity,
30 wherein:

a wheel or track drive of the at least one retractable wheel or track drive assembly is retracted above the lowest point of the hull when operating in marine mode, and at least part of the wheel or track drive is protracted below the lowest
35 point of the hull when operating in land mode,
the hull is a planing V hull;
the hull has a forward bow section defining a frontal bow surface/area across a beam of the hull;

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the at least one discontinuity is provided in the forward bow section of the hull;

the forward bow section is formed by a central bow portion and port and starboard bow portions, each of central bow portion
5 and port and starboard bow portions contributing to the frontal bow surface/area across a beam of the hull;

at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions is spaced laterally from and to the rear of the frontal bow
10 surface/areas contributed by the central bow portion; and

at least a portion of each of the frontal bow surface/areas contributed by the port and starboard bow portions are contoured such that the plane of each area/surface varies in
15 at least one axis of that plane.

9. An amphibian as claimed in claim 8 wherein the portions of each of the frontal bow surface/areas contributed by the port and starboard bow portions are contoured such that the plane of each area/surface varies in at least two non coincident axes of
20 that plane.

10. An amphibian as claimed in claim 8 or claim 9 wherein at least a portion of the wheel or track drive of the at least one retractable wheel or track drive assembly is located ahead of
25 and in front of at least a portion of the frontal bow surface/area when protracted.

11. An amphibian as claimed in claim 10 wherein the portion of the wheel or track drive of the at least one retractable wheel
30 or track drive assembly located ahead of and in front of the portion of the frontal bow surface/area when protracted is located ahead of and in front of the portion of the frontal bow surface/area contributed by the port or starboard bow portion.

12. An amphibian as claimed in any one of the preceding claims wherein more than 50% of the length of the hull has a deadrise angle in the range of 5 to 70 degrees, more preferably in the range of 10 to 50 degrees, and even more preferably in the range of 15 to 35 degrees.

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13. An amphibian as claimed in claim 12 wherein more than 50% of the length of the hull has a deadrise angle of substantially 20 degrees.

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14. An amphibian as claimed in any one of the preceding claims further comprising a one or more jet drives or propellers as a marine propulsion means.

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15. An amphibian as claimed in claim 14 wherein the one or more jet drives or propellers can propel the amphibian to a speed where sufficient hydrodynamic lift is generated to enable the vehicle to plane.

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16. An amphibian as claimed in any one of claims 3 to 15 wherein no part of the frontal bow surface/areas FP or FS contributed by the port and starboard bow portions P, S is located ahead of and in front of at least a portion of the wheel or track drive when retracted.

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17. An amphibian as claimed in any one of claims 3 to 16 wherein the frontal bow surface/areas FP or FS contributed by the port and starboard bow portions P, S is/are located behind the at least one discontinuity provided in the forward bow section of the hull.

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18. An amphibian as claimed in any one of claims 3 to 17 wherein no part of the frontal bow surface/areas FP or FS contributed by the port and starboard bow portions P, S is/are located ahead of the at least one discontinuity provided in the forward bow section of the hull.

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19. An amphibian as claimed in any one of the preceding claims further comprising a four wheel drive or track drive powertrain which can be driven in two or four wheel drive or track drive.

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20. An amphibian substantially as hereinbefore described with reference to or as shown in the accompanying drawings.