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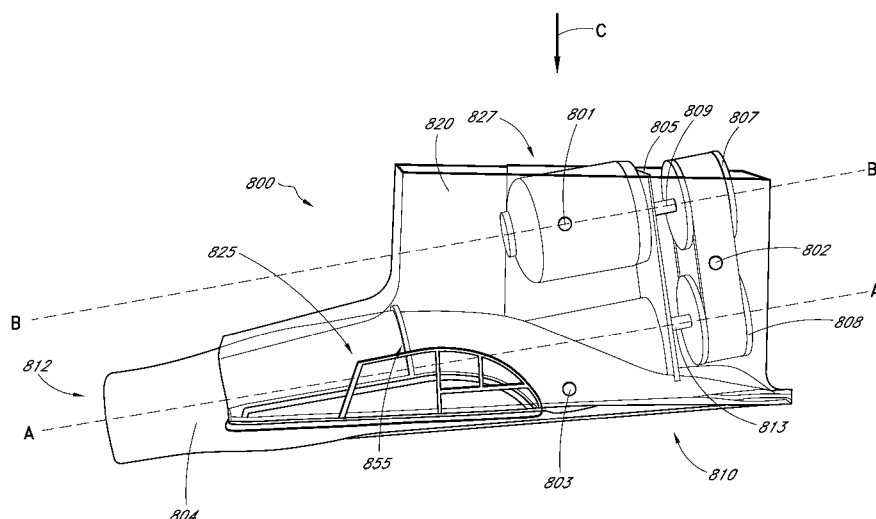


FIG. 24

(57) Abstract: A motorized cassette is configured in size and shape to be insertable into a hole in a personal watercraft and provide a propulsion system for the watercraft. The motorized cassette may include a housing defining a water-tight enclosure, an electric motor disposed within the enclosure, a drive shaft disposed within the enclosure, the drive shaft coupled to the electric motor by a belt drive, a flow path having a water intake port and a water exhaust port; and an impeller positioned within the flow path and coupled to the drive shaft. The electric motor may be positioned above the drive shaft in a stacked configuration.

## **ELECTRIC MOTOR FOR WATERCRAFT**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

**[0001]** This application claims priority to U.S. Provisional Application No. 62/064,165, filed on October 15, 2014, the entirety of which is incorporated herein by reference. This application is also related to U.S. Patent No. 8,480,447, U.S. Patent No. 8,398,446, U.S. Patent App. Pub. No. 2013/0005199, International Patent App. Pub. No. WO 2014/117018, and International Patent App. Pub. No. WO 2014/150752, each of which is hereby incorporated by reference in its entirety.

### **SUMMARY**

**[0002]** The present disclosure relates to motor driven watercraft. More particularly, this disclosure is directed to an enclosed electric drive system configured to propel a watercraft. In some embodiments, the enclosed electric drives system may be configured as a motorized cassette. The term “motorized cassette” is used herein to describe an enclosed electric drive system that is substantially self-contained and configured to be couplable a watercraft. In some embodiments, a motorized cassette is configured to selectively couple with a corresponding hole, opening, or recess in a watercraft. A motorized cassette may include a waterproof enclosure. In some embodiments, the waterproof enclosure houses at least one electric motor coupled to a drive shaft with a belt drive. The electric motor may be positioned above the drive shaft in a stacked configuration. The drive shaft and the electric motor may be positioned such that they are in two different vertical planes are generally parallel to one another in the longitudinal direction. The drive shaft and the electric motor may be positioned at an angle with respect to the longitudinal axis. The angle may be any angle less than 90° from the longitudinal. For example, the angle may be about 10°, 15°, 20°, 25°, 30°, 35°, 40°, and/or about 45° from the longitudinal axis.

**[0003]** The drive shaft can be coupled to an impeller. The impeller may be positioned in a flow path. The flow path may include a water intake port and a water exhaust port in fluid communication with one another. The water intake port may face in a generally downward direction with respect to the watercraft when the electronic drive system is

coupled to the watercraft. The water exhaust port may face in a generally rearward and/or a generally downward direction with respect to the watercraft when the electronic drive system is coupled to the watercraft. The impeller may be shaped such that when it rotates in a first direction, water is drawn through the intake port and expelled out of the exhaust port and when the impeller rotates in a second direction, water is drawn through the exhaust port and expelled out of the intake port. In this way, the same impeller may be used to move a watercraft in two opposite directions.

[0004] In some embodiments, the waterproof enclosure houses one or more batteries. In other embodiments, the waterproof enclosure does not include batteries and instead may be coupled to a separate power source. The separate power source may be located on or within the watercraft. When coupled to the watercraft, the motorized cassette may have no parts that substantially protrude from the underside of the watercraft. For example, the motorized cassette has no portion that extends more than two inches away from the underside of the watercraft.

[0005] In some embodiments, the electric motor and drive shaft are positioned on the same side of a belt drive within the motorized cassette. The electric motor may be positioned over and/or above at least a portion of the drive shaft. The electric motor and the drive shaft may also be tilted at the same angle with respect to the longitudinal axis. In this way, no bevel gears are required and less power may be lost when transferring the energy from the electric motor to the drive shaft. Thus, the system may operate more efficiently and take up less space.

[0006] In some embodiments, the watercraft may be a kayak. Many commercially available kayaks include openings in the kayak hull. So called “scupper holes” may be found, for example, in the cockpit, foot wells, tank well, and/or other locations throughout a kayak. These holes may be self-bailing which means any water coming over the deck of the kayak will drain out. In addition, kayaks may include one or more larger openings or through passages in the kayak hull that may be covered with hatches and/or used to mount underwater fish finders or other equipment. Such opening may or may not be self-bailing.

[0007] In some embodiments, the electronic drive system is shaped and dimensioned to be inserted into and removed from an opening that passes through a kayak.

The opening may be located roughly at the mid-ship position of the kayak. In some embodiments, the opening is forward from a seat positioned within the kayak. In other embodiments, the opening is located in a position that is rearward from the seat positioned within the kayak. The electronic drive system may be configured to be inserted into the opening from above and/or from below. The electronic drive system may be configured to be configured to propel the kayak forward and/or in reverse.

[0008] In some embodiments, the electronic drive system may be mounted to the rear of a watercraft using a tiller and a mounting bracket. For example, in one embodiment, a system for a watercraft comprises a mounting assembly configured to couple the system to a watercraft body, a motorized cassette, and a tiller. The motorized cassette may include a housing, at least one electric motor, at least one impeller, a water inlet, and a water outlet. A drive shaft may be coupled to the motor with a belt drive. The drive shaft may be coupled to an impeller positioned with a flow path. The housing may be shaped to receive at least a portion of the motorized cassette. Manipulation of the tiller may cause rotation of the motorized cassette relative to the mounting assembly.

[0009] Another aspect of the present disclosure is directed to a motorized cassette that is configured to turn off when the motorized cassette is flipped and/or tossed about in the water. For example, in general, the motorized cassettes described herein include at least one downwardly facing inlet port or exhaust port. Thus, in operation, the at least one downwardly facing inlet port or exhaust port is facing the water such that water may be drawn into the flow path while the watercraft is propelled forward. As such, in some embodiments, the motorized cassette may comprise a sensor configured to detect when the downwardly facing inlet port or exhaust port is facing away from the water and may be configured to disengage the electric motor from the power source when such a sensor is activated. For example, the motorized cassette may be coupled to a watercraft ridden by a user. The motorized cassette may be turned on by the user. In some embodiments, the user uses a wireless device to turn on the motorized cassette to propel the watercraft and user in the forward direction. The user may catch a wave and/or ride the wave towards the shore. However, the user may fall or “wipe out” and in the process the watercraft may flip and/or be rolled over by the wave. The sensor will be configured to detect this motion and in response

will turn off the motorized cassette so that the watercraft does not travel too far away from the user.

[0010] An example embodiment of the present disclosure is a motorized cassette comprising a housing containing an electric motor and a drive shaft. The electric motor may be coupled to the drive shaft with a belt drive. The electric motor may be positioned above and may overlap at least a portion of the drive shaft. A flow path may be positioned beneath the electric motor. The flow path may have a water intake port and a water exhaust port. An impeller may be positioned within the flow path and coupled to the drive shaft.

[0011] Another example embodiment of the present disclosure is a motorized cassette comprising a housing. An electric motor may be contained in the housing. The motorized cassette may include a flow path. The flow path may have an intake port and an exhaust port. An impeller may be positioned within the flow path and coupled to the electric motor. The motorized cassette may include a sensor having an output based at least in part on motion or physical orientation of the housing. A circuit may be coupled to the sensor. The circuit may be configured to prevent or stop the electric motor and/or the electric motor's rotation based at least in part on the sensor output.

[0012] 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 features, aspects, and advantages will become apparent from the description, the drawings, and the claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The illustrated embodiments of the disclosed system and components are intended to illustrate but not to limit the invention. Additionally, from figure to figure, the same reference numerals have been used to designate the same components of an illustrated embodiment. It is to be noted that the figures provided herein are not drawn to any particular proportion or scale, and that many variations can be made to the illustrated embodiments. The following is a brief description of each of the drawings.

[0014] Figure 1 is an exploded view of a top shell of a surfboard showing components placed in top shell recesses.

[0015] Figure 2 is an exploded view of a bottom shell of a surfboard showing components placed in bottom shell recesses.

[0016] Figure 3 is a cutaway view of a surfboard made from top and bottom shells with power components mounted therein in accordance with one embodiment of the invention.

[0017] Figure 4 shows a detailed view of a passageway between a motor recess in a top shell and an impeller recess in a bottom shell.

[0018] Figure 5 is a perspective view of a flow housing in which the impeller may be inserted.

[0019] Figure 6 illustrates the bottom shell attached to the top shell in the region of the surfboard tail with one flow housing attached in one of the bottom shell recesses.

[0020] Figure 7 is a block drawing showing one embodiment of a drive control system, which may be used in one embodiment of a motorized watercraft.

[0021] Figure 8 is a flow chart illustrating a method for using the drive control system of Figure 7 with one embodiment of a motorized watercraft.

[0022] Figure 9 is a top view of one embodiment of a drive control system, which may be used in one embodiment of a motorized watercraft.

[0023] Figure 10 is a perspective view of a personal watercraft including a first embodiment of a motorized cassette received in a bottom recess of the personal watercraft. In the illustrated embodiment, the personal watercraft is a surfboard.

[0024] Figure 11 is an exploded view of the surfboard of Figure 10.

[0025] Figure 12 is a perspective view of the surfboard of Figures 10 and 11 including a non-motorized cassette received in a bottom recess of the surfboard.

[0026] Figure 13 is an exploded view of the surfboard of Figure 12.

[0027] Figure 14 is a perspective view of another personal watercraft including the first embodiment of the motorized cassette of Figure 10 received in a bottom recess thereof. In the illustrated embodiment, the personal watercraft is a kayak.

[0028] Figure 15 is an exploded view of the kayak of Figure 14.

[0029] Figure 16 is a perspective view of a personal watercraft including a second embodiment of a motorized cassette received in a bottom recess of the personal watercraft. In the illustrated embodiment, the personal watercraft is a surfboard.

[0030] Figure 17 is an exploded view of the surfboard of Figure 16.

[0031] Figure 18 is an exploded view of the motorized cassette of Figures 16 and 17.

[0032] Figure 19 is a perspective cutaway view of the motorized cassette of Figure 18.

[0033] Figure 20 is a cross-sectional view of a personal watercraft including a curved body section adjacent to an exhaust port of a pump housing.

[0034] Figure 21 is a bottom view of the personal watercraft of Figure 20.

[0035] Figure 22 is a perspective view of a pump housing including a flattened exhaust port.

[0036] Figures 23A and 23B show perspective views of another embodiment of a motorized cassette. Figure 23A shows a top perspective view and Figure 23B shows a bottom perspective view.

[0037] Figure 24 is a side, partially transparent, schematic view of the motorized cassette of Figures 23A and 23B. The housing is illustrated as transparent showing some of the internal components of the motorized cassette.

[0038] Figure 25 is a perspective, partially transparent, schematic view of the motorized cassette of Figures 23A and 23B.

[0039] Figure 26 is a perspective, schematic view of the motorized cassette of Figures 23A and 23B shown with the cover removed.

[0040] Figure 26 is a perspective, partially transparent, schematic view of the motorized cassette of Figures 23A and 23B secured within an opening in a kayak.

[0041] Figure 27 is a partial perspective bottom-side view of the motorized cassette of Figure 23A and 23B positioned near an opening in a kayak.

[0042] Figure 28 is a partial perspective top-side view of a portion of a kayak having an opening for receiving therethrough.

[0043] Figure 29 is a perspective top-side view of the motorized cassette of Figures 23A and 23B secured within an opening in a kayak. As shown, the cover of the housing of the motorized cassette is removed to show some of the components of the motorized cassette.

[0044] Figure 30 is a perspective top-side view of a kayak with a motorized cassette of Figures 23A and 23B secured within an opening in the kayak. A plurality of batteries are positioned on top of the motorized cassette.

[0045] Figure 31 is a perspective bottom-side view of a kayak with a motorized cassette of Figure 23A and 23B secured within an opening in the kayak.

[0046] Figure 32 is another perspective bottom-side view of a kayak with a motorized cassette of Figures 23A and 23B secured within an opening in the kayak.

[0047] Figure 33 is a bottom-side view of a kayak with a motorized cassette of Figures 23A and 23B secured within an opening in the kayak.

[0048] Figure 34 is a perspective view of a kayak and three sample embodiments of a motor mount for the motorized cassettes described herein.

[0049] Figures 35A through 35F depicts side views of various embodiments of motor mounts for use with the motorized cassettes described herein, as well as views of the arrangement of the motorized cassette and batteries therein.

#### DETAILED DESCRIPTION

[0050] Particular implementations of the subject matter described in this disclosure can be implemented to realize one or more of the following potential advantages, among others. The system may be used in shallow water. The system may have zero emissions. In some embodiments, the system may assist in the catching of waves by providing additional speed to a watercraft when attempting to catch a wave. In some embodiments, the system may be used to steer and/or propel a watercraft forwards and/or backwards.

[0051] The enclosed electric drive systems or motorized cassettes described herein may be insertable into pre-fabricated kayaks, surfboards, or other personal watercraft. In other words, the enclosed electric drive systems or motorized cassettes may be sized and

shaped to fit within a previously existing opening through a kayak. The enclosed electric drive systems or motorized cassettes may be designed such that occupy less space than traditional watercraft propulsion systems. They may also include fewer moving parts. When configured as a motorized cassette, the enclosed electric drive system may be contained within a housing that can be easily removed for service and/or replacement. Because the enclosed electric drive systems or motorized cassettes disclosed herein do not have any parts that protrude substantially from the underside of the watercraft, the watercraft may be maneuvered in very shallow water.

[0052] The enclosed electric drive systems or motorized cassettes disclosed herein may be more environmental friendly than traditional gas engines which may emit toxins and/or pollutants into the air or water. In some aspects, the systems disclosed herein may be safer for swimmers and marine life because the impeller is covered and/or enclosed within the watercraft and/or within a rudder body that extends from the rear of the watercraft. Furthermore, an enclosed impeller may also help prevent the impeller from being entangled by, for example, rope, or kelp. In some embodiments, the system is configured to operate in shallow waters and propel a watercraft at a high rate of speed. In some embodiments, the systems disclosed herein are lightweight and configured to be attached to a variety of watercraft. In some embodiments, the motor drive system includes a tiller and/or is shaped to function as a rudder. In some embodiments, the system includes one or more batteries. The batteries may be rechargeable.

[0053] Nautical terms may be used herein and are commonly used to describe watercraft. Such terms are well known in the art and are used consistently throughout this description. For example, “stern” is used in reference to a rear portion of a watercraft while “bow” is used in reference to a front portion. In addition, “aft” refers to the direction towards the stern and “fore” or “forward” refers to the direction towards the bow. “Starboard” refers to the direction towards the right-hand side of the vessel facing forward while “port” refers to the direction towards the left-hand side of the vessel facing forward. Terms such as “upper,” “lower,” “top,” “bottom,” “underside,” “upperside,” and the like, are used to describe the present propulsion system, and are used in reference to the illustrated orientation of the embodiment.

[0054] Figures 1-6 illustrate suitable power and drive train components for a motorized watercraft such as a surfboard. In Figures 1-6, the components are not placed in a motorized cassette. However, these Figures illustrate the components themselves and their relative placement and function. These or similar components may be incorporated in a similar manner into embodiments of motorized cassettes, as described in greater detail below. Moreover, while the embodiment of Figures 1-6 shows the components in use with a surfboard, these components may be incorporated into other types of personal watercrafts, for example, kayaks. Referring now to Figures 1, 2, and 3, in some embodiments, a motorized surfboard comprises a top shell 102 and a bottom shell 202. This hollow shell construction has been utilized for surfboard manufacture and represents a departure from traditionally manufactured shaped foam boards. In some embodiments, this hollow shell design has been adapted to create a motorized surfboard in a manner that minimizes manufacturing costs and provides structural integrity and long term reliability.

[0055] The top shell 102 is illustrated in Figure 1, and the bottom shell 202 is illustrated in Figure 2. In Figure 3, a conceptual cutaway view is provided showing how the shells mate with each other in one embodiment.

[0056] The top shell 102 has an outer surface 104 and an inner surface 106. Similarly, the bottom shell has an outer surface 204 and an inner surface 206. To produce the complete surfboard body, the two shells are sealed together along a seam 302 that extends around the periphery of the top and bottom shells. The “outer surfaces” of the top and bottom shells are the surfaces that are contiguous with the surfaces exposed to the water when the surfboard is in use (although not all of the “outer surface” of the shells is actually exposed to water as will be seen further below). The “inner surfaces” of the top and bottom shells are the surfaces internal to the hollow board after sealing the top shell 102 and bottom shell 202 to form the hollow surfboard body. The general methods of producing surfboards with this hollow shell technique are known in the art. For example, currently, Aviso Surfboards ([www.avisosurf.com](http://www.avisosurf.com)) manufactures surfboards in this manner from carbon fiber top and bottom shells forming a hollow surfboard body.

[0057] The outer surface 104 of the top shell 102 is formed with one or more recessed portions 112, where the recessed portions extend generally toward the inner surface

206 of the bottom shell 202 when the shells are sealed together into a hollow body. The recessed portions 112 form compartments for batteries 114, motor controller boards 116, and motors 118. The motors 118 are coupled to shafts 120 that extend out the rear of the motor compartment as will be explained further below.

[0058] After installation of these components, the recesses can be sealed with a cover 122 that can be secured in place with adhesive such as caulking or other water resistant sealant. If desired, an internally threaded access port 124 can be provided that receives an externally threaded cover 126. This can provide easier access into the recesses than removing or cutting the adhesive on the larger cover 122. In some embodiments, one or both of the covers 122, 126 are clear so that the batteries, motors, and/or other electronics can be seen when they surfboard is sealed up and in use. Another threaded plug 130 can also be provided, which can be used to ensure equal air pressures on the inside and outside of the hollow body. This feature is well known and normally utilized for hollow shell surfboards.

[0059] Turning now to Figure 2, the outer surface 204 of the bottom shell 202 also includes one or more recessed portions 212, where the recessed portions extend generally toward the inner surface 106 of the top shell 102 when the shells are sealed together into a hollow surfboard body. The bottom shell 202 may also contain recesses 218 for fin boxes that accept fins 220 in a manner known in the art. The bottom shell recesses 212 are configured to accept pump housings 224. As shown in Figure 3, the pump housings 224 receive the motor shafts 120, onto which an impeller 226 is attached. At the rear of the pump housing 224, a flow straightener 228 may be attached.

[0060] As shown in Figure 3, the recessed portion 112 in the top shell and the recessed portion 212 in the bottom shell comprise walls 302 in the bottom shell and walls 304 in the top shell that are proximate to one another. In advantageous embodiments, these proximate walls extend approximately perpendicular to the overall top and bottom surfaces of the surfboard. In these proximate walls are substantially aligned openings, through which the motor shaft 120 extends. Thus, the motor(s) 118, which reside in a recessed portion of the top shell, are coupled to the impeller(s) that reside in the pump housing(s) that in turn reside in a recessed portion of the bottom shell.

[0061] Figure 4 illustrates in more detail the surfaces 302 and 304 through which the motor shaft 120 extends. Typically, the motor 118 includes an integral shaft 402 of fairly short extent. This short shaft 402 may be coupled to a longer extended motor shaft 120 with a bellows coupler 404. These couplers 404 are commercially available, from, for example, Ruland, as part number MBC-19-6-6-A. The bellows coupling 404 is advantageous because it allows for smooth shaft rotation even in the presence of vibrations and/or small deviations in linearity of the connection. The long shaft 120 then extends through a bearing 408 which has a threaded rear portion. The threaded rear portion of the bearing 408 is threaded into a threaded insert 410 that is positioned on the other side of the openings, in the recessed portion of the bottom shell. When the bearing is tightened into the insert, a water tight seal is created as the walls 302 and 304 are compressed together. It will be appreciated that the walls 302, 304 may directly touch, or they may remain separated, with or without additional material between. To further minimize any potential for leakage, it is possible to place washers of rubber, polymer, or the like between the insert 410 and the wall 320, and/or between the bearing 408 and the wall 304.

[0062] Figures 5 and 6 illustrate the positioning of a pump housing 224 in the recessed portion 212 of the bottom shell. Figure 5 illustrates the underside of the pump housing 224, and Figure 6 illustrates a pump housing 224 installed in a recess of the bottom shell. The pump housing 224 is basically a hollow tube for directing water up to the impeller and out the rear of the surfboard. Thus, the pump housing 224 comprises an inlet port 502 and an exhaust port 504. The pump housing 224 can be secured in the recess 212 in a variety of ways. The embodiment of Figures 5 and 6 includes shafts 508 that are secured to each side of the pump housing 224. The tip 510 of the shaft 508 extends through an opening 512 in the frontward of the pump housing 224. Referring now to Figure 6, these exposed tips 510 are placed in holes 602 in the recess to secure the pump housing 224 into the frontward portion of the recess 212. The rear of the pump housing 224 may comprise a wall with holes that mate with holes 616 in the bottom shell. The holes in the bottom shell may be provided with press fit threaded inserts. Screws 518 can then be used to secure the rear of the pump housing 224 to the rear of the recess 212.

[0063] It will be appreciated that the pump housing 224 can be secured in the recess 212 in a variety of ways. For example, instead of having holes in the bottom shell for screws and pins, slots and/or blind recesses can be formed in or adhesively attached to the side surfaces of the recesses that engage mating surfaces on the pump housing 224. Such structures can also be provided with threads for engaging screw connections. As another alternative, adhesive could be used to secure the pump housing 224 in place.

[0064] Turning now to the power and control electronics and devices illustrated in Figures 1 through 3, a wide variety of power sources, motor controllers, and motors may be utilized. These can be secured in their respective recesses on metal frames and/or plates (not shown) that are secured in the recesses with adhesive and/or with fasteners such as screws to structures in the recesses integral to the side walls or adhesively secured thereto. Acceptable sources of power include a lithium battery or plurality of lithium batteries, among others.

[0065] To avoid a hard-wired connection to the motor controllers 116 from a throttle control input, the motor controller 116 may include a wireless receiver. This receiver can communicate with a wireless transmitter that is controlled by the user in order to control the motor speed. Wireless throttle controls have been used extensively, but using a throttle while surfing poses unique issues in that paddling, standing, and riding waves will interfere with a surfer's ability to easily manipulate a control mechanism such as a trigger, a dial, or the like. In one embodiment, wireless transmission circuitry can be configured to transmit electromagnetic and/or magnetic signals underwater. Because one or both of the transmitter and receiver can be under the surface of the ocean during much of the duration of surfing, a transmission system and protocol that is especially reliable in those conditions may be used. For example, wireless circuitry can be implemented in accordance with the systems and methods disclosed in U.S. Patent No. 7,711,322, which is hereby incorporated by reference in its entirety. As explained in that patent, it can be useful to use a magnetically coupled antenna operating in a near field regime. A low frequency signal, for example, less than 1 MHz, can further improve underwater transmission reliability. With this type of throttle system, an automatic shut off may be implemented, where if the signal strength between the transmitter and receiver drops below a certain threshold, indicating a certain distance between

the two has been exceeded, the receiver shuts off the electric motor. This is useful as an automatic shut off if the surfer falls off the board.

