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(54) **EXTERNAL PAYLOAD CARRIER FOR UNDERWATER VEHICLE**

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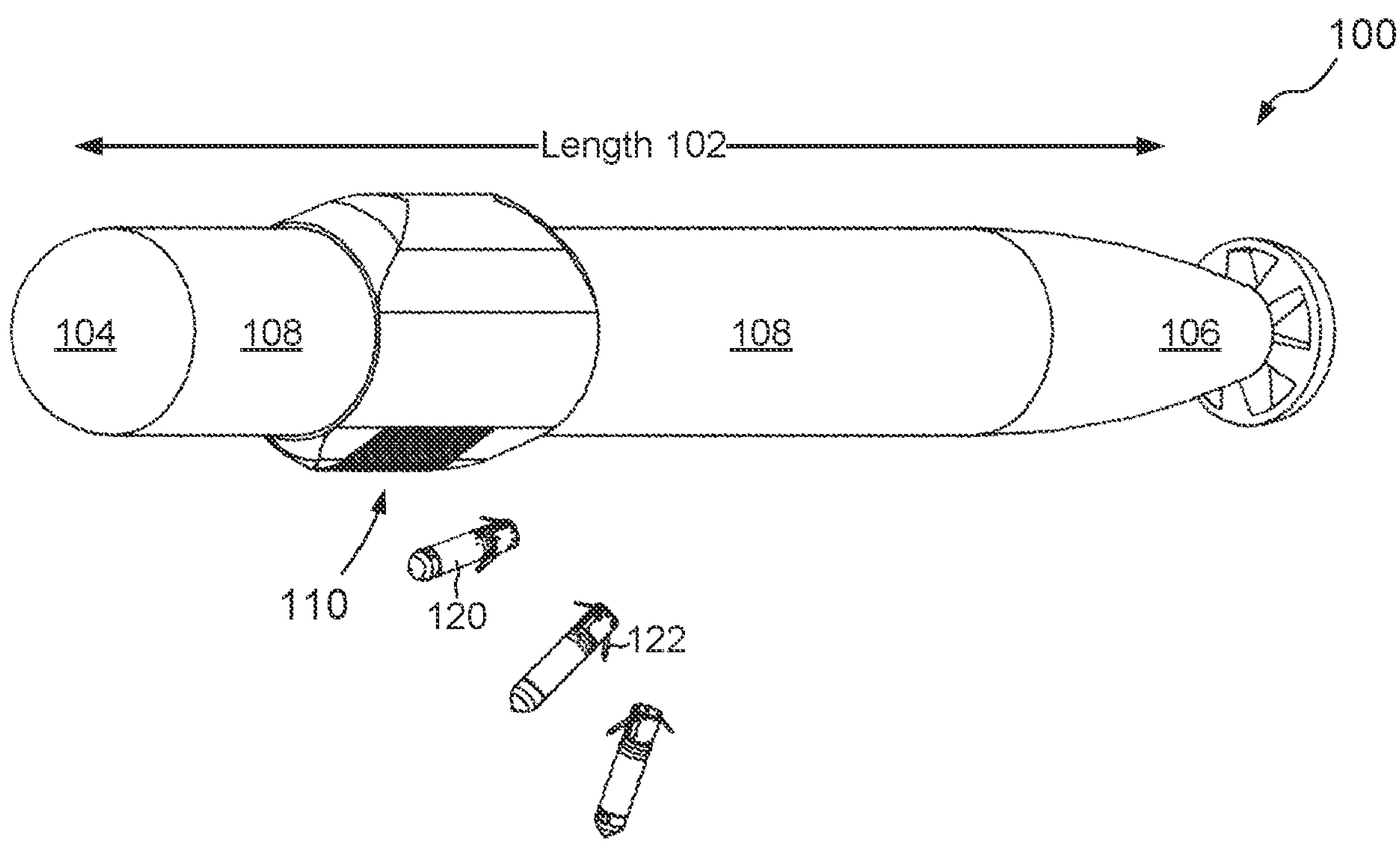
(57) **ABSTRACT**

A technique for carrying a payload by a UUV includes providing a structure that extends around an outer surface of the UUV along a length of the UUV. The structure has an outer membrane that forms a streamlined shape around the UUV and contains the payload.



