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(71) Applicant: **Gurit (UK) Ltd.**
Newport
Isle of Wight PO30 5WU (GB)

(72) Inventor: **Everest, Simon Charles**
Winchester, Hampshire SO21 1QG (GB)

(74) Representative: **Jenkins, Peter David et al**
Page White & Farrer
Bedford House
John Street
London WC1N 2BF (GB)

(54) **MARINE VESSEL HAVING A HULL INCORPORATING A DOOR**

(57) A marine vessel having a door incorporated into a hull of the vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the door being pivotally movable about the hinge axis between a closed position in which a periphery of the door is surrounded by a door frame of the door opening and an open position in which the door is in a substantially horizontal orientation and extends outwardly away from the exterior surface of the hull, wherein the hinge mechanism has first and second hinge elements extending outwardly from respective opposite sides of the door into respective hinge mounts within the hull, an inner face of the door has a pair of sockets with open ends oriented towards the inner face of the door, each socket being located in the vicinity of both an upper or lower edge of the door and a respective one of the opposite sides of the door, and a pair of retractable pin mechanisms fitted to the hull, each retractable pin mechanism comprising a pin, which is movable within a housing fitted to the door frame, between a retracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and, when the door is in the closed position, is received within a respective socket to form a structural load-bearing assembly therebetween, and an actuator mechanism for moving the pins between

the retracted and extended positions.

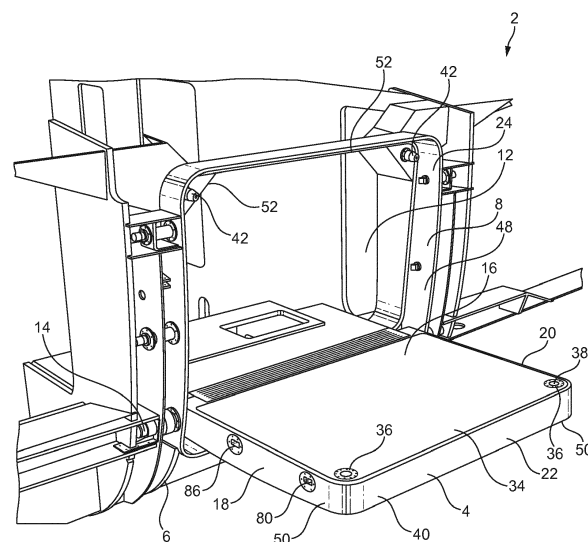


FIG. 1

Description

[0001] The present invention relates to a marine vessel having a door incorporated into a hull of the vessel. The present invention relates to a method of operating a door incorporated into a hull of a marine vessel.

[0002] It is known to manufacture marine vessels such as yachts with a hull composed of a composite material, in particular a composite material which is a fibre-reinforced resin matrix, for example comprising carbon or glass fibres in a thermosetting resin matrix, such as an epoxy resin matrix. It is also known to provide doors in the hulls of marine vessels. In particular, it is known to provide a door access in the side of a hull. The door is located in a door opening and can be opened to permit access to accommodation within the hull; the door is typically closed within the door opening when the vessel is sailing. Of course, if the exterior surface of the door is likely to be exposed to water impact when the vessel is sailing, a seal should be provided between the door and the hull to prevent or minimise water ingress into the vessel.

[0003] Marine vessels having a steel hull are fabricated so that the steel structure provides high structural strength to the hull. If a door is provided in a door opening within a steel hull, the door itself, and the associated fitting mechanism between the door and the door opening, are not required to provide any significant structural strength to the hull.

[0004] In contrast, large yachts, known as superyachts (or mega yachts, or even gigayachts), which have a hull length of about 25 metres or greater, may typically have a hull composed of carbon or glass fibre composite material. These yachts are very expensive luxury items, costing many millions of dollars, and yacht manufacturers and owners typically require extensive accommodations and facilities on board. It is often desired to have an access point near to the waterline for the yacht which can be used for persons to board the yacht conveniently from a tender.

[0005] In a yacht having a hull composed of a composite material, the composite material is required to bear significant structural loads when the yacht is sailing, particularly when the yacht is a sailing yacht which incorporates sails (in addition to an engine) as a means of propulsion. A sailing yacht is subjected to significant structural loads and if a door were to be provided in the hull, the door and the associated fitting mechanism between the door and the door opening, when closed, would be required to contribute to the global strength of the vessel, and in particular the hull.

[0006] In motor yachts, the structural loads applied to a hull are reduced as compared to those in a sailing yacht and in known motor yachts incorporating a door in a hull, the door and the associated fitting mechanism are non-structural.

[0007] One particular difficulty or problem of inserting a door into a hull composed of a composite material is

that the resultant door/hull structure must not compromise the structural integrity of the hull.

[0008] Furthermore, another difficulty or problem is that the opening and closing of the door must ensure that the door/hull structure does not compromise the structural integrity of the hull, and in the closed configuration ensures correct location of the door in a door opening within the hull.

[0009] Another difficulty or problem is that in a sailing vessel, the deck level is typically near to the upper extremity of the hull, and this limits the selection and location of locking mechanisms to ensure that the door is securely closed and locked in position without compromising the structural integrity of the hull or requiring a significant redesign of the structure of the vessel to incorporate a hull door.

[0010] In addition, the number and weight of the locking mechanisms should ideally be minimized to reduce the weight, cost and complexity of the door locking system.

[0011] There is a particular need in the art for a marine vessel having a door incorporated into a hull of the vessel, in which the door and the associated fitting mechanism between the door and the door opening, when closed, contribute to the global strength of the vessel. More particularly, such a need exists for sailing vessels having a hull composed of a composite material.

[0012] The present invention aims to solve these problems by providing a marine vessel having a door incorporated into a hull, in a preferred embodiment composed of a composite material, and a method of operating such a door, in which the door contributes to the global strength of the vessel and does not compromise the structural integrity of the hull.

[0013] Accordingly, the present invention provides a marine vessel having a door incorporated into a hull of the vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the door being pivotally movable about the hinge axis between a closed position in which a periphery of the door is surrounded by a door frame of the door opening and an open position in which the door is in a substantially horizontal orientation and extends outwardly away from the exterior surface of the hull, wherein the hinge mechanism has first and second hinge elements extending outwardly from respective opposite sides of the door into respective hinge mounts within the hull, an inner face of the door has a pair of sockets with open ends oriented towards the inner face of the door, each socket being located in the vicinity of both an upper or lower edge of the door and a respective one of the opposite sides of the door, and a pair of retractable pin mechanisms fitted to the hull, each retractable pin mechanism comprising a pin, which is movable within a housing fitted to the door frame, between a re-

tracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and, when the door is in the closed position, is received within a respective socket to form a structural load-bearing assembly therebetween, and an actuator mechanism for moving the pins between the retracted and extended positions.

[0014] In the preferred embodiments the structural load-bearing assembly is adapted to bear structural loads acting between the hull and door in a direction transverse to a longitudinal direction of the pin and socket. Such structural loads are substantially in the plane of the hull and door when the door is in the closed position.

