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Czarnowski et al.

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(54) **DRAIN MECHANISM FOR WATERCRAFT**

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B63B 19/26 (2006.01)

(52) **U.S. Cl.**
CPC ***B63B 13/00*** (2013.01); ***B63B 19/26*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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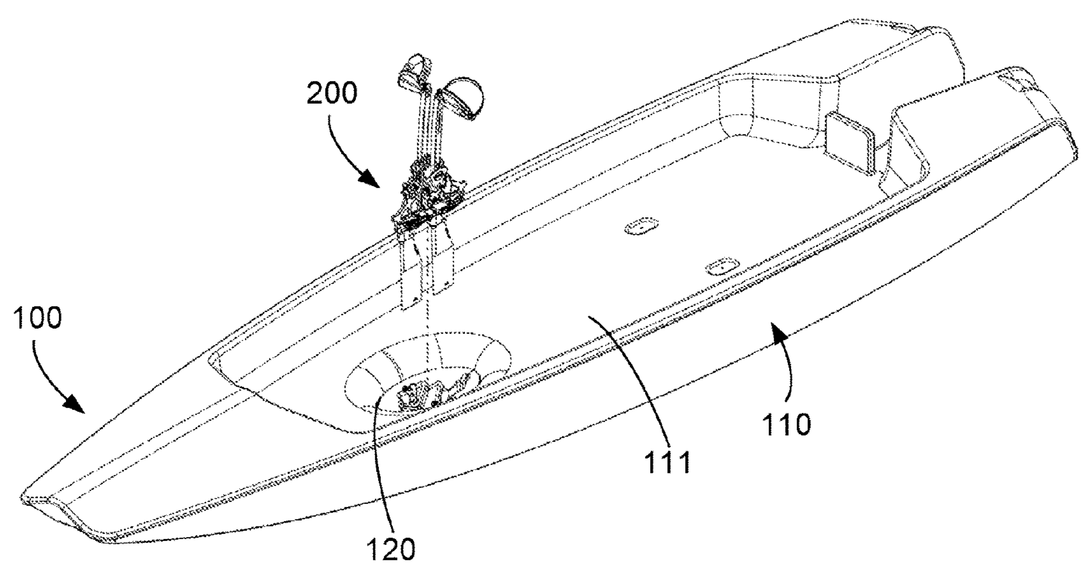
(57) **ABSTRACT**

A watercraft includes a hull, an opening extending through the hull, the opening configured to receive a removable propulsion mechanism, and an insert removably insertable into the opening. The insert includes an inner cavity, an aperture configured to be at least partially submerged in a fluid when the watercraft is positioned on the fluid, the aperture being configured to provide fluid communication between the inner cavity of the insert and the fluid as the watercraft travels in a forward direction, and a surface shaped and dimensioned such that a first pressure within the inner cavity is greater than a second pressure at the aperture as the watercraft travels in the forward direction.

