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(54) Title: SUBMERSIBLE MULTI-HULL CRAFT

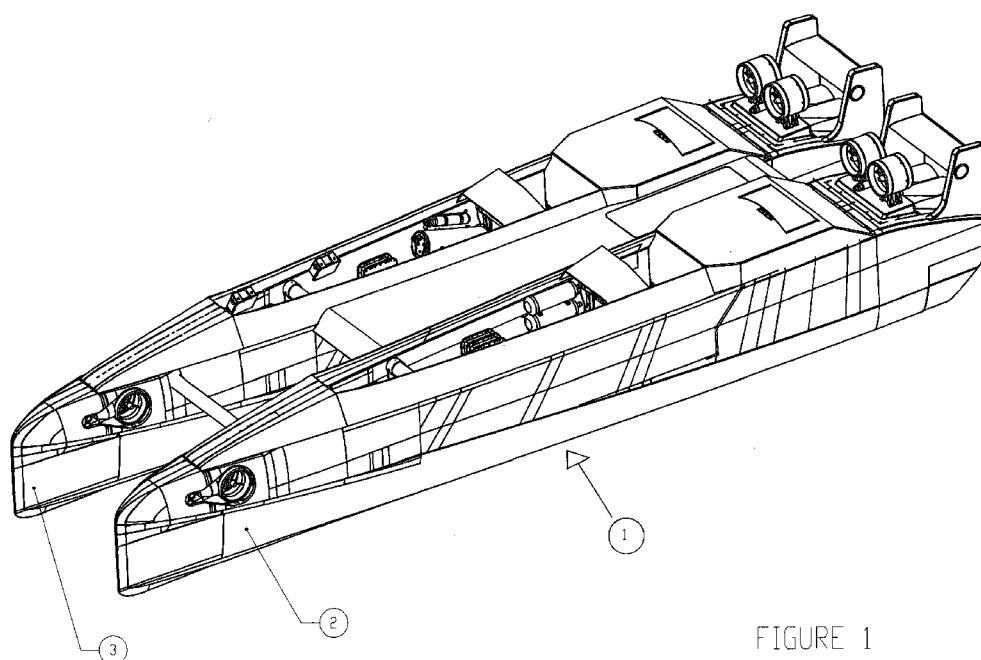


FIGURE 1

(57) Abstract: A submergible multi-hull craft has identical port and starboard hulls, each has watertight compartments and an open cockpit amidships. The hulls are fixedly interconnected by four tubular beams. A deck extends between the hulls over the beams. Floodable and blowable buoyancy tanks with compressed air reservoirs are provided in the compartments and in the cockpit. Each hull has a steerable thrust diesel engine propulsion in a watertight enclosure. The hulls each have two, forward, thrusters with cowlings with propellers. The thrusters can be stowed for surface passage and swung out from the recesses in the hulls when submerged. They can be rotated to thrust up or down. Aft, each hull has two further, aft, thrusters. Astern of them trim surfaces are provided between skegs.



EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
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Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

SUBMERSIBLE MULTI-HULL CRAFT

The present invention relates to a submergible multi-hull craft.

5 Whilst some submarines, particularly smaller ones (also known as
“submersibles” when provided with an umbilical for powering from the surface) not
intended for passage far on the surface, are electrically powered only; normally a
submarine is provided with electric propulsion means for submerged passage and
diesel propulsion for surface passage (diesel propulsion whilst submerged is possible
10 only with expedients such as a snorkel).

 Generally the same propeller is used for submerged electric propulsion and
surface diesel propulsion. This requires either clutching of one or other of an electric
motor and a diesel engine to a propeller shaft, unless the diesel engine drives a
15 generator driving the electric motor.

 Most submarines have a hull closable with a hatch for accommodating a crew
in a dry environment or at least a capsule for the crew in a submersible. Not all
submarines provide a dry environment for the crew. In a “wet submarine”, generally
20 the crew ride the submarine, in the manner of a horse or a motorbike, wearing diving
gear.

 Proposals have been put forward for catamaran submarines, with two separate,
spaced hulls (not to be confused with to a “double hull” having a pressure hull within
25 a casing or outer hull). The applicant is not aware of any catamaran submarine having
been made.

 The object of the present invention is to provide an improved submergible
multi-hull craft.

30

 According to one aspect of the invention there is provided a submergible
multi-hull craft comprising:

- at least two hulls,

- interconnecting structure for spacing the hulls from each other,
- non-electric means for surface propulsion and
- electric means for submerged propulsion.