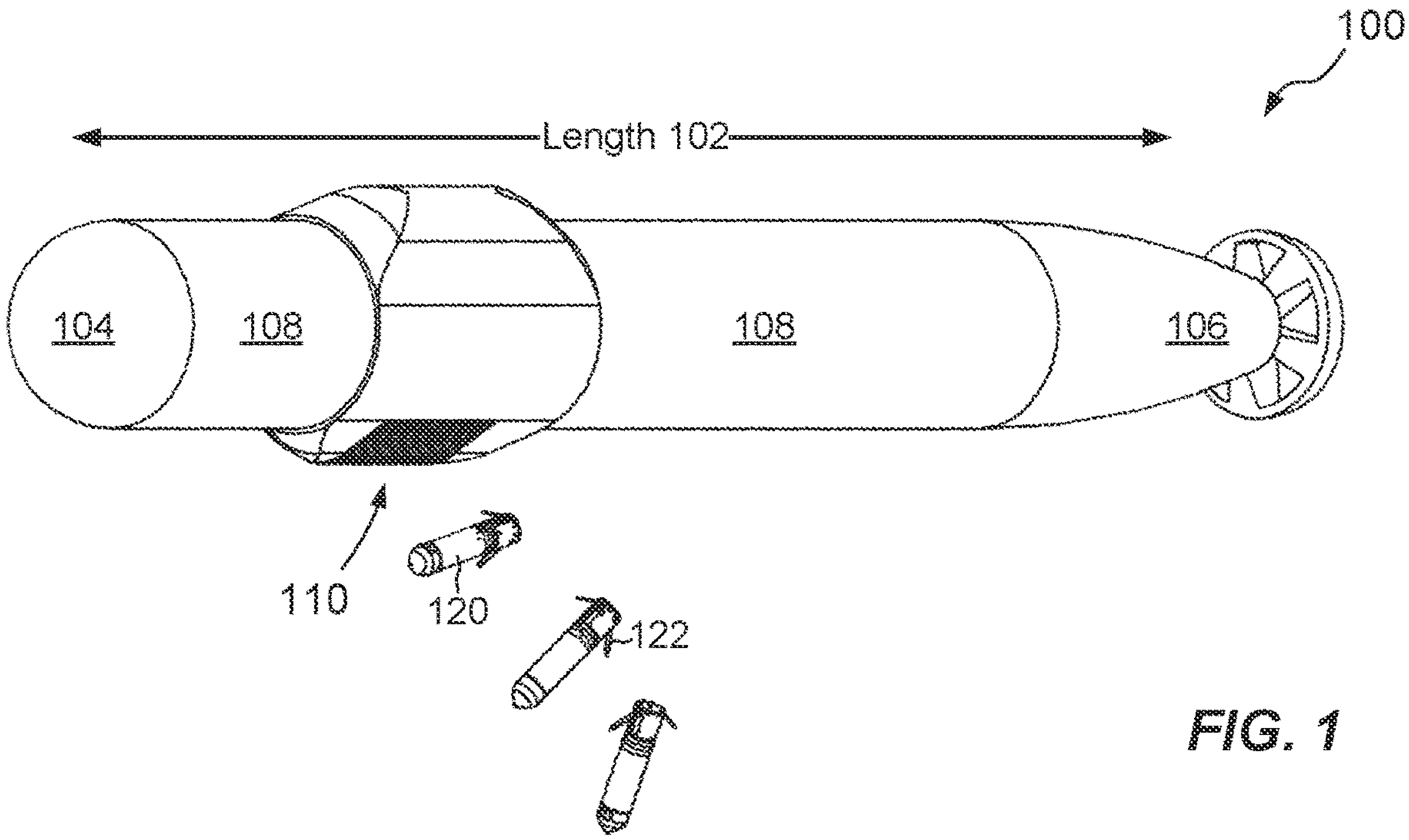

100
Length 102
104
108
108
106
110
120
122

FIG. 1

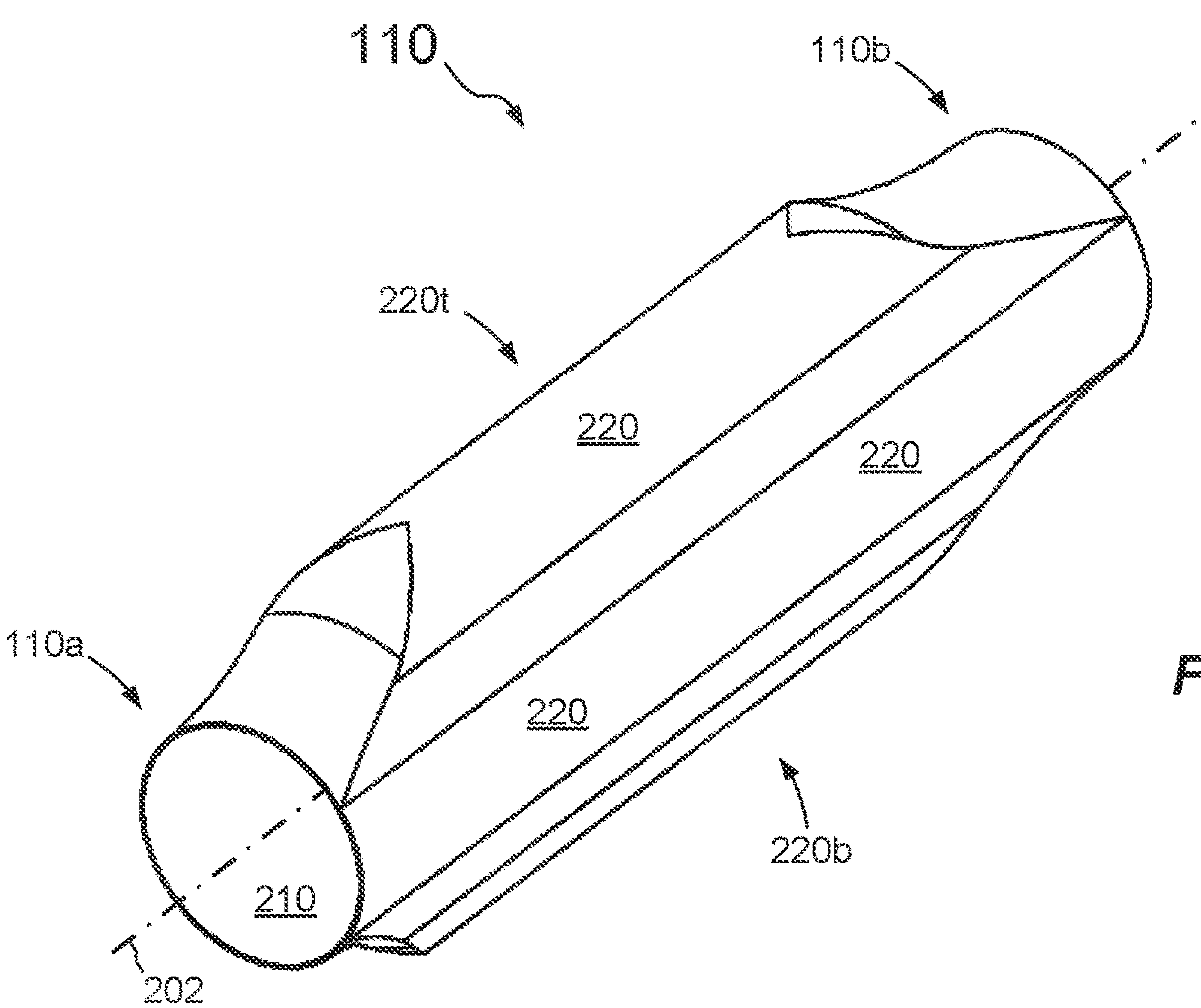