28 Claims, 18 Drawing Sheets



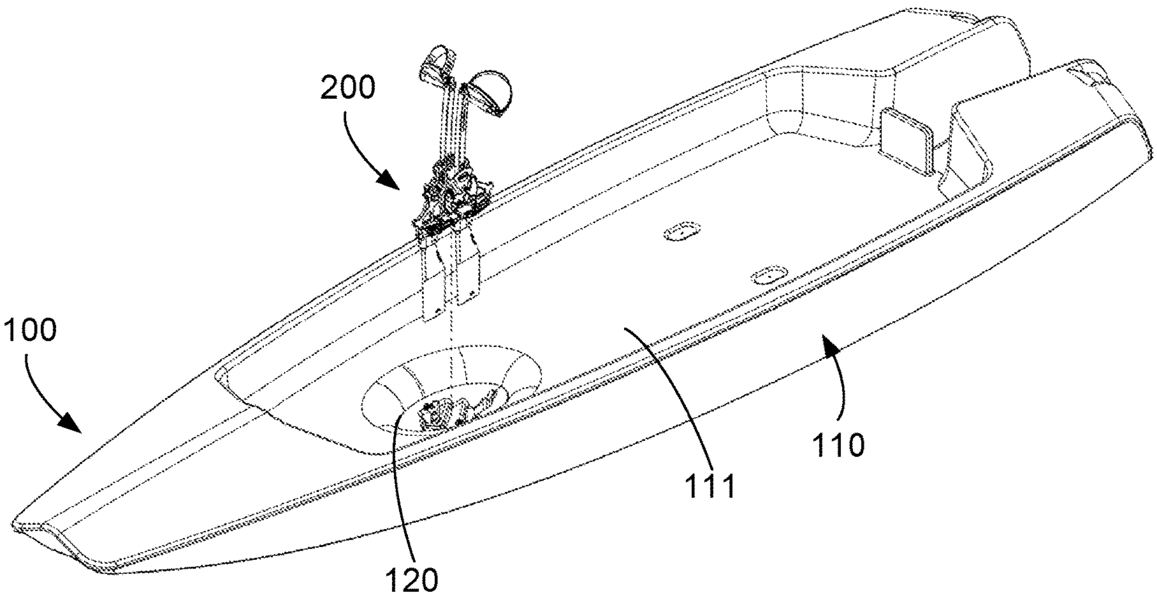


FIG. 1

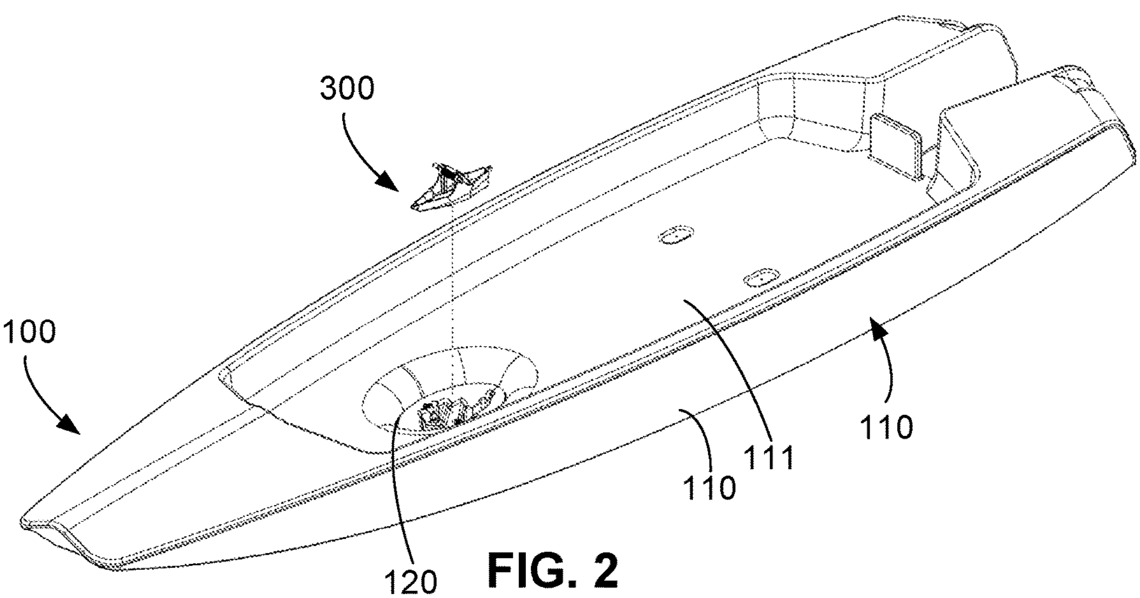


FIG. 2

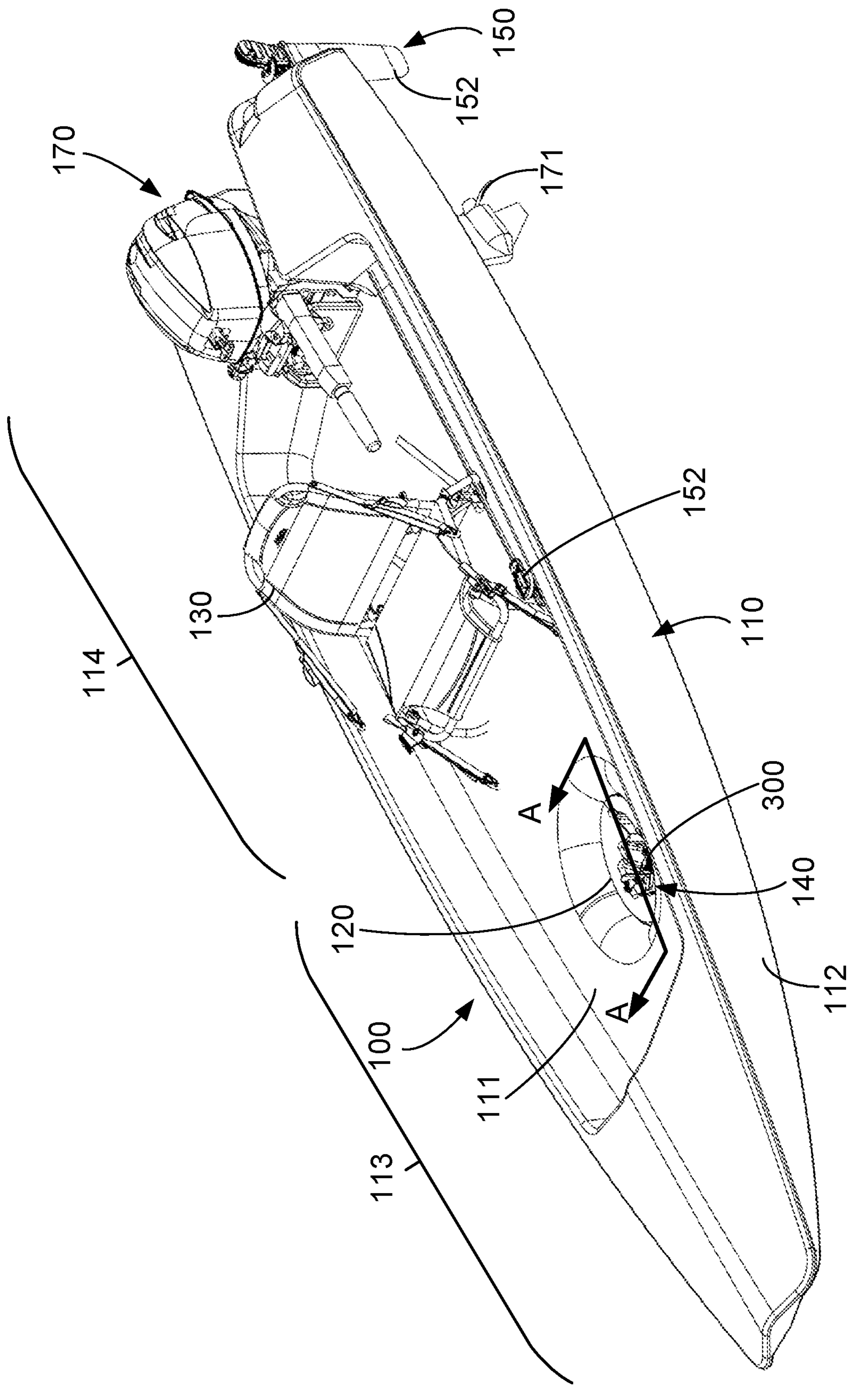


FIG. 3

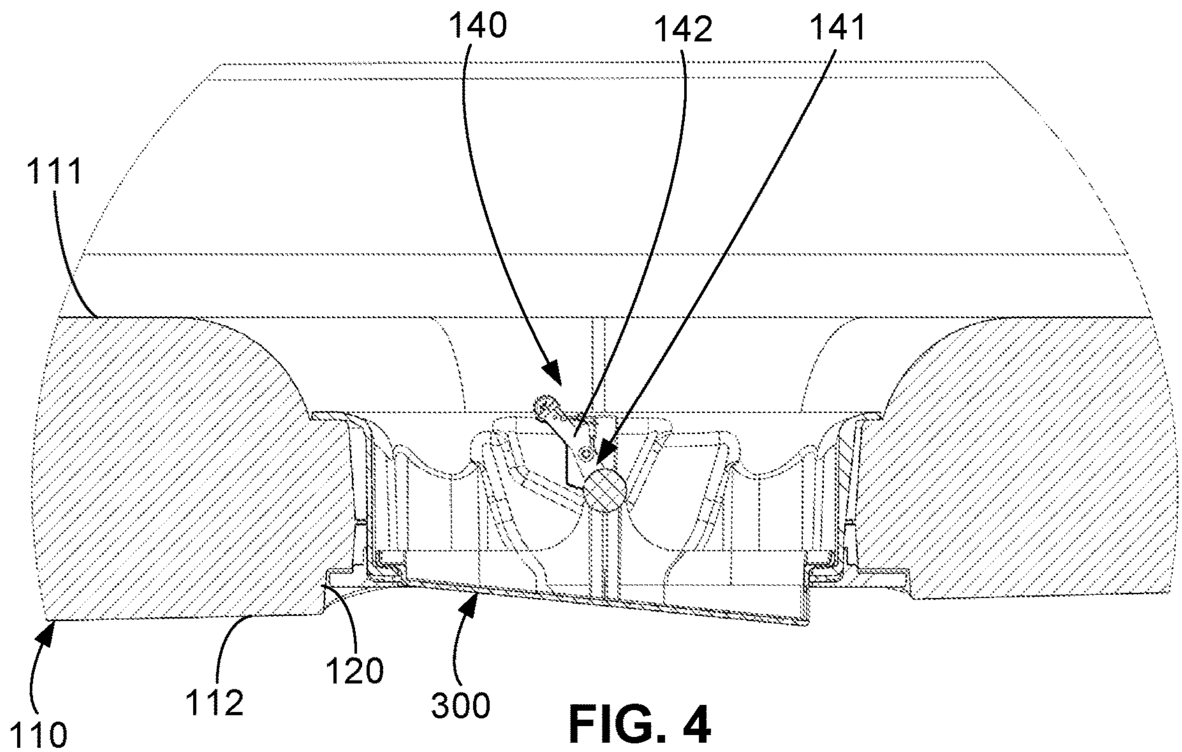


FIG. 4

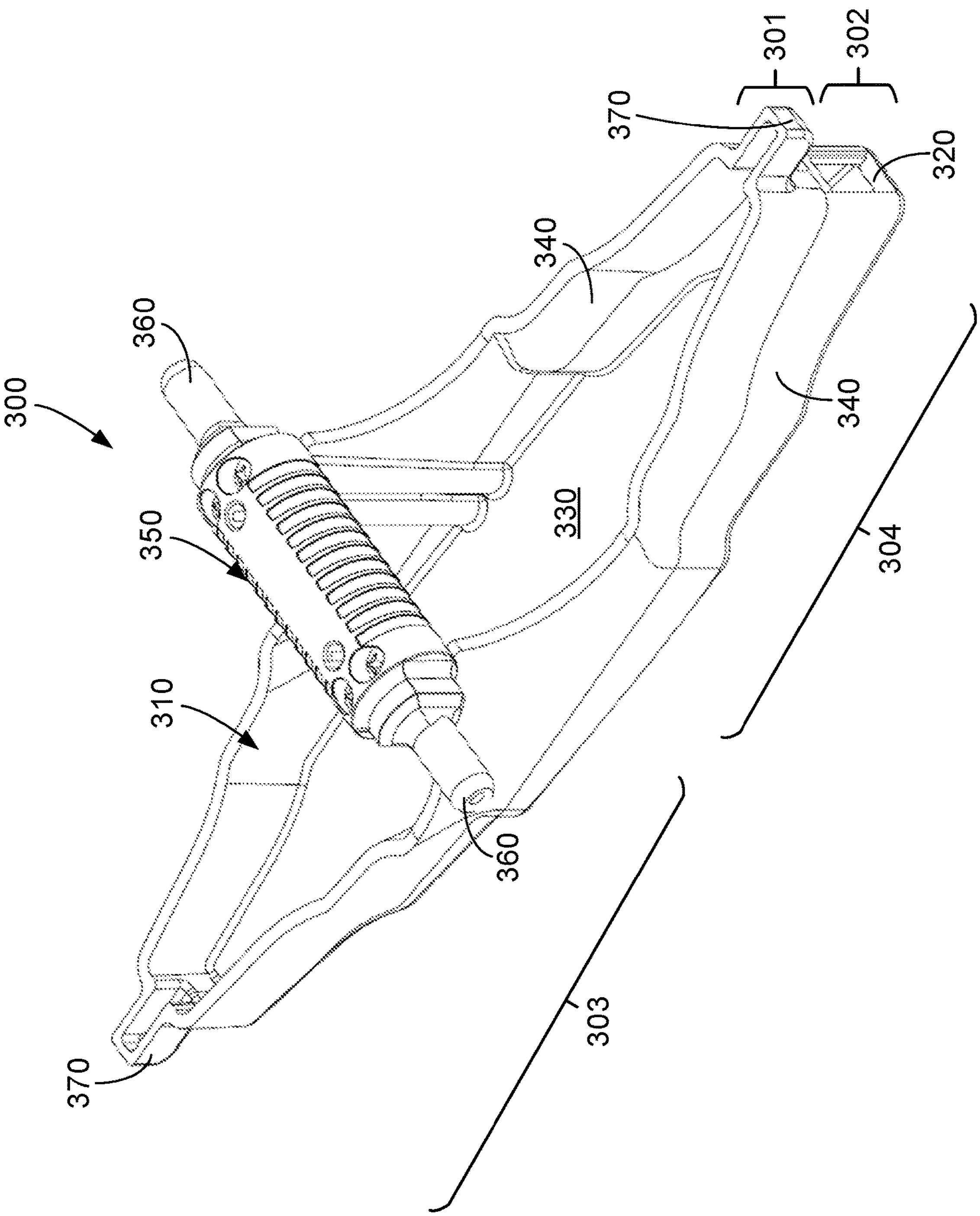


FIG. 5A

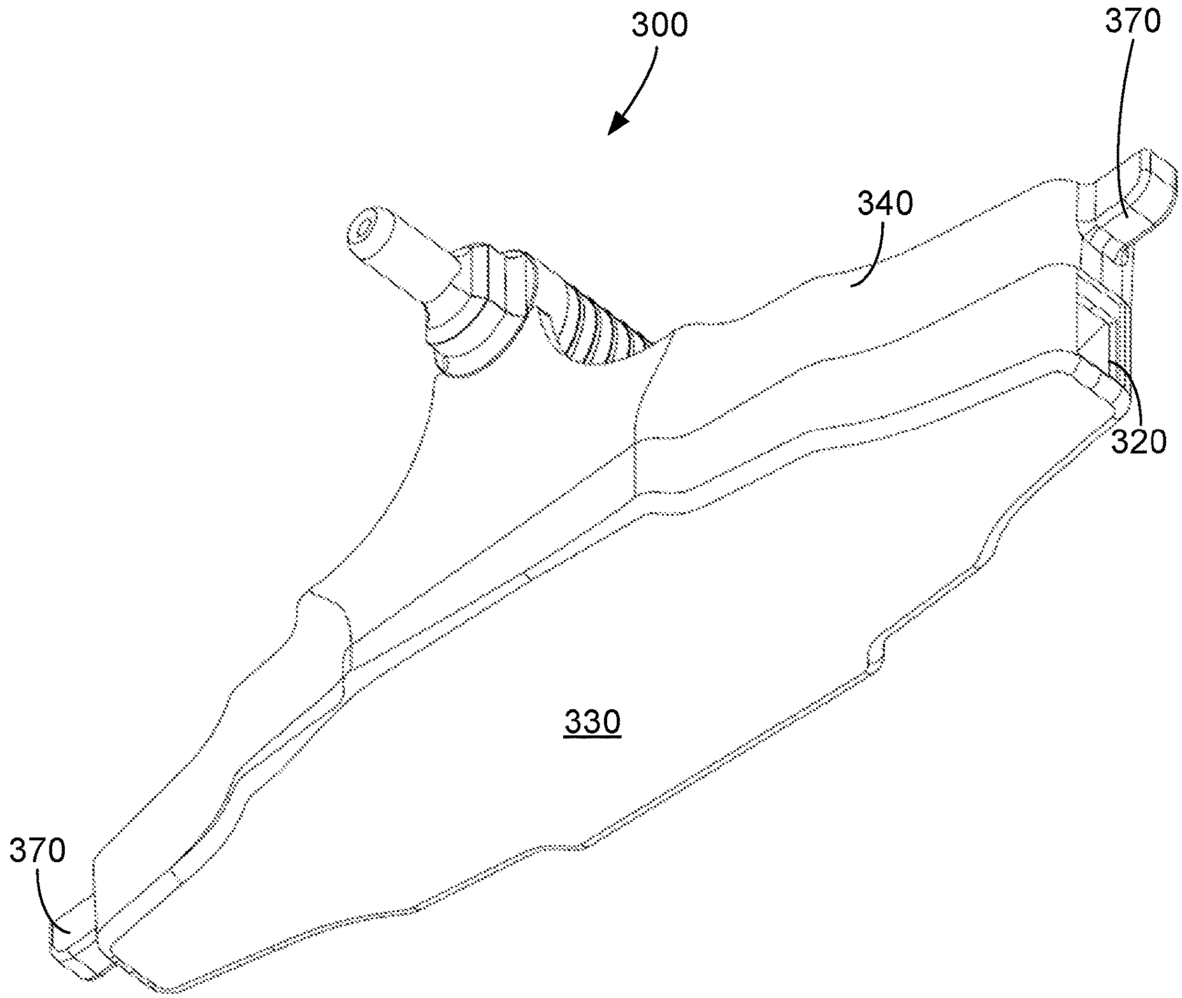


FIG. 5B