[0015] The present invention further provides a method of operating a door incorporated into a hull of a marine vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the method comprising the steps of:

- a. pivotally moving the door about the hinge axis from an open position, in which the door extends outwardly away from the exterior surface of the hull, to a closed position in which a periphery of the door is surrounded by a door frame of the door opening;
- b. moving a pair of side locking pins, each side locking pin being located at a respective opposite side of the door opening, from a retracted position substantially within the door frame to an extended position in which the respective pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket located at a respective opposite side of the door; and
- c. moving a pair of structural pins, fitted to the hull, from a retracted position, in which the structural pin is located substantially within the door frame, to an extended position, in which the structural pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and is received within a respective structural socket in the door to form a structural load-bearing assembly therebetween, wherein the side locking pins and side sockets apply opposite lateral forces on the sides of the door when the door is in the closed position and the side locking pins are located in the extended position within the respective side sockets thereby to align the respective structural pins and structural sockets.

[0016] Embodiments of the present invention will now be described, by way of example only, with reference to

the accompanying drawings, in which:

Figure 1 is a schematic perspective side view of a door in a door opening, with part of the hull cut away, of a marine vessel according to an embodiment of the present invention, the door being in an open position;

Figure 2 is a schematic perspective view of part of the door opening of Figure 1, the door being in an open position;

Figure 3 is a schematic side view, partly in phantom, of the door and door opening of Figure 1, the door being in a closed position;

Figure 4 is a schematic side view, partly in phantom, of the door of Figure 1, the door being in a closed position; and

Figure 5 is a schematic side cross-section of part of the door and door opening of Figure 1, the door being in a closed position.

[0017] Referring to Figures 1 to 5, there is shown a part of a marine vessel 2 having a door 4 incorporated into a hull 6 of the vessel according to an embodiment of the present invention.

[0018] In the preferred embodiments, the hull 6 is composed of a fibre-reinforced resin matrix composite material, most typically a carbon fibre-reinforced epoxy resin matrix composite material. However, the invention also has application for metal-hulled vessels. Correspondingly, in the preferred embodiments, the door 4 is composed of a fibre-reinforced resin matrix composite material, most typically a carbon fibre-reinforced epoxy resin matrix composite material. The marine vessel is typically a sailing yacht which has a length of at least 25 metres. Preferably, the door 4 has a minimum height of 2 metres and a minimum width of 2 metres. The invention has particular application to carbon fibre hulled superyachts, which are sailing yachts.

[0019] A door opening 8 is provided in the hull 6 and extends between an exterior surface 10 of the hull 6 and an area 12, such as an accommodation area, within the hull 6. The door 4 is hingedly mounted to the hull 6 within the door opening 8 by a hinge mechanism 14 having a hinge axis X-X which extends laterally across a lower portion 16 of the door 4 between opposite sides 18, 20 of the door 4.

[0020] The door 4 is pivotally movable about the hinge axis between a closed position, in which a periphery 22 of the door 4 is surrounded by a periphery 24 of the door opening 8, and an open position, in which the door 4 is in a substantially horizontal orientation and extends outwardly away from the exterior surface 10 of the hull 6. A seal 23 is provided between the door 4 and the hull 6 to prevent or minimise water ingress into the vessel 2 when

the door 4 is closed.

[0021] The hinge mechanism 14 has first and second hinge elements 26 extending outwardly from respective opposite sides 18, 20 of the door 4 into respective hinge mounts 27 within the hull 6. Typically, the first and second hinge elements 26 are separately fitted to the respective opposite sides 18, 20 of the door 4. However, alternatively a single hinge device may incorporate both the first and second hinge elements 26 and be fitted as a single unit to the door 4.

[0022] Each hinge element 26 at one end has a shaft 28 coupled to a torque transfer mechanism 29 fitted into a recess 30 within a structural member 31 of the door 4 and at the opposite end the shaft 28 is fitted to a bracket 33 fitted to the hull 6 to transfer axial loads on the shaft 28 to the hull 6. For at least one of the first and second hinge elements 26, the opposite end is coupled to an actuator arm 35 for rotating the hinge mechanism 14 to move the door 4 between the closed and open positions. The hinge actuator arm 35 may be coupled to the hinge shaft 28 by a spline connection. The bracket 33 is typically composed of steel and transfers axial hinge loads to the hull structure. The axial hinge load is transferred to the structural member 31, typically composed of carbon fibre-reinforced epoxy resin matrix composite material, by the torque transfer mechanism 29 which is fitted tightly within the recess 30.

[0023] As described in detail hereinafter, in the closed position the door 4 is structurally integrated into the hull 6 so that the door 4 contributes to the global strength of the vessel and does not compromise the structural integrity of the hull 6. Moreover, this is achieved even though the door has large dimensions so that, for the preferred and illustrated embodiment, in the open position the door can function as a balcony, sun deck and/or platform near the waterline for personnel access by a tender near the waterline.

[0024] In an alternative embodiment, the hinge mechanism has a hinge axis which extends laterally across an upper portion of the door and the door opens upwardly rather than downwardly.

[0025] An inner face 34 of the door 4 has a pair of structural sockets 36 with open ends 38 oriented towards the inner face 34 of the door 4. Each socket 36 is located in the vicinity of both an upper edge 40 of the door 4 and a respective one of the opposite sides 18, 20 of the door 4.

[0026] A pair of retractable pin mechanisms 42 is fitted to the hull 6. Each retractable pin mechanism 42 comprises a structural pin 44 which is movable within a housing 46 fitted to a door frame 48 defining the door opening 8. The pin 44 is movable between a retracted position, as shown in Figure 2, in which the pin 44 is located substantially within the door frame 48, and an extended position, as shown in Figure 5, in which the pin 44 extends forwardly from the door frame 48 in a transverse direction oriented towards the exterior surface 10 of the hull 6. When the door 4 is in the closed position, the structural pin 44 is received within a respective structural socket

36 to form a structural load-bearing assembly therebetween. The structural load-bearing assembly is adapted to bear structural loads acting between the hull 6 and door 4 in a direction transverse to a longitudinal direction of the structural pin 44 and structural socket 36. Such structural loads are substantially in the plane of the hull 6 and door 4 when the door 4 is in the closed position. When the door 4 is in the open position, the structural pin 44 is recessed within the housing 46, although an end 45 of the structural pin 44 may project slightly from the housing 46.

[0027] Typically, the pin 44 and socket 36 are cylindrical in cross-section, and are shaped and dimensioned so that the pin is slidably received within the socket by a tight fitting therebetween, with an absence of play therebetween in the direction transverse to a longitudinal direction of the pin 44 and socket 36. In the illustrated embodiment the end 45 of the structural pin 44 is frustoconical to assist alignment of the pin 44 in the socket 36 and to provide a smooth surface to minimize potential personal injury.

[0028] The pins 44 and sockets 36 are composed of metal, such as steel, and are adapted to carry a structural load from the hull 6 into the door 4, and vice versa, when the door 4 is in the closed position. In the preferred embodiment, each socket 36 is located at a respective upper corner 50 of the door 4 and each pin 44 is located adjacent to a corresponding respective upper corner 52 of the door opening 8.

[0029] In the alternative embodiment in which the hinge axis is at an upper portion of the door, and the door opens upwardly and is closed downwardly, each socket is located at a respective lower corner of the door and each pin is located adjacent to a corresponding respective lower corner of the door opening.