[0066] Figure 7 illustrates an alternative control mechanism 680 for controlling a motorized personal watercraft. Control mechanism 680 has a processor 690 for coordinating the operation of the control mechanism 680. The processor 690 is coupled to an accelerometer 700. The accelerometer 700 measures acceleration. These measurements are communicated to processor 690. Processor 690 may also communicate with accelerometer 700 for the purpose of initializing or calibrating accelerometer 700. In one embodiment, accelerometer 700 is a 3-axis accelerometer and can measure acceleration in any direction. Processor 690 is also coupled to memory 710. In one example, memory 710 is used to store patterns or profiles of accelerometer readings which have been associated with particular motor control commands. For example, memory 710 may store a pattern of accelerometer readings which has been previously associated with a command to cause the motor controller to activate the motors. The processor 690 can compare the current accelerometer 700 outputs to the previously stored profiles to determine whether the current outputs should be interpreted as a motor command. Control mechanism 680 also has a radio transmitter 720 coupled to the processor 690. In one embodiment, radio transmitter 720 transmits information received from processor 690, such as motor commands, to radio receiver 504.

[0067] Figure 8 illustrates one implementation of a method 740 for using the control mechanism 680 of Figure 7. At step 745, output is received from the accelerometer. In one embodiment, the output from the accelerometer may be an analog signal representative of the acceleration measured along each axis measured by the accelerometer. In another embodiment, an analog to digital converter may be used to convert the output to a digital representation of the analog signal. Alternatively, the accelerometer may be configured to output digital signals. For example, the accelerometer itself may be configured to output a digital pulse when the acceleration detected on each axis exceeds some threshold amount.

[0068] After the output from the accelerometer is received, the control mechanism compares the output to pre-determined command profiles as shown in step 750. These command profiles may also be referred to as accelerometer output patterns or simply as patterns. For example, the control mechanism may store a pattern corresponding to a

repeated positive and negative acceleration substantially along a particular axis. Another pattern may correspond to an isolated positive acceleration along a particular axis. The patterns of accelerometer outputs may be associated with particular commands for the motor controllers. For example, one pattern may correspond to a command to activate a subset of the available motors. Another pattern may correspond to a command to activate one or more available motors with a particular duty cycle or at a particular percentage of maximum operation potential.

[0069] The comparison of the current accelerometer output to the command profile results in a determination of whether the output matches a particular command profile, as shown in step 755. In one embodiment, if the current output does not match a command profile, the output from the accelerometer is discarded and the method concludes, leaving the control mechanism to wait for more output from the accelerometer. However, if the current output does match a command profile, the control mechanism transmits the corresponding command to the motor controllers, as shown in step 760. After the transmission, the command mechanism may again wait for additional output from the accelerometer.

[0070] In alternative embodiments, the control mechanism may operate without the need for pattern comparison. For example, in one embodiment, the control mechanism may be configured to interpret accelerometer readings as a proxy for throttle control. In one embodiment, the magnitude and duration of the accelerometer output may be directly translated into magnitude and duration signals for the motor controllers. For example, an acceleration reading above a particular threshold may be interpreted as a command to activate the motors. The duration of the command may be a proportional to the duration for which the acceleration reading is received.

[0071] Figure 9 illustrates one possible embodiment for the control mechanism 680. In this embodiment the control mechanism is encapsulated in a package 790 which is integrated into a glove 780. It will be appreciated by one of ordinary skill in the art that the term integrated into the glove may comprise being attached to the surface or within the structure of glove 780. In one embodiment the package 790 is a water tight package. In one embodiment, package 790 comprises a plastic box. In another embodiment, package 790 comprises layers of fabric or other materials. Advantageously, this embodiment facilitates

control of the motorized surfboard while maintaining the ability of the surfer to use his hands for normal surfing activity. For example, rather than positioning one hand on a throttle to control the motorized surfboard, the normal motion of the surfer's hand, while wearing the glove, may be used to control the motorized surfboard. For example, it may be desirable for the motor controller to activate the motors while the surfer would normally be paddling. This may be when the surfer is paddling out or when the surfer is attempting to position himself to catch a wave. Accordingly, when the control mechanism is embedded in a glove 780, the control mechanism may be configured to recognize the acceleration experienced by a surfer's hand during the paddling motion as a command to engage the motors. Thus, the surfer is free to use his hands for normal surfing activity while the control mechanism activates the motors when the surfer's hand motions indicate that the surfer is performing an activity which would be aided by additional motor support. Alternatively, the control mechanism may be configured to activate the motors in response to patterns which, though not necessarily surfing related, require less effort or distraction than involved in manually manipulating a throttle. For example, while riding a wave, rather than adjusting a throttle, the surfer wearing glove 780 might simply shake his hand to engage or disengage the motor. Accordingly, the surfer is able to control the motors of the surfboard with less effort and coordination than would be required to manipulate the throttle embedded in body of the surfboard. In an alternative embodiment, the packaged control mechanism 790 may also be attached to or integrated into a wrist strap of other clothing or accessory. In another embodiment, a glove 780 or other accessory or clothing may be worn on each hand and each corresponding control mechanism may control a different subset of motors in the motorized surfboard.

[0072] The control mechanism 790 may also be used in other embodiments of motorized personal watercrafts, for example kayaks. In an embodiment, the control mechanism 790 integrated in the glove 760 is configured to detect acceleration experienced by a user's hand while paddling a kayak. As above, when the control mechanism 790 detects such an acceleration pattern, it may be configured to activate the motors of a drive system.

[0073] Turning now to Figures 10 and 11, a personal watercraft comprising a first embodiment of a motorized cassette 1020 and a watercraft body 1000 is shown. The body 1000 comprises a top side 1004 and a bottom side 1002. In some embodiments, the body

1000 may comprise a surfboard, and, in other embodiments, the body 1000 may comprise other traditionally non-powered watercrafts including, for example, inflatable watercrafts, dinghies, life rafts, tenders, sail boards, stand up paddle boards (“SUP boards”), kayaks, and canoes. The body 1000 may be constructed by affixing a top shell to a bottom shell as discussed above or may be constructed using other various methods known to those having ordinary skill in the art. The body 1000 may optionally comprise one or more fin boxes 1010 configured to receive one or more fins 1012.

[0074] Turning now also to Figure 11, the bottom side 1002 of the body 1000 may comprise a recess 1008 configured to receive the motorized cassette 1020 therein. The recess 1008 may extend from the bottom surface 1002 toward the top surface 1004 and comprise a generally convex shaped depression in the bottom surface 1002 of the body 1000. In one embodiment, the recess 1008 forms a tear-drop shaped aperture in the bottom surface 1002. The tear-drop shaped aperture may be complimentary to the shapes of an insert 1014 and/or the motorized cassette 1020 such that the insert 1014 and/or motorized cassette 1020 can be oriented and/or positioned in a desired configuration within the recess 1008. As explained in further detail below, the insert can be useful because it can include desired features such as flanges, threaded holes for fastener engagement, and the like that can be used to, among other things, secure the motorized cassette 1020 in the recess 1008 of the surfboard. This may allow the shell of the surfboard itself to be entirely made with smooth and gently rounded surfaces in and around the recess 1008 and without sharp corners, holes, or other features that require difficult manufacturing processes. This may make the production of the surfboard 1000 itself easier and require minimal changes to the process of manufacturing a conventional surfboard.

[0075] With continued reference to Figure 11, the insert 1014 may comprise a solid or substantially ring-shaped sheet structure configured to cover at least a portion of the recess 1008. The insert 1014 may be coupled to the recess 1008 using various coupling means, for example, adhesives, bonding agents, and/or fasteners. In some embodiments, by virtue of the complimentary shapes of the insert 1014 and the recess 1008, the insert 1014 may be form fitted within the recess 1008 such that the engagement therebetween inhibits longitudinal, lateral, and/or transverse motion of the insert 1014 relative to the recess 1008.

When disposed within the recess 1008, the insert 1014 can define a receiving space 1016 for receiving the motorized cassette 1020. In some embodiments, the insert 1014 may comprise one or more relatively small flanges or protrusions (not shown) extending into the receiving space 1016. The one or more flanges can be configured to engage one or more mating grooves (not shown) disposed in the motorized cassette 1020. In one embodiment, a flange extends from a forward most portion of the insert 1014 into the receiving space 1016 and the forward most portion of the motorized cassette 1020 includes a corresponding groove. In this way, the motorized cassette 1020 may releasably engage the insert 1014 to align and hold the front of the motorized cassette 1020 relative to the insert 1014 and body 1000. As shown in Figure 10, the base surface 1022 of the motorized cassette 1020 may be configured to substantially match the adjacent base surface 1002 of the body 1000 to achieve a desired hydrodynamic profile of the personal watercraft.

[0076] The motorized cassette 1020 may be releasably coupled to the insert 1014 and recess 1008 by one or more fasteners 1060. In one embodiment, the insert 1014 includes an internally threaded bore 1062 configured to threadably engage a portion of a threaded fastener 1060, for example, a screw, that passes through a corresponding aperture 1024 formed in the motorized cassette 1020. In another embodiment, a threaded bore is disposed in the body 1000 and configured to engage a portion of threaded fastener 1060. In one embodiment, a groove on a first end of the motorized cassette 1020 may releasably receive at least a portion of a corresponding flange extending from the insert 1014 and the second end of the motorized cassette 1020 may be fastened to the insert/body by fastener 1060 to restrict longitudinal, lateral, and/or transverse motion of the motorized cassette 1020 relative to the recess 1008. As discussed in more detail below, the receiving space 1016 may be configured to releasably receive various different cassettes that are similarly shaped to the motorized cassette 1020.

[0077] As shown in Figures 10 and 11, the removable motorized cassette 1020 may comprise a drive system for the personal watercraft. In one embodiment, the drive system components disclosed with reference to Figures 1-6 may be housed within the motorized cassette 1020. For example, motorized cassette 1020 may comprise one or more exhaust ports 1026, one or more pump housings 1028, one or more motor shafts 1030, one or

more motors (see, for example, Figures 18 and 19), one or more batteries (see, for example, Figures 18 and 19), and/or one or more impellers (see, for example, Figures 18 and 19). The orientation and design of these components may be basically the same as described above in reference to the embodiments of Figures 1-6 but housed within the motorized cassette 1020. Thus, the motorized cassette 1020 may propel the body 1000 relative to a body of water, for example, to aid in paddling out a surfboard and catching waves.

[0078] Figures 12 and 13 show the personal watercraft comprising a second embodiment of a cassette 1040 received within body 1000. Cassette 1040 may be similarly shaped to motorized cassette 1020 of Figures 10 and 11 such that both cassettes fit tightly within the receiving space 1016 formed by insert 1014. Cassette 1040 may be releasably coupled to the body 1000 by one or more threaded fasteners 1060 and/or the engagement between a flange extending from the insert and a groove in the cassette 1040. As shown, fastener 1060 may pass through an aperture 1034 in the cassette 1040 and be received within threaded bore 1062 in insert 1014.

[0079] In contrast to the motorized cassette 1020 of Figures 10 and 11, cassette 1040 may be un-powered or non-motorized. In some embodiments, the cassette 1040 may be hollow and may enclose a storage space configured to store personal items, for example, sun screen, watercraft hardware, keys, mobile phones, etc. In one embodiment, the storage space may be substantially water tight to protect items stored therein from the ingress of water from a body of water, for example, the ocean. In other embodiments, the cassette 1040 may be substantially solid such that the watercraft has generally uniform buoyancy and/or rigidity characteristics from the front end to the back end.

[0080] The motorized cassette 1020 of Figures 10 and 11 and the cassette 1040 of Figures 12 and 13 may be interchanged to convert the body 1000 between a motorized configuration (Figures 10 and 11) and a non-motorized configuration (Figures 12 and 13). The body 1000 may come as a kit with one or both of the motorized cassette 1020 and the non-motorized cassette 1040. A user may switch between cassettes 1020 and 1040 depending on water conditions and/or desired performance characteristics of the personal watercraft. For example, a user may wish to lower the overall mass characteristic of the personal watercraft by opting to place the non-motorized cassette 1040 within the body 1000

or a user may wish to minimize human energy used in a surf session by opting to place the motorized cassette 1020 within the body 1000.

[0081] Figures 14 and 15 show a kayak including the motorized cassette 1020 and insert 1014 of Figures 10 and 11 received within a recess 1408 of the kayak body 1400. As shown, a single cassette (e.g., motorized cassette 1020 of Figures 10 and 11 or cassette 1040 of Figures 12 and 13) may be placed in different watercraft bodies that have recesses configured to receive the cassette. For example, a motorized cassette 1020 can be configured to fit within a recess in the body of a surfboard and a similarly shaped recess in the body of a kayak such that a user may use the same motorized cassette in multiple watercrafts. In this way, a user may purchase a single motorized cassette to propel different watercrafts. Further, in some implementations, a motorized cassette may be used as a stand-alone device to propel a user without a watercraft. For example, a user may hold a motorized cassette 1020 and be propelled through a body of water without a more substantial watercraft (e.g., without a surf board or kayak).

[0082] Turning now to Figures 16 and 17, a personal watercraft comprising another embodiment of motorized cassette 1620 and a watercraft body 1600 is shown. The body 1600 comprises a top side 1604 and a bottom side 1602. In some embodiments, the body 1600 may comprise a surfboard and in other embodiments the body 1600 may comprise other various watercrafts, such as a kayak, among others. Similar to the personal watercraft of Figures 10-13, the body 1600 may be constructed by affixing a top shell to a bottom shell as discussed above or may be constructed using other various methods known to those having ordinary skill in the art. The body 1600 may optionally comprise one or more fin boxes 1610 configured to receive one or more fins 1612.

[0083] Turning now to Figure 17, the bottom side 1602 of the body 1600 may comprise a recess 1608 configured to receive the motorized cassette 1620 therein. The recess 1608 may extend from the bottom surface 1602 toward the top surface 1604 and comprise a generally convex shaped depression in the bottom surface 1602 of the body 1600. In one embodiment, the recess 1608 forms a tear-drop shaped aperture in the bottom surface 1602. The tear-drop shaped aperture may be complimentary to the shapes of the insert 1614 and/or

motorized cassette 1620 such that the insert 1614 and/or motorized cassette 1620 can be oriented and/or positioned in a desired configuration within the recess 1608.

[0084] With continued reference to Figure 17, the insert 1614 may comprise a solid or substantially ring-shaped sheet structure configured to cover at least a portion of the recess 1608. The insert 1614 may be coupled to the recess 1608 using various coupling means, for example, adhesives, bonding agents, and/or fasteners. In some embodiments, by virtue of the complimentary shapes of the insert 1614 and the recess 1608, the insert 1614 may be form fitted within the recess 1608 such that the engagement therebetween inhibits longitudinal, lateral, and/or transverse motion of the insert 1614 relative to the recess 1608. When disposed within the recess 1608, the insert 1614 can define a receiving space 1616 for receiving the motorized cassette 1620.

[0085] In some embodiments, the insert 1614 may include one or more protrusions 1651 configured to be inserted into one or more indentations 1659 (shown in Figure 18) on the motorized cassette 1620. The protrusions 1651 and indentations 1659 on the motorized cassette 1620 can have complimentary shapes such that the protrusions may be received by the indentations by sliding the motorized cassette 1620 forward longitudinally relative to the insert 1614. The engagement of the protrusions 1651 and corresponding indentations can result in one or more abutments that act to arrest or inhibit longitudinal, lateral, and/or transverse movement of the motorized cassette 1620 relative to the insert 1614 and body 1600.

[0086] The insert 1614 may also include a latch element 1653 that is cantilevered from a latch plate 1655. The latch element 1653 may catch one or more surfaces within a receptacle 1661 (shown in Figure 18) on the motorized cassette 1620 when the motorized cassette 1620 is received within the insert 1614 to secure the motorized cassette 1620 in the longitudinal direction relative to the insert 1614. In this way, the motorized cassette 1620 may be slid forward into the insert 1614 until the latch 1653 releasably engages a notch or other feature on the cassette such that the motorized cassette 1620 is aligned and secured relative to the insert 1614. To remove the motorized cassette 1620 from the insert 1614, the latch element 1653 may be depressed by applying a force to the cantilevered end of the latch element 1653 to disengage the latch element from the notch or other feature of the cassette.

Disengaging the latch element 1653 then will allow a user to slide the motorized cassette 1620 backward longitudinally relative to the insert 1614 to release the protrusions 1651 from the indentations 1659 and to remove the motorized cassette 1620 from the body 1600.

[0087] As shown in Figure 16, the base surface 1622 of the motorized cassette 1620 may be configured to substantially match the adjacent base surface 1602 of the body 1600 to achieve a desired hydrodynamic profile of the personal watercraft. The base surface 1622 may also include a charging port 1631 and/or activation switch 1633. Thus, the motorized cassette 1620 may be charged when the cassette is coupled to the watercraft body 1600 or when it is separate from the watercraft body. In embodiments when these are provided, the charger port 1631 can be disposed on an opposite side of the motorized cassette 1620 and the activation switch 1633 can be disposed elsewhere as well if desired.

[0088] As shown in Figures 18 and 19, the motorized cassette 1620 may comprise a drive system including one or more motors 1675. In one embodiment, the drive system can be at least partially housed between a cassette base 1671 and a cassette cover 1657. The one or more motors 1675 can be powered by one or more batteries 1665 and can be mounted to the cassette base 1671 by motor mounts 1677. In some embodiments, each motor 1675 can be coupled to a motor shaft 1690 by a shaft coupler 1679, shaft bearing 1681, bearing holder 1683, and spacer 1685. Each shaft 1690 can be coupled to an impeller 1699 that is disposed at least partially within a pump housing 1695 and a bearing 1697 can optionally be disposed between each shaft and the impeller 1699. In this way, the one or more motors 1675 can drive each impeller 1699 to draw water through the pump housing 1695 to propel the cassette relative to a body of water.

[0089] In some embodiments, each shaft 1690 can be disposed within a shaft housing 1694 that is configured to limit the exposure of the shaft 1690 to objects that are separate from the cassette 1620. Thus, the shaft housing 1694 can protect a user from inadvertently contacting the shaft 1690 during use and/or can protect the shaft 1690 from contacting other objects, for example, sea grass. Additionally, the shaft housing 1694 can improve performance of the cassette 1620 by isolating each shaft 1690 from the water that passes through the pump housing 1695. In some embodiments, each shaft 1690 can be protected from exposure to the water by one or more shaft seals 1692.

[0090] The motorized cassette 1620 can also include one or more grates 1693 disposed over intake ports of the pump housing 1695. The grates 1693 can limit access to the impeller 1699 and shaft 1690 to protect these components and/or to prevent a user from inadvertently contacting these components during use. In some embodiments, each pump housing 1695 and/or grate 1693 can be coupled to one or more magnetic switches (not shown) that can deactivate the motors 1675 when the pump housing 1695 and/or grate 1693 are separated from the cassette base 1671. Therefore, the one or more magnetic switches may prevent the cassette from operating without the optional grate 1693 and/or pump housing in place.

[0091] With continued reference to Figures 18 and 19, the drive system may also include one or more motor controllers 1673 for each motor 1675, one or more relays 1687 configured to connect the one or more batteries 1665 with the one or more motor controllers 1673, an antenna 1667, and a transceiver 1669. The one or more motor controllers 1673, one or more relays 1687, one or more batteries 1665, antenna 1667, and transceiver 1669, can be electrically connected to each another by one or more wiring harnesses 1663. As discussed above, the transceiver 1669 can include or be coupled to wireless transmission circuitry that is configured to transmit electromagnetic and/or magnetic signals underwater.

[0092] Figures 20 and 21 show a personal watercraft 2000 comprising a body 2031 having a curved section 2033 disposed adjacent to and rearward of a pump housing 2020 and pump housing exhaust port 2025. The curved section 2033 may be shaped to create a Coanda Effect to direct flow from the exhaust port 2025 to follow the curve of the curved section 2033. The Coanda Effect on the flow that exits the exhaust port 2025 can result in an effective thrust of the expelled fluid in a thrust area 2050 as the expelled fluid enters the surrounding water 2060. As used herein, the term “Coanda Effect” refers to the tendency of a fluid jet to be attracted to a nearby surface, for example, the curved section 2033 of personal watercraft 2000 body 2031. The curved section 2033 and the relative positioning of the curved section 2033 and the pump housing 2020 can be incorporated in any of the personal watercraft described herein to create a thrust area between the exhaust port 2025 and the curved section 2033.

[0093] Figure 22 shows an embodiment of a pump housing 2220 having a generally curvilinear cross-sectional shape that tapers to a flattened and oblong exhaust port 2225. The exhaust port 2225 includes a first flattened side 2221 and a second flattened side 2223 disposed opposite to the first side. The first and second sides 2221, 2223 of exhaust port 2225 stabilize the rotational flow of water passing therethrough to create a more uniform flow of expelled water in the thrust area 2250 adjacent to and rearward of the exhaust port 2225. Pump housing 2220 can optionally include one or more flow straighteners, for example, flow straighteners 228 previously discussed with reference to Figures 2 and 3. The optional flow straighteners can be configured to stabilize the flow of water passing through the pump housing 2220 and the exhaust port 2225 can be configured to further stabilize the flow of water passing therethrough. The shape of the pump housing 2220 and the exhaust port 2225 can be incorporated in any of the personal watercraft described herein to create a more uniform flow in the thrust area adjacent to the exhaust port 2225.

[0094] Turning to Figures 23A–33, a motorized cassette 800 according to another embodiment is shown. The motorized cassette 800 is generally constructed to be insertable into pre-fabricated openings through commercially available kayaks, although the motorized cassette 800 may also be used in other types of personal watercrafts, for example, surfboards, inflatable watercrafts, dinghies, life rafts, tenders, sail boards, stand up paddle boards (“SUP boards”), and canoes, among others. One example of a kayak 883 that can be used with embodiments of the motorized cassette 800 is shown in Figure 34. As shown in that figure, the kayak 883 may include a plastic molded hull including one or more recesses configured to receive a user and/or various gear. Example openings 889 are visible in the partial views of the kayak 888 that is shown in Figures 27 and 28. Figure 28 shows a section of a bottom portion of kayak 888 including the opening 889. Figure 28 shows a top view of a section of kayak 889 including the opening 889. These views will be described in greater detail below. In some embodiments, the motorized cassette 800 may not require a pre-fabricated opening in the watercraft for use.

[0095] Figures 23A and 23B show perspective views of the motorized cassette 800. Figure 23A shows a top perspective view and Figure 23B shows a bottom perspective view. The motorized cassette 800 includes a housing 820. The housing 820 may include a

removable top cover 821. The cover 821 may be removable to allow access to the interior of the housing 820. The housing 820 may form a watertight enclosure 827 or “dry box.” The housing 820 may also define (or partially define, as will be explained below) a flow path extending 825 therethrough. The housing may include a water intake port 810 and a water exhaust port 812. The water intake port 810 is configured to draw water into the housing 820 and the water exhaust port 812 expels it, providing thrust for a watercraft incorporating the motorized cassette. As will be shown below, the motorized cassette may include one or more electric motors coupled to one or more drive shafts and impellers configured to accelerate the water through the flow path 825. The impeller may be positioned within the flow path 825. As seen in Figures 23A and 23B, the housing 820 may include a removable pump body 804 partially defining the flow path. The removable pump body 804 may include a water exhaust port 825. In some embodiments, the removable pump body 804 may be omitted and the housing 820 may fully define the flow path 825. The water intake port 810 may be covered by a grate 1693. The grate 1693 protects the user from contact with the impeller, while still allowing water to be drawn into the flow path 825. The grate 1693 may be removable. In some embodiments, the grate 1693 is omitted. In some embodiments, one or more ports 891 may extend through the housing 820. The ports 891 may be watertight ports that allow electrical connection (for example, for connecting the internal components of the motorized cassette 800 to a power source, for charging, or for control). The housing 820 may be configured in size and shape to be received into an opening in a watercraft, for example, and opening in kayak (as shown in Figures 27 and 28, below). The housing includes a flange or securement plate 890 extending at least partially around the bottom edge of the housing 820. The securement plate 890 may include features (for example, openings for receiving screws or other fastening methods, or surfaces for applying adhesives) that can be used to secure the motorized cassette 820 to a watercraft.