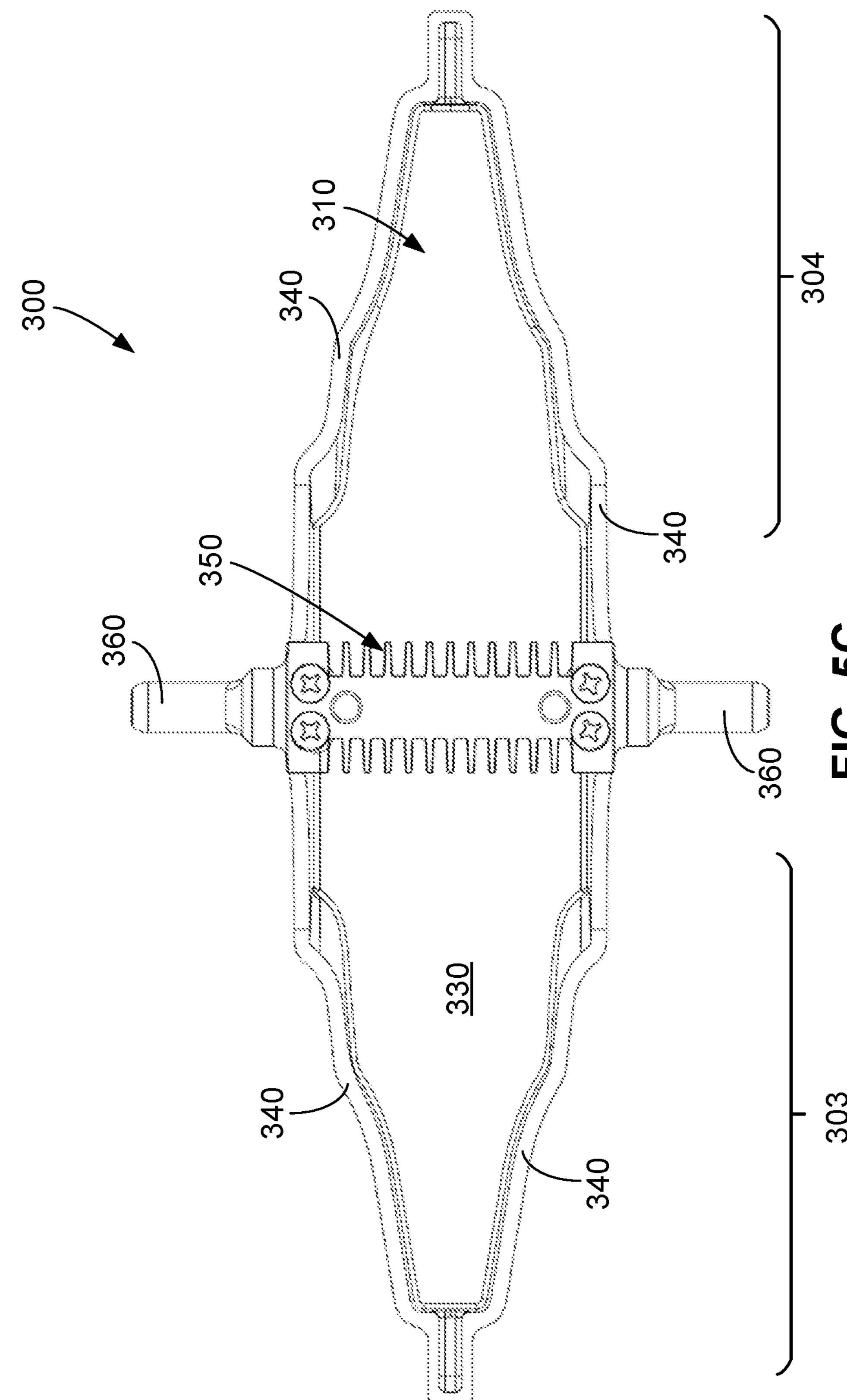


FIG. 5C

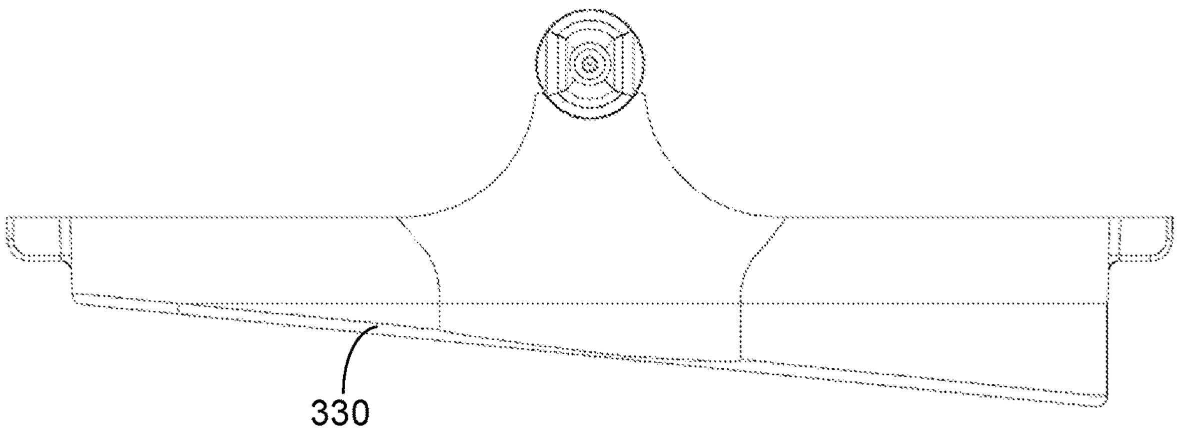


FIG. 5D

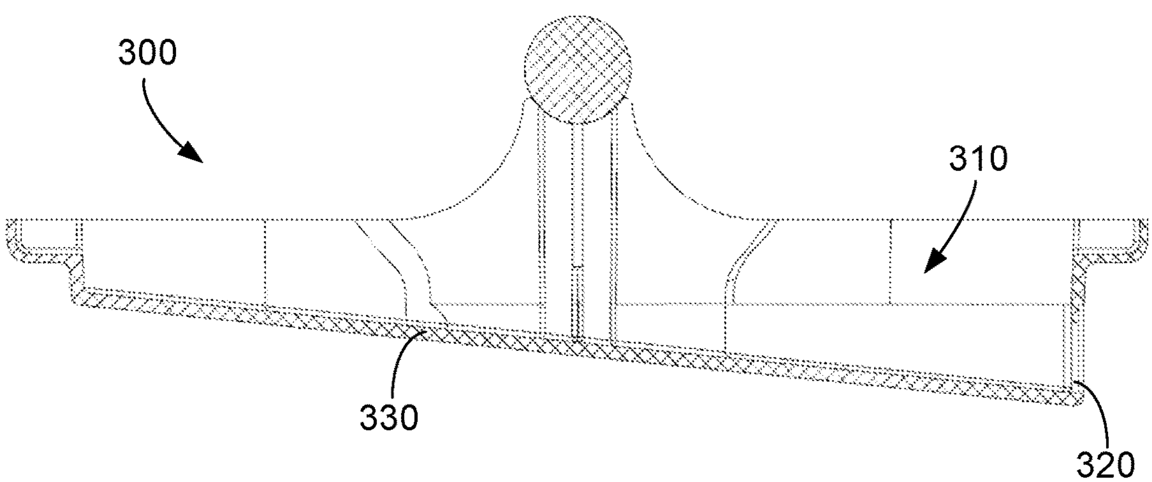


FIG. 5E

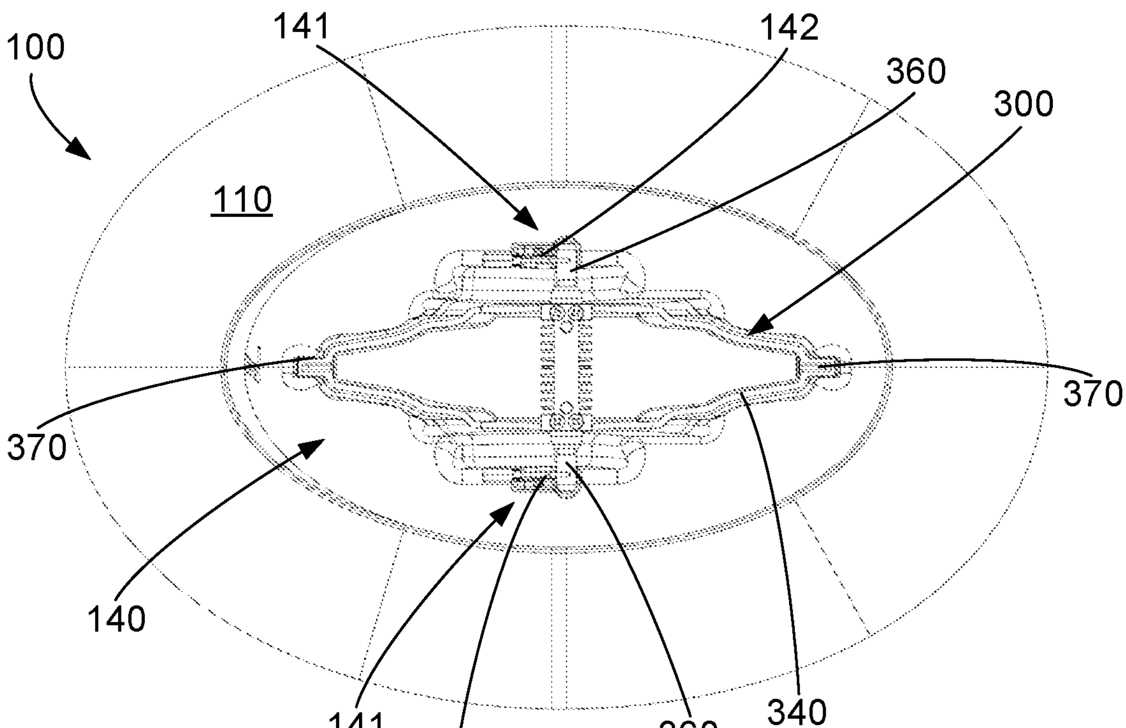

100
141
142
360
300
110
370
370
140
141
142
360
340

FIG. 6

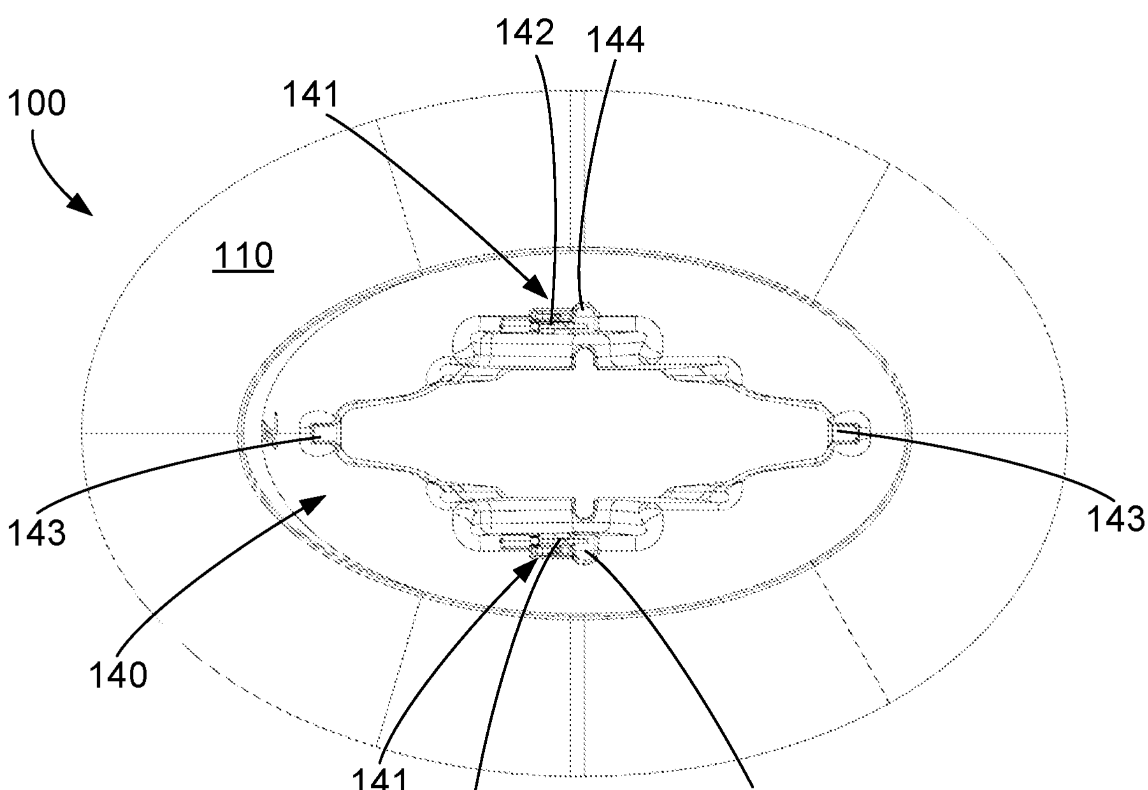

142
144
141
100
110
143
143
140
141
142
144

FIG. 7

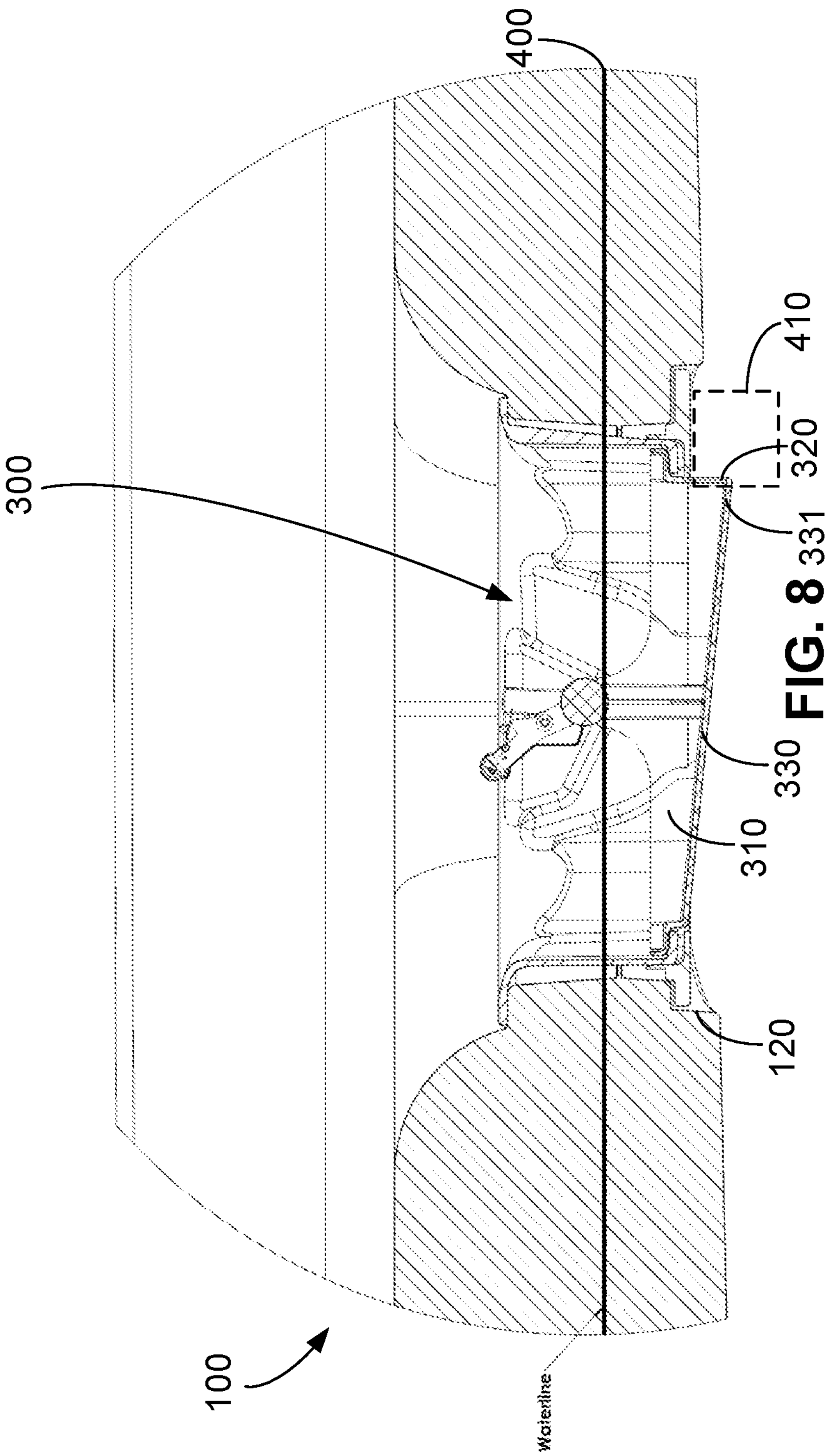