[0030] A hydraulically operated actuator mechanism 54 is provided for moving the pins 44 between the retracted and extended positions. The actuator mechanism 54 comprises a pair of actuators 56, each associated with a respective retractable pin mechanism 42.

[0031] Each housing 46 is fitted to an inner bottom surface 58 of a hollow body 60 which is fitted to the hull 6. The housing 46 has a plate 62 fitted thereto or integral therewith and the plate 62 is fitted to the inner bottom surface 58 of the hollow body 60. The hollow body 60, which typically has a general shape resembling a bucket, is composed of a fibre-reinforced resin matrix composite material, such as carbon fibre-reinforced epoxy resin.

[0032] The hull 6 comprises a structural beam 64, such as a box body, which has an end 66 fitted to the hollow body 60. The structural beam 64, like the hull 6, is typically composed of a fibre-reinforced resin matrix composite material, such as carbon fibre-reinforced epoxy resin. The structural beam 64 has a longitudinal direction which is substantially aligned with a diagonal direction of the door 4 and door opening 8 extending between a respective retractable pin mechanism 42 and a respective one of the first and second hinge elements 26.

[0033] The door 4 comprises a sheet member 68 defining an exterior face 70 of the door 4 and a structural member 72 fitted, directly or indirectly, thereto. Another sheet member provides the inner face of the door. The sheet member 68 and the structural member 72 are, like the hull 6, typically composed of a fibre-reinforced resin matrix composite material, such as carbon fibre-reinforced epoxy resin.

[0034] The structural member 72 preferably comprises at least two interconnected structural beam elements 74. One beam element 74 extends diagonally in a direction across the door 4 between a location adjacent to a first socket 36 and a location adjacent to the first hinge element 26 and another beam element 74 extends diagonally in a direction across the door 4 between a location adjacent to a second socket 36 and a location adjacent to the second hinge element 26. Typically, the structural member 72 comprises two interconnected structural beam elements 73 and is in the shape of an X which interconnects the location adjacent to the first socket 36, the location adjacent to the first hinge element 26, the location adjacent to the second socket 36 and the location adjacent to the second hinge element 26.

[0035] A first pair of side locking pins 78 and correspondingly a first pair of side sockets 80 are provided, which are adapted to apply opposite lateral forces on the sides 18, 20 of the door 4 when the door 4 is in the closed position. In the closed position, the side locking pins 78 are in an extended position and located within the respective side sockets 80 thereby axially to align the respective pins 44 and sockets 36 of the pair of retractable pin mechanisms 42.

[0036] Each side locking pin 78 is located at a respective opposite side of the door opening 8 at a height position between the hinge mechanism 14 and the retractable pin mechanisms 42. In the illustrated embodiment, the side locking pins 78 are located at an upper part of the door opening 8. Each side socket 80 is located at a respective opposite side 18, 20 of the door 4 and arranged to receive a respective side locking pin 78 when the door 4 is in the closed position.

[0037] The side locking pins 78 are retractable and movable between a retracted position, in which the pin 78 is located substantially within the door frame 48 as shown in Figure 2, and an extended position, in which the pin 78 extends forwardly from the door frame 48 in a lateral direction oriented along the hull 6 and is received in a respective side socket 80 when the door 4 is in a closed position. A side actuator mechanism 82 is provided for moving the side locking pins 78 between the retracted and extended positions.

[0038] A second pair of side locking pins 84 and correspondingly a second pair of side sockets 86 are provided which are adapted to position a middle section of the door 4 at a predetermined water sealing position when the door 4 is in the closed position. Each side locking pin 84 is located at a respective opposite side of the door opening 8 at a height position between the hinge

mechanism 14 and the first pair of side locking pins 78. Each side socket 86 is located at a respective opposite side 18, 20 of the door 4 and arranged to receive a respective side locking pin 84 when the door 4 is in the closed position. A side actuator mechanism 88 is provided for moving the side locking pins 84 between retracted and extended positions.

[0039] The side locking pins 84 are retractable and movable between a retracted position, in which the pin 84 is located substantially within the door frame 48 as shown in Figure 2, and an extended position, in which the pin 84 extends forwardly from the door frame 48 in a lateral direction oriented along the hull 6 and is received in a respective side socket 86 when the door is in a closed position.

[0040] During the method of closing the door 4, the door 4 is pivotally moved about the hinge axis X-X from the open position, in which the door 4 extends outwardly away from the exterior surface 10 of the hull 6, to the closed position in which the periphery of the door 4 is surrounded by the door frame 48 of the door opening 8.

[0041] Then, the pair of side locking pins 78 is moved from the retracted position substantially within the door frame 48 to an extended position in which the respective pin 78 extends forwardly from the door frame 48 in a lateral direction oriented along the hull 6 and is received in a respective side socket 80.

[0042] Thereafter, the pair of structural pins 44 is moved from the retracted position substantially within the door frame 48 to the extended position in which the structural pin 44 extends forwardly from the door frame 48 in a transverse direction oriented towards the exterior surface 10 of the hull 6 and is received within a respective structural socket 36 in the door 4 to form a structural load-bearing assembly therebetween. As described above, the structural load-bearing assembly is adapted to bear structural loads acting between the hull 6 and door 4 in a direction transverse to a longitudinal direction of the structural pin 44 and structural socket 36.

[0043] Using this sequence of steps, the side locking pins 78 and side sockets 80 are adapted to apply opposite lateral forces on the sides 18, 20 of the door 4 when the door 4 is in the closed position and the side locking pins 78 are located in the extended position within the respective side sockets 80 so that the subsequently actuated structural load-bearing assembly is reliably achieved by axially aligning the respective structural pins 44 and structural sockets 36 prior to moving the structural pins 44 forwardly to be received within the respective structural sockets. Optionally, the side locking pins 78 may be slightly retracted after forming the structural load-bearing assembly between the structural pins 44 and structural sockets 36.

[0044] These hydraulically actuated side locking pins 78 push on the opposite door sides axially to align the structural pins 44 with their respective structural sockets 36 during the closing procedure and allow the door smoothly to assume its deflected position during the

opening procedure. The transversely mounted hydraulically actuated structural pins 44 connect the hull frame to the door 4 via respective tight fitting structural sockets 36 within the door 4 to transfer structural loads from the hull 6 into the door 4. The door 4 is structurally designed with the structural member 72 to bear these structural loads. The diagonal framing, for example by the X-shaped structural member 72, connects the opposing forces between the hinges 26 and their opposite structural pins 44 at the opposite corners of the door 4. This enables the door 4 to carry high structural loads from the hull 6, and vice versa. The structural hinges 26 transfer hull global loads into the door 4, and are able to transfer tension, compression, and shear forces. The structural beams 64 transfer loads from the structural pins 44 into the hull 6.

[0045] In addition, simultaneously with or subsequent to the actuation of the side locking pins 78 into the side sockets 80 during the closing operation, the side locking pins 84 are moved from the retracted position substantially within the door frame 48 to the extended position in which the pin 84 extends forwardly from the door frame 48 in a lateral direction oriented along the hull 6 and is received in a respective side socket 86 when the door 4 is in a closed position. The side locking pins 84 and side sockets 86 position a middle section of the door 4 at a predetermined water sealing position when the door 4 is in the closed position. The hydraulically actuated side locking pins 84 do not need to provide a structural support for the door 4 or the hull 6, but instead act to position the middle of the door 4 accurately within the door frame 48 so as to ensure a watertight seal around the door 4 within the frame 48 when the door 4 is closed.