[0096] Turning to Figures 24 and 25, some of the internal components of the motorized cassette 800 are shown. In Figures 24 and 25, the housing 820 is illustrated as transparent, thus allowing a view of some of the internal components of the motorized cassette 800. As mentioned above, the housing 820 defines a water-tight enclosure 827, which may safely housing the internal components of the motorized cassette 800 in a dry

environment. In broad terms, a drive system for the motorized cassette may include an electric motor 801 coupled a drive shaft 813 and impeller by a belt drive 802. The enclosure 827 may house other components as well. For example, the enclosure 827 may further house a motor controller, one or more batteries, an air pump, a wireless receiver, a wireless transmitter, one or more motor control systems, battery control systems, and/or sensors (including water sensors), among other components. These components may be the same or similar to like components described in reference to Figures 1, 3, 18, and 19, above. A motor control system (for example, as described in reference to Figures 7 and 8 above) may be configured to activate or deactivate the motor, control the speed of the motor and/or the amount of power supplied to the motor, and/or control other motor functions.

[0097] The electric motor 801 may be mounted to plate 805 at an angle with respect to the horizontal. In some embodiments, the angle may be any angle less than 90° from the horizontal. For example, the angle may be about 10°, 15°, 20°, 25°, 30°, 35°, 40°, and/or about 45° from horizontal. The electric motor 801 may include an electric motor drive 809 that is coupled to a motor-side pulley 807. The motor-side pulley 807 may be coupled to a drive shaft-side pulley 808 with a belt 802. The drive shaft-side pulley 808 may be coupled to a drive shaft 813. The drive shaft 813 may pass through a water-tight passageway such that water cannot pass from the flow path 825 into the water tight enclosure 827. A similar construction is shown in Figure 4 and described above.

[0098] As shown in Figure 24, the motor shaft or output shaft may be positioned on axis B and the drive shaft may be positioned on axis A. The two axes may be substantially parallel. In addition, the electric motor 801 may be positioned above and overlap at least a portion of the drive shaft 813. Thus, when looking down into the housing 820 in the direction of arrow C, the motor is at least partially superimposed over the drive shaft. In some embodiments, the two axes need not be parallel. In some embodiments, the electric motor 801 may be mounted below the drive shaft 813. In some embodiments, the electric motor 801 and the drive shaft 813 may be mounted side by side. The drive shaft 813 may be coupled to an impeller positioned within the flow path 825. In the illustrated embodiment, the impeller and the electric motor 801 are both mounted on the same side of

the plate 805. In this configuration, the electric motor 801 and impeller are both located rearward from the belt 802, that is, closer to the rear water exhaust port 812.

[0099] As described above and shown again in Figure 24, the flow path 825 includes a water intake port 810 and a water exhaust port 812. The flow path may be formed by the removable pump body 804 coupled to a flow housing 803 at interface 855. In this embodiment, the removable pump body 804 includes water exhaust port 812. The flow housing 803 may include the intake port 810. The intake port 810 may face in a generally downward direction and may draw water up through the intake port 810 and into the flow path. The intake port 810 may be at least partially covered by one or more grates. An impeller, positioned in the flow path 825, may be rotated causing water to be drawn up through the intake port 810 and directed through the flow housing 803 towards the water exhaust port 812. Water can then flow past the impeller and out of the water exhaust port 812. The flow housing 803 and impeller placement therein on the drive shaft may be similar to the embodiment shown in Figures 3, 4, and 6 or Figures 18 and 19 described above.

[0100] Figure 26 illustrates the motorized cassette 800 shown with the cover 821 removed, partially showing the interior of the housing 820. The plate 805 and electric motor 801 can be seen.

[0101] Figure 27 illustrates a motorized cassette 800 installed within an opening in the kayak 888. In Figure 27, only a portion of the kayak 889 is shown, the bow and stern of the kayak are omitted. The kayak 889 shown in Figure 27 may be substantially similar to the kayak 883 of Figure 34, where a complete view of the kayak 883 is provided. As discussed above, many commercially available kayaks have one or more openings formed therethrough. The openings may be used to bail water from the kayak and/or to gain access to the water. For example, fishing equipment and/or fish finding equipment may be inserted into and secured within such openings.

[0102] In the partial view of Figure 27, the motorized cassette 800 is removed from the opening 889 in the kayak 888. The opening 889 may be formed in the body of the kayak 888 and configured in size and shape to receive the motorized cassette 800. In other words, the motorized cassette 800 is configured to be inserted into the opening 889. In some embodiments, the opening 889 extends entirely through kayak 889, while in other

embodiments, the opening 889 is merely a recess, extending only partially through the kayak 888. In some embodiments, the opening 889 may be a pre-fabricated opening formed in commercially available kayaks. In some embodiments, the opening 889 may be cut into an existing kayak in a shape that is configured to receive the motorized cassette 800.

[0103] As shown, the intake port 810 is facing in a downward direction (in other words, away from the bottom surface of the kayak 888). In some embodiments, the motorized cassette 800 includes an underside having a substantially planar surface and the intake port 810 is positioned on the substantially planar surface. One or more grates 1693 may be positioned over the intake port 810. In the embodiment shown in Figure 27, the underside of the motorized cassette 800 also includes the securement plate 890. The securement plate 890 may be sized such that the securement plate 890 extends out from the opening 889 in the kayak 888. That is, the securement plate 890 at least partially overlaps the bottom surface of the kayak 888 when the motorized cassette is inserted into the opening 889. The securement plate 890 may be secured to the underside of the kayak 888 to hold the motorized cassette 800 in place. In this way, the motorized cassette 800 may be inserted into the opening 889 in the kayak 888 from below. However, in other embodiments, the motorized cassette 800 may be sized and shaped such that it is insertable from above. In other embodiments, the motorized cassette 800 may be sized and shaped such that it is insertable from above and below. The motorized cassette 800 may be secured to the kayak 888 at the top side and/or the bottom side of the kayak 888. In some embodiments, the water intake port 810 may be configured to extend perpendicular (or at some other angle less than perpendicular) to the bottom side of the kayak 888. For example, in some embodiments, the flow path 825 may comprise a substantially straight tube extending below the kayak 888 and parallel to the bottom side of the kayak 888.

[0104] Figure 28 is a partial perspective top-side view of the kayak 888 having an opening 889 therethrough. Again, the kayak 888 may be substantially similar to the kayak 883 shown in Figure 34. In Figure 28, various recesses and other features formed in the body of the kayak are illustrated. However, these features need not be present in all embodiments. Moreover, the stern and the bow of the kayak 888 are not shown. The portion of the kayak 888 illustrated in Figure 28 may represent a portion of the kayak towards the bow of the

kayak, in the middle of the kayak, or towards the stern of a kayak, or any other portion therebetween. Accordingly, in various embodiments, the opening 889 for receiving the motorized cassette 800 may be located at various positions along the length of the kayak. In some embodiments, the opening may be centered over the keel of the kayak, that is, centered across the kayak's width. However, this need not be the case in all embodiments. As shown, the opening 889 extends through the kayak 888 and is surrounded by sidewalls. The side walls may prevent the egress of water into other areas of the kayak 888. The motorized cassette 800 may be configured to be easily inserted and removed from the opening 889. In this way, the opening 889 may be used for multiple purposes. For example, a user can insert the motorized cassette 800 into the opening 889 to integrate a propulsion source into the kayak, or the user may remove the motorized cassette 800 from the opening 889 and use the opening 889 for another purpose, for example, with a fish finder or to drain water from the kayak 889. In some embodiments, the motorized cassette 800 may be easily removed for service. In some embodiments, the motorized cassette 800 may include one or more rechargeable batteries. The motorized cassette 800 may include a charging port (for example port 889 in Figures 23A and 23B) and/or a battery management system. In some embodiments, the motorized cassette 800 may be removed from the kayak 888 in order for the batteries to be charged using a wall outlet.

**[0105]** Figure 29 is a partial perspective top-side view of a kayak 888 having a motorized cassette 800 inserted through the opening 889 in the kayak 888. In the illustrated embodiment, the portion of the kayak 889 shown is the same as that shown in Figure 28. As shown, the cover 821 of the housing 820 has been removed and the electric motor 801 and belt drive 802 can be seen. As shown in Figure 30, in some embodiments a plurality of batteries 950 may be positioned on top of the motorized cassette 800. The batteries 950 may be held in place by the sidewalls surrounding the opening 889 in the kayak 888. The batteries 950 may include a separate housing and/or may be located anywhere on or within the kayak 888, including within the housing 820. In some embodiments, batteries 950 may be located at a distance away from the where the motorized cassette 800 is installed within the kayak 888. As such, a length wiring may be needed to connect the batteries 950 to the motorized cassette 800. In some embodiments, the wiring may extend down through an opening or

supper hole within the kayak 888 and along the underside of the kayak 888 and connected to an underside of the motorized cassette 800.

[0106] Moving on to Figure 31, a perspective partial bottom-side view of the kayak 888 with a motorized cassette 800 installed within an opening 889 in the kayak 888 is illustrated. Again, only a portion of the kayak 889 is illustrated. A full view of a similar kayak 883 is shown in Figure 34. As shown in Figure 31, when installed, the motorized cassette 800 may not extend substantially from the underside of the kayak 888. In some embodiments, the motorized cassette 800 extends no more than three inches from the underside 886 of the kayak 888. In other embodiments, the motorized cassette 800 extends no more than two inches from the underside 886 of the kayak 888. In still other embodiments, the motorized cassette 800 extends no more than one inch from the underside 886 of the kayak 888. In still other embodiments, the motorized cassette 800 is flush with the underside 886 of the kayak 888.

[0107] As further shown in Figure 31, the mounting plate 890 is secured to the underside 886 of the kayak 888. In addition, the underside 886 of the kayak 888 includes a recessed portion 887 rear of the opening 889 in the watercraft. In some embodiments, water may be expelled from the exhaust port 812 towards the recessed portion 887 to create a Coanda Effect (as described above in reference to Figures 20 and 21) that increases the performance of the motorized cassette 800. Additional views of portions of the underside of the kayak 888 with installed motorized cassette 800 are shown in Figures 32 and 33.

[0108] Turning now to Figures 34 and 35, it will be understood that in some embodiments, the motorized cassette 800 may be coupled to the stern of a kayak 883. For example, a motor mount 880a, 880b, and 880c may include a receiving space in the bottom side of the motor mount. The receiving space may be shaped to receive the motorized cassette 800 inserted from below. A mounting bracket 884 may be positioned over the transom of the stern of the kayak 883 and be configured to be coupled to the motor mount at location 881. The motor mount 880a, 880b, 880c may be rotatable with respect to the mounting bracket 884. A tiller (not shown) may be coupled to the motor mount 880a, 880b, 880c. In another embodiment, foot pedals may be installed in the kayak 883 such that manipulation of the foot pedals causes the rotation of the motor mount with respect to the

mounting bracket. In Figure 34, batteries 950 to power the motorized cassette 800 are located on the kayak 883. However, as shown in Figure 35A-35C, motor mounts may include space for one or more batteries 950. For example, Figure 35 shows the arrangement of a motorized cassette 800 and two batteries 950 within a motor mount (the motor mount itself is shown in Figure 35D). Figure 35B illustrates an additional embodiment of an arrangement of two batteries 950 and the motorized cassette 800 (the corresponding motor mount is shown in Figure 35E). Figure 35C illustrates an embodiment of an arrangement of one battery 950 and motorized cassette 800 (the corresponding motor mount is shown in FIG. 35F).

[0109] Any of the motorized cassettes described herein may be configured to turn off when the motorized cassette is flipped over and/or tossed about in the water. As such, in some embodiments, the motorized cassette includes at least one sensor configured to detect the orientation and/or movement of the motorized cassette. The sensor may comprise an accelerometer and/or a gyroscope. In other embodiments, the sensor comprises a sensor configured to detect water in the flow path. When there is no water detected in the flow path, the sensor may cause the motor to stop. In some embodiments, the sensor is connected to a switch which disengages the power supply from the motor when the switch receives a signal from the sensor. In some embodiments, the power supply is disconnected from the motor when a gyroscope detects that the motorized cassette's position is inverted and/or rotated. In some embodiments a circuit is coupled to one or more sensors and configured to disconnect the power source from the electric motor based at least in part on sensor detection of the orientation of the motorized cassette.

[0110] Based on the foregoing description, it will be readily understood by those persons skilled in the art that the present invention is susceptible of broad utility and application. Many embodiments and adaptations of the present invention other than those specifically described herein, as well as many variations, modifications, and equivalent arrangements, will be apparent from or reasonably suggested by the present invention and the foregoing descriptions thereof, without departing from the substance or scope of the present invention.

[0111] Accordingly, while the present invention has been described herein in detail in relation to one or more preferred embodiments, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for the purpose of providing a full and enabling disclosure of the invention. The foregoing disclosure is not intended to be construed to limit the present invention or otherwise exclude any such other embodiments, adaptations, variations, modifications or equivalent arrangements, the present invention being limited only by the claims appended hereto and the equivalents thereof.

WHAT IS CLAIMED IS:

1. A motorized cassette comprising:
  - a housing configured in size and shape to be at least partially received in an opening formed in a watercraft, the housing defining a water-tight enclosure;
  - an electric motor disposed within the enclosure;
  - a drive shaft disposed within the enclosure, the drive shaft coupled to the electric motor by a belt drive;
  - a flow path having a water intake port and a water exhaust port; and
  - an impeller positioned within the flow path and coupled to the drive shaft.
2. The motorized cassette of claim 1, wherein the electric motor is positioned above the drive shaft in a stacked configuration.
3. The motorized cassette of claim 2, wherein the electric motor includes an output shaft and the output shaft and the drive shaft are parallel.
4. The motorized cassette of claim 3, wherein the output shaft and the drive shaft are each positioned at an angle from about 10° to about 45° with respect to a horizontal plane.
5. The motorized cassette of claim 1, further comprising a plate disposed within the housing, and wherein the electric motor and the impeller are mounted on a first side of the plate and the belt drive is mounted on a second side of the plate that is opposite to the first side of the plate.
6. The motorized cassette of claim 6, wherein the belt drive comprises:
  - a first pulley mounted to an output shaft of the electric motor, the output shaft of the electric motor extending through a first opening in the plate;
  - a second pulley mounted to the drive shaft, the drive shaft extending through a second opening in the plate;
  - and a belt operatively connecting the first pulley and the second pulley.
7. The motorized cassette of claim 7, wherein the plate is positioned within the housing at an angle from about 10° to about 45° with respect to a horizontal plane.
8. The motorized cassette of claim 1, wherein the flow path is defined by the housing.

9. The motorized cassette of claim 1, wherein the flow path is defined by a removable pump body coupled to a flow housing, and wherein the removable pump body and flow housing are receiving into an opening in the bottom of the housing.

10. The motorized cassette of claim 9, wherein the removable pump body includes the water exhaust port.

11. The motorized cassette of claim 10, wherein the flow housing includes the water intake port.

12. The motorized cassette of claim 1, wherein the water intake port includes a substantially planar opening that faces in a substantially downward direction.

13. The motorized cassette of claim 1, wherein the water exhaust port includes a substantially planar opening that faces in a substantially rearward direction.

14. The motorized cassette of claim 1, wherein the impeller is shaped such that when it rotates in a first direction, water is drawn through the intake port and expelled out of the exhaust port and when the impeller rotates in a second direction, water is drawn through the exhaust port and expelled out of the intake port.

15. The motorized cassette of claim 1, further comprising a grate coupled to the housing and configured to cover the water intake port.

16. The motorized cassette of claim 15, wherein the grate is removable.

17. The motorized cassette of claim 16, further comprising a magnetic switches positioned between the grate and the housing, the magnetic switch in communicative connection with the electric motor and configured to deactivate the electric motor when the grate is separated from the housing.

18. The motorized cassette of claim 1, further comprising one or more batteries.

19. The motorized cassette of claim 18, wherein the one or more batteries are positioned within the housing.

20. The motorized cassette of claim 1, wherein the motorized cassette is configured such that no parts substantially protrude from the underside of the watercraft when the motorized cassette is received in the opening of the watercraft

21. The motorized cassette of claim 21, wherein no parts of the motorized cassette extend more than about two inches away from the underside of the watercraft.

22. The motorized cassette of claim 1, further comprising:  
a sensor within the enclosure, the sensor having an output based at least in part on the physical orientation of the housing; and  
a circuit coupled to the sensor, the circuit configured to prevent or stop electric motor rotation based at least in part on the sensor output.
23. The motorized cassette of claim 22, wherein the circuit is configured to prevent or stop electric motor rotation when the sensor determines that the housing is upside down.
24. The motorized cassette of claim 1, further comprising:  
a sensor within the flow path, the sensor configured to determine whether liquid is present within the flow path and provide an output; and  
a circuit coupled to the sensor, the circuit configured to prevent or stop electric motor rotation based at least in part on the sensor output.
25. The motorized cassette of claim 24, wherein the circuit is configured to prevent or stop electric motor rotation when the sensor determines that liquid is not present in the flow path.
26. A motorized cassette comprising:  
a housing;  
an electric motor contained in the housing;  
a flow path having an intake port and an exhaust port;  
an impeller positioned within the flow path and coupled to the electric motor;  
a sensor having an output based at least in part on a physical characteristic of the housing; and  
a circuit coupled to the sensor, the circuit configured to prevent or stop electric motor rotation based at least in part on the sensor output.
27. The motorized cassette of claim 26, wherein the physical characteristic is an orientation of the housing.
28. The motorized cassette of claim 27, wherein the circuit is configured to prevent or stop electric motor rotation when the output of the sensor indicates that the housing is upside down.

29. The motorized cassette of claim 26, wherein the sensor is positioned within the flow path and the physical characteristic whether liquid is present within the flow path.

30. The motorized cassette of claim 29, wherein the circuit is configured to prevent or stop electric motor rotation when the output of the sensor indicates liquid is not present in the flow path.