FIG. 8

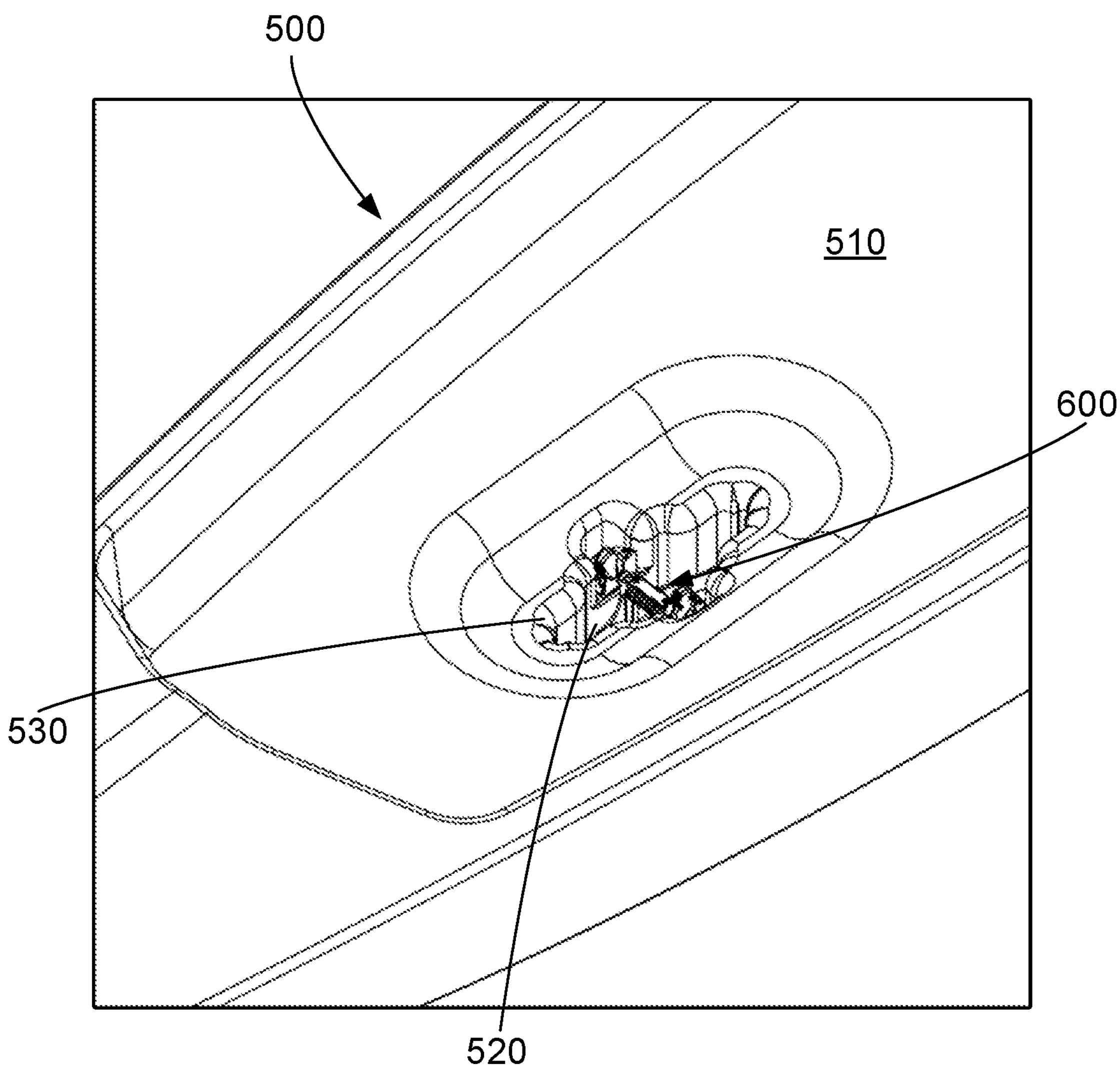


FIG. 9

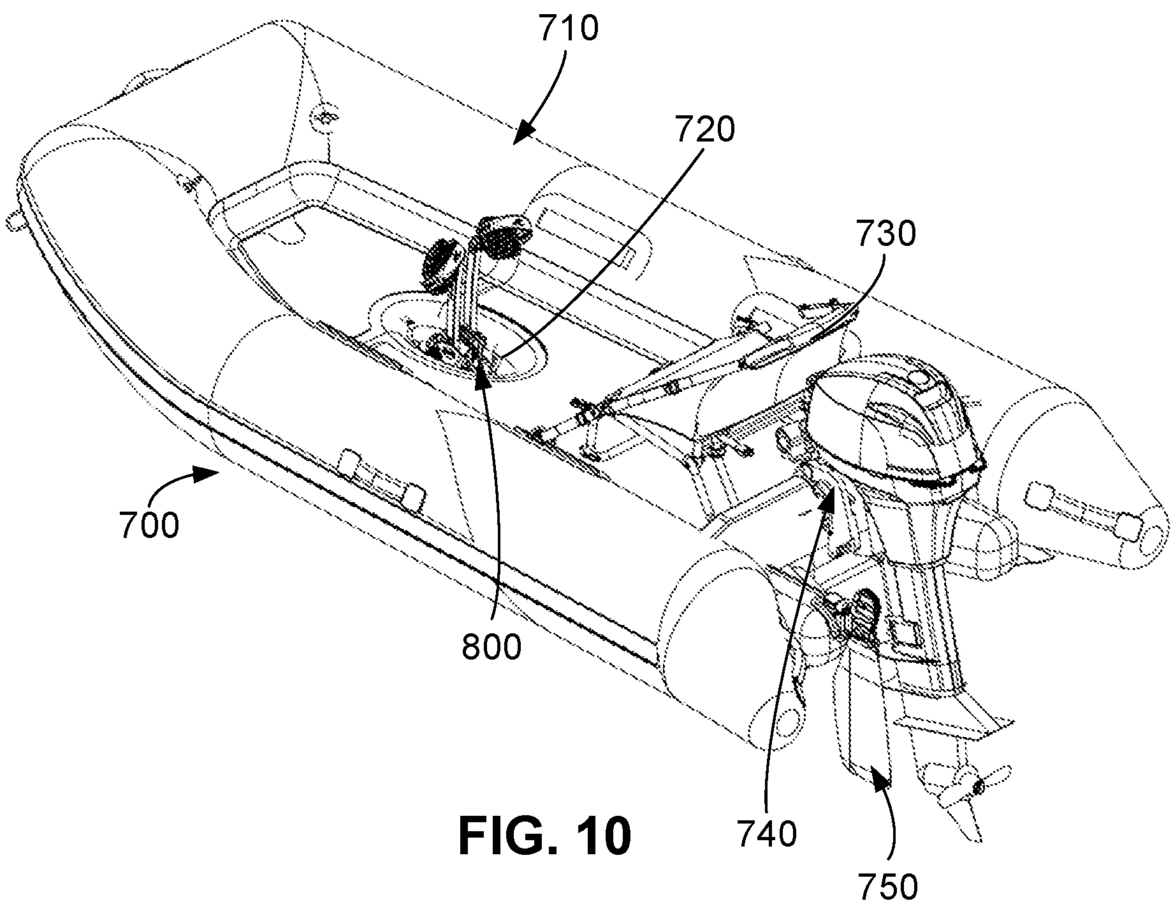


FIG. 10

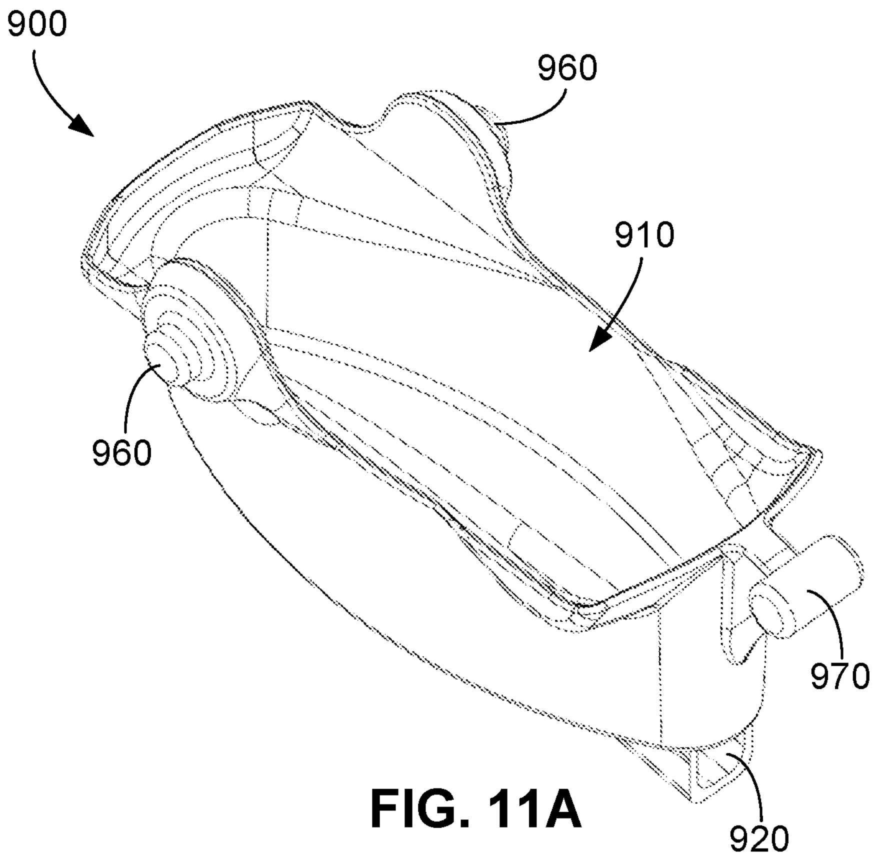


FIG. 11A

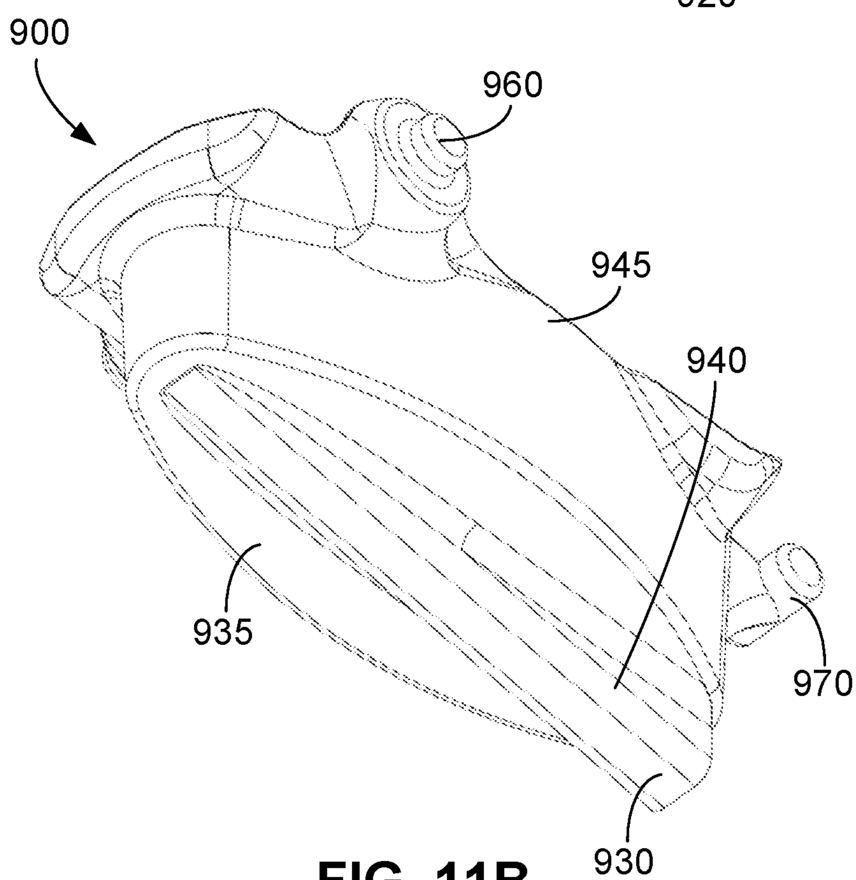


FIG. 11B

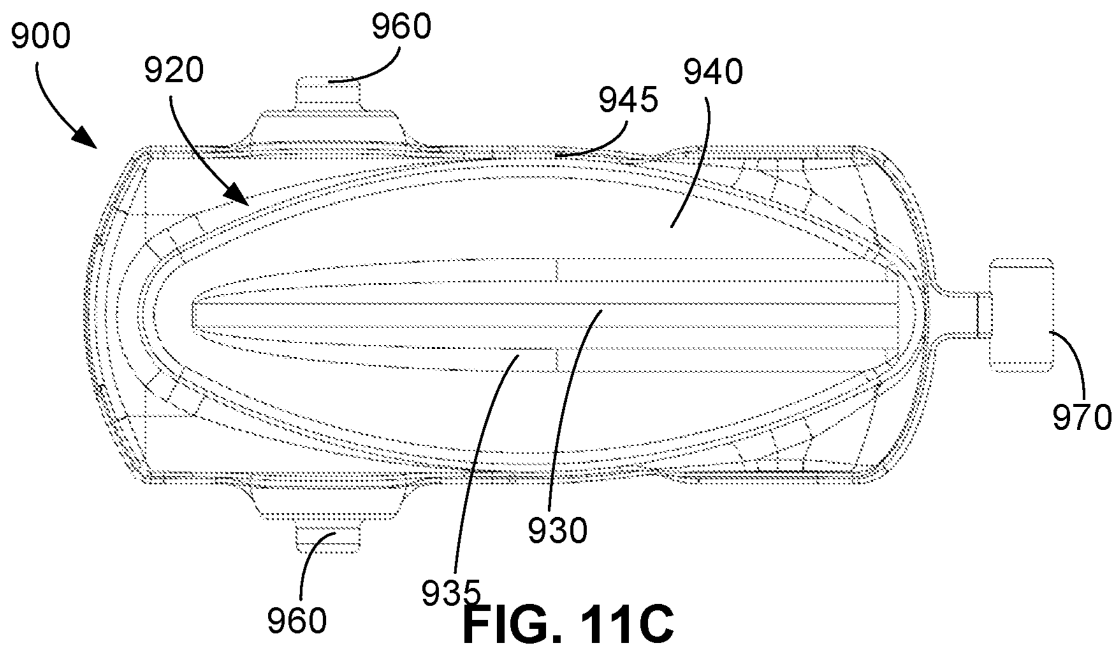


FIG. 11C

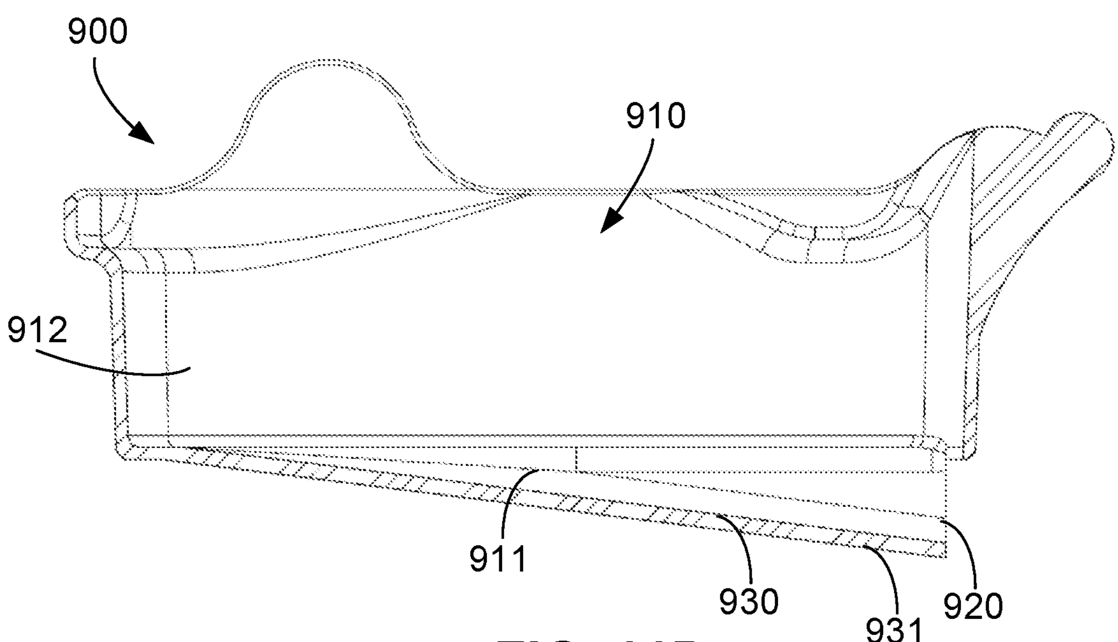


FIG. 11D