5 Whilst it can be envisaged that the two propulsion means could be mechanically interconnected as by a non-electric motor and an electric motor arranged to drive through a common propeller; preferably they are independent, ideally both mechanically and electrically.

10 Further whilst it can be envisaged that the non-electric propulsion means could be adapted for charging of batteries for the electric propulsion means; preferably the non-electric propulsion means is provided with generation capacity equivalent to a minor proportion of the battery capacity, the batteries being arranged for interchangeability or recharging via a recharge connection from an external source.

15 Also whilst it can be envisaged that the hulls could be arranged as a central hull and two, port and starboard, outrigger hulls; preferably, the hulls are arranged as a pair of similar port and starboard hulls in a catamaran arrangement.

20 Preferably each hull its own non-electric means for surface propulsion and its own electric means for submerged propulsion.

 According to another aspect of the invention there is provided a submergible multi-hull craft, comprising:

- 25 • at least two hulls,
- interconnecting structure for spacing the hulls from each other,
 - surface propulsion means, including
 - at least one propeller or water impeller and
 - submerged propulsion means, including
- 30 • at least one other propeller or water impeller.

 Preferably the craft includes one or more of the following features:

- the surface propulsion propeller(s) or impellers are arranged to be at least substantially out of water flow past the hulls when the craft is submerged;
- the surface propulsion means is at least one jet or pump drive;
 - the or each jet or pump drive preferably being directable for steering and
- 5 • one is in one hull and the other is in the other when two or more are provided;
- the submerged propulsion propeller(s) or water impeller(s) are arranged above the craft's surface propulsion waterline;
- the submerged propulsion propeller(s) or water impeller(s) are arranged as at
- 10 least one fore and aft set;
- the submerged propulsion propeller(s) or water impeller(s) are arranged as at least one port and starboard pair;
- the submerged propulsion propeller(s) or water impeller(s) or at least some of them are arranged to be steerable or to have their thrust steered by a steering
- 15 fin in their flow;
- the submerged propulsion propeller(s) or water impeller(s) or at least some of them are arranged to be vectored up and down and/or to have their thrust vectored by a steering fin in their flow and/or adapted to be driven at differential thrust speeds for steering.

20

According to a third aspect of the invention there is provided a submergible multi-hull craft, comprising:

- at least two hulls and
 - interconnecting structure for spacing the hulls from each other;
- 25 wherein the hulls are not provided with dry environment crew accommodation.

Preferably the craft includes one or more of the following features:

- the interconnecting structure fixedly spaces the hulls from each other;
- the interconnecting structure is adapted for pivotal arrangement of the hulls
- 30 into a configuration more compact than a use configuration in which the hulls are spaced from each other in an even keel arrangement;
- each hull has at least one crew station or cockpit;
- one crew station of one or both hulls is a helmsman's station or cockpit;

- pumps are provided for pumping out the crew accommodation for surface passage;
- floodable buoyancy tanks for trimming the craft when submerged.

5 To help understanding of the invention, a specific embodiment thereof will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is an isometric view of a submergible multi-hull craft in accordance with the invention;

10 Figure 2 is a side view of the craft of Figure 1;

Figure 3 is a plan view of the craft;

Figure 4 is a front view of the craft;

Figure 5 is an aft view of the craft;

15 Figure 6 is a side view similar to that of Figure 2, showing the position of certain main components of the craft.

Referring to the drawings, the craft 1 there shown has a port hull 2 and a starboard hull 3, which are substantially identical and parallel with each other. They comprise a watertight forrard compartment 4, a watertight aft compartment 5 and an
20 open cockpit 6 amidships. Fore and aft bulkheads 7,8 are provided to close the watertight compartments 4,5.

The hulls are interconnected by four tubular beams 11,12,13,14. These are fast with both sides of the hulls. The forrard beam 11 is secured to the forrard
25 bulkheads 7. The second and third beams 12,13 are secured to ribs 16,17 between the bulkheads and the fourth beam is secured to aft ribs 18 in the aft compartments. A deck 19 extends between the hulls over the beams 12,13,14, but not over the front beam 11.

30 Buoyancy tanks which are floodable and blowable and have integral compressed air reservoirs are provided as a forrard tank 21 in the forrard compartment 4, a midships tank 22 in the cockpit 6 and three aft tanks 23 in the aft compartment,

three being provided in view of the mass of the engines referred to below. Crew air bottles 24 are provided in the cockpit.

Each hull also has in its aft compartment a steerable thrust diesel engine propulsion system 25, which is an off the shelf unit, with a waterjet thrust unit. The systems include a watertight enclosure 26 whereby the aft compartment can be flooded with the engine remaining dry. The enclosures are provided with non-shown, sealable air intakes for surface running of the engines passing through the aft compartments.