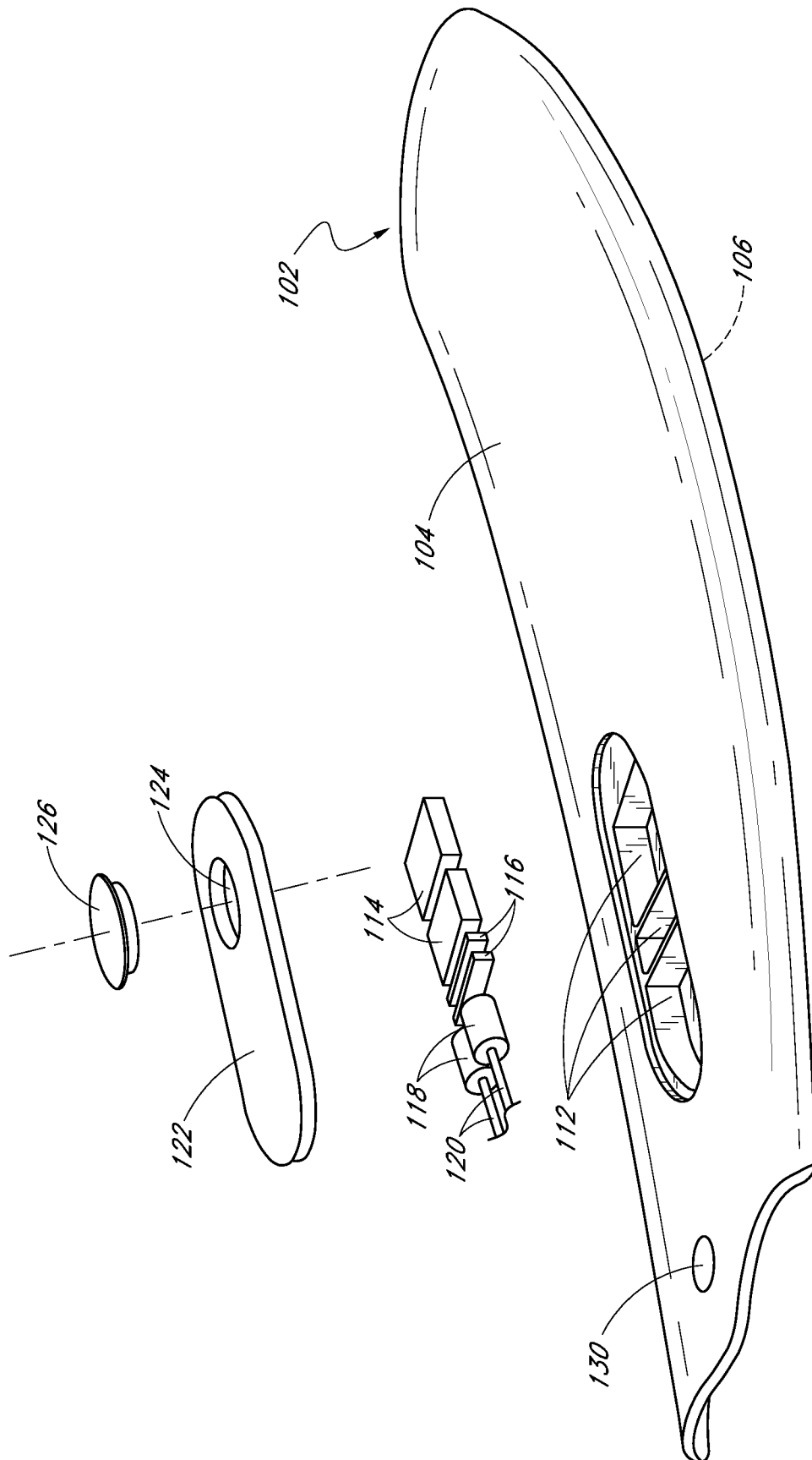


FIG. 1

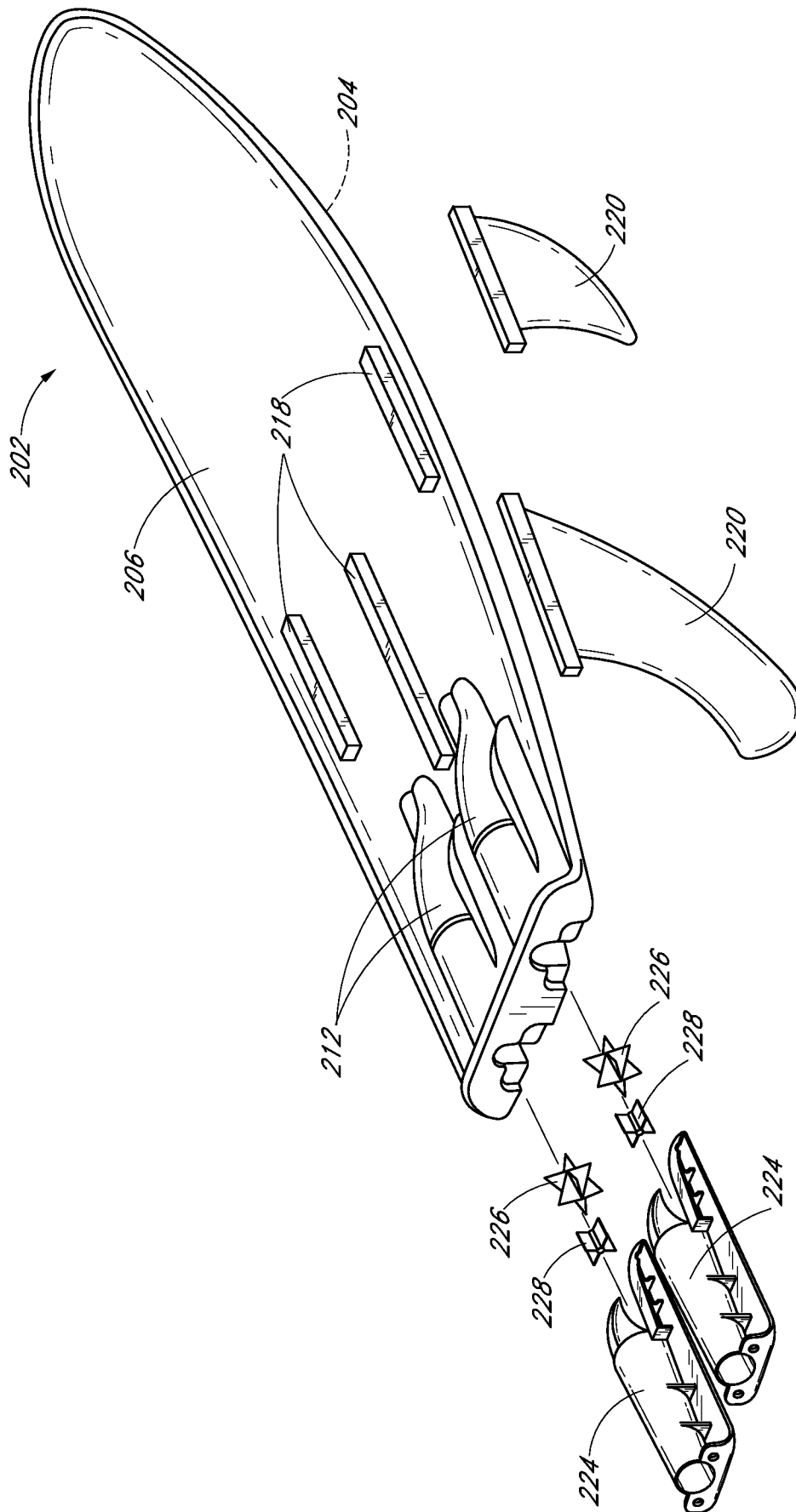


FIG. 2

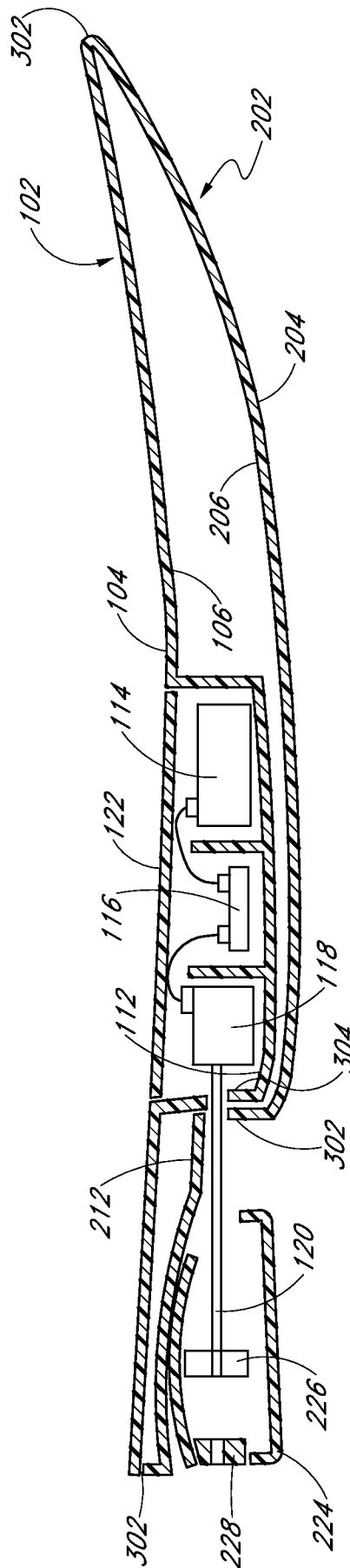


FIG. 3

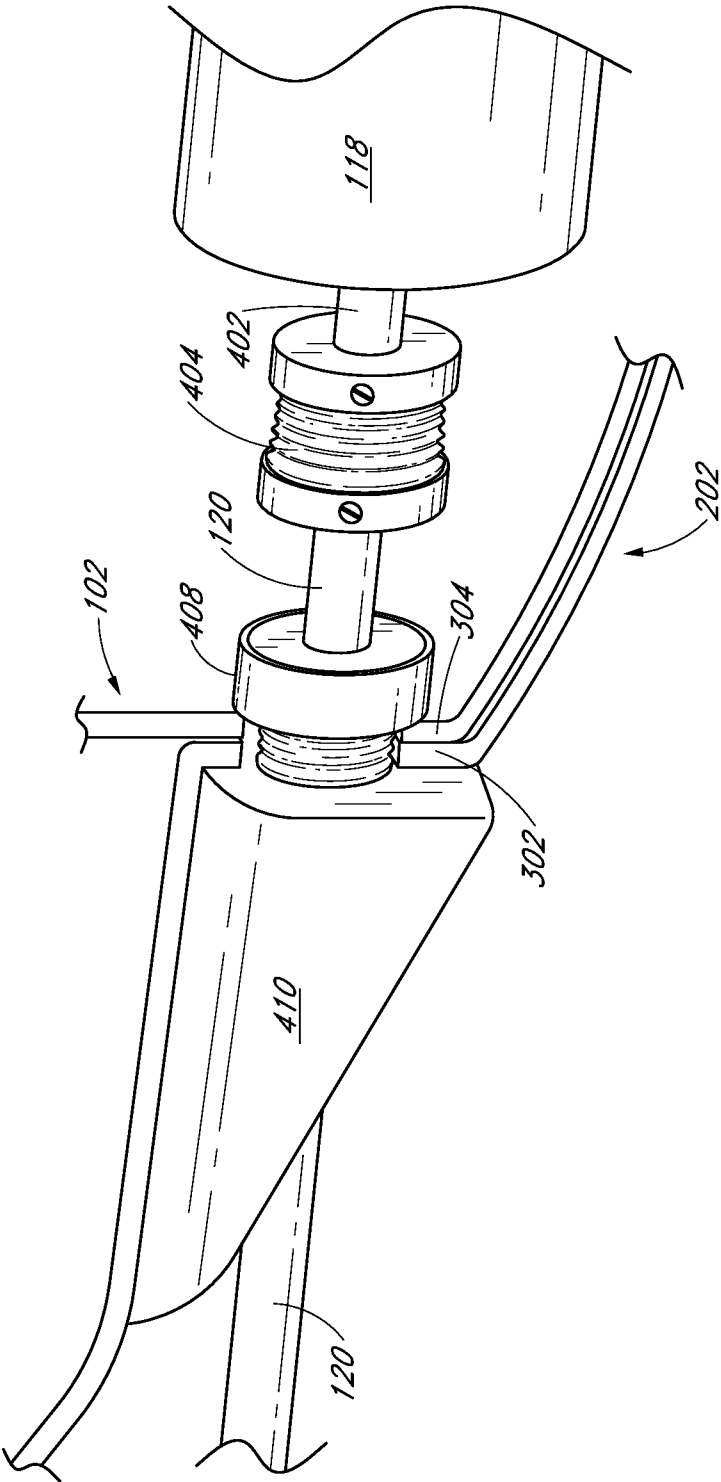


FIG. 4

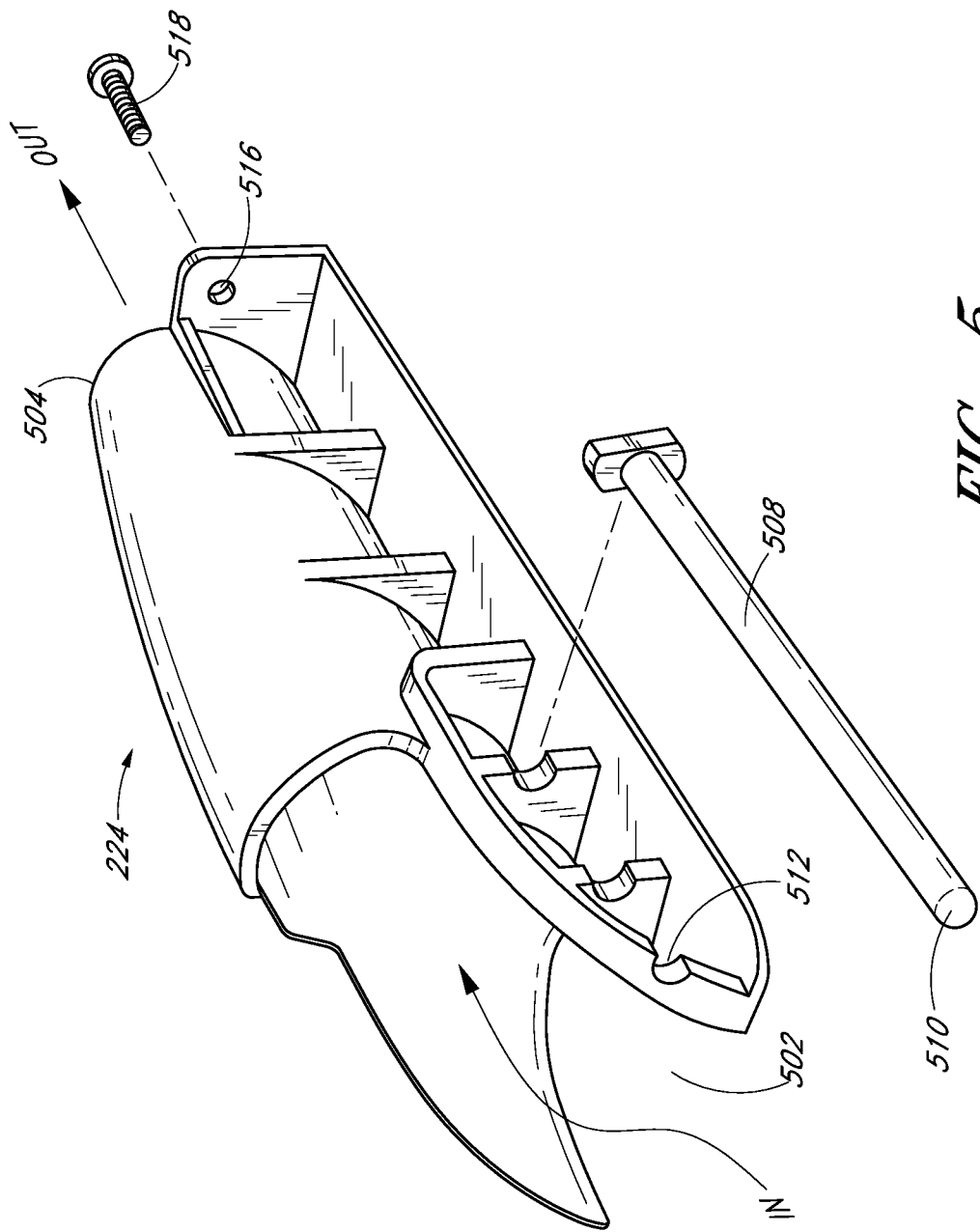
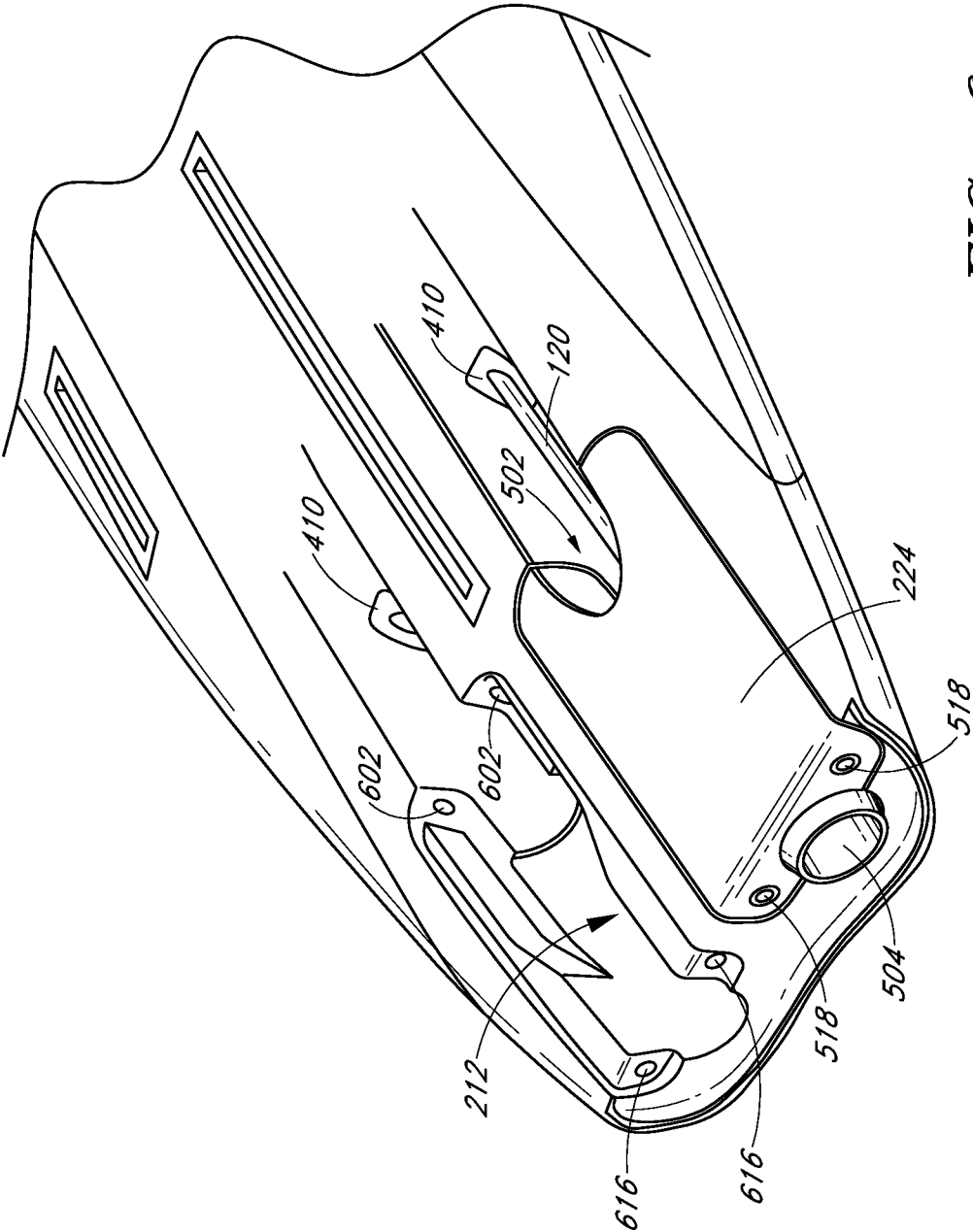
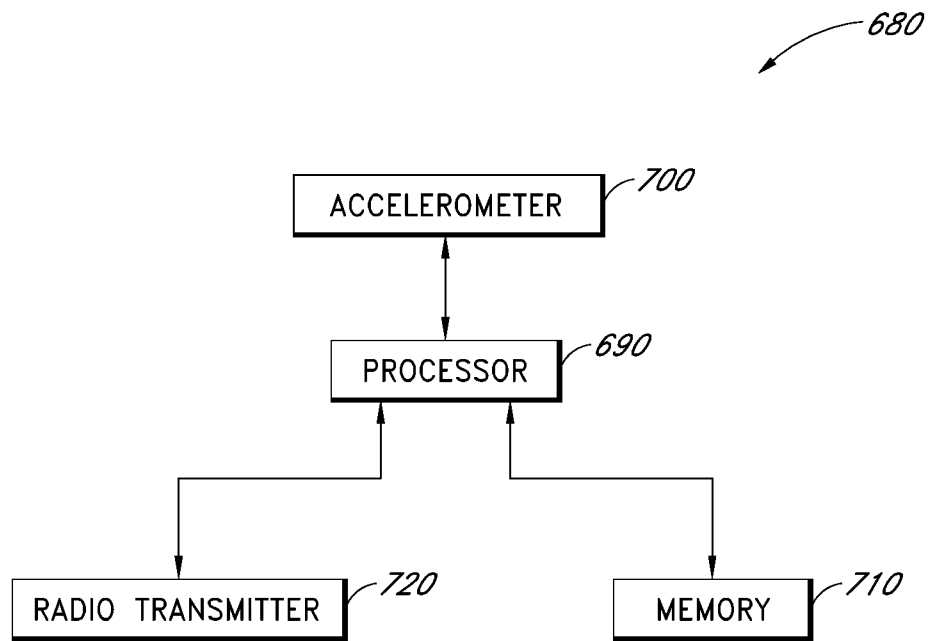
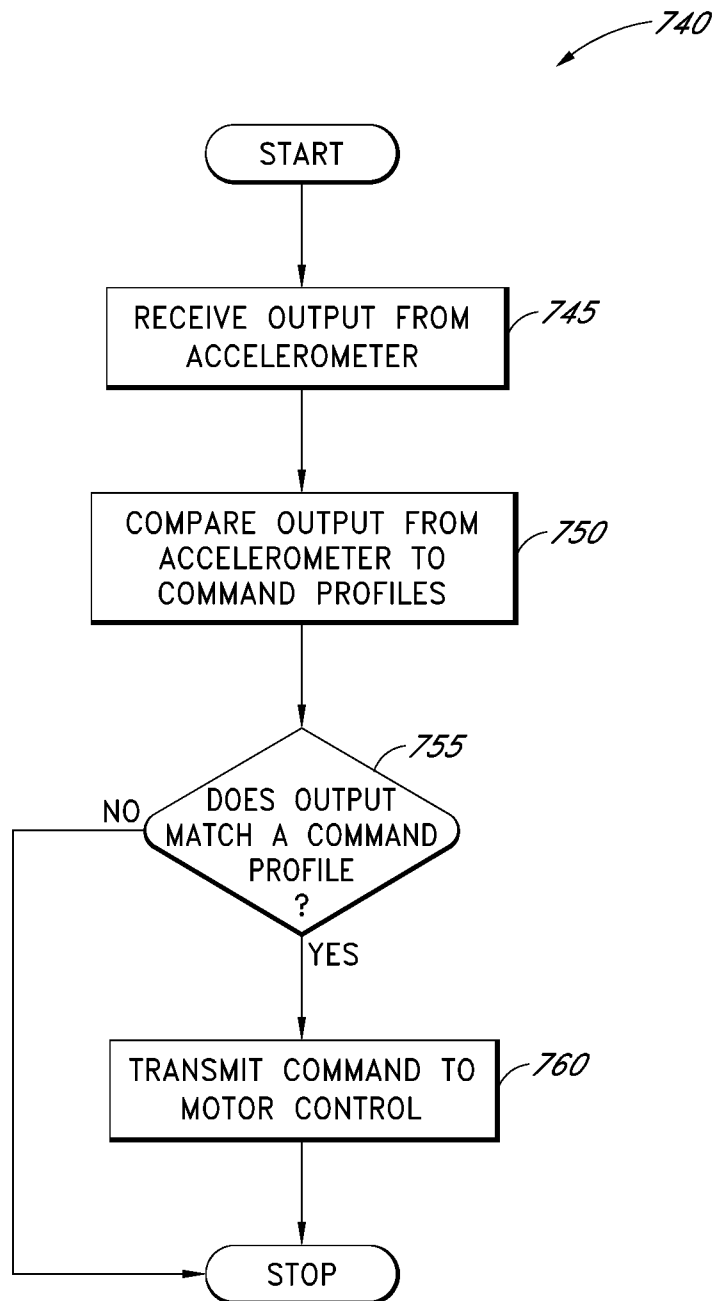