[0046] During a reverse opening operation, the sequence of steps is reversed. In other words, the structural pins 44 are retracted from the structural sockets 36, then the side locking pins 78 and the side locking pins 84 are retracted, in either order or simultaneously, and then the door 4 is pivoted about the hinge axis X-X to open the door 4.

[0047] In the preferred embodiments of the present invention, in order to achieve a high level of global stiffness, as well as achieving tight, even shut lines, the door is structural, i.e. the door is rigidly connected to the surrounding topsides of the hull and contributes to the global strength of the hull when sailing. Also, the behaviour of the vessel with the door open is also critical, since not only must the vessel retain a level of residual strength in the event of a system or hardware failure, but also the operation of the door must not be impaired by local deformation of the door frame.

[0048] In the preferred embodiments of the present invention, the door can be provided with a clearance between the top of the door frame and the underside of the deck which can be very small, as little as 200mm. Such a small dimension can be accommodated because, in the absence of significant space for mechanical devices in this area, the structural pins are located within the area

of the door and are moved transversely (i.e. horizontally), and not downwardly, and the actuator system is located adjacent to the door rather than above the door. In addition, the number of door closing and locking devices is minimised in order to limit complexity, weight, and risk of mechanical failure.

[0049] In the preferred embodiments of the present invention, structural hinges are located at the bottom corners of the door, and lateral structural pins at the upper corners of the door opening to engage upper corners of the door. This structural arrangement has the effect of holding the four corners of the door and transferring the in-plane global loads in a way comparable to a diagonal truss, whilst minimising the number of moving parts. Additional locking pins are incorporated in the door sides for the purposes of water-tightness but do not play a structural role and hence are allowed to be comparatively small. For smaller height doors, the additional locking pins may be omitted

[0050] The preferred embodiments of the present invention provide a structural arrangement that is distinguished from a conventional design for a locking door. A standard approach to providing a lockable door would be to install 8 orthogonal pins, 2 per side/edge of the door, that transfer the global loads in shear into the door. However this arrangement would require a hinge mechanism and 8 pins, which would be very heavy, expensive and complex. Furthermore there would not be space above the door for vertically orientated pins.

[0051] Various aspects of the present invention are disclosed in the following clauses:

Clauses

[0052]

1. A marine vessel having a door incorporated into a hull of the vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the door being pivotally movable about the hinge axis between a closed position in which a periphery of the door is surrounded by a door frame of the door opening and an open position in which the door is in a substantially horizontal orientation and extends outwardly away from the exterior surface of the hull, wherein the hinge mechanism has first and second hinge elements extending outwardly from respective opposite sides of the door into respective hinge mounts within the hull, an inner face of the door has a pair of sockets with open ends oriented towards the inner face of the door, each socket being located in the vicinity of both an upper or lower edge of the door and a respective one of

the opposite sides of the door, and a pair of retractable pin mechanisms fitted to the hull, each retractable pin mechanism comprising a pin, which is movable within a housing fitted to the door frame, between a retracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and, when the door is in the closed position, is received within a respective socket to form a structural load-bearing assembly therebetween, and an actuator mechanism for moving the pins between the retracted and extended positions.

2. A marine vessel according to clause 1 wherein each socket is located at a respective corner of the door and each pin is located adjacent to a corresponding respective corner of the door opening.

3. A marine vessel according to clause 1 or clause 2 wherein each housing is fitted to an inner bottom surface of a hollow body which is fitted to the hull.

4. A marine vessel according to clause 3 wherein the hollow body is composed of a fibre-reinforced resin matrix composite material.

5. A marine vessel according to clause 3 or clause 4 wherein the hull comprises a structural beam which has an end fitted to the hollow body.

6. A marine vessel according to clause 5 wherein the structural beam is composed of a fibre-reinforced resin matrix composite material.

7. A marine vessel according to clause 5 or clause 6 wherein the structural beam has a longitudinal direction which is substantially aligned with a diagonal direction of the door opening extending between a respective retractable pin mechanism and a respective one of the first and second hinge elements.

8. A marine vessel according to any one of clauses 3 to 7 wherein the housing has a plate fitted thereto or integral therewith and the plate is fitted to the inner bottom surface of the hollow body.

9. A marine vessel according to any one of clauses 1 to 8 wherein the actuator mechanism is hydraulically operated.

10. A marine vessel according to any one of clauses 1 to 9 wherein the actuator mechanism comprises a pair of actuators, each associated with a respective retractable pin mechanism.

11. A marine vessel according to any one of clauses 1 to 10 wherein the pin and socket are cylindrical in cross-section.

12. A marine vessel according to any one of clauses 1 to 11 wherein the pin and socket are shaped and dimensioned so that the pin is slidably received within the socket.

13. A marine vessel according to clause 12 wherein the pin is slidably received within the socket by a tight fitting therebetween, with an absence of play therebetween in the direction transverse to a longitudinal

direction of the pin and socket.

14. A marine vessel according to any one of clauses 1 to 13 wherein the pins and sockets are composed of metal.

15. A marine vessel according to any one of clauses 1 to 14 wherein the pins and sockets are adapted to carry a structural load from the hull into the door when the door is in the closed position.

16. A marine vessel according to any one of clauses 1 to 15 wherein the structural load-bearing assembly is adapted to bear a structural load acting between the hull and door in a direction transverse to a longitudinal direction of the pin and socket.

17. A marine vessel according to clause 15 or clause 16 wherein the structural load is substantially in the plane of the hull and the door when the door is in the closed position.

18. A marine vessel according to any one of clauses 1 to 17 further comprising a first pair of side locking pins, each side locking pin being located at a respective opposite side of the door opening at a height position between the hinge mechanism and the retractable pin mechanisms, and a first pair of side sockets, each side socket being located at a respective opposite side of the door and arranged to receive a respective side locking pin when the door is in the closed position, wherein the side locking pins are retractable and movable between a retracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket when the door is in a closed position, and a side actuator mechanism for moving the side locking pins between the retracted and extended positions.

19. A marine vessel according to clause 18 wherein the first pair of side locking pins and first pair of side sockets are adapted to apply opposite lateral forces on the sides of the door when the door is in the closed position and the side locking pins are located in the extended position within the respective side sockets thereby to align the respective pins and sockets of the pair of retractable pin mechanisms.

20. A marine vessel according to clause 18 or clause 19 further comprising a second pair of side locking pins, each side locking pin of the second pair being located at a respective opposite side of the door opening at a height position between the hinge mechanism and the first pair of side locking pins, and a second pair of side sockets, each side socket of the second pair being located at a respective opposite side of the door and arranged to receive a respective side locking pin of the second pair when the door is in the closed position, wherein the side locking pins of the second pair are retractable and movable between a retracted position, in which the pin is located substantially within the door frame, and an

extended position, in which the pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket of the second pair when the door is in a closed position, and a second side actuator mechanism for moving the side locking pins of the second pair between the retracted and extended positions.