Forrard, the hulls each have two, forrard, thrusters 31. These are deployable from recesses 32 in the sides of the hulls. The recesses have watertight walls 33 sealing them from the forrard compartments. The forrard thrusters have cowlings 34 in which electrically driven propellers 35 are journalled. The cowlings are connected to the hulls via arms 36. These are pivotally connected to the hulls at their proximal ends about upright axes 37. The cowlings are pivotally connected to their arms about horizontal axes 38. The arrangement is such that the thrusters can be stowed for surface passage and swung out from the recesses in the hulls when submerged and powered to thrust ahead or astern. They can be rotated to thrust up or down to provide vectored thrust for assisting in surfacing or diving.

Aft, each hull has two further, aft, thrusters 41 provided. They have similar cowlings 42 in which further electrically driven propellers 43 journalled. They are fixed in their deployment as they remain above water during surface passage. Astern of them trim surfaces 26 are provided between skegs 27. When submerged, the thrusters can drive ahead or astern. The attitude of the trims surfaces, past which water flows from/to the thrusters, can be controlled for surfacing and diving.

Whilst the cockpits are shown empty, normally stations for one crew member per hull will be provided between the third beam and the aft compartments. At least one of the stations will be provided with conning instruments and handles, not shown, but arranged in conjunction with a control system housing 51.

When the craft is arranged for personnel, each hull can have two crew stations between the second and third beams 12,13. A further crew station can be provided between the forrard bulkhead 4 and the first beam 11.

5 Further important features are batteries 52 for the thrusters in the bottom of the central part of the cockpit and diesel tanks 53 for the surface propulsion engines in the bottom of the aft part of the cockpit. Pumps 54 are provided in the bottom of the forrard part of the cockpit.

10 For surface passage, the hulls are pumped out, that is to say all of the forrard and aft compartments and the cockpits. The craft floats high in the water and can be propelled at speed by the diesel engine propulsion systems.

For submerged passage, the compartments and the cockpit are flooded. The
15 craft then has neutral buoyancy and can be trimmed with the tanks 21,22,23. These are half flooded when the craft has neutral buoyancy. To dive the tanks are flooded somewhat and the thrusters 31,41 and the aft trim surfaces 26 can be set to maintain an even keel during diving. For continued passage the thrusters and the trim surfaces can be set level and the tanks adjusted as required. Submerged steering is by
20 differential speed of port and starboard thrusters. Surfacing is the reverse procedure including pumping out for surface passage.

The craft can be of fibre reinforced polymer construction.

25 The invention is not intended to be restricted to the details of the above described embodiment. For instance, whilst the following are not expected to be required, they remain possibilities:

- Rudders aft,
- Vectoring of the aft thrusters in the manner of the forrard thrusters,
- 30 • Forrard hydroplanes.
- Steerable thrusters.

Further it is envisaged that the beams could be hinged at their point of meeting the hulls for reducing the width of the craft for air transport.

CLAIMS:

1. A submersible multi-hull craft comprising:
 - at least two hulls,
 - interconnecting structure for spacing the hulls from each other,
 - 5 • non-electric means for surface propulsion and
 - electric means for submerged propulsion.
2. A submersible multi-hull craft as claimed in claim 1, wherein that the two propulsion means are mechanically interconnected.
3. A submersible multi-hull craft as claimed in claim 1, wherein that the two
- 10 propulsion means are independent, preferably both mechanically and electrically.
4. A submersible multi-hull craft as claimed in claim 1, claim 2 or claim 3, wherein the non-electric propulsion means is adapted for charging of batteries for the electric propulsion means.
5. A submersible multi-hull craft as claimed in claim 1, claim 2 or claim 3, wherein
- 15 the non-electric propulsion means is provided with generation capacity equivalent to a minor proportion of the capacity of batteries for the electric propulsion means, the batteries being arranged for interchangeability or recharging via a recharge connection from an external source.
6. A submersible multi-hull craft as claimed in any preceding claim, wherein the
- 20 hulls are arranged as a central hull and two, port and starboard, outrigger hulls.
7. A submersible multi-hull craft as claimed in any one of claims 1 to 5; wherein the hulls are arranged as a pair of similar port and starboard hulls in a catamaran arrangement.
8. A submersible multi-hull craft as claimed in claim 7, wherein each hull its own
- 25 non-electric means for surface propulsion and its own electric means for submerged propulsion.
9. A submersible multi-hull craft comprising:
 - at least two hulls,
 - interconnecting structure for spacing the hulls from each other,
 - 30 • surface propulsion means, including
 - at least one propeller or water impeller and
 - submerged propulsion means, including
 - at least one other propeller or water impeller.