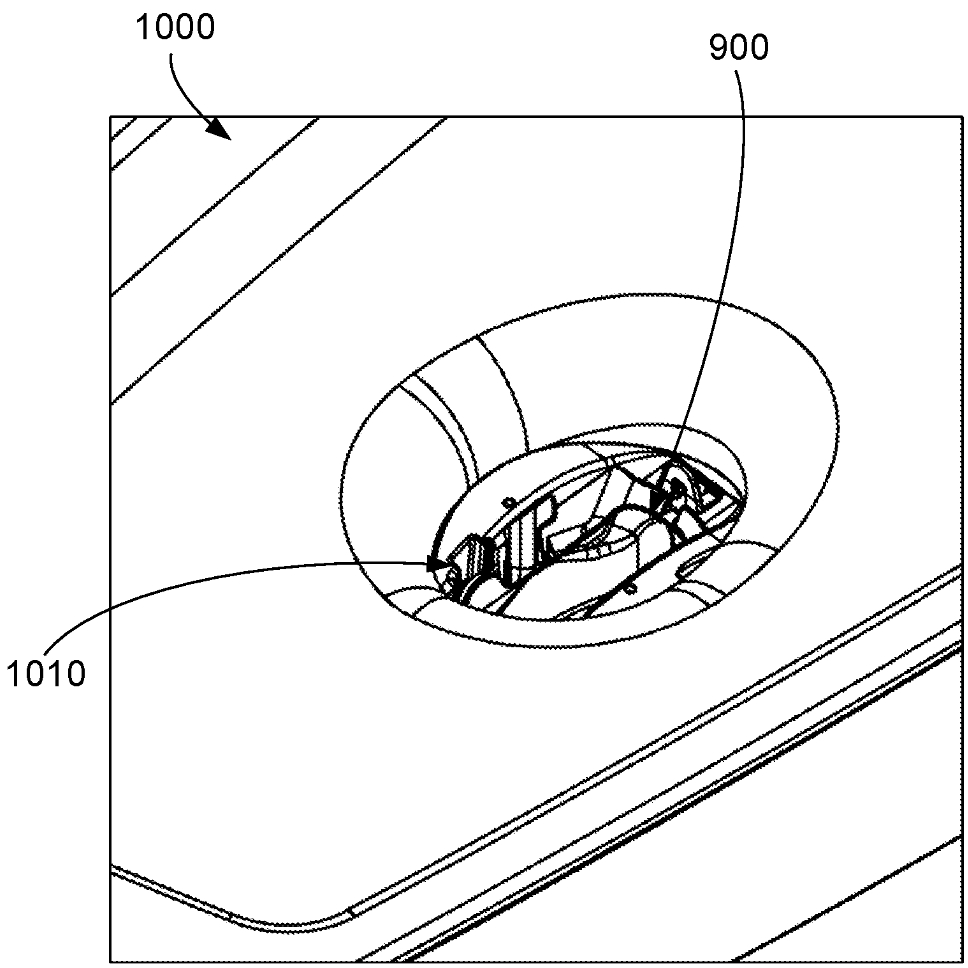


FIG. 12

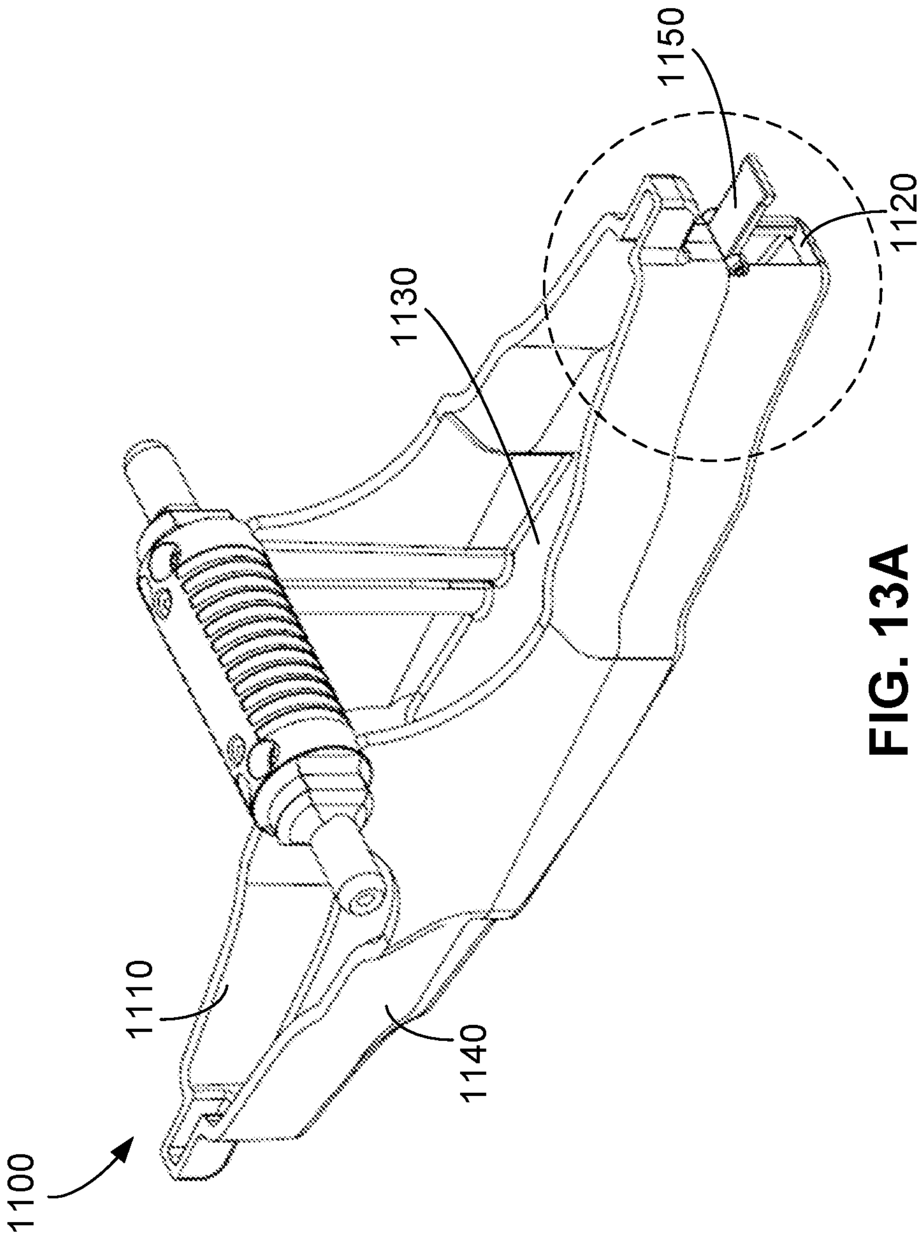


FIG. 13A

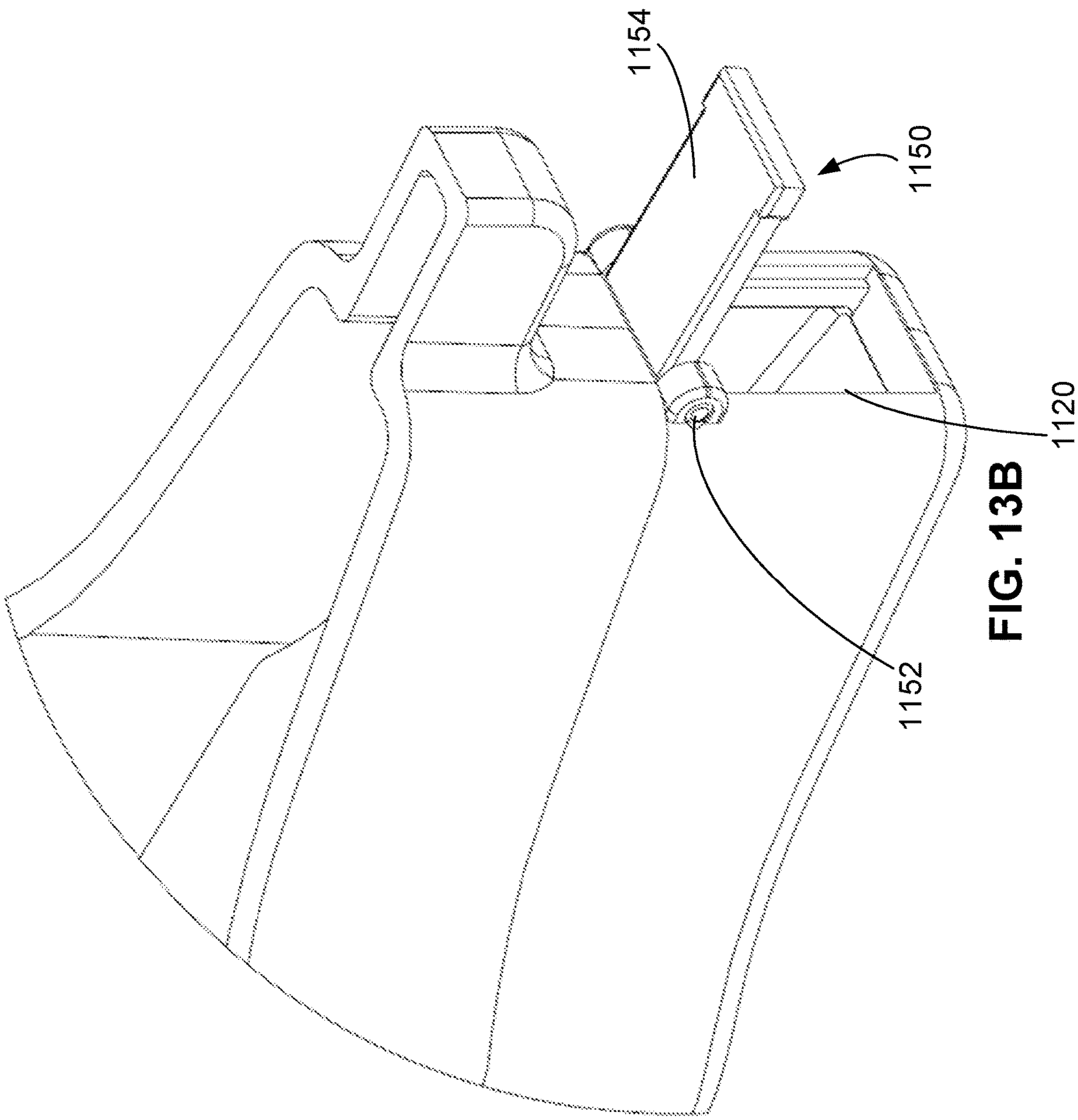


FIG. 13B

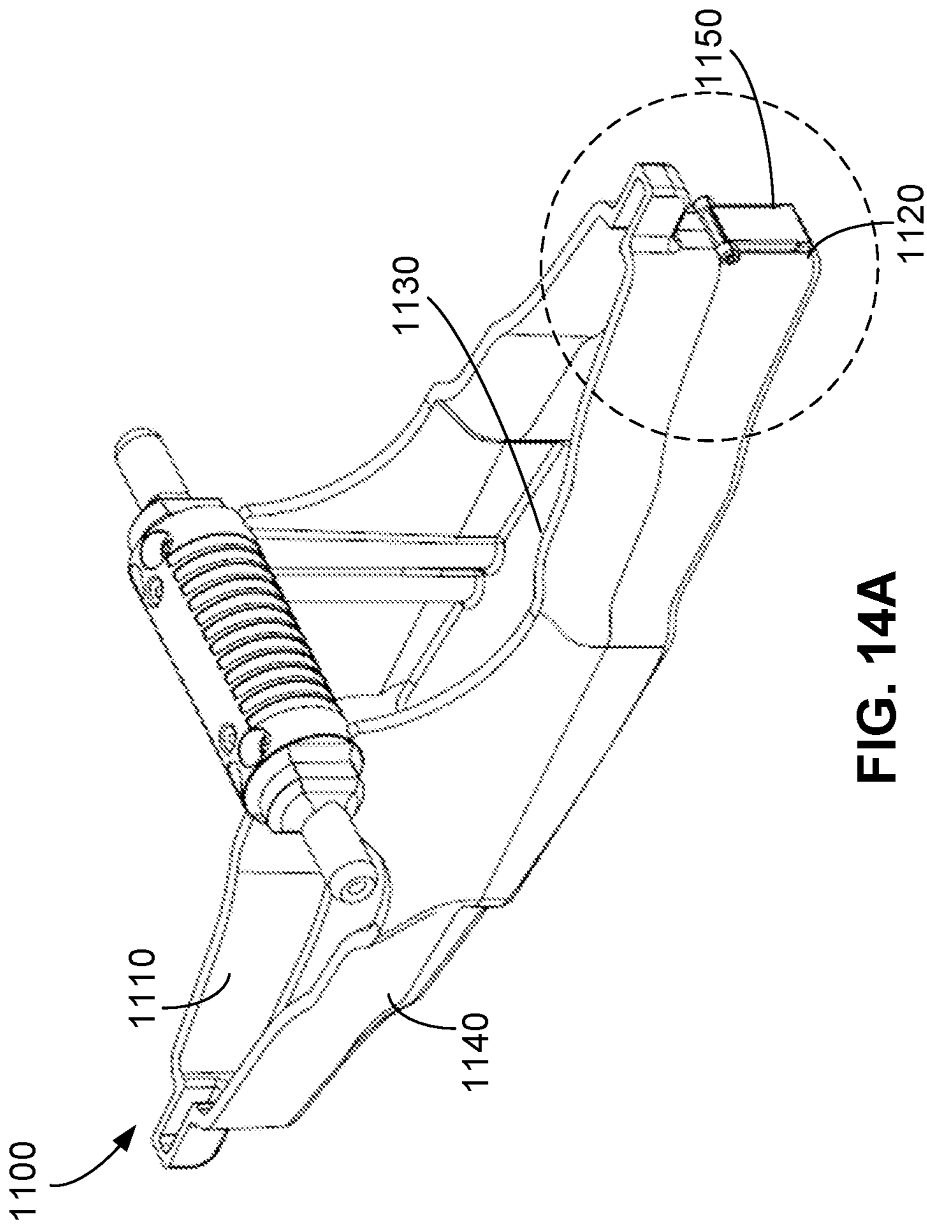


FIG. 14A

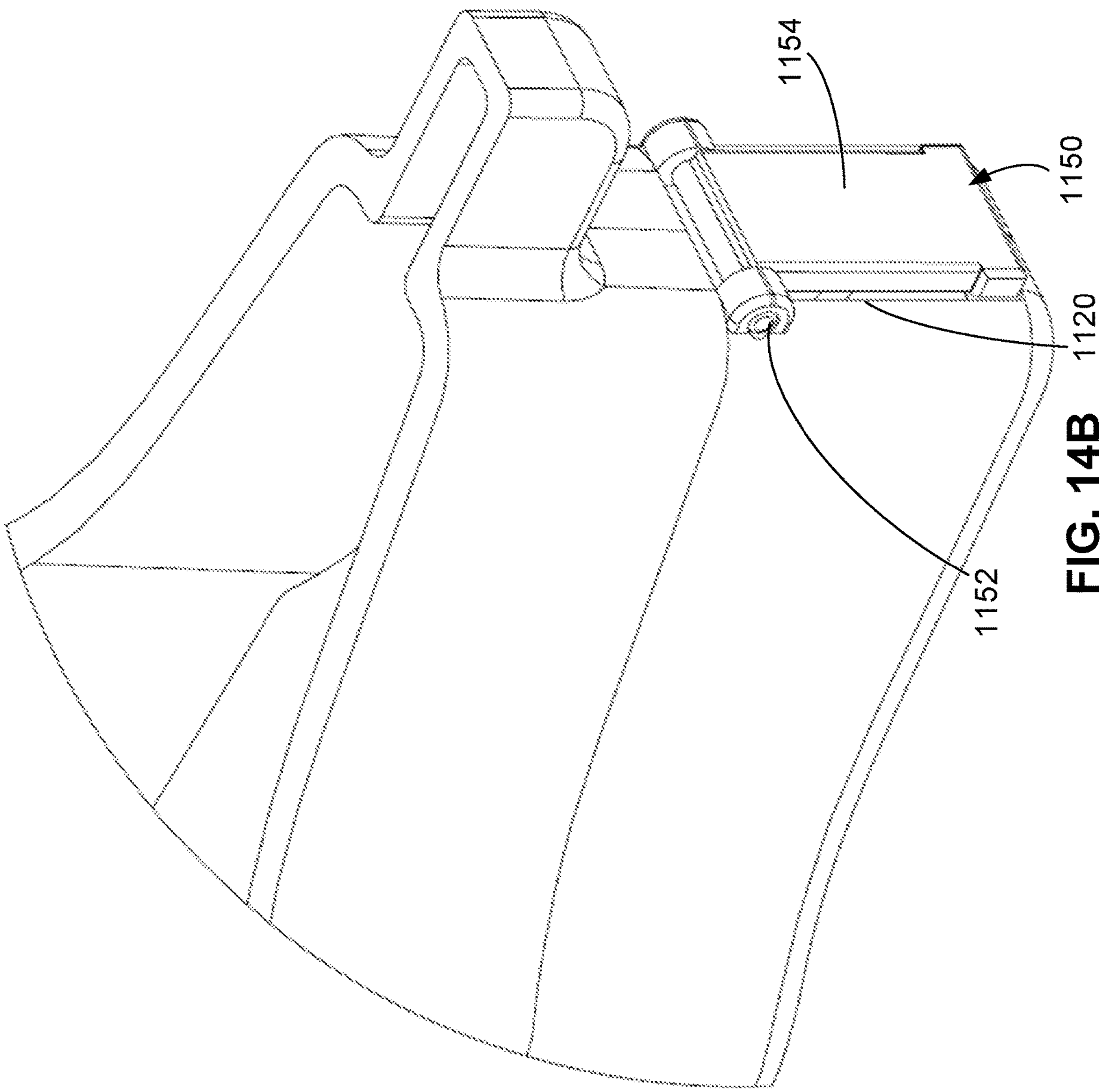


FIG. 14B

DRAIN MECHANISM FOR WATERCRAFT

TECHNICAL FIELD

This specification relates to a drain mechanism for a watercraft.