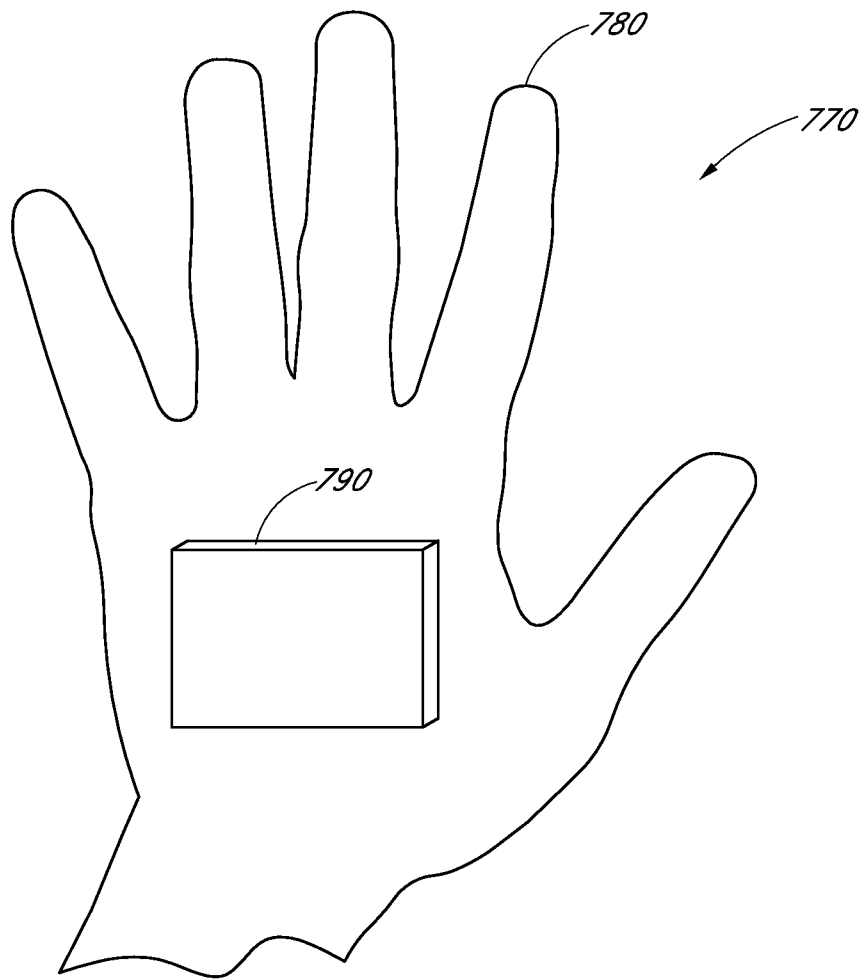
FIG. 5



*FIG. 6*

*FIG. 7*

*FIG. 8*



*FIG. 9*

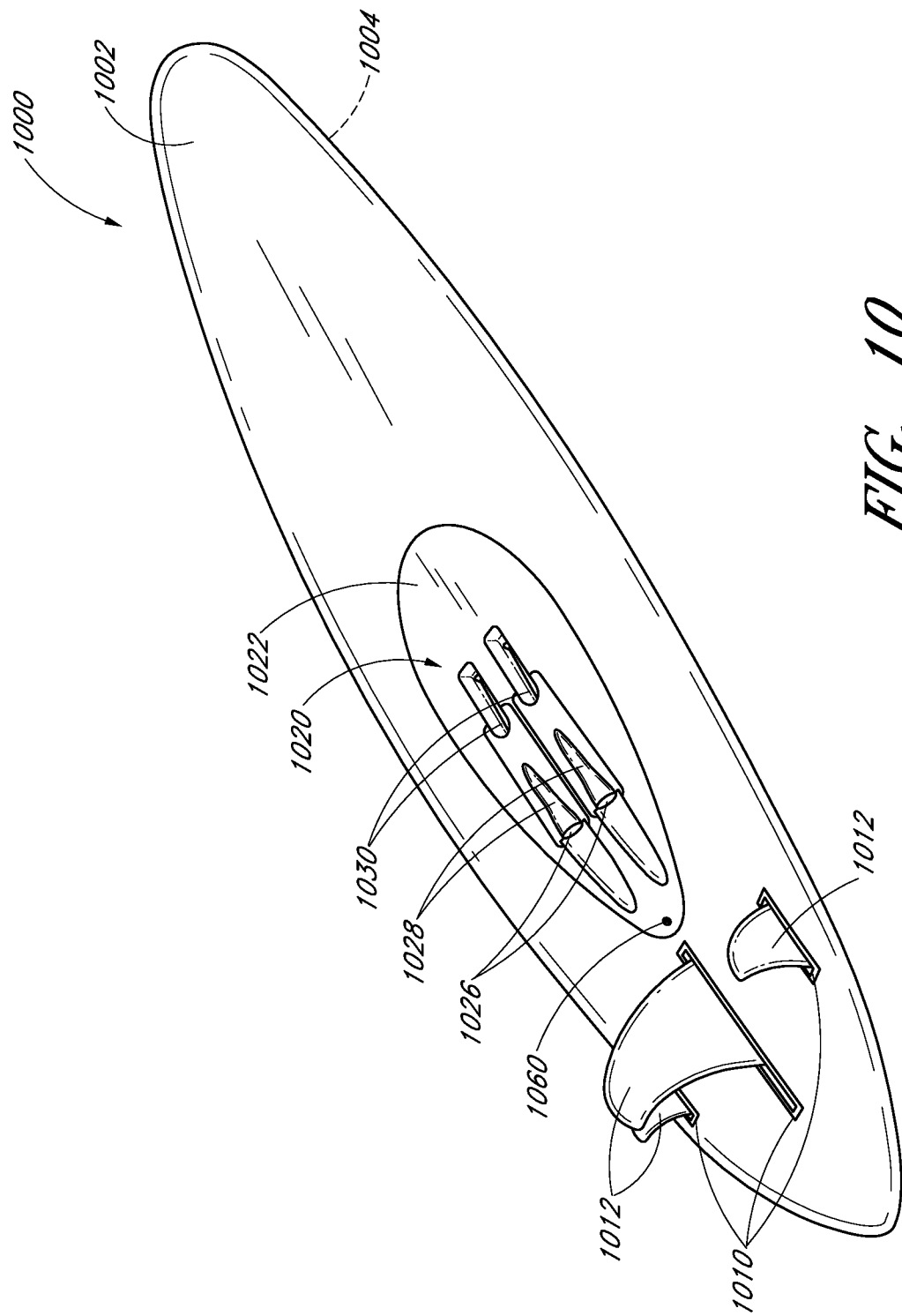


FIG. 10

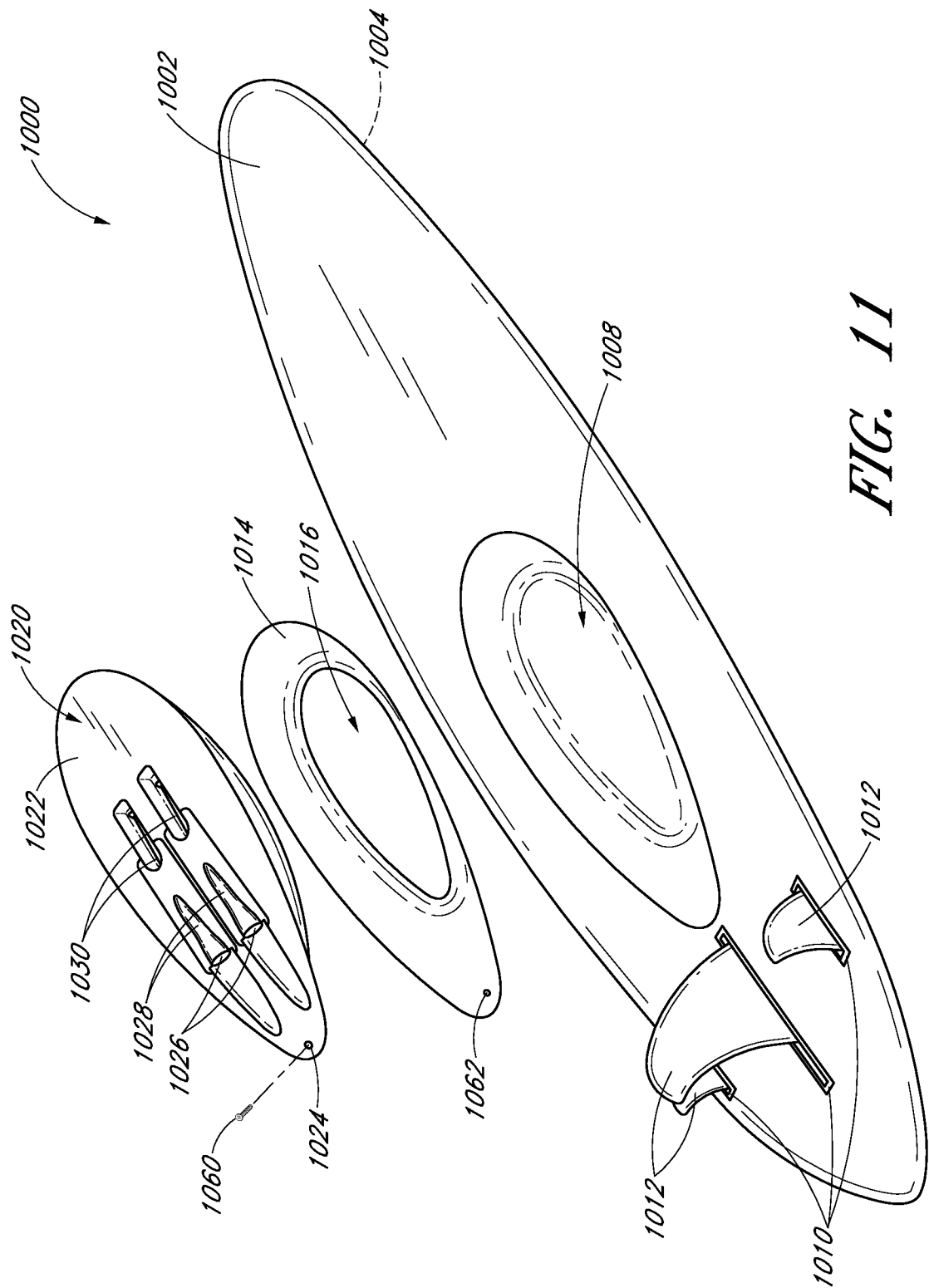


FIG. 11

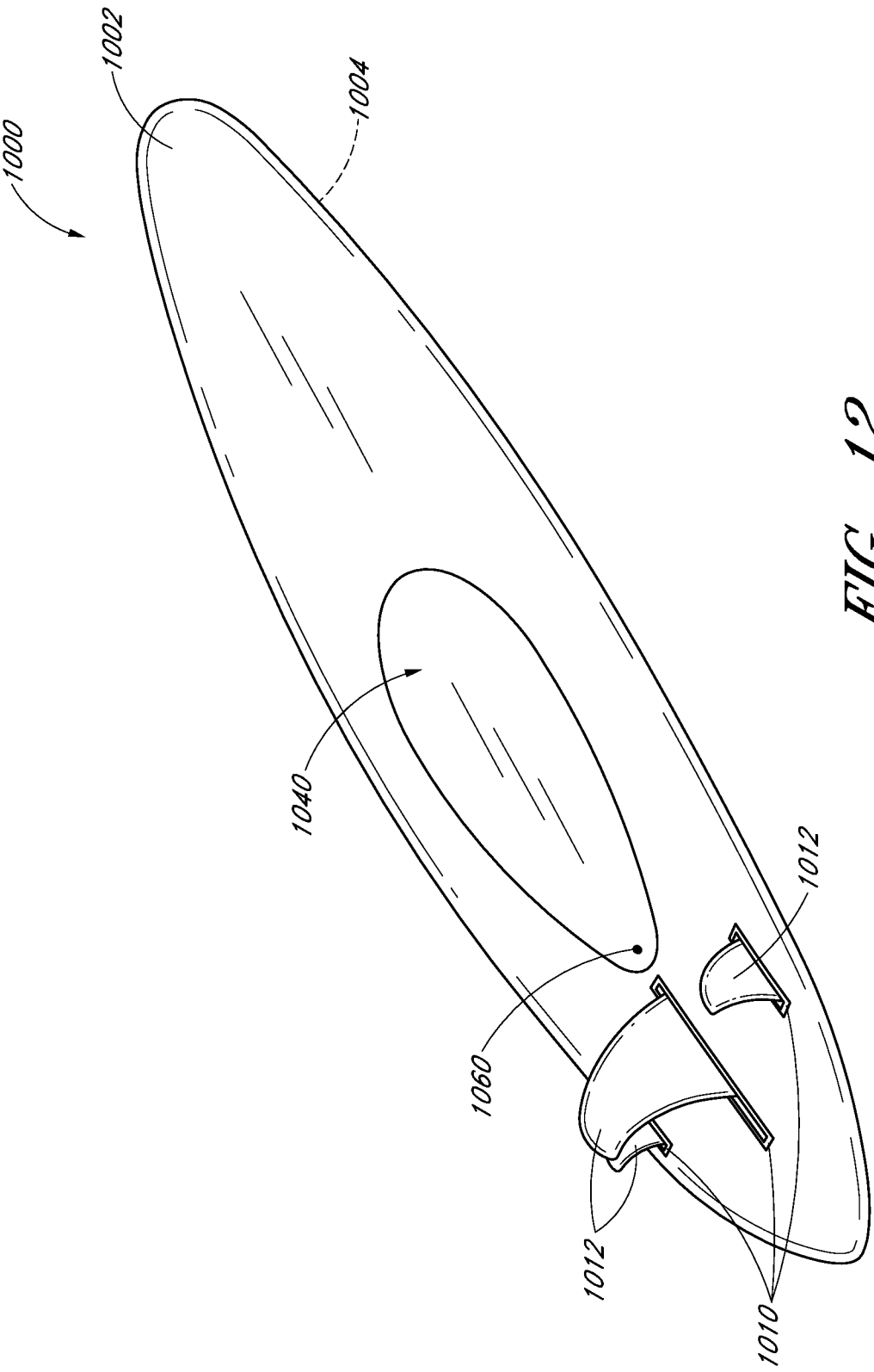


FIG. 12

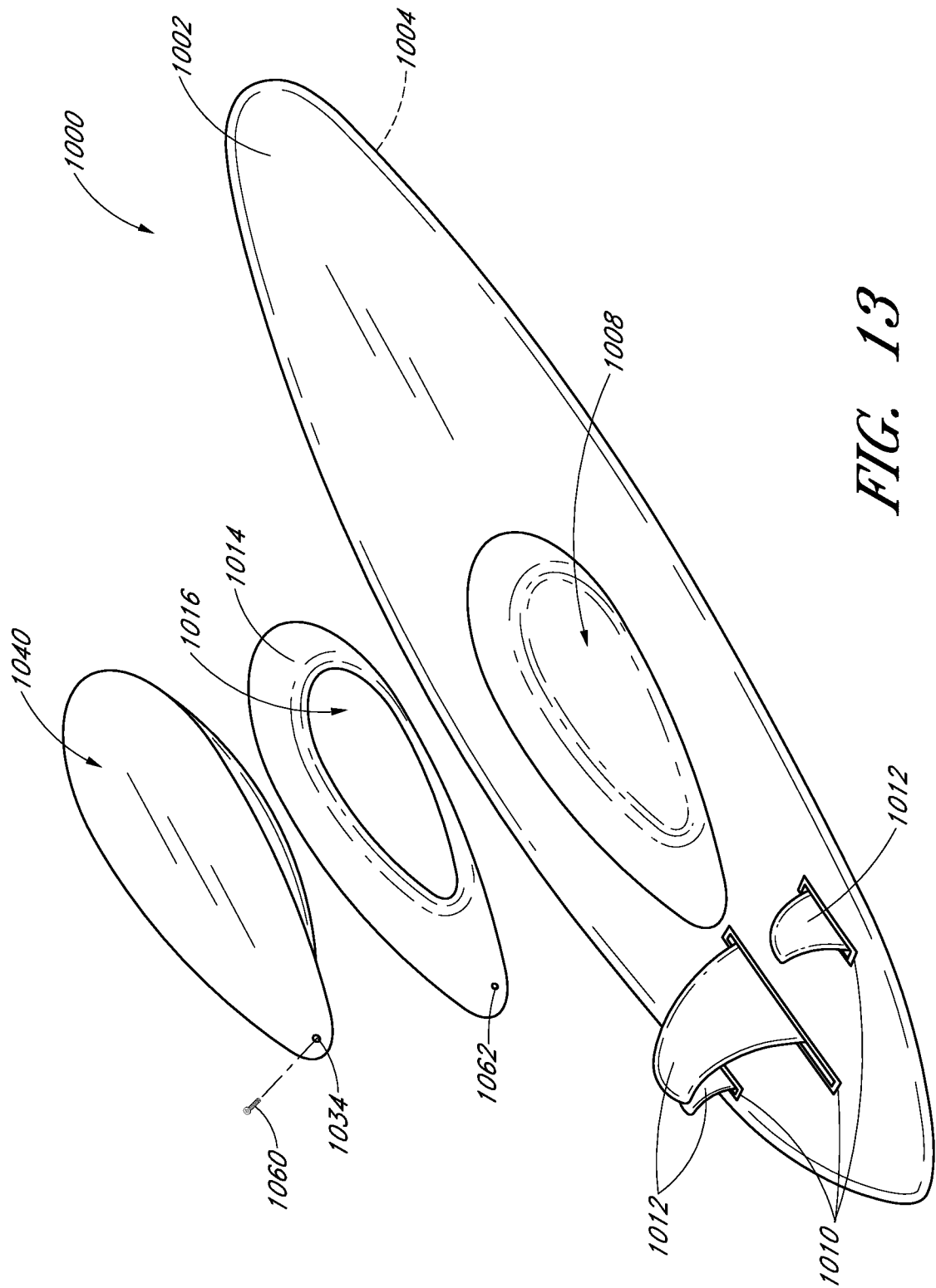


FIG. 13

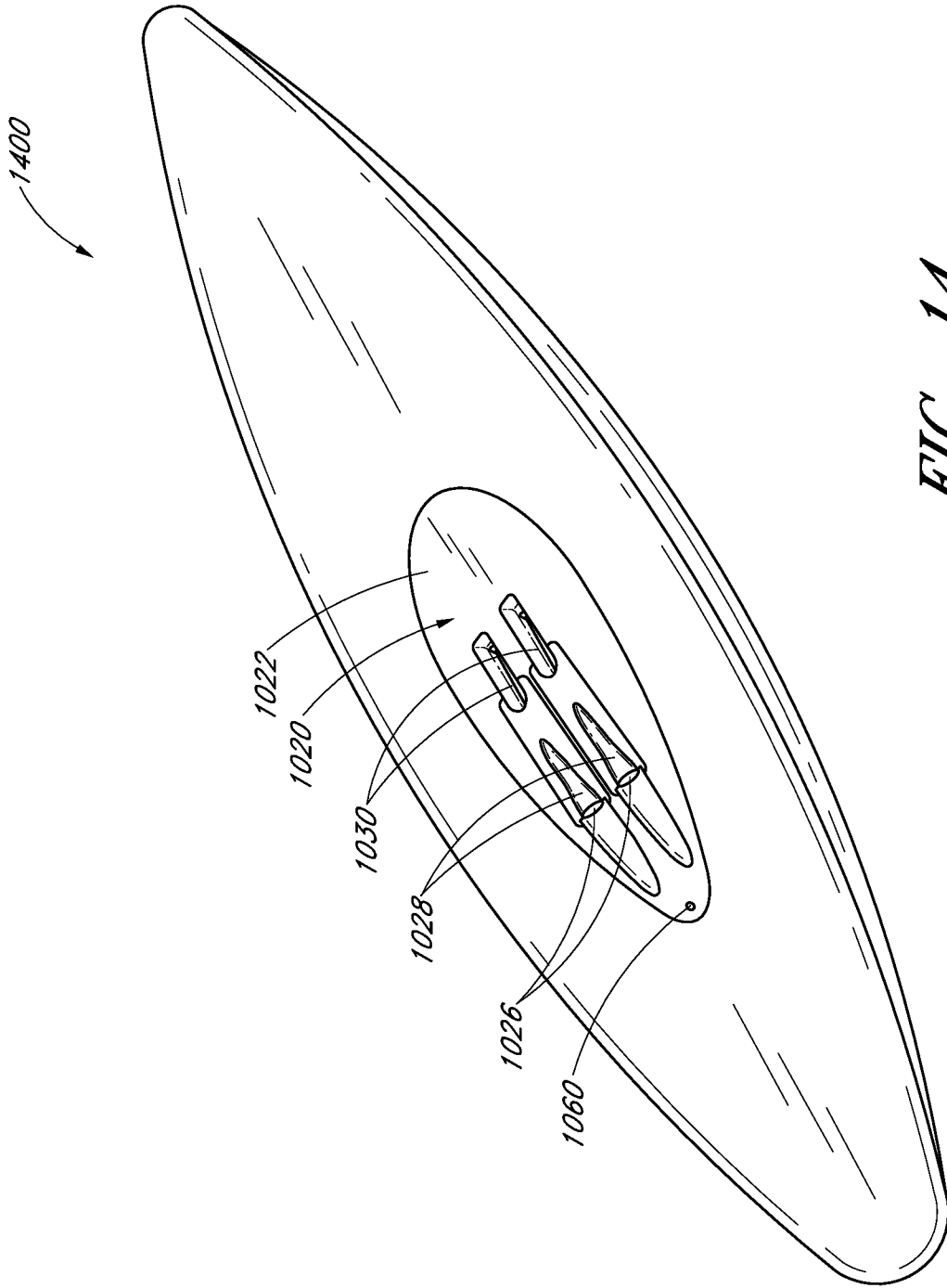
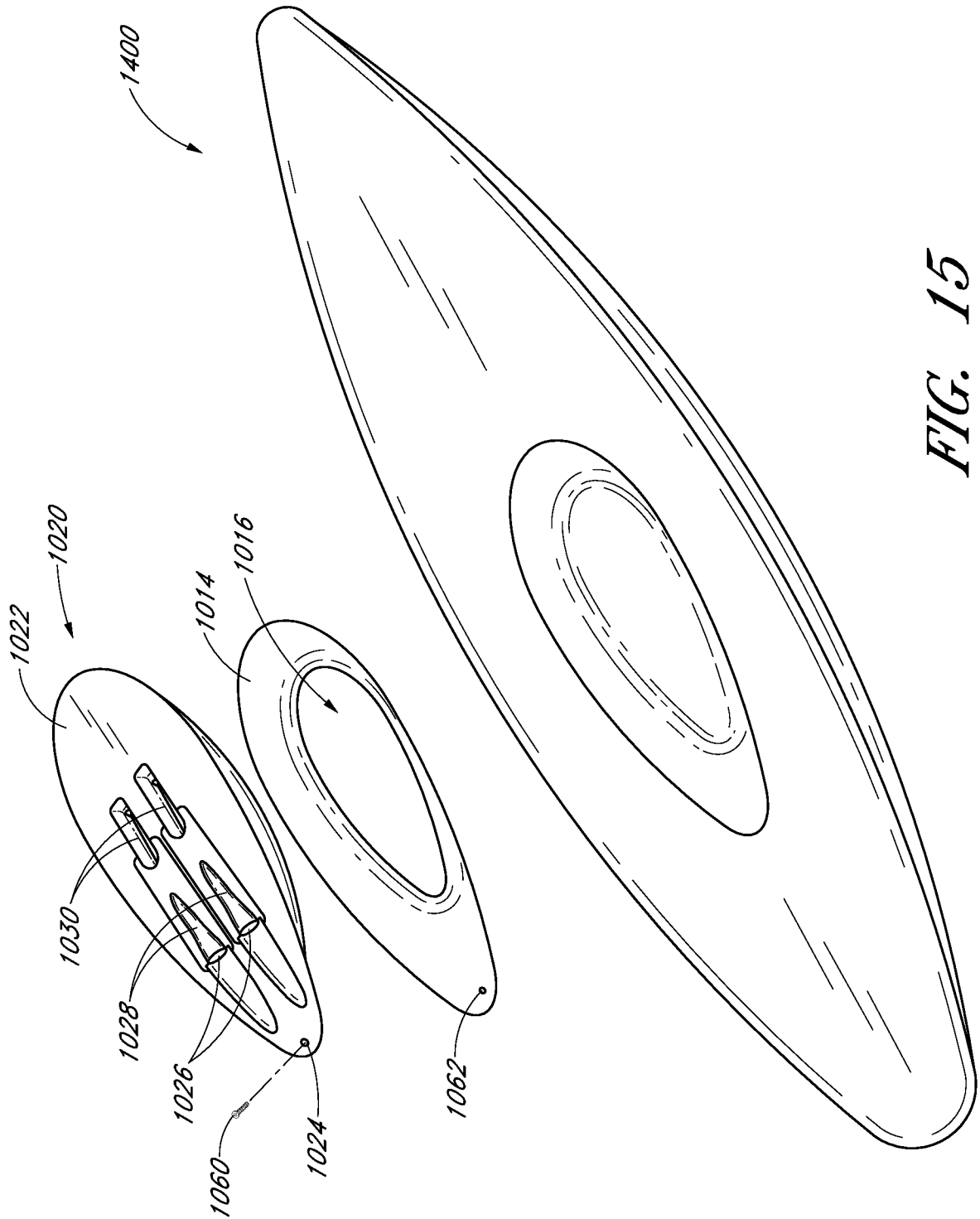