21. A marine vessel according to clause 20 wherein the second pair of side locking pins and second pair of side sockets are adapted to position a middle section of the door at a predetermined water sealing position when the door is in the closed position.

22. A marine vessel according to any one of clauses 1 to 21 wherein the first and second hinge elements are separately fitted to the respective opposite sides of the door, and each hinge element at one end has a shaft coupled to a torque transfer mechanism fitted into a recess within a structural member of the door and at the opposite end the shaft is fitted to a bracket is fitted to the hull to transfer axial loads on the shaft to the hull.

23. A marine vessel according to clause 22 wherein for at least one of the first and second hinge elements, the opposite end is coupled to an actuator arm for rotating the hinge mechanism to move the door between the closed and open positions.

24. A marine vessel according to any one of clauses 1 to 23 wherein the hull is composed of a fibre-reinforced resin matrix composite material.

25. A marine vessel according to clause 24 wherein the hull is composed of a carbon fibre-reinforced epoxy resin matrix composite material.

26. A marine vessel according to any one of clauses 1 to 25 wherein the door comprises a sheet member defining an exterior face of the door and a structural member fitted, directly or indirectly, thereto, the structural member comprising at least two interconnected structural beam elements, at least one structural beam element extending diagonally in a direction across the door between a location adjacent to a first socket and a location adjacent to the first hinge element and at least one structural beam element extending diagonally in a direction across the door between a location adjacent to a second socket and a location adjacent to the second hinge element.

27. A marine vessel according to clause 26 wherein the structural member comprises two interconnected structural beam elements and is in the shape of an X which interconnects the location adjacent to the first socket, the location adjacent to the first hinge element, the location adjacent to the second socket and the location adjacent to the second hinge element.

28. A marine vessel according to any one of clauses 1 to 27 wherein the hinge axis extends laterally across a lower portion of the door which pivots downwardly during opening and each socket is located in the vicinity of the upper edge of the door.

29. A marine vessel according to any one of clauses 1 to 28 wherein the door is composed of a fibre-reinforced resin matrix composite material.

30. A marine vessel according to clause 29 wherein the door is composed of a carbon fibre-reinforced epoxy resin matrix composite material.

31. A marine vessel according to any one of clauses 1 to 30 which is a yacht.

32. A marine vessel according to clause 31 which is a sailing yacht.

33. A marine vessel according to clause 31 or clause 32 wherein the yacht has a length of at least 25 metres.

34. A marine vessel according to any one of clauses 1 to 33 wherein the door has a minimum height of 2 metres and a minimum width of 2 metres.

35. A method of operating a door incorporated into a hull of a marine vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the method comprising the steps of:

a. pivotally moving the door about the hinge axis from an open position, in which the door extends outwardly away from the exterior surface of the hull, to a closed position in which a periphery of the door is surrounded by a door frame of the door opening;

b. moving a pair of side locking pins, each side locking pin being located at a respective opposite side of the door opening, from a retracted position substantially within the door frame to an extended position in which the respective pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket located at a respective opposite side of the door; and

c. moving a pair of structural pins, fitted to the hull, from a retracted position, in which the structural pin is located substantially within the door frame, to an extended position, in which the structural pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and is received within a respective structural socket in the door to form a structural load-bearing assembly therebetween, wherein the side locking pins and side sockets are adapted to apply opposite lateral forces on the sides of the door when the door is in the closed position and the side locking pins are located in the extended position within the respective side sockets thereby to align the respective structural pins and structural sockets.

36. A method according to clause 35 wherein the hinge axis extends laterally across a lower portion of the door which pivots upwardly during closing and each socket is located in the vicinity of an upper edge of the door.

37. A method according to clause 35 or clause 36 wherein the structural pins and structural sockets are adapted to carry a structural load from the hull into the door when the door is in the closed position.

38. A method according to any one of clauses 35 to 37 wherein the structural load-bearing assembly is adapted to bear a structural load acting between the hull and door in a direction transverse to a longitudinal direction of the pin and socket.

39. A method according to clause 37 or clause 38 wherein the structural load is substantially in the plane of the hull and the door when the door is in the closed position.

40. A method according to any one of clauses 35 to 39 wherein the hull and the door are composed of a carbon fibre-reinforced epoxy resin matrix composite material.

41. A method according to any one of clauses 35 to 40 which is a sailing yacht which has a length of at least 25 metres and the door has a minimum height of 2 metres and a minimum width of 2 metres.

[0053] Various modifications to the preferred embodiments of the present invention will be apparent to those skilled in the art.

Claims

1. A marine vessel having a door incorporated into a hull of the vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the door being pivotally movable about the hinge axis between a closed position in which a periphery of the door is surrounded by a door frame of the door opening and an open position in which the door is in a substantially horizontal orientation and extends outwardly away from the exterior surface of the hull, wherein the hinge mechanism has first and second hinge elements extending outwardly from respective opposite sides of the door into respective hinge mounts within the hull, an inner face of the door has a pair of sockets with open ends oriented towards the inner face of the door, each socket being located in the vicinity of both an upper or lower edge of the door and a respective one of the opposite sides of the door, and a pair of retractable pin mechanisms fitted to the hull, each retract-

able pin mechanism comprising a pin, which is movable within a housing fitted to the door frame, between a retracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and, when the door is in the closed position, is received within a respective socket to form a structural load-bearing assembly therebetween, and an actuator mechanism for moving the pins between the retracted and extended positions.

2. A marine vessel according to claim 1 wherein each socket is located at a respective corner of the door and each pin is located adjacent to a corresponding respective corner of the door opening and/or each housing is fitted to an inner bottom surface of a hollow body which is fitted to the hull, optionally wherein the hollow body is composed of a fibre-reinforced resin matrix composite material.

3. A marine vessel according to claim 2 wherein the hull comprises a structural beam which has an end fitted to the hollow body, optionally wherein the structural beam is composed of a fibre-reinforced resin matrix composite material, further optionally wherein the structural beam has a longitudinal direction which is substantially aligned with a diagonal direction of the door opening extending between a respective retractable pin mechanism and a respective one of the first and second hinge elements.

4. A marine vessel according to any one of claims 1 to 3 wherein when the door is in the closed position the structural load-bearing assembly bears a structural load acting between the hull and door in a direction transverse to a longitudinal direction of the pin and socket, optionally wherein the structural load is substantially in the plane of the hull and the door when the door is in the closed position.

5. A marine vessel according to any one of claims 1 to 4 further comprising a first pair of side locking pins, each side locking pin being located at a respective opposite side of the door opening at a height position between the hinge mechanism and the retractable pin mechanisms, and a first pair of side sockets, each side socket being located at a respective opposite side of the door and arranged to receive a respective side locking pin when the door is in the closed position, wherein the side locking pins are retractable and movable between a retracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket when the door is in a closed position,

and a side actuator mechanism for moving the side locking pins between the retracted and extended positions, optionally wherein the first pair of side locking pins and first pair of side sockets are adapted to apply opposite lateral forces on the sides of the door when the door is in the closed position and the side locking pins are located in the extended position within the respective side sockets thereby to align the respective pins and sockets of the pair of retractable pin mechanisms.