10. A submergible multi-hull craft as claimed in claim 9, wherein the surface propulsion propeller(s) or impellers are arranged to be at least substantially out of water flow past the hulls when the craft is submerged.

11. A submergible multi-hull craft as claimed in claim 10, wherein the surface propulsion means is at least one jet or pump drive, one in one hull and the other in the other when two or more are provided.

12. A submergible multi-hull craft as claimed in claim 11, wherein the or each jet or pump drive are directable for steering.

13. A submergible multi-hull craft as claimed in any one of claims 9 to 12, wherein the submerged propulsion propeller(s) or water impeller(s) are arranged above the craft's surface propulsion waterline.

14. A submergible multi-hull craft as claimed in claim 13, wherein the submerged propulsion propeller(s) or water impeller(s) are arranged as at least one fore and aft set

15. A submergible multi-hull craft as claimed in claim 13 or claim 14, wherein the submerged propulsion propeller(s) or water impeller(s) are arranged as at least one port and starboard pair.

16. A submergible multi-hull craft as claimed in claim 13, claim 14 or claim 15, wherein the submerged propulsion propeller(s) or water impeller(s) or at least some of them are arranged to be steerable or to have their thrust steered by a steering fin in their flow.

17. A submergible multi-hull craft as claimed in any one of claims 13 to 16; wherein the submerged propulsion propeller(s) or water impeller(s) or at least some of them are arranged to be vectored up and down and/or to have their thrust vectored by a steering fin in their flow and/or adapted to be driven at differential thrust speeds for steering.

18. A submergible multi-hull craft, comprising:

- at least two hulls, the hulls having
 - crew accommodation and
- interconnecting structure for spacing the hulls from each other;

wherein the crew accommodation is provided as wet, not dry environment, crew accommodation.

19. A submergible multi-hull craft as claimed in claim 18, wherein the interconnecting structure fixedly spaces the hulls from each other.

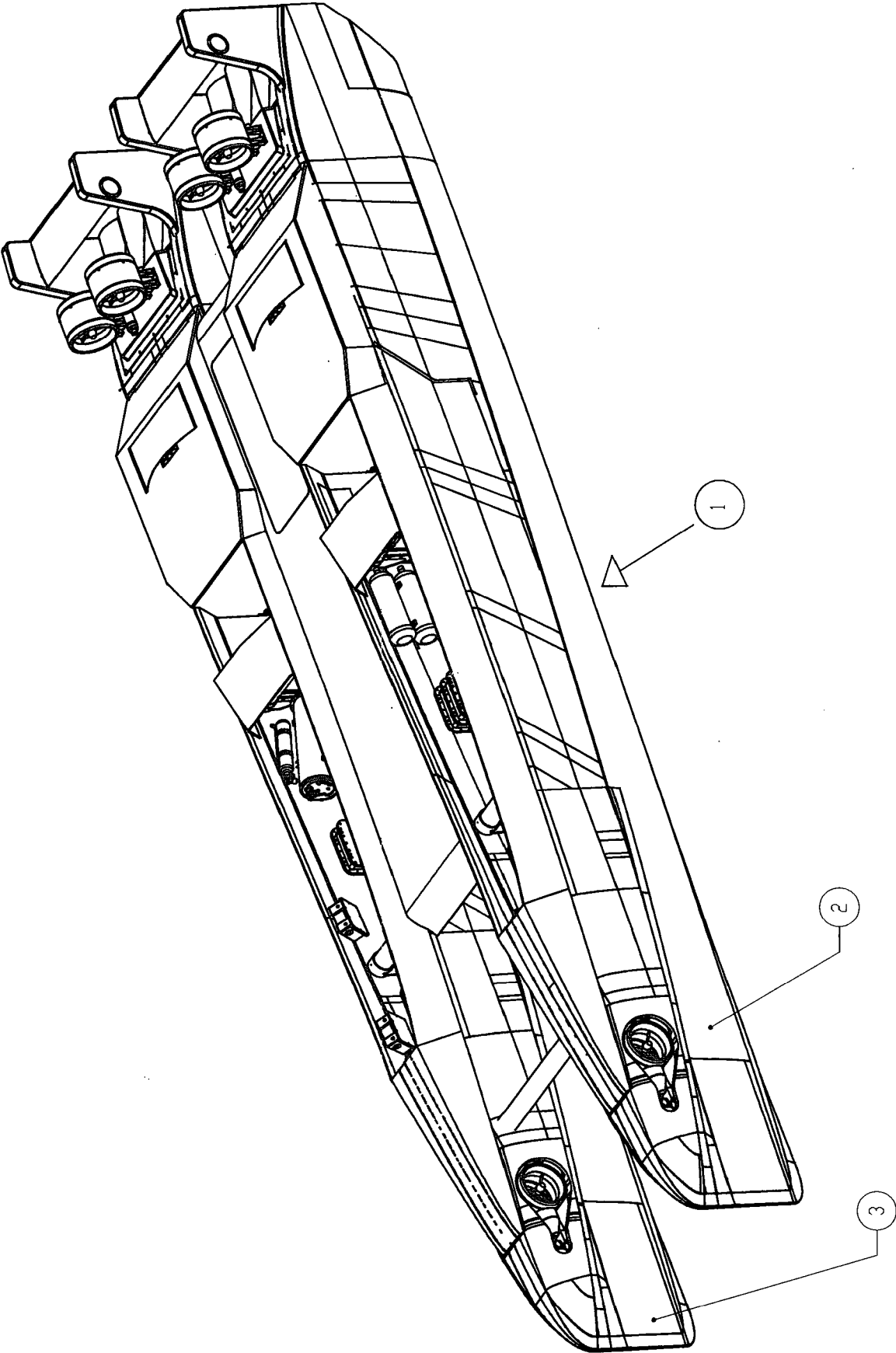
20. A submergible multi-hull craft as claimed in claim 18, wherein the interconnecting structure is adapted for pivotal arrangement of the hulls into a configuration more compact than a use configuration, in which the hulls are spaced from each other in an even keel arrangement.