FIG. 14



**FIG. 15**

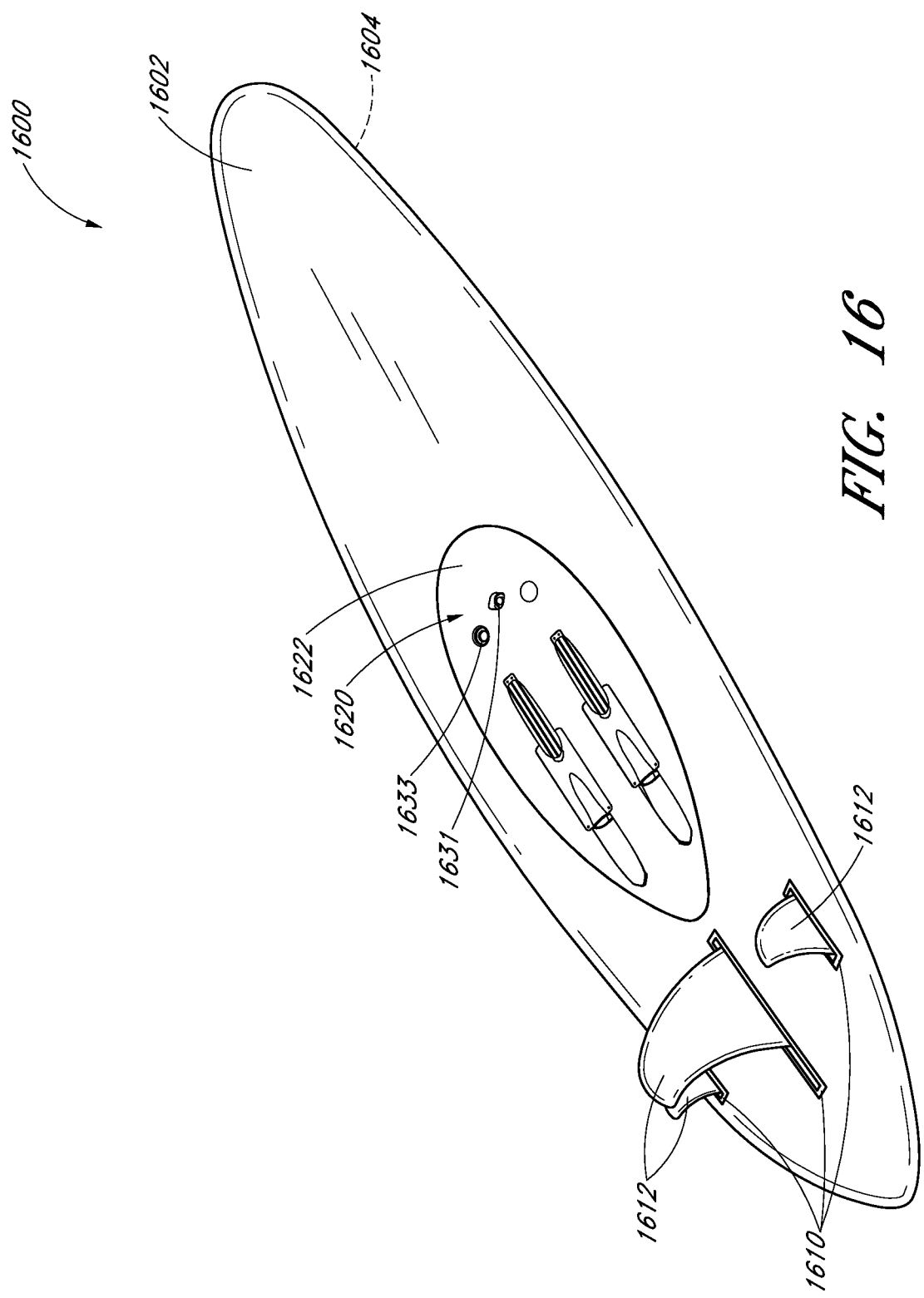
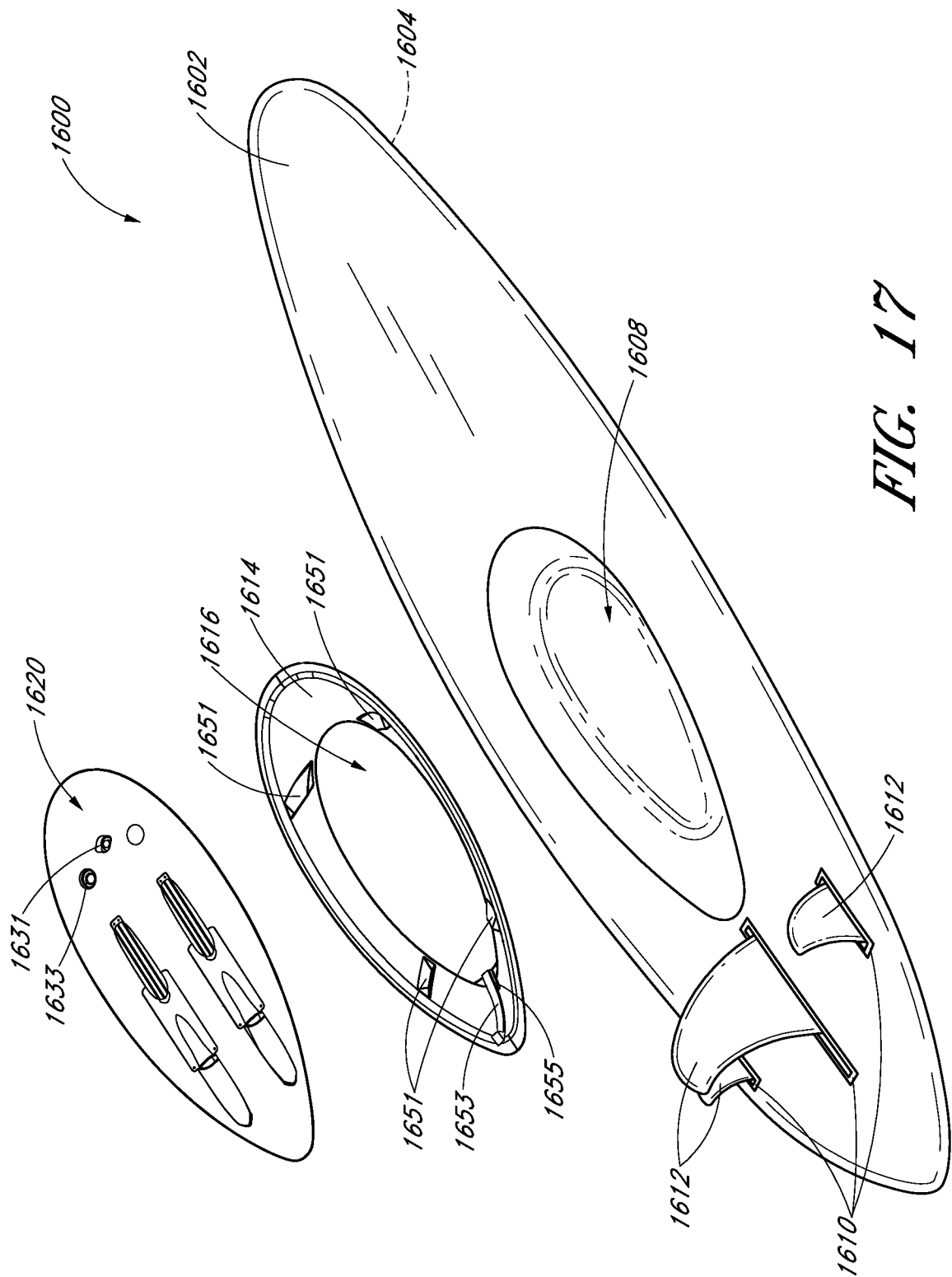
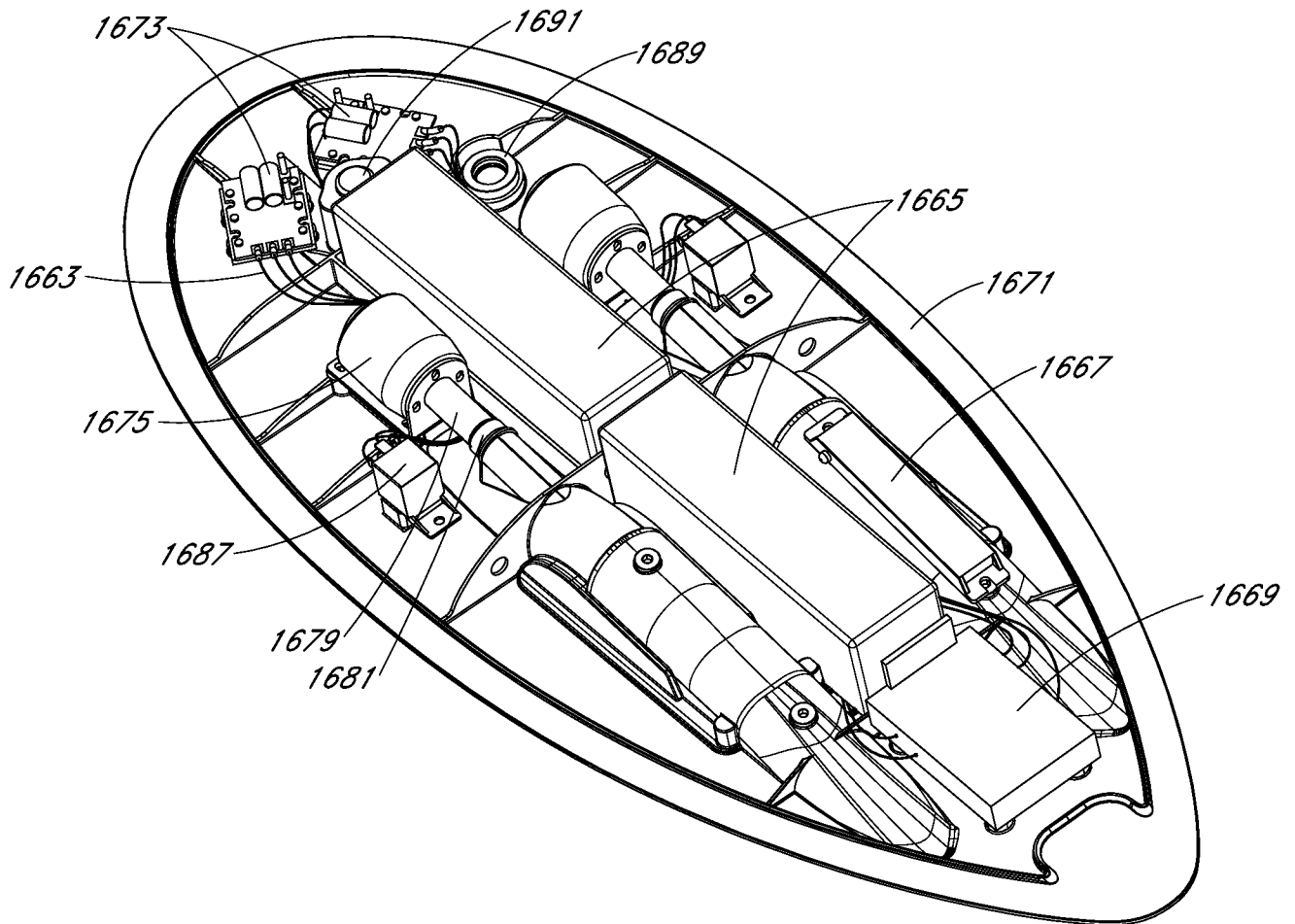


FIG. 16







*FIG. 19*

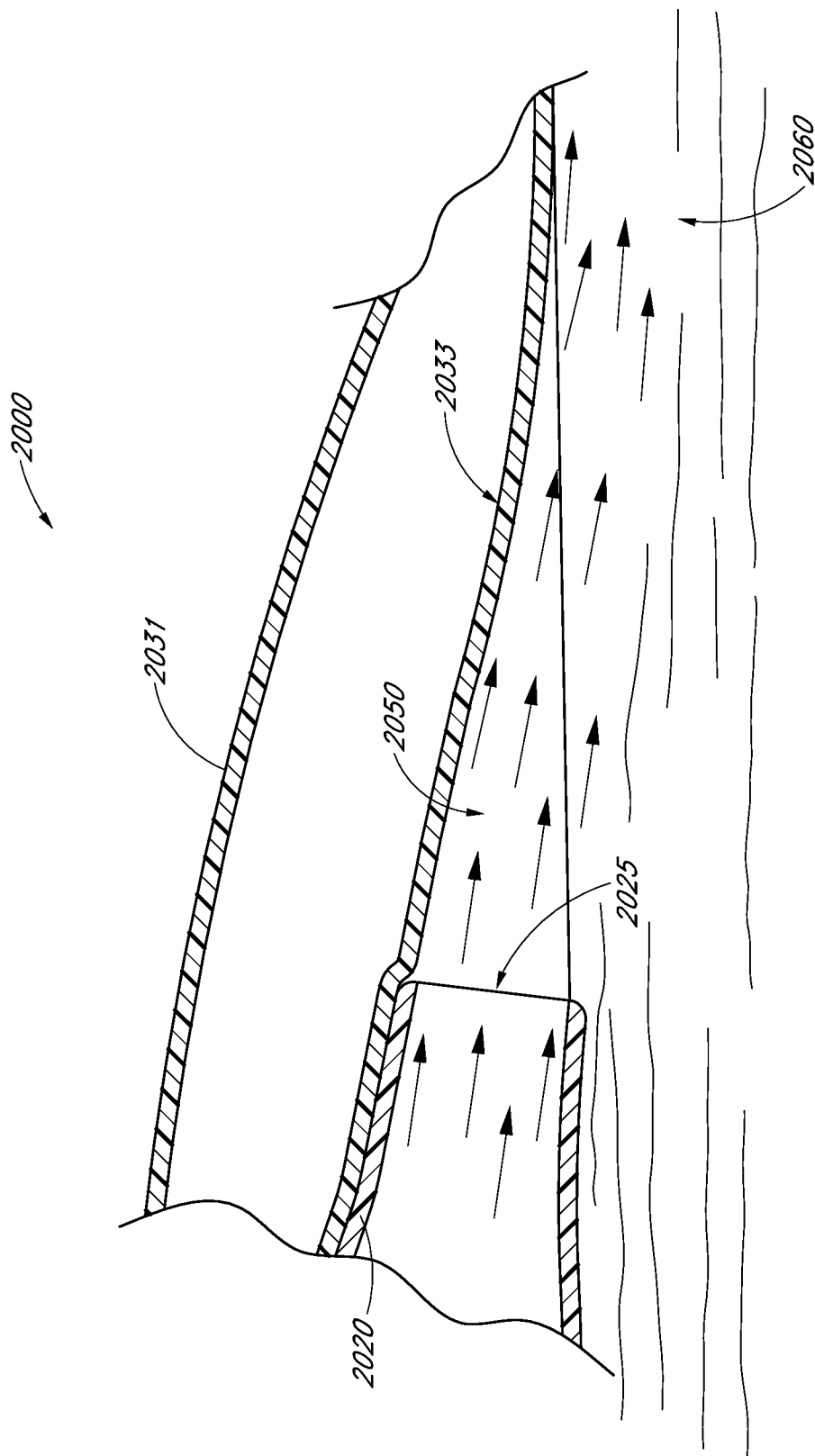


FIG. 20

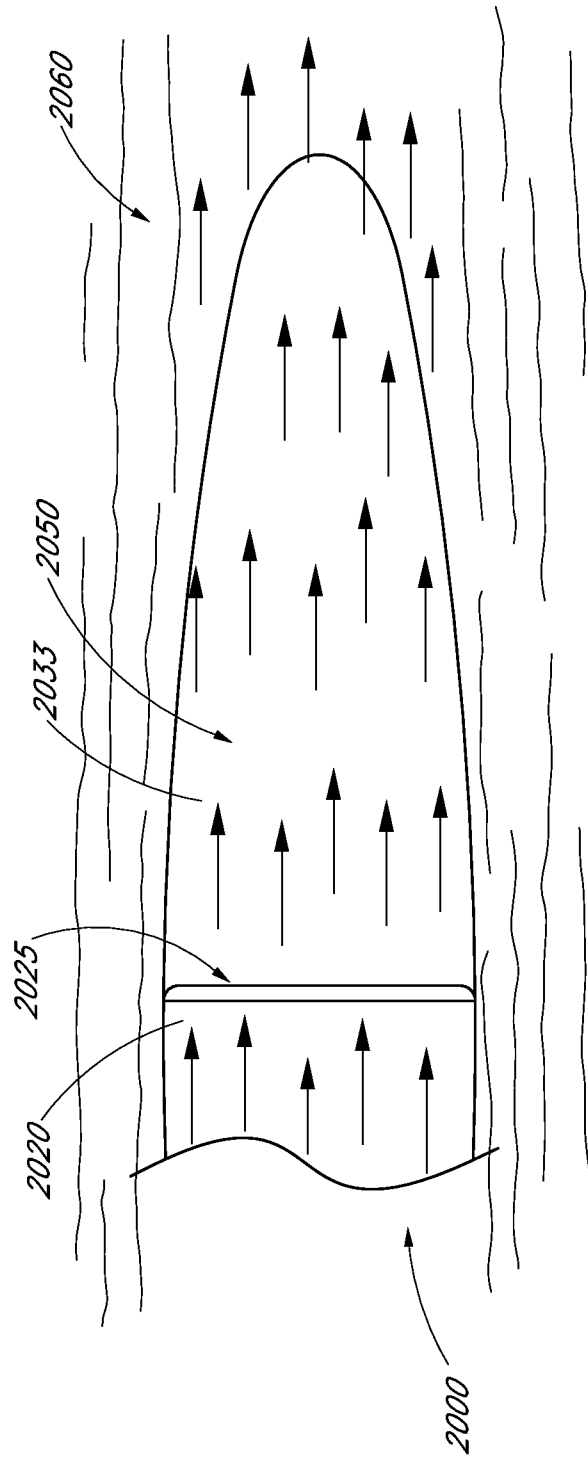


FIG. 21

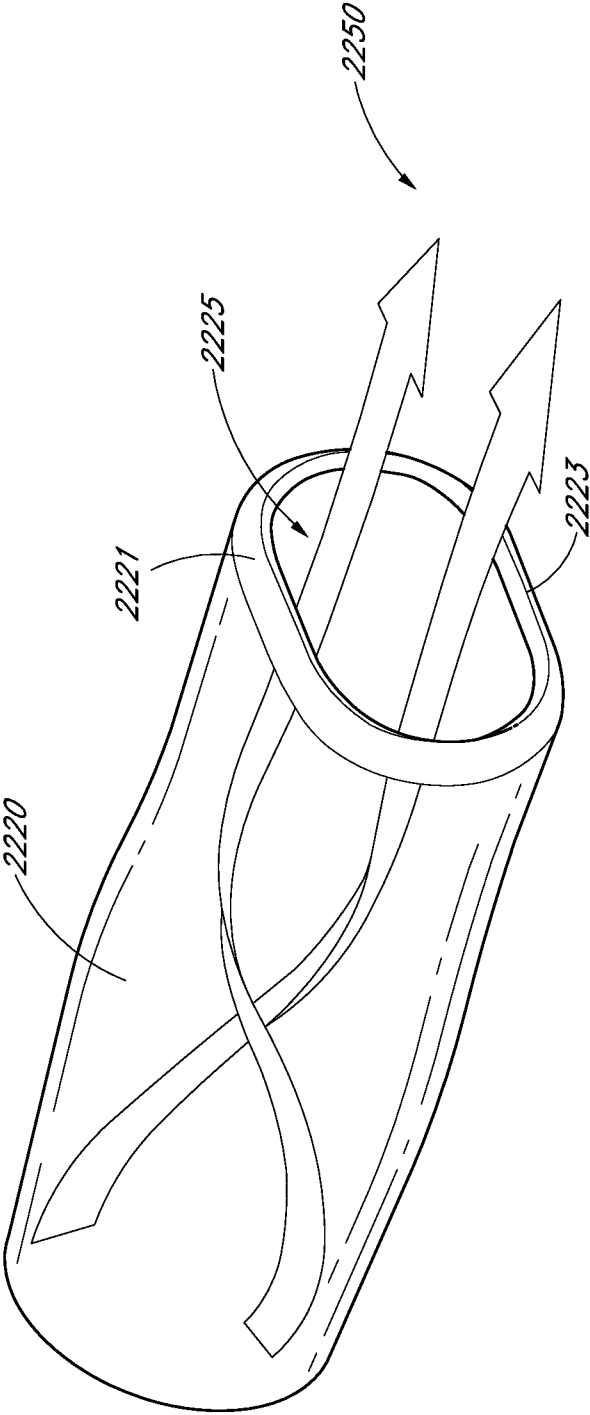
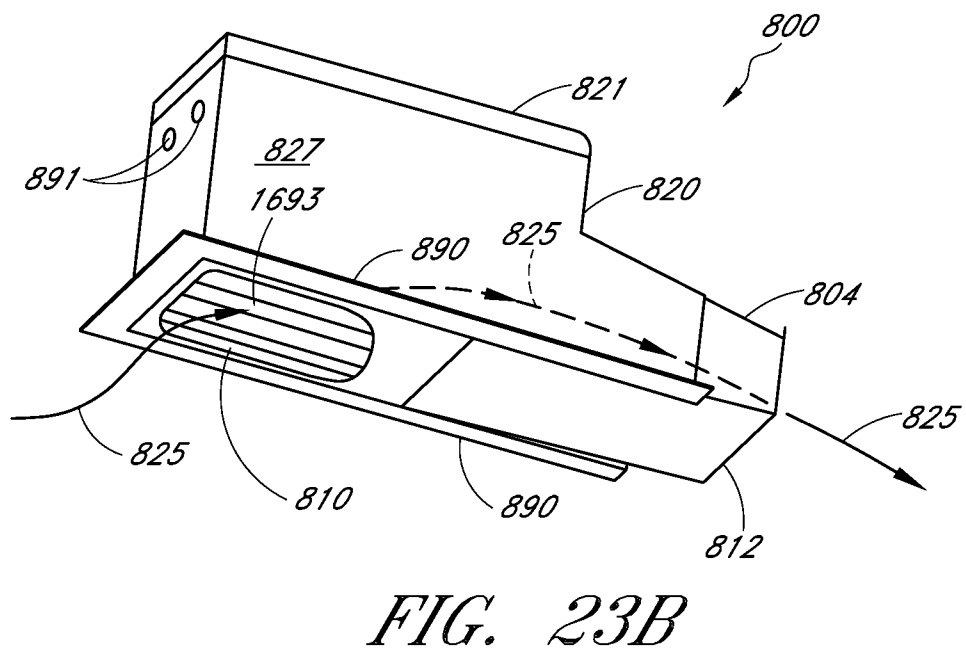
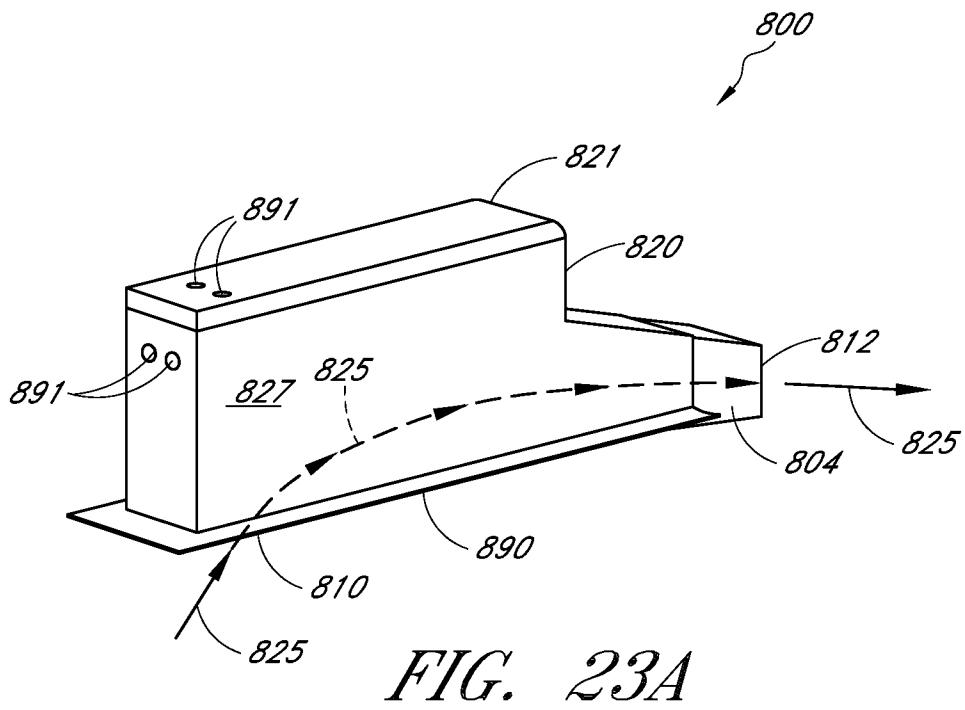
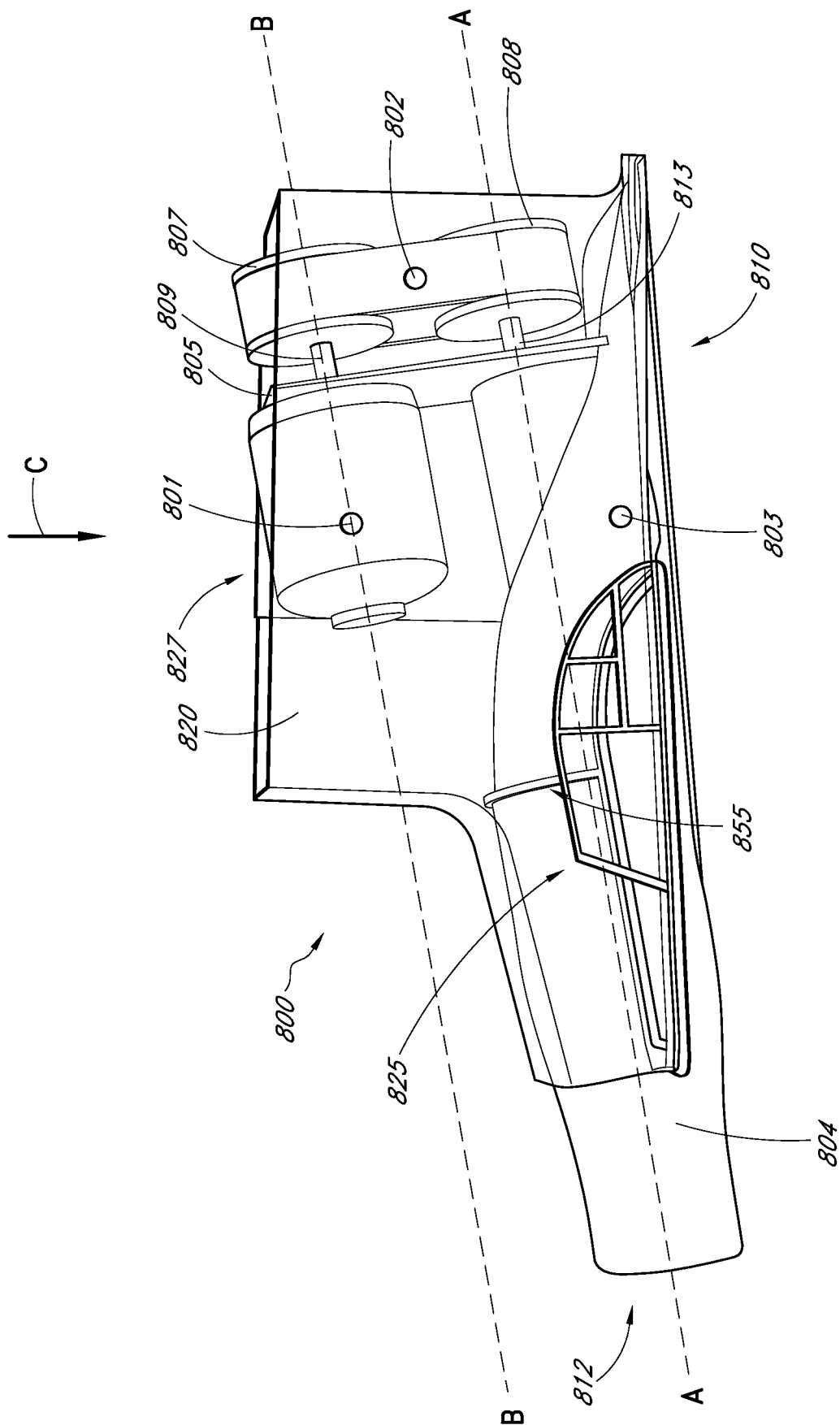
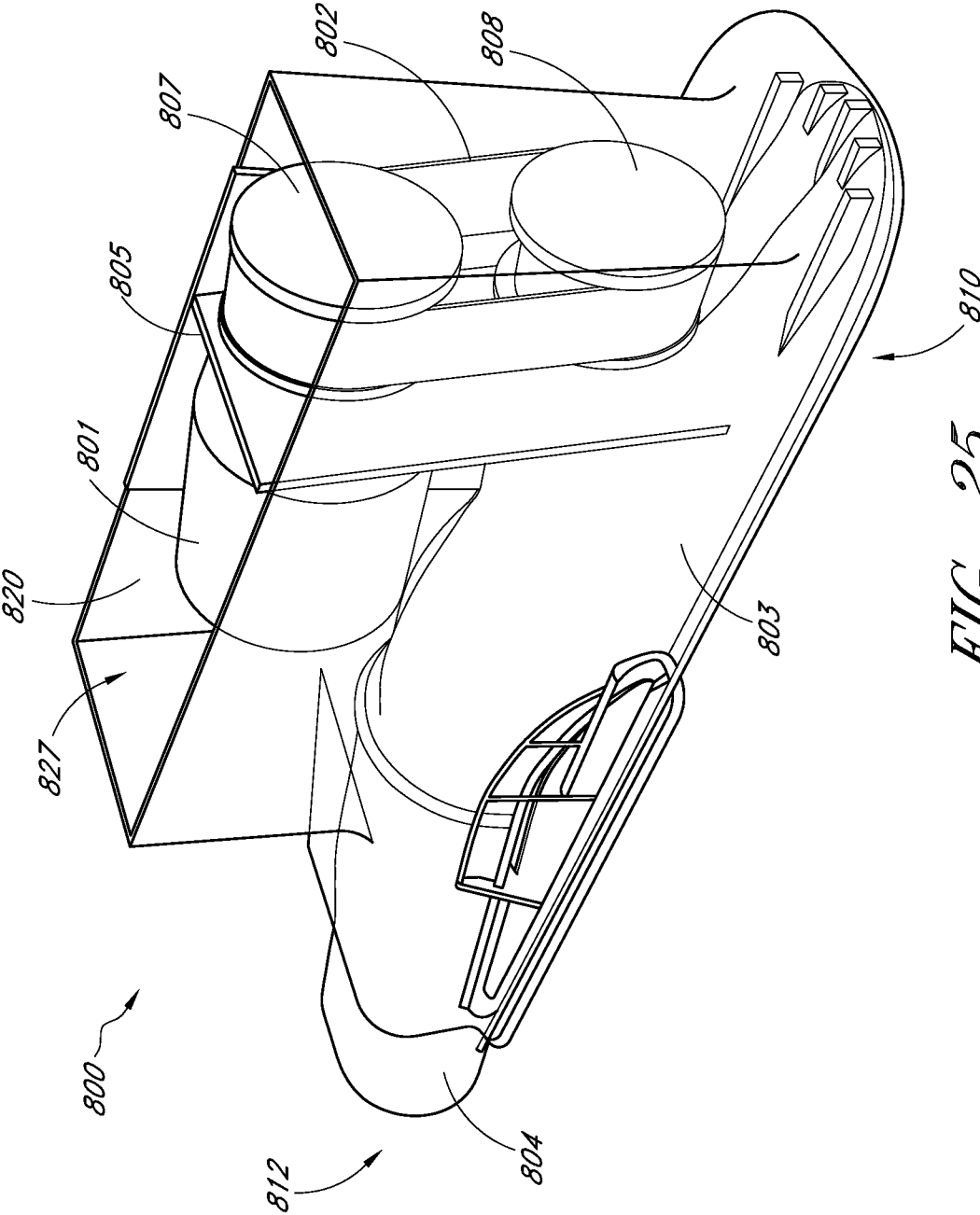