BACKGROUND

A personal watercraft can include a hull for carrying one or more passengers. The hull of the watercraft floats when the watercraft is placed on a body of water. As the watercraft travels along the body of water, the hull of the watercraft may collect water. For example, water can splash onto the hull, or the watercraft can include features that enable water to flow into the hull, such as an opening exposed to the body of water. The collected water can be bailed out of the watercraft to prevent objects and people on the hull from getting wet and to prevent excessive water mass from being collected on the hull.

SUMMARY

This disclosure features a watercraft that includes a drain mechanism that drains water from a hull of the watercraft as the watercraft travels across a body of water. In some examples in this disclosure, the hull can include an opening that can receive a modular device (e.g., a removable propulsion mechanism, a removable sensing device, an insert, or other device that can be mounted to and dismounted from the opening) that contacts the body of water. In examples in which the modular device is a removable propulsion mechanism, the removable propulsion mechanism can be operable to drive the watercraft across the water. The opening, however, is exposed to the body of water and can allow water to flow onto the hull, thus possibly inadvertently wetting objects on the hull. The likelihood of water flowing onto the hull can increase when the propulsion mechanism is removed from the opening, thus exposing an upper portion of the hull through an entirety of the opening to the body of water.

To prevent water from flowing onto the upper portion of the hull, an insert can be placed in the opening. This insert can include structures that discourage water from flowing onto the hull and, in particular, can include an aperture that limits exposure of the upper portion of the hull to the body of water as the watercraft travels across the body of water. In addition, as the watercraft travels across the body of water, the structures of the insert can interact with the water displaced by the watercraft in such a way that a low pressure zone is created near the aperture through the Venturi effect. In this low pressure zone, the pressure on one side of the aperture (e.g., the side within the body of water) can be lower than the pressure on the other side of the aperture (e.g., the side within the insert). As a result of the low pressure zone on the side of the aperture within the body of water, water collected in the insert (e.g., including water that flows through the aperture or water that is collected in the insert through other splashing or other mechanisms) can have a tendency to be pulled back through the aperture into the body of water, thus preventing the upper portion of the hull from collecting too much water.

In one aspect, a watercraft is featured. The watercraft includes a hull, an opening extending through the hull, the opening configured to receive a removable propulsion mechanism, and an insert removably insertable into the opening. The insert includes an inner cavity, an aperture configured to be at least partially submerged in a fluid when the watercraft is positioned on the fluid, the aperture being configured to provide fluid communication between the inner cavity of the insert and the fluid as the watercraft travels in a forward direction, and a surface shaped and dimensioned such that a first pressure within the inner cavity is greater than a second pressure at the aperture as the watercraft travels in the forward direction.

In another aspect, an insert is featured. The insert is configured to be received in an opening extending through a hull of a watercraft. The opening is configured to receive a removable pedal-driven propulsion system. The insert includes an inner cavity, an aperture configured to be at least partially submerged in a fluid when the watercraft is positioned on the fluid, the aperture being configured to provide fluid communication between the inner cavity of the insert and the fluid as the watercraft travels in a forward direction, and a surface shaped and dimensioned such that a first pressure within the inner cavity is greater than a second pressure at the aperture as the watercraft travels in the forward direction.

In some implementations, the opening is defined by the hull.

In some implementations, a support assembly within the opening. The support assembly can be configured to receive the removable propulsion mechanism. The insert can be removably insertable into the support assembly.

In some implementations, the aperture is located at a first location rearward a second location, and the surface is shaped and dimensioned such that a first fluid pressure at the first location is lower than a second fluid pressure at the second location along the insert as the watercraft travels in the forward direction. In some implementations, the first location is along a rear portion of the insert, and the second location is along a forward portion of the insert.

In some implementations, the surface is angled relative to the forward direction such that a forward portion of the surface is above a rearward portion of the surface. In some implementations, the surface is substantially planar.

In some implementations, the insert includes one or more lateral walls extending upwardly from the surface, the one or more lateral walls at least partially define the aperture and the inner cavity.

In some implementations, the insert includes a lower wall and one or more lateral walls, the lower wall at least partially defining the surface, and the lower wall and the one or more lateral walls at least partially defining the inner cavity. In some implementations, the one or more lateral walls are configured to extend along at least part of a perimeter of the opening when the insert is received within the opening.

In some implementations, the insert includes a shaft on a first side portion of the insert, the shaft engageable with a bearing surface within the opening. In some implementations, the watercraft further includes a locking assembly to releasably lock the shaft of the insert to the watercraft when the insert is received within the opening. In some implementations, the watercraft further includes a support assembly within the opening. The support assembly can be configured to receive the removable propulsion mechanism. The insert can be removably insertable into the support assembly. The support assembly can include the locking assembly. In some implementations, the hull includes the locking assembly. In some implementations, the shaft is a first shaft, the bearing surface is a first bearing surface, and the insert includes a second shaft on a second side portion of the insert, the second shaft engageable with a second bearing surface. In some implementations, the hull or a support assembly within the opening defines the first and second bearing surfaces. In some implementations, the insert includes a handle extending from the first shaft to the second shaft.

In some implementations, the insert includes a longitudinal support member positioned to engage with a bearing surface within the opening.

In some implementations, the aperture is configured to extend to a location below the opening when the insert is mounted within the opening.

In some implementations, the watercraft further includes the removable propulsion mechanism. The removable propulsion mechanism can be a pedal-driven system.

In some implementations, the surface is shaped and dimensioned such that the first pressure within the inner cavity is greater than the second pressure at the aperture when a speed of the watercraft as the watercraft travels in the forward direction is between 2.5 and 20 meters per second.

In some implementations, the surface is shaped and dimensioned such that a difference between the first pressure and the second pressure is between 6,250 and 400,000 MPa.

In some implementations, the insert includes a flap adjacent to the aperture, the flap being movable between an open position and a closed position, and the flap configured to be in the open position as the watercraft travels in the forward direction and configured to be in the closed position as the watercraft travels in a rearward direction.

In some implementations, the insert further includes a lower wall defining the surface, and one or more lateral walls extending away from the lower wall. The one or more lateral walls and the aperture can extend along an entirety of a perimeter of the lower wall. The inner cavity can be at least partially defined by the lower wall and the one or more lateral walls. In some implementations, the surface is angled relative to the forward direction such that a forward portion of the surface is above a rearward portion of the surface.

In some implementations, the insert further includes a left shaft along a left side of the insert, the left shaft configured to bear against a left bearing surface in the opening of the watercraft when the insert is mounted to the watercraft, and a right shaft along a right side of the insert, the right shaft configured to bear against a right bearing surface in the opening of the watercraft when the insert is mounted to the watercraft. In some implementations, the insert further includes a forward support member along a forward portion of the insert, the forward support member configured to bear against a forward bearing surface in the opening of the watercraft when the insert is mounted to the watercraft, and a rearward support member along a rearward portion of the insert, the rearward support member configured to bear against a rearward bearing surface in the opening of the watercraft when the insert is mounted to the watercraft.

Advantages of the systems and methods described in this disclosure may include those described below and elsewhere in this disclosure. First, the insert can drain water from the watercraft in a passive manner and thus allows water to be removed from the watercraft without the use of heavy and costly pumps. Second, the insert can be easily and cheaply manufactured, for example, using injection molding techniques. Third, in examples in which the watercraft includes an opening for receiving a modular device, the insert can be easily exchanged with the modular device and can be easily locked to the hull, for example, using a locking mechanism within the opening.

The details of one or more implementations of the subject matter described in this specification are set forth in the accompanying drawings and the description below. Other potential features, aspects, and advantages will become apparent from the description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are top perspective exploded views of a watercraft, with FIG. **1** showing the watercraft with a removable propulsion mechanism, and FIG. **2** showing the watercraft with a removable insert for draining water.

FIG. **3** is a top perspective view of a watercraft including a removable insert for draining water.

FIG. **4** is a side cross-sectional view of a portion of the watercraft through the section line A-A in FIG. **3**.

FIGS. **5**A-**5**E are top-rear perspective, bottom-rear perspective, top, side, and side cross-sectional views of a removable insert for draining water.

FIGS. **6** and **7** are top views of a portion of a watercraft that receives a removable insert for draining water, with FIG. **6** showing the removable insert received in the portion of the watercraft and FIG. **7** showing the portion of the watercraft without the removable insert.

FIG. **8** is a side cross-sectional view of the portion of the watercraft through the section line A-A in FIG. **3**, with a possible waterline schematically depicted.

FIG. **9** is a top perspective view of a portion of a watercraft with a support assembly and a removable insert mounted to the support assembly.

FIG. **10** is a top perspective view of another example of a watercraft with a removable propulsion mechanism.

FIGS. **11**A-**11**D are top-rear perspective, bottom-front perspective, top, and side cross-sectional views of another example of a removable insert for draining water.

FIG. **12** is a top perspective view of a portion of a watercraft with a support assembly in which the insert of FIGS. **11**A-**11**D is inserted.

FIG. **13**A is a rear perspective view of another example of a removable insert, with a flap of the insert in an open position.

FIG. **13**B is an enlarged rear perspective view of a portion of the removable insert of FIG. **13**A.

FIG. **14**A is a rear perspective view of the removable insert of FIG. **13**A, with the flap of the insert in a closed position.

FIG. **14**B is an enlarged rear perspective view of the portion of the removable insert of FIG. **14**A.

DETAILED DESCRIPTION

Referring to FIGS. **1** and **2**, a watercraft **100** includes a hull **110** and an opening **120** extending through the hull **110**, e.g., vertically through the hull **110**. The opening **120** is configured to receive and support removable devices that, for example, enable a user of the watercraft **100** to propel the watercraft **100** across a body of water. FIG. **1** illustrates an example in which a removable propulsion mechanism **200** is insertable into the opening **120**, the removable propulsion mechanism **200** being a manually operable propulsion mechanism with pedals that can be driven by the user to propel the watercraft **100** across the body of water. The removable propulsion mechanism **200** can be removed from the watercraft **100**, thereby exposing an upper portion **111** of the hull **110** to the body of water on which the watercraft **100** is positioned. As discussed in this disclosure, an insert **300** can be removably inserted into the opening **120** to partially obstruct water from flowing or splashing onto the upper portion **111** of the hull **110**. In addition, the insert **300** can, as described in greater detail in this disclosure, include structure and geometry that uses the Venturi effect to encourage drainage of water on the watercraft into the body of water.

FIG. **3** illustrates an exemplary implementation of a watercraft including an insert. In particular, the watercraft **100** shown in FIG. **3** includes the insert **300** in the opening **120** of the watercraft **100**. In the example depicted in FIG. **3**, the watercraft **100** is a personal kayak that can sit one passenger. The hull **110** of the watercraft **100** includes the upper portion **111**, a lower portion **112**, a forward portion **113**, and a rearward portion **114**. In addition to including the hull **110** and the insert **300**, the watercraft **100** includes a chair **130** on the upper portion **111** and the rearward portion **114** of the hull **110**, an outboard motor system **170** on the rearward portion **114** of the hull **110**, and a rudder mechanism **150** on the rearward portion **114** of the hull **110**. As discussed above, the opening **120** is also configured to receive the removable propulsion mechanism **200**. In particular, the removable propulsion mechanism **200** can be exchanged with the insert **300** to allow the user to manually drive the watercraft **100** through the body of water. In the example shown in FIG. **3**, the watercraft **100** includes a support assembly **140** within the opening **120** that is configured to receive the removable propulsion mechanism **200**, and is also configured to receive the insert **300**.

The outboard motor system **170** is operable to propel the watercraft **100** through the body of water. The outboard motor system **170** includes a motor that, when driven, rotates a propeller **171**. Rotation of the propeller **171** through the body of water causes the watercraft **100** to be propelled through the body of water in a forward direction of the watercraft **100**. The motor can be operated in reverse to allow rotation of the propeller **171** through the body of water such that the watercraft is propelled through the body of water in a rearward direction of the watercraft **100**. The outboard motor system **170** can be dismounted from the watercraft **100**, thereby reducing the weight of the watercraft **100**.

The rudder mechanism **150** is operable to steer the watercraft **100** as the watercraft **100** is driven in the forward direction or in the rearward direction. The rudder mechanism **150** can be manually operable. For example, the rudder mechanism **150** includes a rudder **151** that is movably mounted to the watercraft **100** and a handle **152** mounted to the upper portion **111** of the hull **110** to allow the user to access and manipulate the handle **152**. When manipulated, the handle **152** causes the rudder **151** to rotate, thereby allowing the user to steer the watercraft **100** as the watercraft **100** is propelled through the body of water, e.g., via the removable propulsion mechanism **200** (shown in FIG. **1**) or via the outboard motor system **170**. The handle **152** can be located adjacent to the chair **130** such that the user can easily access the handle **152** when the user is sitting in the chair **130**. In addition, when sitting in the chair, the user can easily access the removable propulsion mechanism **200** when the removable propulsion mechanism **200** is inserted into the opening **120**. Thus the user can simultaneously propel the watercraft **100** through manual efforts and also steer the watercraft **100** as the watercraft **100** is being propelled.