6. A marine vessel according to claim 5 further comprising a second pair of side locking pins, each side locking pin of the second pair being located at a respective opposite side of the door opening at a height position between the hinge mechanism and the first pair of side locking pins, and a second pair of side sockets, each side socket of the second pair being located at a respective opposite side of the door and arranged to receive a respective side locking pin of the second pair when the door is in the closed position, wherein the side locking pins of the second pair are retractable and movable between a retracted position, in which the pin is located substantially within the door frame, and an extended position, in which the pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket of the second pair when the door is in a closed position, and a second side actuator mechanism for moving the side locking pins of the second pair between the retracted and extended positions, optionally wherein the second pair of side locking pins and second pair of side sockets are adapted to position a middle section of the door at a predetermined water sealing position when the door is in the closed position.
7. A marine vessel according to any one of claims 1 to 6 wherein the first and second hinge elements are separately fitted to the respective opposite sides of the door, and each hinge element at one end has a shaft coupled to a torque transfer mechanism fitted into a recess within a structural member of the door and at the opposite end the shaft is fitted to a bracket which is fitted to the hull to transfer axial loads on the shaft to the hull, optionally wherein for at least one of the first and second hinge elements, the opposite end is coupled to an actuator arm for rotating the hinge mechanism to move the door between the closed and open positions.
8. A marine vessel according to any one of claims 1 to 7 wherein the hull, the door or both the hull and the door, is or are composed of a fibre-reinforced resin matrix composite material, optionally a carbon fibre-reinforced epoxy resin matrix composite material.
9. A marine vessel according to any one of claims 1 to

8 wherein the door comprises a sheet member defining an exterior face of the door and a structural member fitted, directly or indirectly, thereto, the structural member comprising at least two interconnected structural beam elements, at least one structural beam element extending diagonally in a direction across the door between a location adjacent to a first socket and a location adjacent to the first hinge element and at least one structural beam element extending diagonally in a direction across the door between a location adjacent to a second socket and a location adjacent to the second hinge element, optionally wherein the structural member comprises two interconnected structural beam elements and is in the shape of an X which interconnects the location adjacent to the first socket, the location adjacent to the first hinge element, the location adjacent to the second socket and the location adjacent to the second hinge element.

10. A marine vessel according to any one of claims 1 to 9 wherein the hinge axis extends laterally across a lower portion of the door which pivots downwardly during opening and each socket is located in the vicinity of the upper edge of the door.
11. A marine vessel according to any one of claims 1 to 10 which is a yacht or a sailing yacht, optionally wherein the yacht or sailing yacht has a length of at least 25 metres and/or wherein the door has a minimum height of 2 metres and a minimum width of 2 metres.
12. A method of operating a door incorporated into a hull of a marine vessel, the marine vessel comprising a hull, a door opening provided in the hull and extending between an exterior surface of the hull and an area within the hull, and a door, wherein the door is hingedly mounted to the hull within the door opening by a hinge mechanism having a hinge axis which extends laterally across the door between opposite sides of the door, the method comprising the steps of:
 - a. pivotally moving the door about the hinge axis from an open position, in which the door extends outwardly away from the exterior surface of the hull, to a closed position in which a periphery of the door is surrounded by a door frame of the door opening;
 - b. moving a pair of side locking pins, each side locking pin being located at a respective opposite side of the door opening, from a retracted position substantially within the door frame to an extended position in which the respective pin extends forwardly from the door frame in a lateral direction oriented along the hull and is received in a respective side socket located at a respective opposite side of the door; and

- c. moving a pair of structural pins, fitted to the hull, from a retracted position, in which the structural pin is located substantially within the door frame, to an extended position, in which the structural pin extends forwardly from the door frame in a transverse direction oriented towards the exterior surface of the hull and is received within a respective structural socket in the door to form a structural load-bearing assembly therebetween, wherein the side locking pins and side sockets apply opposite lateral forces on the sides of the door when the door is in the closed position and the side locking pins are located in the extended position within the respective side sockets thereby to align the respective structural pins and structural sockets.
13. A method according to claim 12 wherein the hinge axis extends laterally across a lower portion of the door which pivots upwardly during closing and each socket is located in the vicinity of an upper edge of the door.
14. A method according to claim 12 or claim 13 wherein when the door is in the closed position the structural load-bearing assembly bears a structural load acting between the hull and door in a direction transverse to a longitudinal direction of the pin and socket and/or wherein the structural load is substantially in the plane of the hull and the door when the door is in the closed position.
15. A method according to any one of claims 12 to 14 wherein the hull and the door are composed of a carbon fibre-reinforced epoxy resin matrix composite material, optionally wherein the marine vessel is a yacht or a sailing yacht which has a length of at least 25 metres and the door has a minimum height of 2 metres and a minimum width of 2 metres.