FIG. 22





**FIG. 24**



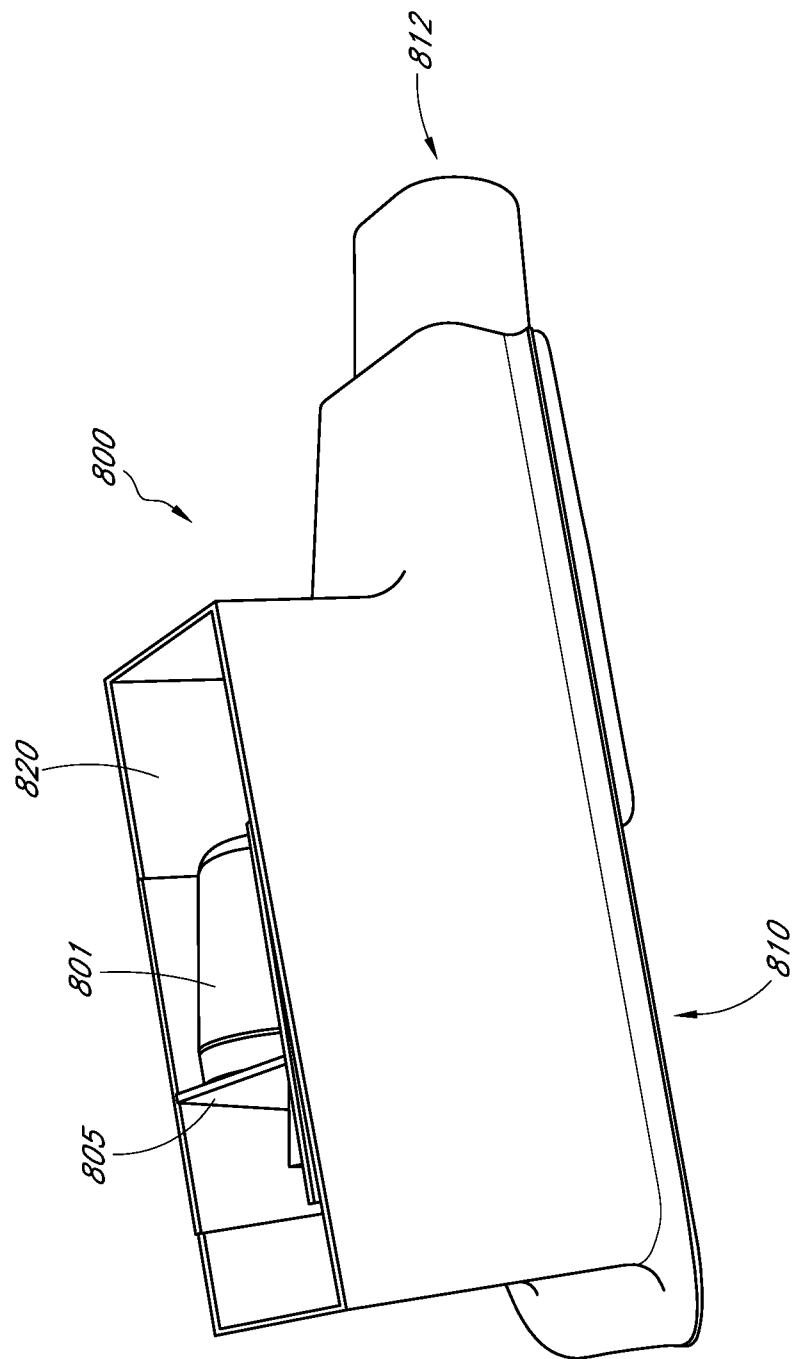


FIG. 26

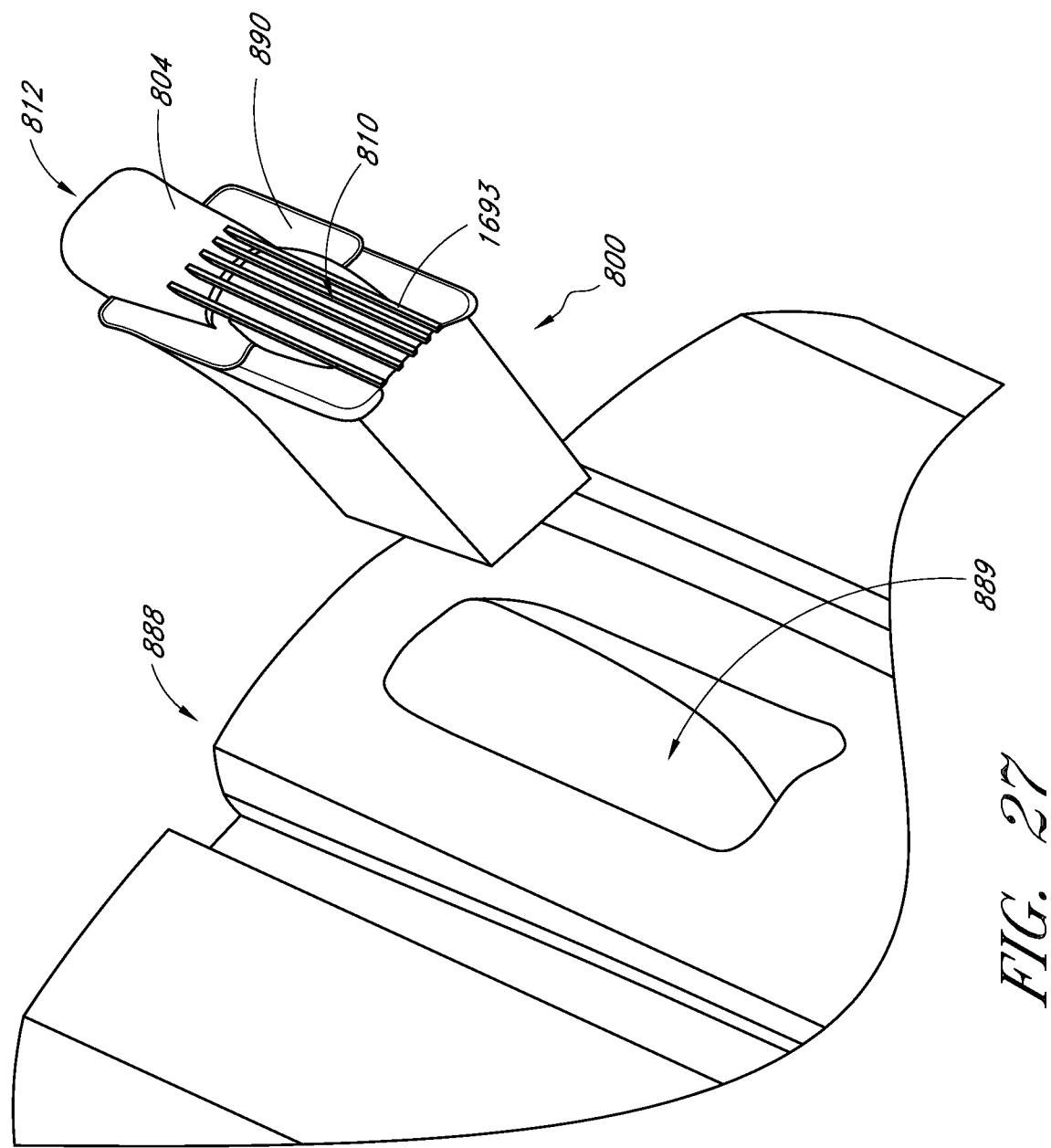


FIG. 27

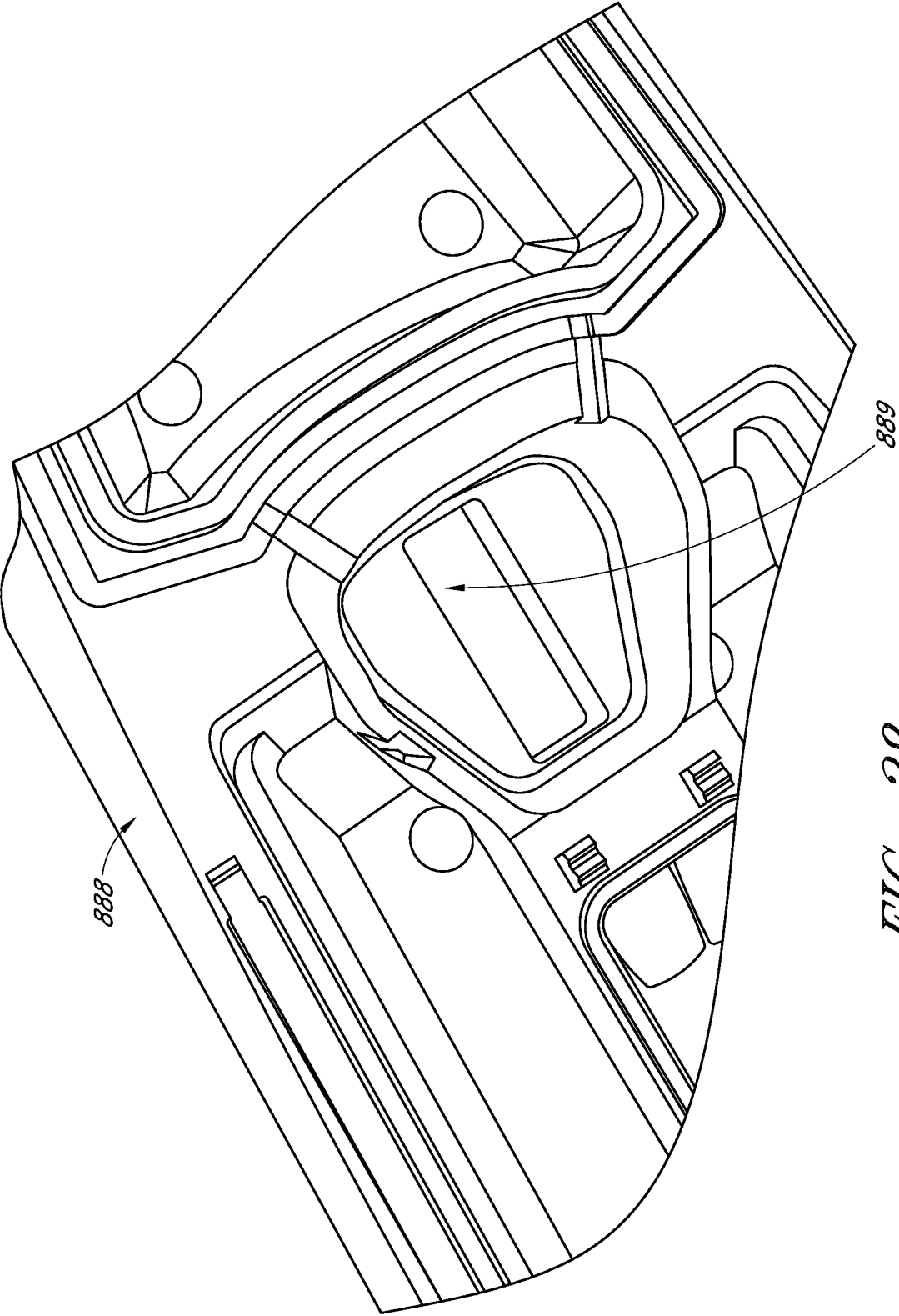
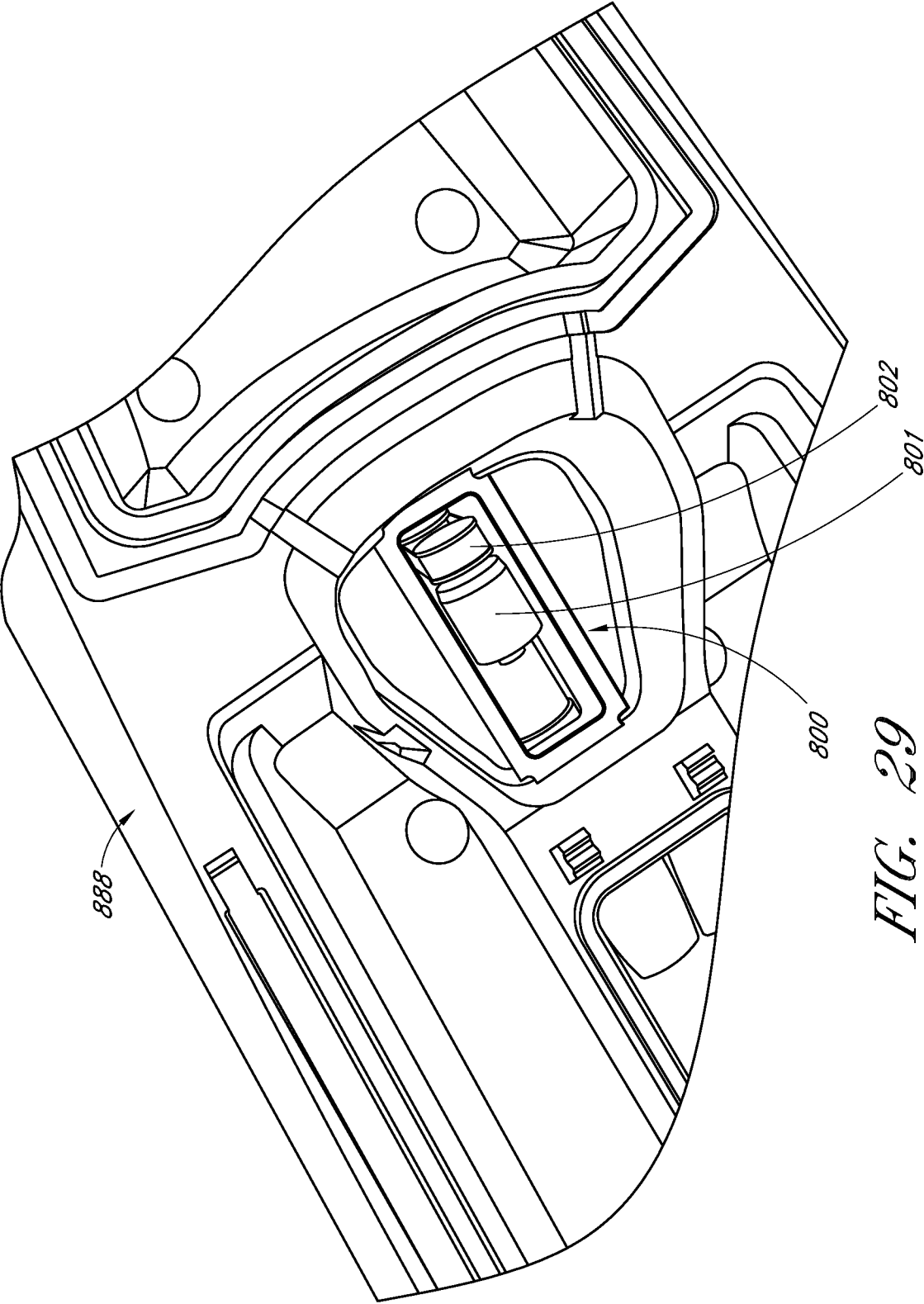
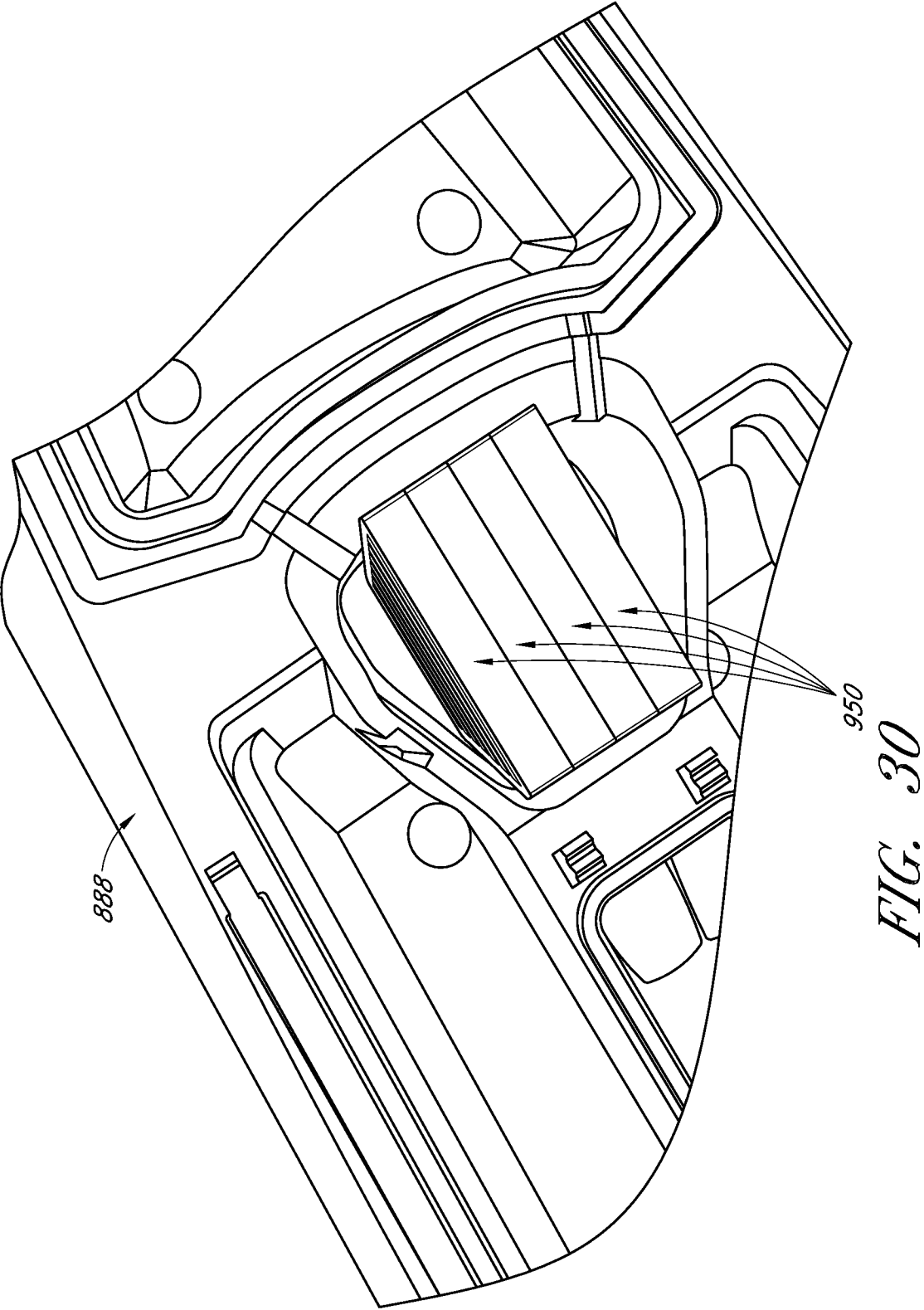