FIG. **4** illustrates the insert **300** removably inserted into the opening **120** through the hull **110**. The opening **120** is defined by the hull **110**. The opening **120** is a through-opening that extends from the upper portion **111** of the hull **110**, through the hull **110**, and to the lower portion **112** of the hull **110**. The support assembly **140** is located within the opening **120**. The support assembly **140** includes a locking assembly **141** to releasably lock a portion of a modular assembly, e.g., the removable propulsion mechanism **200** or the insert **300**, to the hull **110**. The locking assembly **141**, for example, can include one or more manually operable arms, e.g., a manually operable arm **142** shown in FIG. **4**, that engages with part of the modular assembly to releasably lock the modular assembly to the hull **110**. In the example shown in FIG. **4**, the insert **300** corresponds to the modular assembly. The support assembly **140**, in some implementations, is a separate component that is received within the opening **120**. The support assembly **140** in turn is configured to receive the removable propulsion mechanism **200** and is also configured to receive the insert **300**. In other implementations, as described in greater detail in this disclosure, the support assembly **140** is at least in part integral with the hull **110**.

FIGS. **5**A-**5**E illustrate an exemplary implementation of a drain mechanism for a watercraft. In particular, an example of the insert **300** is depicted. The insert **300** is a structure that can be mounted in the opening **120** for draining water from the hull **110** of the watercraft **100**. In the example shown, the insert **300** includes an inner cavity **310** extending through an upper portion **301** and a lower portion **302** of the insert **300** and an aperture **320** along a rearward portion **304** and the lower portion **302** of the insert **300**. The insert **300** further includes a lower wall **330** extending from a forward portion **303** to the rearward portion **304** of the insert **300** and along the lower portion **302** of the insert **300** and lateral walls **340** extending around an outer perimeter of the insert **300**. The insert **300** also includes a handle **350** on an upper portion **301** of the insert **300**. The insert **300** also includes mounting shafts **360** on the upper portion **301** of the insert **300** and longitudinal support members **370** on the forward portion **303** and the rearward portion **304**.

The inner cavity **310** serves as a reservoir for collecting water that is drained into the body of water through the insert **300**. Referring to FIGS. **5**A and **5**C, the inner cavity **310** is defined by outer walls of the insert **300**, e.g., the lower wall **330** and the lateral walls **340**. The inner cavity **310** extends through at least 75% of a length of the insert **300**, e.g., at least 80%, 85%, 90%, or 95% of the length of the insert **300**. In implementations, the length of the insert **300** is between 20 and 40 centimeters (e.g., between 20 and 30 centimeters, between 25 and 35 centimeters, between 30 and 40 centimeters, about 25 centimeters, about 30 centimeters, about 35 centimeters, etc.). The insert **300** and its outer walls are shaped to fit within the opening **120** of the watercraft **100**. Thus in the example of the watercraft **100** shown in FIGS. **3-4** in which the opening **120** has a substantially elliptical shape, the outer walls of the insert **300** and the inner cavity **310** form elongate shapes that allow the insert **300** to fit within the opening **120** of the watercraft **100** and that allow the inner cavity **310** to provide sufficient volume for the inner cavity **310** to serve as a reservoir for water.

The inner cavity **310** is directly connected to the aperture **320**, thus allowing fluid flow through the aperture **320** into the inner cavity **310** and fluid flow from the inner cavity **310** through the aperture **320** and out of the insert **300**. The inner cavity **310** also occupies a sufficient volume to serve as a reservoir for fluid that flows through the aperture **320**. For example, the volume occupied by the inner cavity **310** is between 0.5 and 2.5 liters (e.g., between 0.5 and 1.5 liters, between 1 and 2 liters, between 1.5 and 2.5 liters, about 1 liter, about 1.5 liters, about 2 liters, etc.). Indeed, in the example shown in FIGS. **5**A-**5**E, the aperture **320** corresponds to the only fluid conduit into the inner cavity **310** through the lower portion **302** of the insert **300**.

In addition, the inner cavity **310** is exposed from above, e.g., exposed to the atmosphere, during use of the watercraft **100**. The inner cavity **310** thus is exposed to fluid from both above and below. Typically, during use of the watercraft **100**, the inner cavity **310** is exposed to water from below, e.g., through the aperture **320**, and is exposed to atmosphere or air from above, e.g., through the upper portion **301** of the insert **300**.

Referring to FIGS. **5**A-**5**B and **5**E, the aperture **320** is located along the lower portion **302** of the insert **300** and on the rearward portion **304** of the insert **300**. The aperture **320** extends through a lateral wall **340** of the insert **300** in a longitudinal direction and spans a substantial part of the lower portion **302**, e.g., at least 80% of the height of the lower portion **302**. The aperture **320** has an overall height between 1 and 4 centimeters (e.g., between 1 and 2 centimeters, between 2 and 3 centimeters, between 3 and 4 centimeters, about 2 centimeters, about 3 centimeters, etc.). In the example shown in FIG. **5**E, the aperture **320** extends vertically from the lower wall **330** to a portion of a lateral wall **340** of the insert **300**, e.g., the rearmost lateral wall of the lateral walls **340**. The aperture **320** extends over an area, e.g., an area of a vertical cross-section of the aperture **320**, of about 1.5 and 12 square centimeters (e.g., between 1.5 and 6 square centimeters, between 4 and 9 square centimeters, between 7 and 12 square centimeters, about 3 square centimeters, about 5 square centimeters, about 7 square centimeters, about 9 square centimeters, etc.).

The aperture **320** is connected to the inner cavity **310**, as discussed above. The aperture **320** extends horizontally through the rearmost lateral wall of the lateral walls **340** to bridge the inner cavity **310** and a space outside of the insert **300**. The aperture **320** provides fluid communication between the inner cavity **310** of the insert **300** and the water on which the watercraft **100** is located. Further, when the insert **300** is mounted within the opening **120** of the watercraft **100**, the aperture **320** is configured to extend to a location below the opening **120** of the watercraft **100**.

Referring to FIGS. **5**B-**5**E, the lower wall **330** extends from the forward portion **303** to the rearward portion **304** of the insert **300**. The lower wall **330** at least partially defines the inner cavity **310**, e.g., with the lateral walls **340**. The lower wall **330** defines a lower surface **331** that similarly extends from the forward portion **303** to the rearward portion **304** of the insert **300**. The surface **331** is angled relative to a longitudinal axis of the insert **300**, e.g., relative to a longitudinal axis of and a forward direction of the watercraft **100**, such that a forward portion of the surface **331** is above a rearward portion of the surface **331**. An angle of the surface **331** relative to the longitudinal axis of the insert **300** is between 5 and 45 degrees (between 5 and 20 degrees, between 15 and 30 degrees, between 25 and 40 degrees, about 10 degrees, about 20 degrees, about 30 degrees, about 40 degrees, etc.). In the example depicted in FIGS. **5**A-**5**E, the surface **331** is substantially planar such that the surface **331** extends linearly from the forward portion of the surface **331** to the rearward portion of the surface **331**, although in other implementations, the surface **331** can be curved. As shown in FIG. **5**E, the surface **331** extends longitudinally to the aperture **320**.

The lateral walls **340** are a series of interconnected walls defining lateral surfaces of the insert **300**. One or more of the lateral walls **340** extend vertically from the lower wall **330**. For example, the lateral walls **340** can include a forward lateral wall, a left lateral wall, a right lateral wall, and a rearward lateral wall, with the aperture **320** being defined in the rearward lateral wall. The forward, left, and right lateral walls extend vertically from the lower portion **302** of the insert **300** to the upper portion **301** of the insert **300**, thereby preventing fluid communication across these lateral walls. In contrast, the aperture **320** extends from the lower wall **330** and through a portion of the rearward lateral wall, thus providing fluid communication across the rearward lateral wall. In this regard, the aperture **320** in combination with the forward, left, and right lateral walls extend along an entirety of a perimeter of the lower wall **330**. The lateral walls **340** at least partially define the inner cavity **310**, e.g., with the lower wall **330**, and extend along an outer perimeter of the lower wall **330**, e.g., an outer perimeter of the surface **331**.

Referring to FIGS. **5**A and **5**C, the handle **350** and the shafts **360** are located along a transverse central axis of the insert **300**. The shafts **360** can be part of an elongate member extending along the transverse central axis, across a width of the portion of the insert **300** defined by the lateral walls **340** and the lower wall **330**. This elongate member can be fixed to the handle **350**, e.g., via fasteners. The handle **350** is manually graspable by a user of the watercraft **100**, thus providing an easy mechanism for the user to place the insert **300** into the opening **120** of the watercraft **100** and to remove the insert **300** from the opening **120**. The handle **350** can similarly extend along the transverse central axis of the insert **300**. Further, the handle **350** is positioned above the inner cavity **310** to provide sufficient space for the user's hand to grasp around an entirety of the handle **350**. The handle **350** can extend from the left shaft to the right shaft of the shafts **360**. The left shaft is on a left side portion of the insert **300**, while the right shaft is on a right side portion of the insert **300**. In addition, the shafts **360** protrude radially outwardly away from a center of the insert **300**, and further protrude radially outwardly away from the lateral walls **340** of the insert **300**.

FIGS. **6** and **7** illustrate an interface between the watercraft **100** and the insert **300**, specifically an interface between the support assembly **140** of the watercraft **100** and bearing surfaces of the insert **300**. When the insert **300** is received within the opening **120** of the watercraft **100**, the lateral walls **340** extend along at least part of a perimeter of the opening **120** of the watercraft **100**. The insert **300**, referring briefly back to FIGS. **5**B, includes bearing surfaces on the shafts **360** and the longitudinal support members **370**. The longitudinal support members **370** are positioned along a longitudinal central axis of the insert **300**. The longitudinal support members **370** provide downward facing bearing surfaces that rest on corresponding longitudinal support surfaces **143** (forward and rearward bearing surfaces **143** shown in FIG. **7**) on the support assembly **140**. The shafts **360** also provide bearing surfaces that can rest on corresponding side support surfaces **144** (left and right side support surfaces **144** shown in FIG. **7**) on the support assembly **140**. The longitudinal support surfaces **143** and the side support surfaces **144** are located within the opening **120** of the watercraft **100**.

In implementations, the support assembly **140** can include the structure for defining the bearing and support surfaces **143**, **144** and the structure for the locking assembly **141**. For example, in implementations in which the support assembly **140** is an assembly separate from the watercraft **100**, the structure for defining the bearing and support surfaces **143**, **144** can be formed of one or more components that are then mounted to the watercraft **100**, e.g., attached to the watercraft. In implementations in which the support assembly **140** is integral to the watercraft **100**, the structure for defining the bearing and support surfaces **143**, **144** can be formed as part of the hull **110** of the watercraft **100**. For example, the hull

110 and the structure for defining the bearing and the support surfaces 143, 144 can be formed in a process that forms a monolithic component including the hull 110 and this structure, e.g., a molding, inflatable, or thermoforming process.

As shown in FIG. 6, the locking assembly 141 can engage with the shafts 360 of the insert 300 to lock the insert 300 to the watercraft 100. In particular, the locking arms 142 of the locking assembly 141 can engage the shafts 360 and prevent the shafts from being removed from the opening 120, e.g., in a vertical direction. The locking arms 142 can be manually manipulated by a user to release the insert 300 and thereby allow the user to pull the insert 300 out of the opening 120.

FIG. 8 illustrates a schematic example of the watercraft 100 when the watercraft 100 is positioned on a body of water having a waterline 400 (e.g., an upper surface of the body of water). The watercraft 100 is configured such that the waterline 400 is positioned above the aperture 320 and above the inner cavity 310 when the insert 300 is removably inserted into the opening 120.

In use, the insert 300 can encourage drainage of water through the aperture 320 out of the inner cavity 310. As discussed in this disclosure, when the watercraft 100 is positioned on the body of water, the aperture 320 is at least partially submerged in the water and can fluid communication between the inner cavity 310 of the insert 300 and the body of water.

Particularly, as the watercraft 100 travels along the surface of the body of water, water can splash onto or otherwise flow through the aperture 320.

The forward travel of the watercraft 100 can create a zone 410 of low fluid pressure proximate to the aperture 320 due to the Venturi effect caused by the shape and dimension of the lower surface 331 of the insert 300. The lower wall 330 is shaped and dimensioned such that a first pressure within the inner cavity 310, e.g., a first fluid pressure within the inner cavity 310, is greater than a second pressure at the aperture 320, e.g., a second fluid pressure within the inner cavity 310, as the watercraft 100 travels in a forward direction. For example, with the angle of the lower surface 331, the forward portion of the lower surface 331 is positioned above the rearward portion of the lower surface 331, thus reducing fluid pressure at the rearward portion as the watercraft 100 travels in the forward direction. If the aperture 320 is located at a first location in the body of water along a longitudinal axis of the insert 300, or a longitudinal axis of the watercraft 100, a pressure at a second location proximate to the lower wall 330 in the body of water is greater than a pressure at the first location. This first location is located along the rearward portion 304 (FIG. 5A) of the insert 300, the second location is located along the forward portion 303 (FIG. 5A) of the insert 300.

In examples in which some water from the body of water has intruded into the inner cavity 310 as the watercraft 100 is traveling in the forward direction, the movement of the watercraft 100 in the forward direction can further limit accumulation of water in the inner cavity 310 and can also drain the water accumulated within the inner cavity due to pressure differential between the fluid in the inner cavity 310 and the fluid in the low-pressure zone 410 of the body of water proximate to the aperture 320. In implementations, the watercraft 100 travels in the forward direction at a speed between 2.5 and 20 meters per second (e.g., between 2.5 and 15 meters per second, between 5 and 17.5 meters per second, between 7.5 and 20 meters per second, about 5 meters per second, about 10 meters per second, about 15 meters per second, etc.). At least at such speeds, the lower surface 331 of the insert 300 can reduce pressure in the low-pressure zone 410 near the aperture 320 sufficiently to cause drainage of water from the inner cavity 310 back into the body of water. Further, at such speeds, the lower surface 331 creates a difference between pressure within the inner cavity 310 and pressure in the low-pressure zone 410 that is 6,250 to 400,000 MPa.