21. A submergible multi-hull craft as claimed in claim 18, claim 19 or claim 20, wherein each hull has at least one crew station or cockpit.

22. A submergible multi-hull craft as claimed in claim 21, wherein one crew station of one or both hulls is a helmsman's station or cockpit.

23. A submergible multi-hull craft as claimed in any one of claims 18 to 22, including pumps for pumping out the crew accommodation for surface passage.

24. A submergible multi-hull craft as claimed in any one of claims 18 to 24, including floodable buoyancy tanks for trimming the craft when submerged.



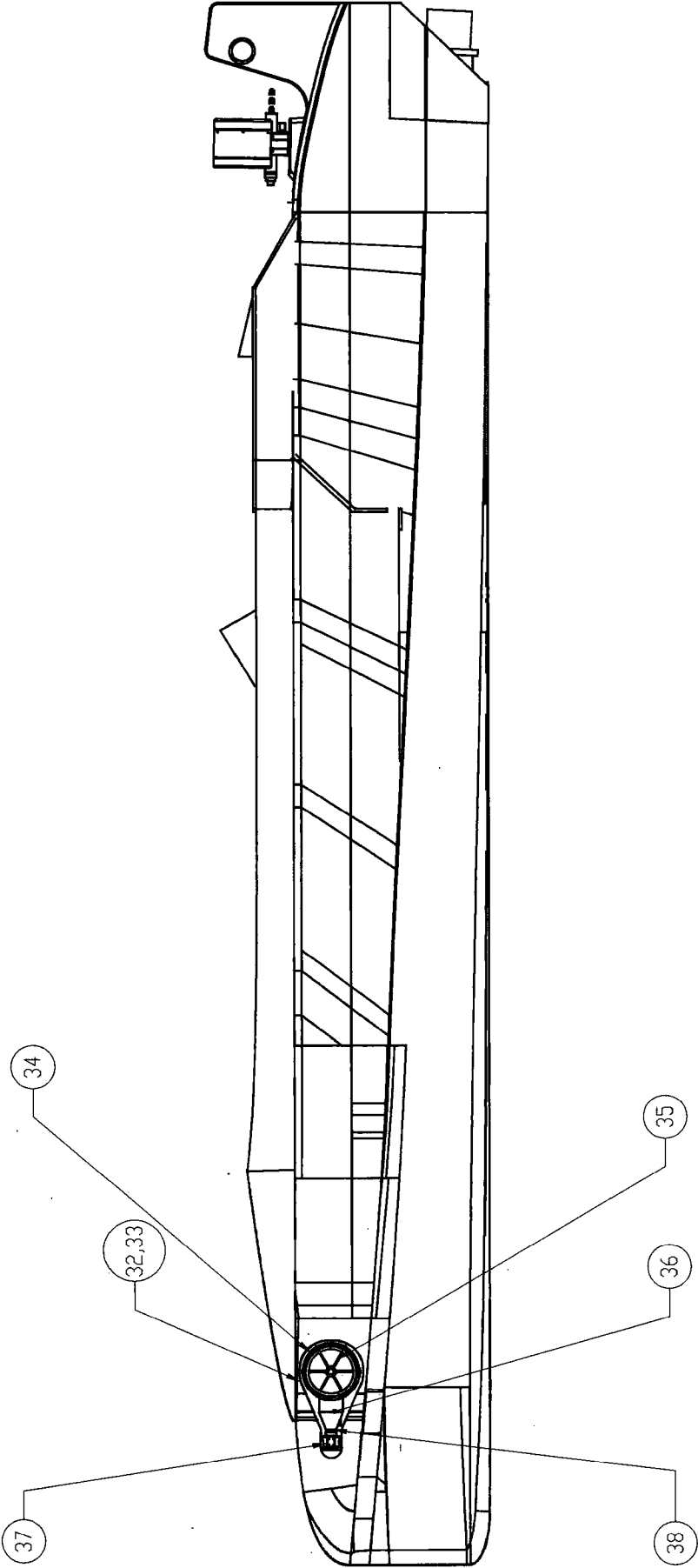


FIGURE 2

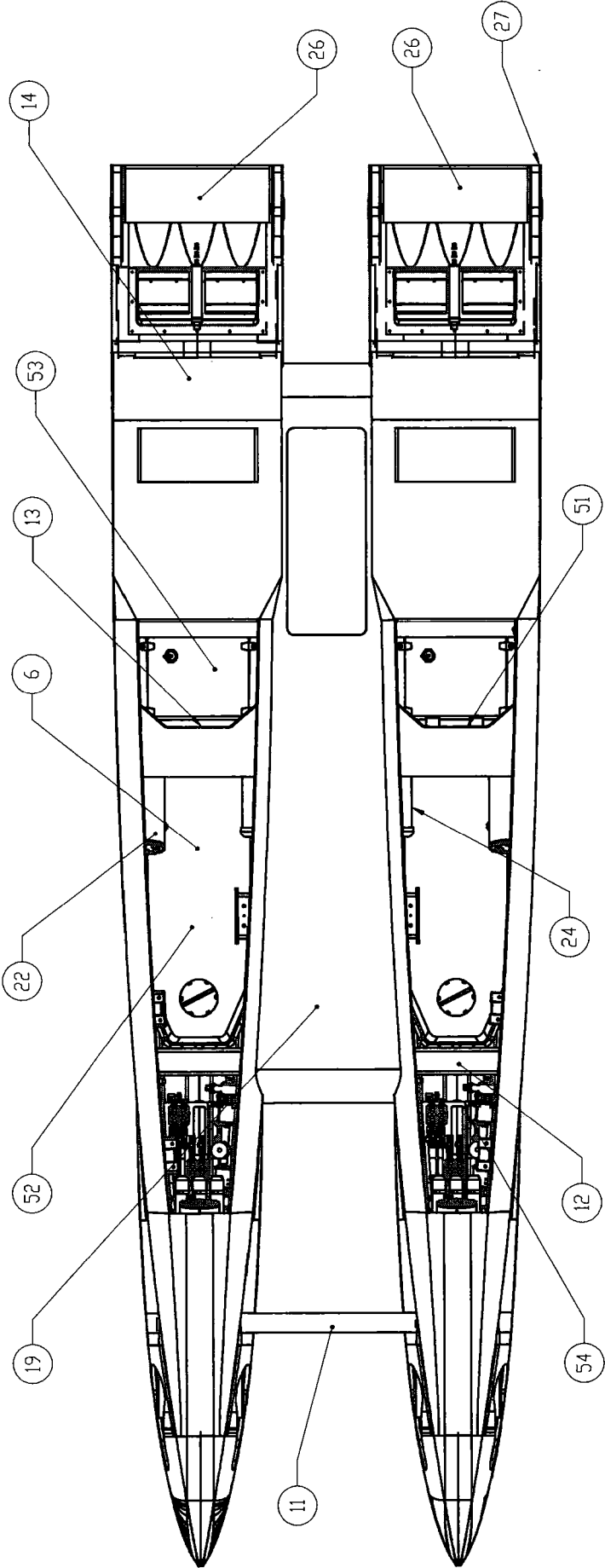


FIGURE 3

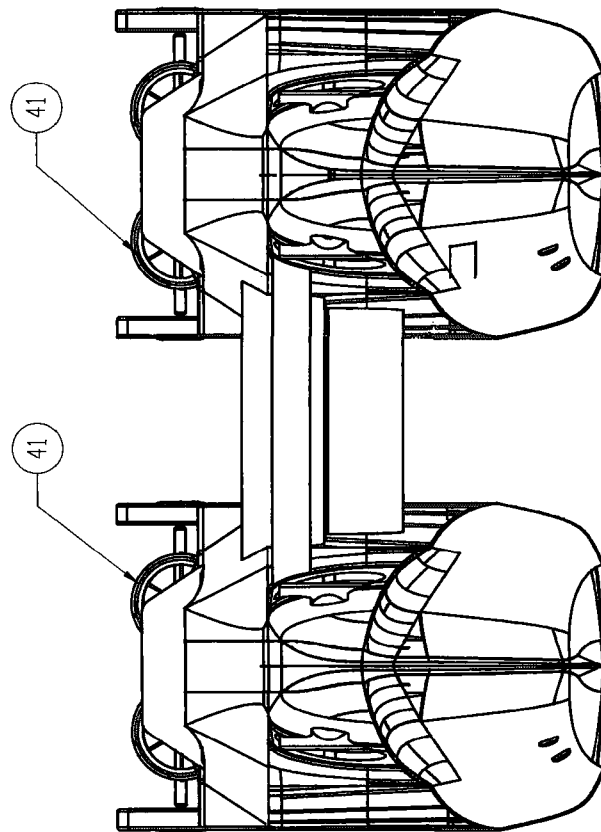


FIGURE 4

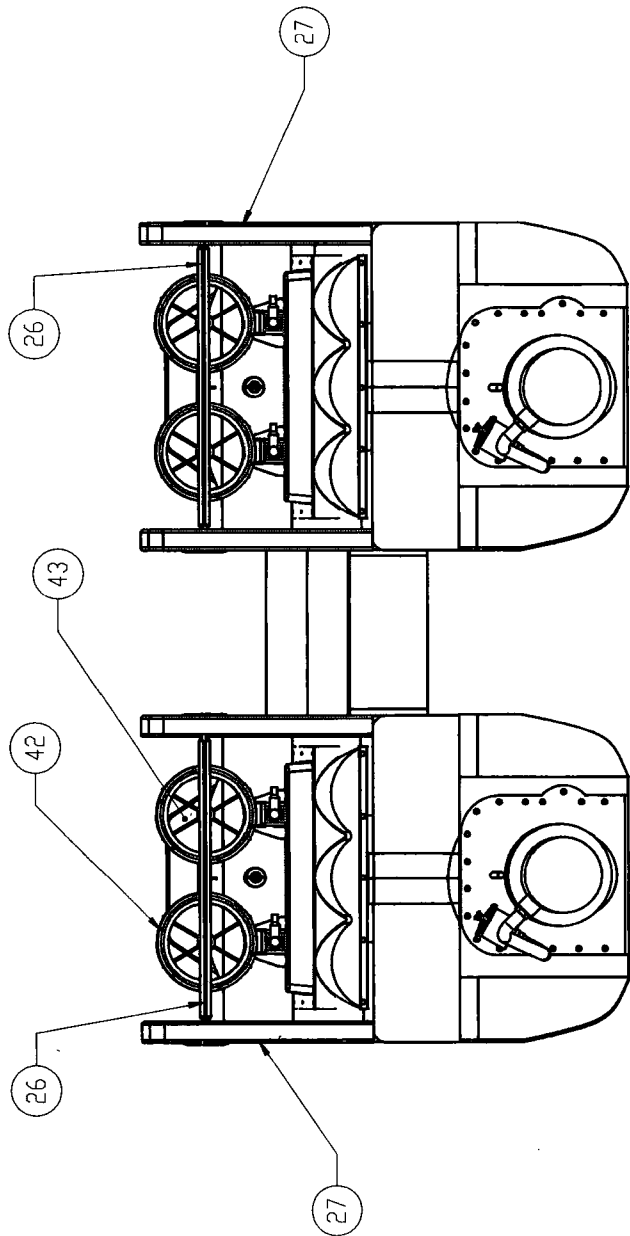


FIGURE 5

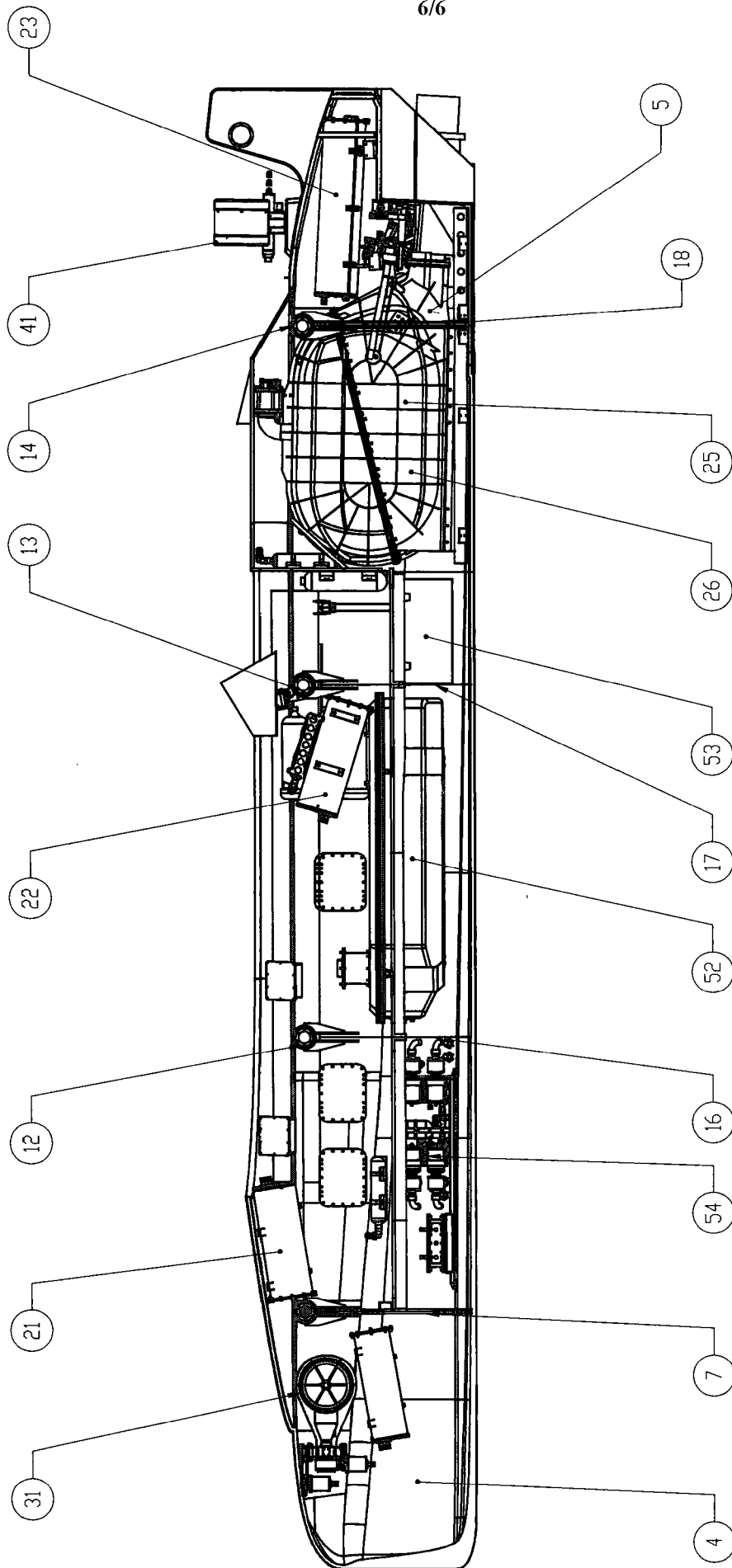


FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/052319

A. CLASSIFICATION OF SUBJECT MATTER
INV. B63B1/12 B63G8/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B63B B63G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 2 060 504 A (LAUKIEN GUENTHER R) 7 May 1981 (1981-05-07) page 3, line 106 - page 4, line 2; figures 1-5	1,2,4,7 5,8
X A	----- EP 0 716 012 A1 (SUBIBOR SA [ES]) 12 June 1996 (1996-06-12) column 3, line 45 - column 4, line 8; figures 2,3,6,9	1,3,4,7 5
X A	----- GB 823 441 A (LAPO LEGAT) 11 November 1959 (1959-11-11) page 1, line 48 - page 2, line 3; figures 1-4	1,3,4,6 5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 October 2018

Date of mailing of the international search report

07/01/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2018/052319

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-8

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8

propulsion means configuration on a submersible multi-hull craft.

2. claims: 9-17

Propeller or impeller configuration on a submersible multi-hull craft

3. claims: 18-24

hull arrangements and accommodation on a multi-hull craft

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2018/052319

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