FIG. 28





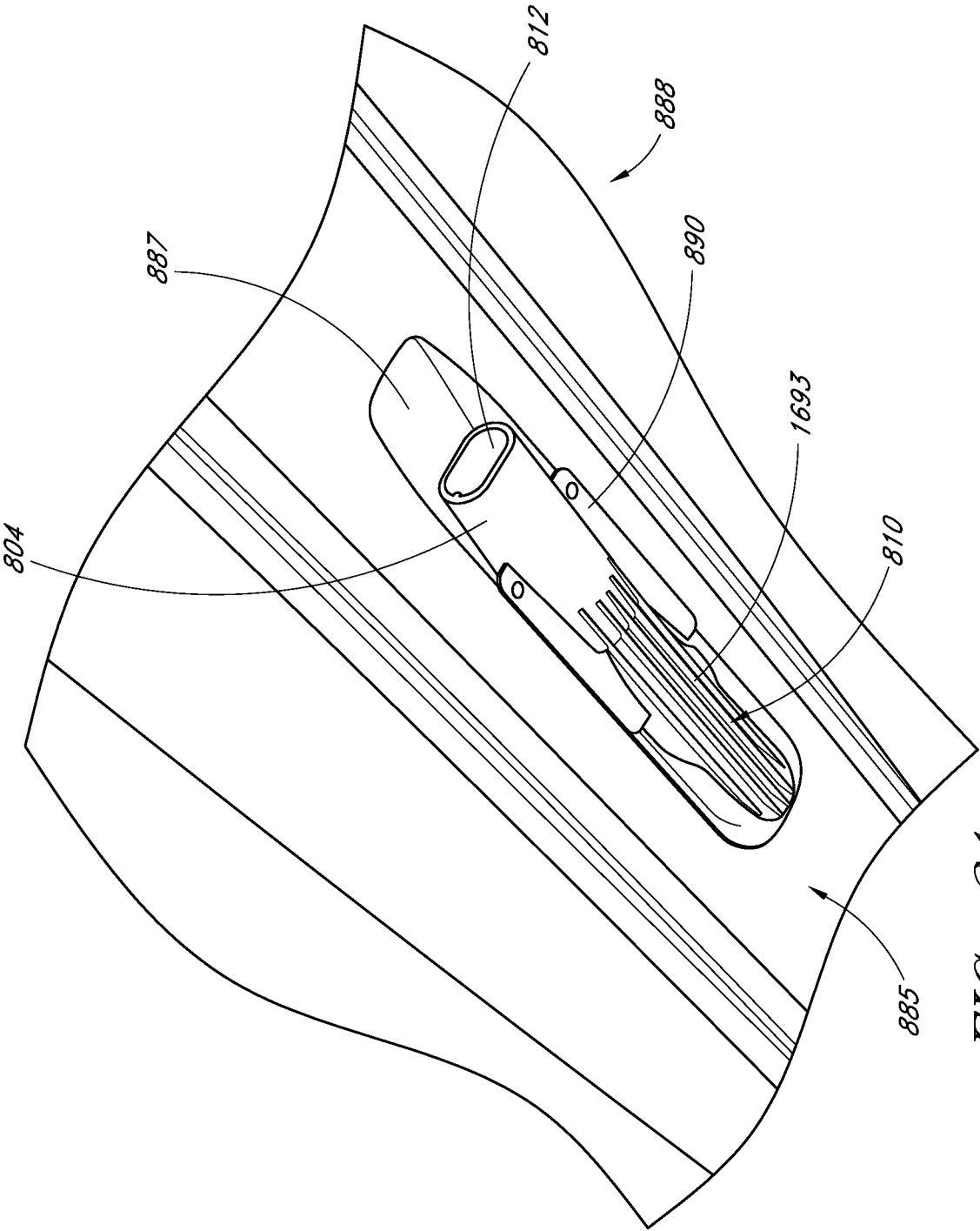


FIG. 31

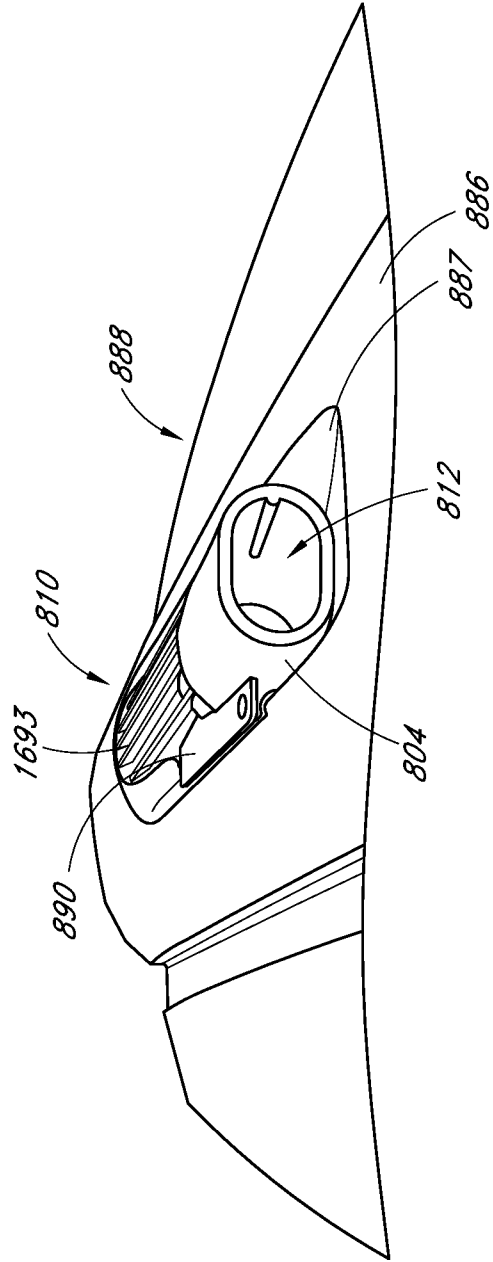


FIG. 32

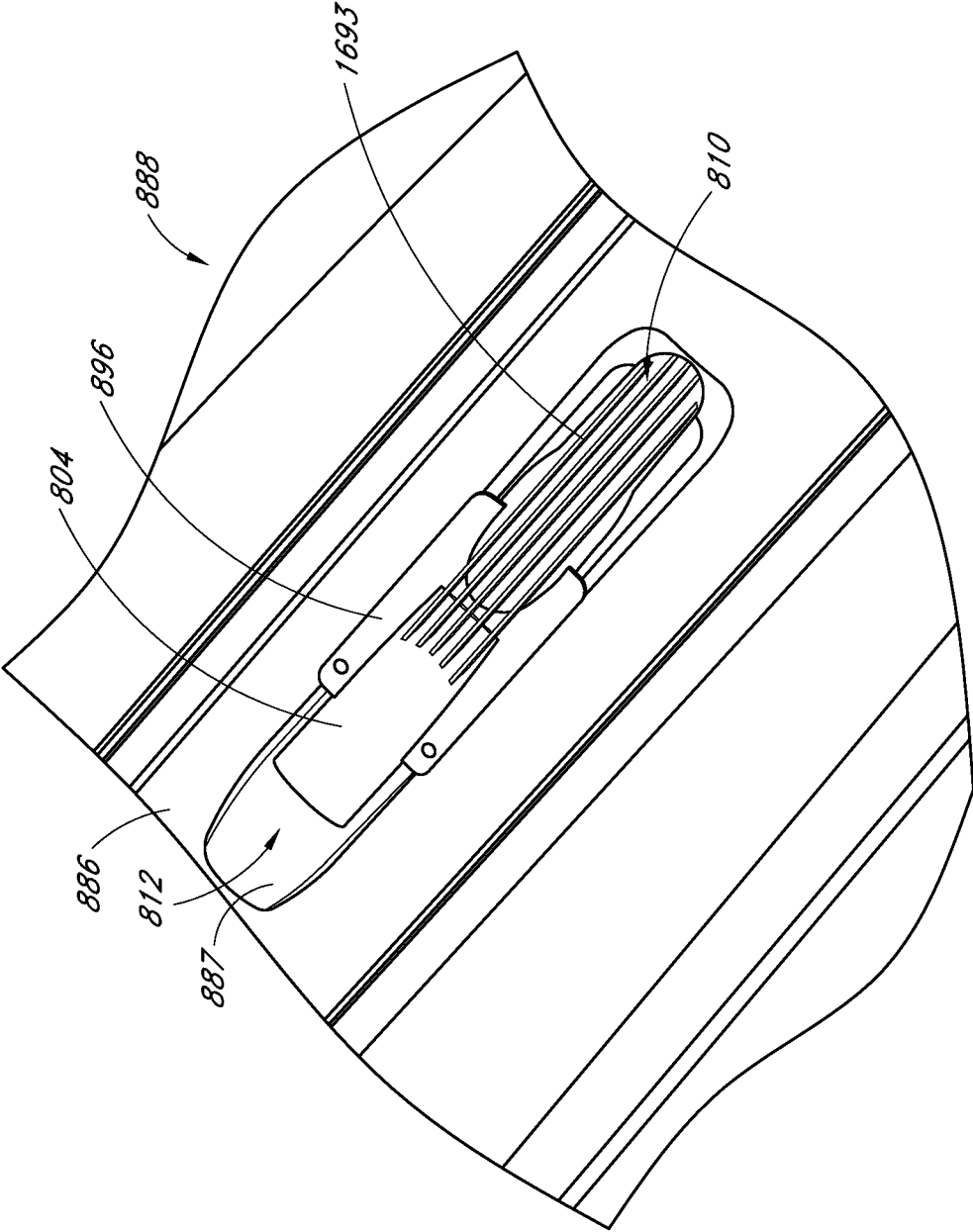


FIG. 33

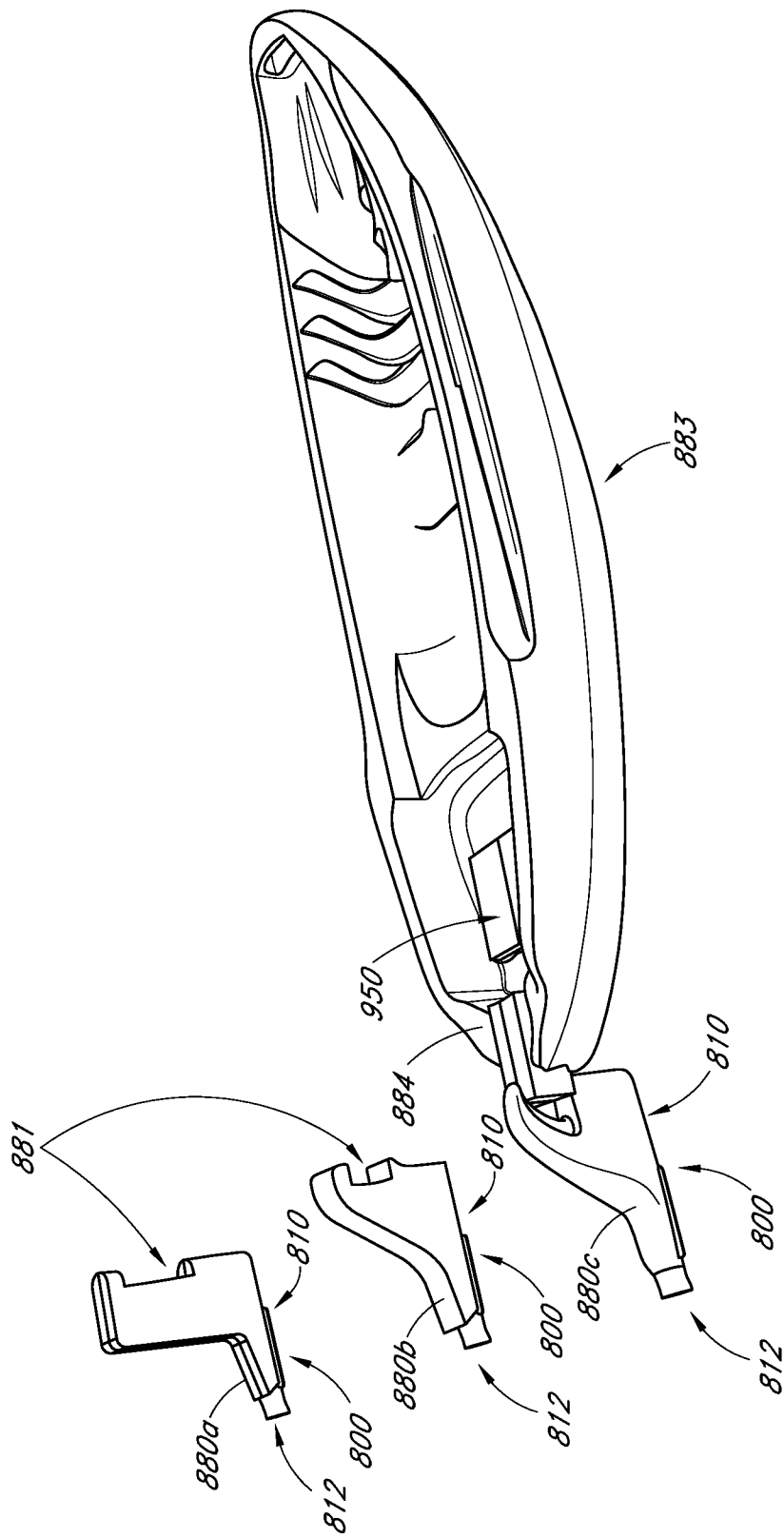


FIG. 34

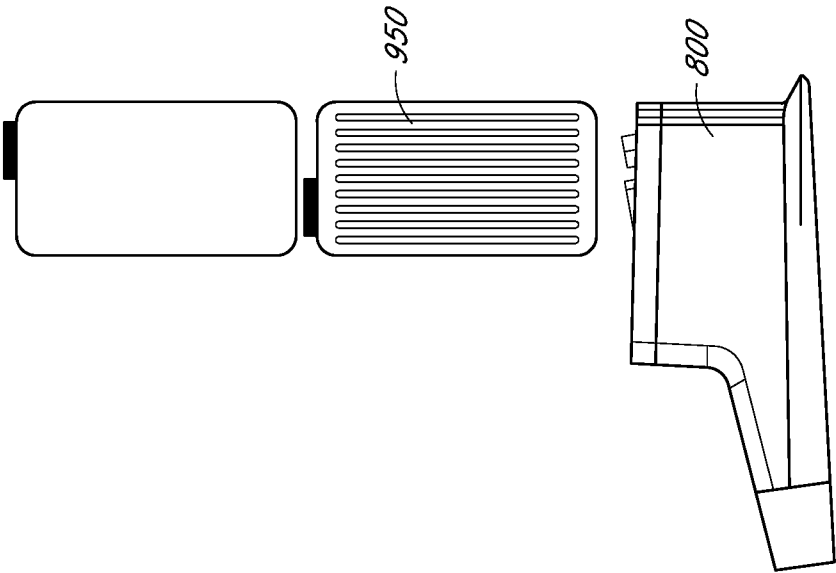


FIG. 35A

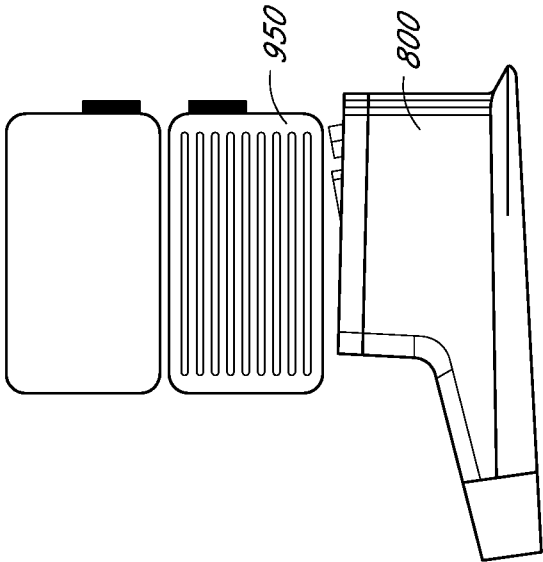
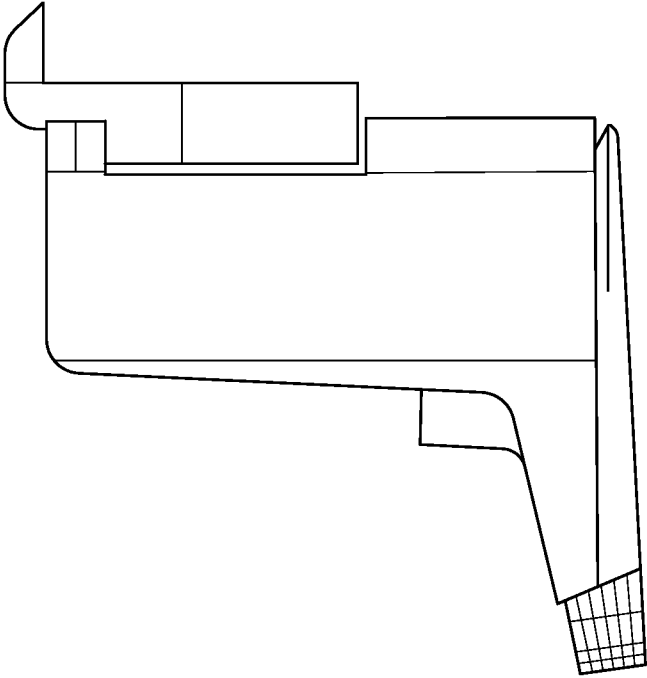
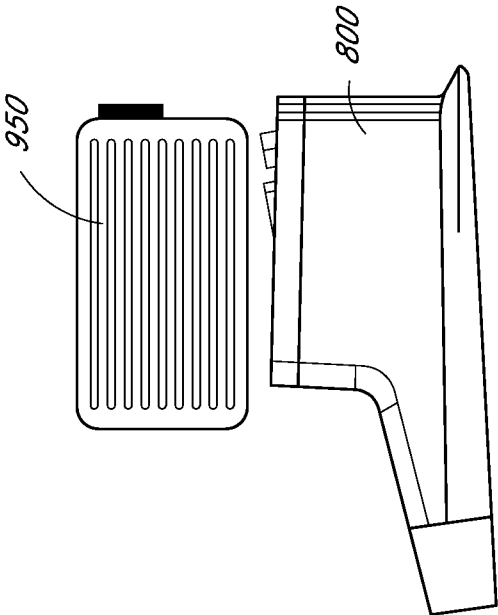


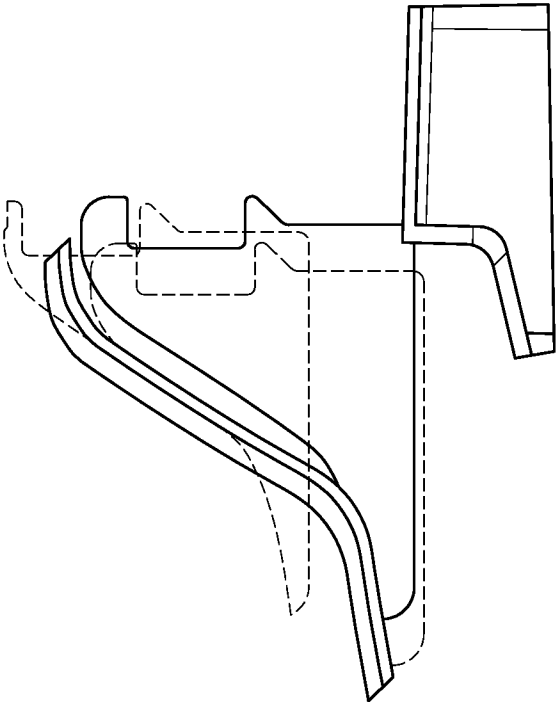
FIG. 35B



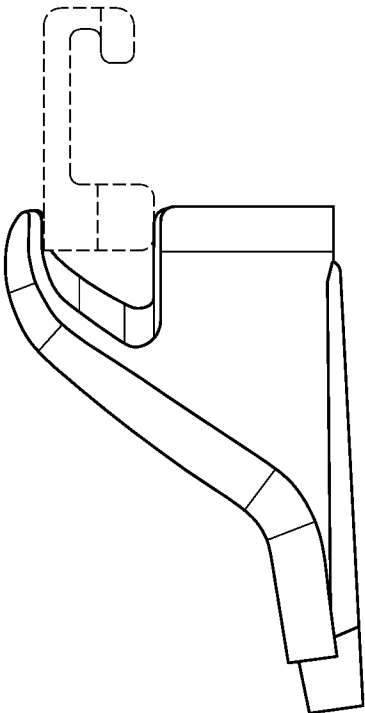
*FIG. 35D*



*FIG. 35C*



*FIG. 35F*



*FIG. 35E*

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2015/055598****A. CLASSIFICATION OF SUBJECT MATTER****B63H 11/08(2006.01)i, B63H 21/17(2006.01)i, B63B 35/73(2006.01)i**

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B63H 11/08; A63H 23/00; F02F 7/00; B63H 21/17; B63H 20/20; B63B 7/00; B60L 11/00; B63B 35/73

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: motorized cassette, watercraft, motor, drive shaft, belt drive, impeller, flow path

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                               | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2013-0059489 A1 (VLOCK et al.) 07 March 2013<br>See paragraphs [0006]-[0011], [0049]-[0054], [0080]-[0086], [0103]; claim 1; and figures 1-3, 5-6, 18, 20-21. | 26-30                 |
| A         |                                                                                                                                                                  | 1-25                  |
| A         | US 6223712 B1 (MONTGOMERY, ROBERT E.) 01 May 2001<br>See column 3, line 66 - column 5, line 38; and figures 1-3, 5.                                              | 1-30                  |
| A         | US 2004-0002282 A1 (LEE, KEUNG) 01 January 2004<br>See paragraphs [0011]-[0014], [0026]-[0032]; and figures 1-2, 6-7.                                            | 1-30                  |
| A         | US 2011-0201238 A1 (ROTT et al.) 18 August 2011<br>See paragraphs [0033]-[0041], [0054]-[0057]; and figures 1A-1B, 2, 5.                                         | 1-30                  |
| A         | WO 2014-150752 A2 (BOOMERBOARD, LLC.) 25 September 2014<br>See paragraphs [0059]-[0065]; and figures 21-22.                                                      | 1-30                  |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

31 December 2015 (31.12.2015)

Date of mailing of the international search report

**05 January 2016 (05.01.2016)**

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

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Authorized officer

RHEE, Jun Ho

Telephone No. +82-42-481-8288



**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2015/055598**

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                                                                                                                                                                                                       | Publication<br>date                                                                                                                                                                                                                        |
|-------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| US 2013-0059489 A1                        | 07/03/2013          | TW 201321260 A<br>US 2015-011133 A1<br>US 8851947 B2<br>US 9120547 B2<br>WO 2013-036536 A2<br>WO 2013-036536 A3                                                                                                                                                                                                  | 01/06/2013<br>08/01/2015<br>07/10/2014<br>01/09/2015<br>14/03/2013<br>12/12/2013                                                                                                                                                           |
| US 6223712 B1                             | 01/05/2001          | AU 1220901 A<br>AU 2001-12209 A1<br>AU 2001-12209 B2<br>EG 22311 A<br>EP 1226351 A1<br>EP 1226351 A4<br>HR 20000692 A2<br>HR 20000692 B1<br>JP 2003-512243 A<br>JP 3678702 B2<br>KR 10-2002-0060203 A<br>KR 20-0408563 Y1<br>PK 20000692 B1<br>TW 487781 A<br>TW 487781 B<br>WO 2001-029389 A1<br>ZA 200005803 A | 30/04/2001<br>30/04/2001<br>31/07/2003<br>31/12/2002<br>31/07/2002<br>06/04/2005<br>30/04/2002<br>30/06/2003<br>02/04/2003<br>03/08/2005<br>16/07/2002<br>17/11/2006<br>30/06/2003<br>21/05/2002<br>21/05/2002<br>26/04/2001<br>03/05/2001 |
| US 2004-0002282 A1                        | 01/01/2004          | US 6729931 B2                                                                                                                                                                                                                                                                                                    | 04/05/2004                                                                                                                                                                                                                                 |
| US 2011-0201238 A1                        | 18/08/2011          | WO 2011-100654 A2<br>WO 2011-100654 A3                                                                                                                                                                                                                                                                           | 18/08/2011<br>29/12/2011                                                                                                                                                                                                                   |
| WO 2014-150752 A2                         | 25/09/2014          | WO 2014-150752 A3                                                                                                                                                                                                                                                                                                | 29/10/2015                                                                                                                                                                                                                                 |