The insert 300 can be useful in situations where the watercraft 100 is being propelled with a propulsion mechanism that is separate from a removable propulsion mechanism (e.g., the removable propulsion mechanism 200 shown in FIG. 2) that is received within the opening 120. In particular, this propulsion mechanism could correspond to the outboard motor system 170. The outboard motor system 170 could be operated to propel the watercraft 100 at speeds that could cause water to flow through the opening 120 of the watercraft 100 onto the hull 110, if the insert 300 were not present. With the insert 300, the forward movement of the watercraft 100 can drain water at a rate sufficient to ensure that water does not flow onto the hull 110. I

In another example, a user may wish to remove the removable propulsion mechanism and use the outboard motor 170 for propelling the watercraft 100 across the water. A user may prefer to use the removable propulsion mechanism for traveling across relatively short distances (e.g., less than 100 meters, less than 200 meters, less than 300 meters, less than 400 meters, less than 500 meters, etc.) while performing tasks in a particular area (e.g., recreation, fishing, or other task that could be limited to a small area). The user may prefer to use the outboard motor system 170 for traveling longer distances (e.g., more than 100 meters, more than 200 meters, more than 300 meters, more than 400 meters, more than 500 meters, etc.) at higher speeds. The user may remove the removable propulsion mechanism to reduce drag on the watercraft 100 as the watercraft 100 travels in the forward direction under the propulsion of the outboard motor system 170. If the removable propulsion mechanism were kept mounted within the opening 120, the movement of the watercraft 100 could result in water intruding onto the hull 110 of the watercraft 100 through the removable propulsion mechanism.

A number of implementations have been described. While this specification contains many specific implementation details, these should not be construed as limitations on the scope of what is being claimed, which is defined by the claims themselves, but rather as descriptions of features that may be specific to particular implementations of particular inventions. It will be understood that various modifications may be made.

The support assembly 140 for supporting modular assemblies and mounting modular assemblies to the watercraft 100 can vary in implementations as described herein. In some implementations, the support assembly 140 is integral to the watercraft 100 while in other implementations, the support assembly 140 is separate from the watercraft 100. FIG. 9 illustrates an example of a portion of a watercraft 500 including a hull 510, an opening 520, and a support assembly 530 that is integral to the watercraft 500, and an insert 600. The bearing and support surfaces (e.g., similar to the bearing and support surfaces 143, 144 discussed with respect to FIGS. 6-7) are surfaces on the hull 510, rather than surfaces on a separate component mounted to the hull 510. Further, the bearing and support surfaces are located within the opening 520 and are configured to support the insert 600 within the opening 520 of the watercraft 500.

Other implementations with variations in the structure and design of the support assembly 140 are possible. For example, a support assembly can be formed of multiple interconnected components. In implementations in which the support assembly is separate from the watercraft **100**, the support assembly can be mounted to the hull of the watercraft in a number of ways, including via fasteners, adhesives, or other methods.

The watercraft **100** shown in FIGS. **1-3** is a personal kayak. The type of watercraft that can benefit from inserts similar to those discussed in this disclosure can vary in implementations. For example, the watercraft can be a kayak for a single passenger, a tandem kayak for multiple passengers, a fishing kayak, a raft, a dinghy, an inflatable kayak, a pontoon, or another watercraft. In particular, the watercraft can include an opening for receiving a modular assembly for a propulsion mechanism, a data collection apparatus (e.g., a sonar device), or other device that can be received in the opening and that interfaces with the body of water.

Referring to FIG. **10**, in another exemplary implementation, a watercraft **700** is a dinghy that differs from the watercraft **100** in the structure and design of the hull **710** of the watercraft **700**. The watercraft **700** can be wider than the watercraft **100**. In some implementations, the watercraft **700** can be suitable for multiple passengers. Like the watercraft **100**, the watercraft **700** includes an opening **720** (similar to the opening **120** for receiving modular assemblies), a chair **730** (similar to the chair **130**), an outboard motor system **740** (similar to the outboard motor system **170**), and a rudder mechanism **750** (similar to the rudder mechanism **150**). In the example shown in FIG. **10**, the opening **720** receives a removable propulsion mechanism **800**. This opening **720** is similarly configured to receive an insert similar to the insert **300** described with respect to FIGS. **1-8**, or other implementations of inserts described in this disclosure.

While the watercraft **100** of FIGS. **1-3** is described as having a pedal-driven system in the form of the removable propulsion mechanism, other removable propulsion mechanisms can be present in implementations. For example, the propulsion mechanism can include foot pedals, hand cranks, or other manually driven propulsion mechanisms.

The design and form factor of inserts may also vary in implementations. For example, lateral walls of the inserts need not extend along a perimeter of the lower wall of the insert that defines the sloped lower surface. Further, the bearing surfaces of the insert that are supported by the support assembly of the watercraft need not be positioned along a central longitudinal axis or a central transverse axis of the insert.

For example, referring to FIGS. **11A-11D**, an insert **900** is similar in function to the insert **300** in that the insert **900** can be easily placed within an opening of a watercraft that is configured to receive various modular assemblies. The insert **900** differs from the insert **300** in a number of ways.

For example, the insert **900** includes an inner cavity **910** with a narrower first portion **911** adjoining an aperture **920** of the insert **900** and a wider second portion **912** adjoining the narrower first portion **911**. A lower wall **930** of the insert **900** is similar to the lower wall **330** in that the lower wall **930** defines a sloped lower surface **931** similar to the lower surface **331**. The lower wall **930** at least partially defines the narrower first portion **911** of the inner cavity **910**. The insert **900** further includes another lower wall **935** that is not sloped and that partially defines the wider second portion **912** of the inner cavity **910**. A first set of lateral walls **940** at least partially defines the narrower first portion **911** of the inner cavity **910**, and a second set of lateral wall **945** at least partially defines the wider second portion **912** of the inner cavity **910**. The narrower first portion **911** can further obstruct water from flowing into the inner cavity **910**.

The insert **900** also differs from the insert **300** in that shafts **960** of the insert **900** are located forward of a central transverse axis of the insert **300**, and longitudinal support members **970** of the insert **900** differ in form from the longitudinal support member **370** of the insert **300**. To accommodate for this difference, referring to the portion of a watercraft **1000** shown in FIG. **12**, a support assembly **1010** of the watercraft **1000** can have bearing surfaces at corresponding locations to support the longitudinal support members **970** and the shafts **960**.

FIGS. **13A-14B** illustrate another example of a removable insert **1100**. The insert **1100** includes an inner cavity **1110**, an aperture **1120**, a lower wall **1130**, and lateral walls **1140** similar to the inner cavity **310**, the aperture **320**, the lower wall **330**, and the lateral walls **340** of the insert **300**. The removable insert **1100** differs from the insert **300** in that the insert **1100** includes a flap **1150** that is adjacent to the aperture **1120** and that is movable between an open position (FIGS. **13A-13B**) and a closed position (FIGS. **14A-14B**). The flap **1150** is movably mounted, e.g., hingedly and/or pivotally mounted, to a rearward lateral wall of the lateral walls **1140** of the insert **1100**. An upper edge of the flap **1150** is movably attached to the rearward lateral wall. The flap **1150** is sized and dimensioned to cover an entirety of the aperture **1120** and to seal the inner cavity **1110** from the body of water to prevent fluid from flowing into the inner cavity **1110**. The flap **1150** is rotatable about a shaft **1152** that mounts the flap **1150** to the rearward lateral wall of the lateral wall **1150**. The flap **1150** extends downwardly from the shaft **1152** to cover the aperture **1120**.

The flap **1150** is configured such that the flap **1150** is in the closed position (FIGS. **14A-14B**) when a watercraft to which the insert **1100** is mounted is moving in a forward direction and such that the flap **1150** is in the open position (FIGS. **13A-13B**) when the watercraft is moving in a rearward direction. A neutral position of the flap **1150** can be the closed position (FIGS. **14A-14B**). When the watercraft is positioned on a body of water and moving in the forward direction, a significant difference between fluid pressure in the inner cavity **1110** and fluid pressure on a surface **1154** of the flap **1150** facing the body of water can exist. This significant difference in fluid pressure can cause the flap **1150** to move into the open position, thereby allowing fluid in the inner cavity **1110** to drain through the aperture **1120** into the body of water as the watercraft moves in the forward direction. The configuration of the flap **1150** causing the flap **1150** to be in the closed position when the watercraft is moving in the rearward direction can prevent the insert **1100** from drawing in excessive water into the inner cavity **1110** through the aperture **1120** as the watercraft is moving in the rearward direction (e.g., as the watercraft is moving in a direction that does not create a low pressure region at the aperture **1120**, thus causing water to have a tendency to flow from the body of water into the inner cavity **1110**).

Certain features that are described in this specification in the context of separate implementations can also be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation can also be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially be claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claim may be directed to a subcombination or variation of a subcombination.

Accordingly, other implementations are within the scope of the claims.

What is claimed is:

1. A watercraft comprising:

a hull;

an opening extending through the hull, the opening configured to receive a removable propulsion mechanism; and

an insert removably insertable into the opening, wherein the insert comprises:

an inner cavity,

an aperture located at a first location rearward of a second location, the aperture being configured to be at least partially submerged in a fluid when the watercraft is positioned on the fluid, and the aperture being configured to provide fluid communication between the inner cavity of the insert and the fluid as the watercraft travels in a forward direction, and

a surface shaped and dimensioned such that a first pressure within the inner cavity is greater than a second pressure at the aperture as the watercraft travels in the forward direction and such that a first fluid pressure at the first location is lower than a second fluid pressure at the second location along the insert as the watercraft travels in the forward direction.

2. The watercraft of claim **1**, wherein the opening is defined by the hull.

3. The watercraft of claim **1**, further comprising:

a support assembly within the opening,

wherein the support assembly is configured to receive the removable propulsion mechanism, and

wherein the insert is removably insertable into the support assembly.

4. The watercraft of claim **1**, wherein:

the first location is along a rear portion of the insert, and the second location is along a forward portion of the insert.

5. The watercraft of claim **1**, wherein:

the surface is angled relative to the forward direction such that a forward portion of the surface is above a rearward portion of the surface.

6. The watercraft of claim **5**, wherein:

the surface is substantially planar.

7. The watercraft of claim **1**, wherein:

the insert comprises one or more lateral walls extending upwardly from the surface, the one or more lateral walls at least partially define the aperture and the inner cavity.

8. The watercraft of claim **1**, wherein:

the insert comprises a lower wall and one or more lateral walls, the lower wall at least partially defining the surface, and the lower wall and the one or more lateral walls at least partially defining the inner cavity.

9. The watercraft of claim **8**, wherein:

the one or more lateral walls are configured to extend along at least part of a perimeter of the opening when the insert is received within the opening.

10. The watercraft of claim **1**, wherein:

the insert comprises a shaft on a first side portion of the insert, the shaft engageable with a bearing surface within the opening.

11. The watercraft of claim **10**, further comprising:

a locking assembly to releasably lock the shaft of the insert to the watercraft when the insert is received within the opening.

12. The watercraft of claim **11**, further comprising:

a support assembly within the opening,

wherein the support assembly is configured to receive the removable propulsion mechanism,

wherein the insert is removably insertable into the support assembly, and

wherein the support assembly comprises the locking assembly.

13. The watercraft of claim **11**, wherein:

the hull comprises the locking assembly.

14. The watercraft of claim **10**, wherein:

the shaft is a first shaft,

the bearing surface is a first bearing surface,

the insert comprises a second shaft on a second side portion of the insert, the second shaft engageable with a second bearing surface.

15. The watercraft of claim **14**, wherein:

the hull or a support assembly within the opening defines the first and second bearing surfaces.

16. The watercraft of claim **14**, wherein:

the insert comprises a handle extending from the first shaft to the second shaft.

17. The watercraft of claim **1**, wherein:

the insert comprises a longitudinal support member positioned to engage with a bearing surface within the opening.

18. The watercraft of claim **1**, wherein:

the aperture is configured to extend to a location below the opening when the insert is mounted within the opening.

19. The watercraft of claim **1**, further comprising:

the removable propulsion mechanism, wherein the removable propulsion mechanism is a pedal-driven system.

20. The watercraft of claim **1**, wherein:

the surface is shaped and dimensioned such that the first pressure within the inner cavity is greater than the second pressure at the aperture when a speed of the watercraft as the watercraft travels in the forward direction is between 2.5 and 20 meters per second.

21. The watercraft of claim **1**, wherein:

the surface is shaped and dimensioned such that a difference between the first pressure and the second pressure is between 6,250 and 400,000 MPa.

22. The watercraft of claim **1**, wherein:

the insert comprises a flap adjacent to the aperture, the flap being movable between an open position and a closed position, and the flap being configured to be in the open position as the watercraft travels in the forward direction and configured to be in the closed position as the watercraft travels in a rearward direction.

23. An insert configured to be received in an opening extending through a hull of a watercraft, the opening being configured to receive a removable pedal-driven propulsion system, the insert comprising:

an inner cavity;

an aperture located at a first location rearward of a second location, the aperture being configured to be at least partially submerged in a fluid when the watercraft is positioned on the fluid, and the aperture being configured to provide fluid communication between the inner cavity of the insert and the fluid as the watercraft travels in a forward direction; and a surface shaped and dimensioned such that a first pressure within the inner cavity is greater than a second pressure at the aperture as the watercraft travels in the forward direction and such that a first fluid pressure at the first location is lower than a second fluid pressure at the second location along the insert as the watercraft travels in the forward direction.

24. The insert of claim **23**, further comprising:

a lower wall defining the surface, and

one or more lateral walls extending away from the lower wall, wherein the one or more lateral walls and the aperture extend along an entirety of a perimeter of the lower wall,

wherein the inner cavity is at least partially defined by the lower wall and the one or more lateral walls.

25. The insert of claim **24**, wherein:

the surface is angled relative to the forward direction such that a forward portion of the surface is above a rearward portion of the surface.

26. The insert of claim **23**, further comprising:

a left shaft along a left side of the insert, the left shaft configured to bear against a left bearing surface in the opening of the watercraft when the insert is mounted to the watercraft, and

a right shaft along a right side of the insert, the right shaft configured to bear against a right bearing surface in the opening of the watercraft when the insert is mounted to the watercraft.

27. The insert of claim **26**, further comprising:

a forward support member along a forward portion of the insert, the forward support member configured to bear against a forward bearing surface in the opening of the watercraft when the insert is mounted to the watercraft, and

a rearward support member along a rearward portion of the insert, the rearward support member configured to bear against a rearward bearing surface in the opening of the watercraft when the insert is mounted to the watercraft.

28. A watercraft comprising:

a hull;

an opening extending through the hull, the opening configured to receive a removable propulsion mechanism; and

an insert removably insertable into the opening, wherein the insert comprises:

an inner cavity,

an aperture configured to be at least partially submerged in a fluid when the watercraft is positioned on the fluid, the aperture being configured to provide fluid communication between the inner cavity of the insert and the fluid as the watercraft travels in a forward direction, and

a surface shaped and dimensioned such that a first pressure within the inner cavity is greater than a second pressure at the aperture as the watercraft travels in the forward direction and when a speed of the watercraft as the watercraft travels in the forward direction is between 2.5 and 20 meters per second.

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