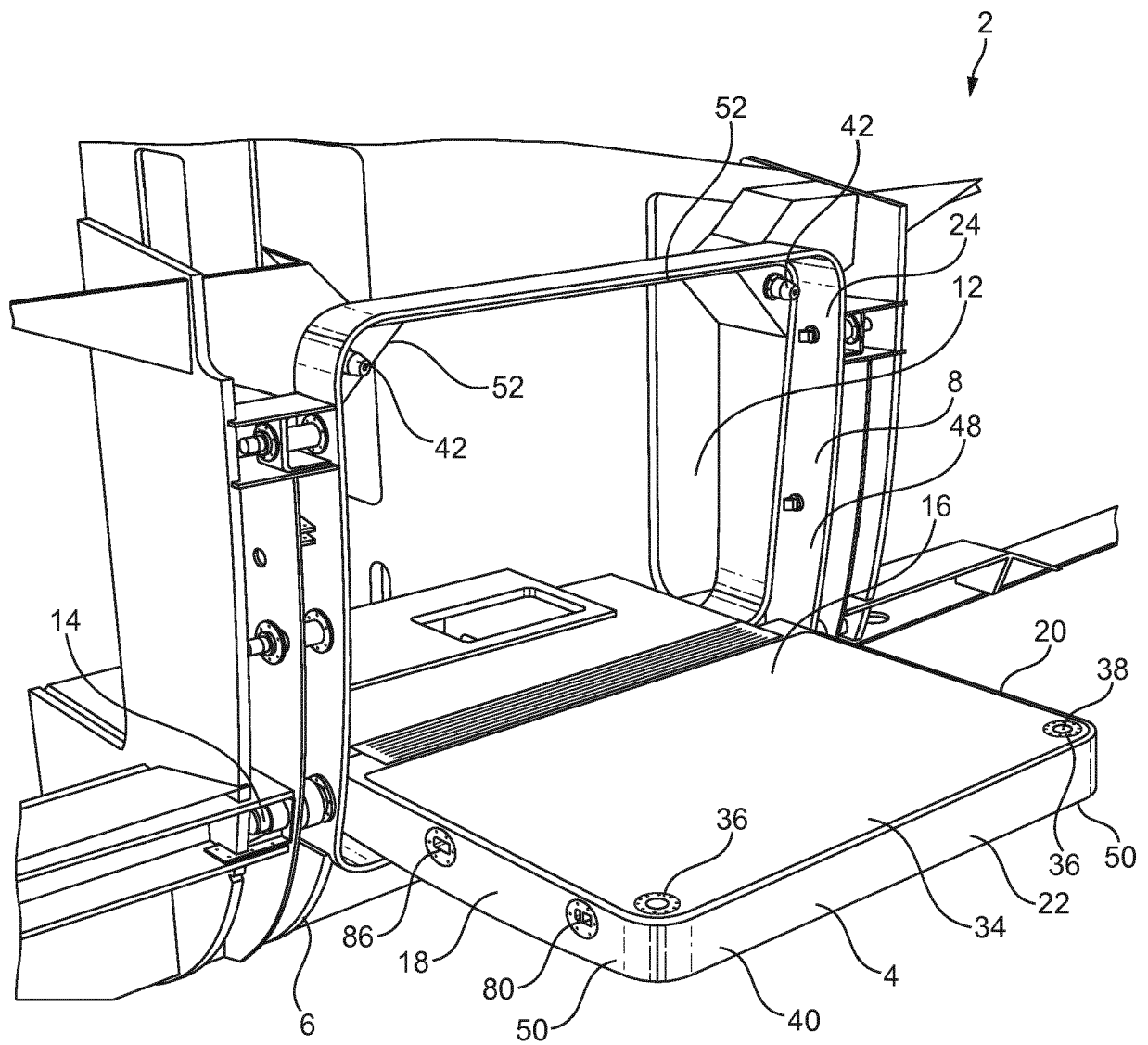


FIG. 1

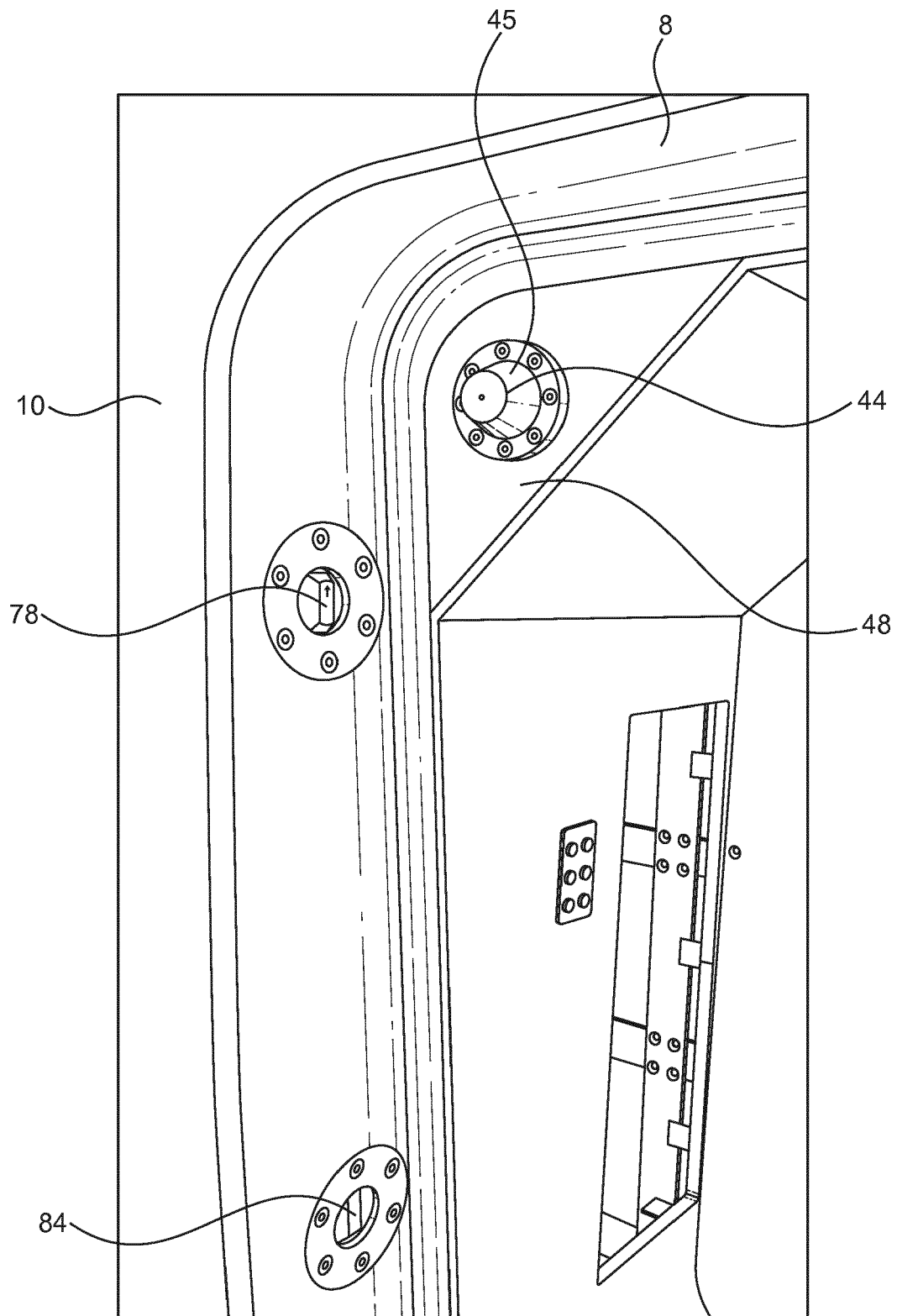


FIG. 2

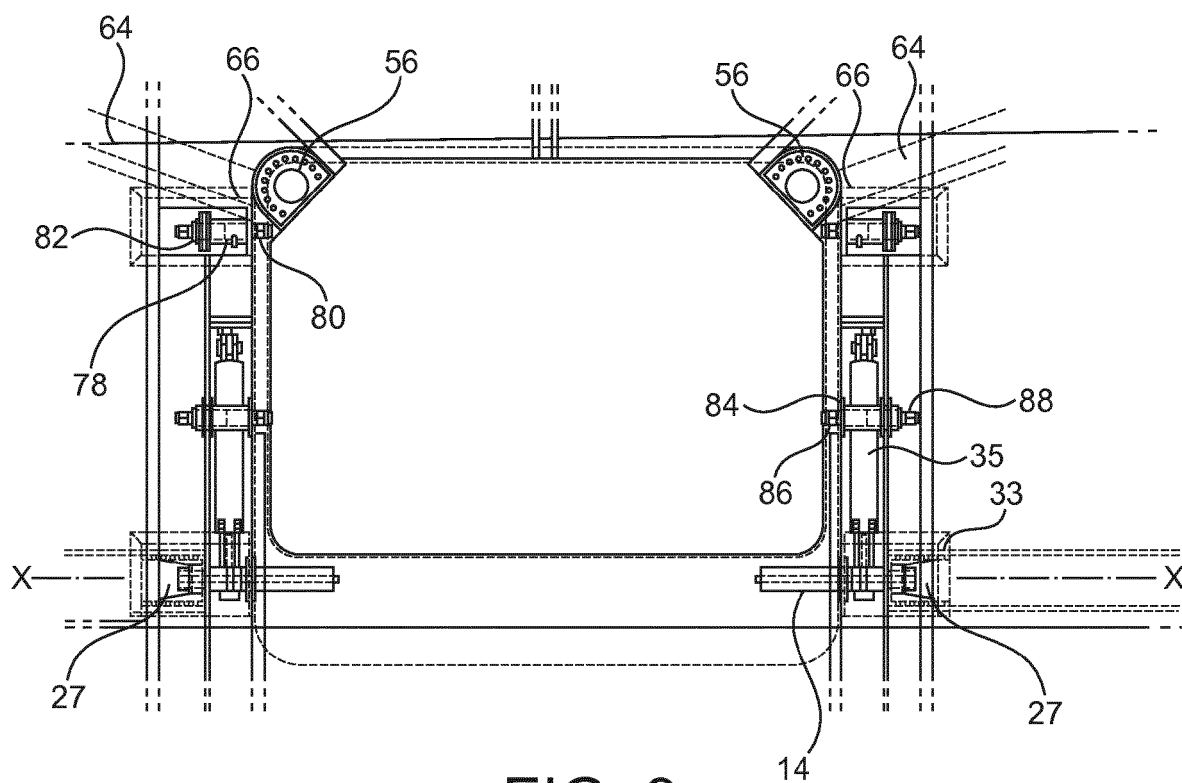


FIG. 3

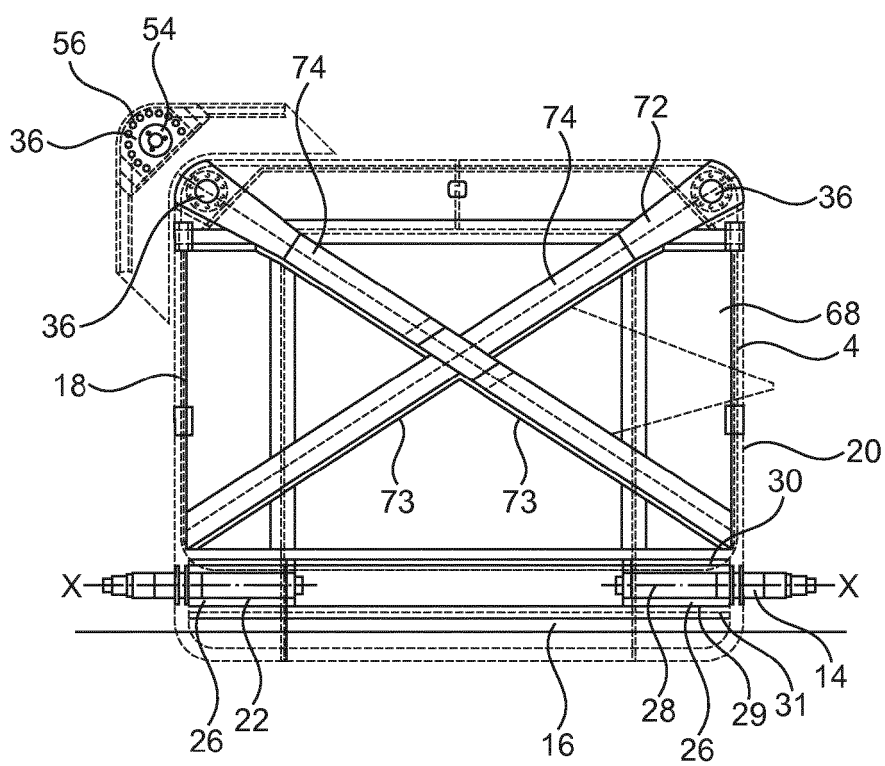


FIG. 4

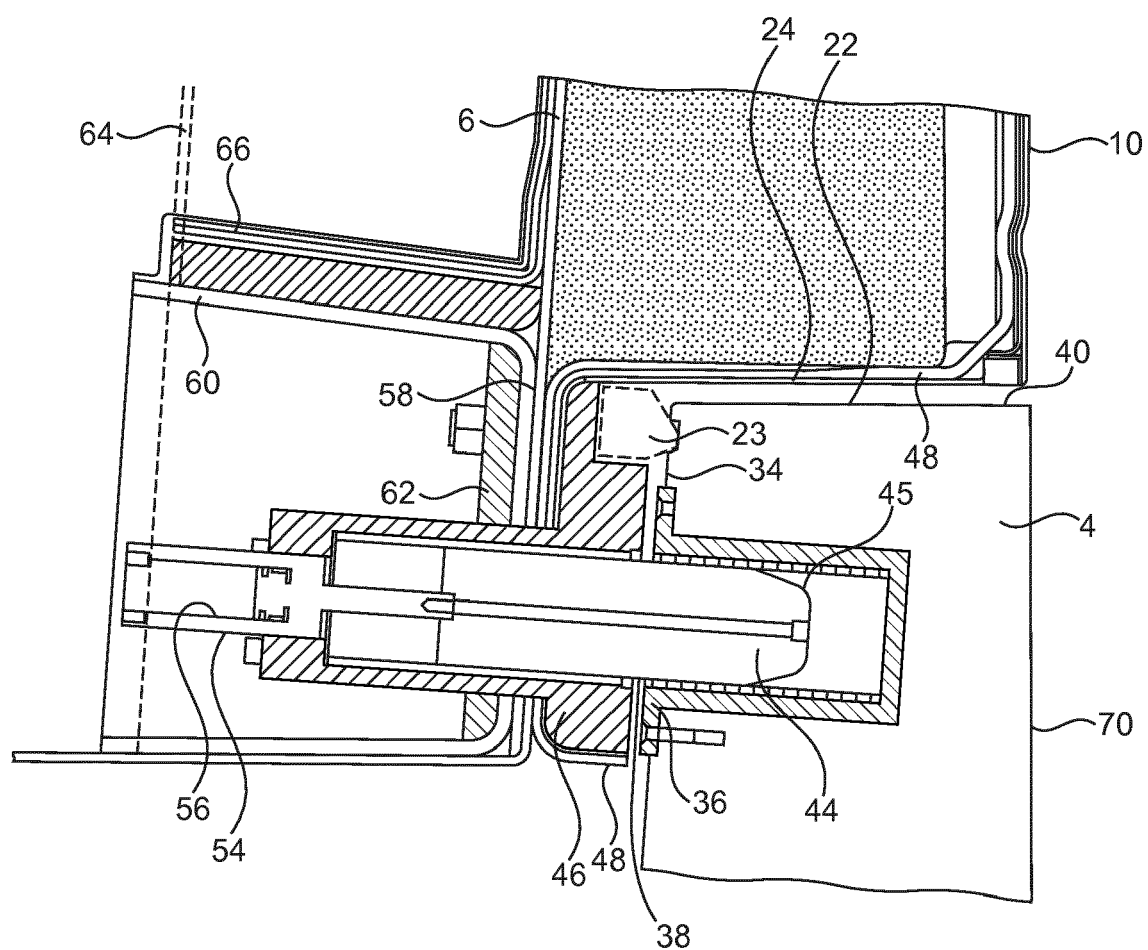


FIG. 5



EUROPEAN SEARCH REPORT

Application Number
EP 18 02 0467

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			TECHNICAL FIELDS SEARCHED (IPC)
			B63B E05C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 21 February 2019	Examiner Martínez, Felipe
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 02 0467

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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21-02-2019

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