110
110b
220t
220
220
220
110a
210
202
220b

FIG. 2

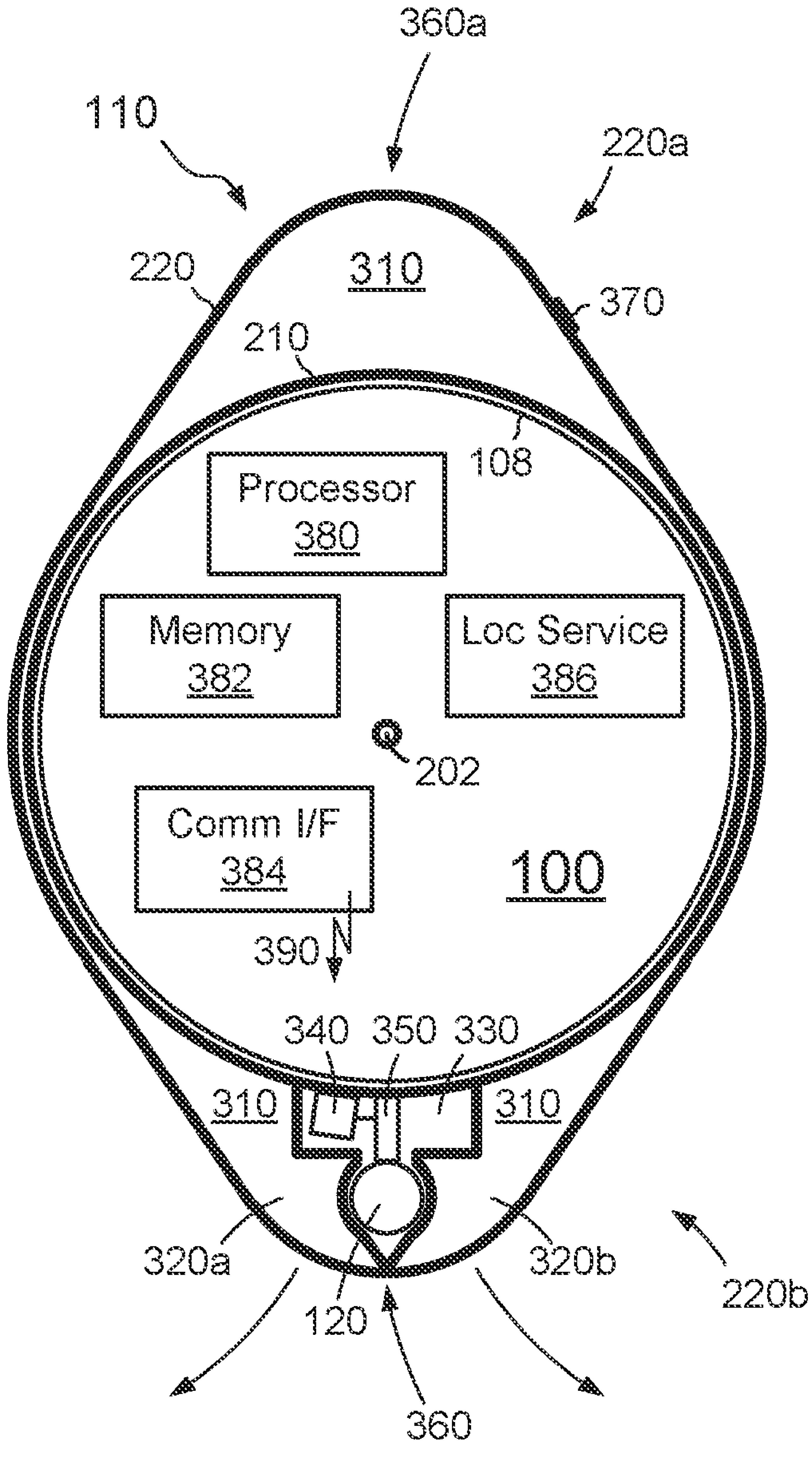

360a
110
220a
310
220
370
210
108
Processor
380
Memory
382
Loc Service
386
202
Comm I/F
384
100
390
340
350
330
310
310
320a
320b
220b
120
360

FIG. 3

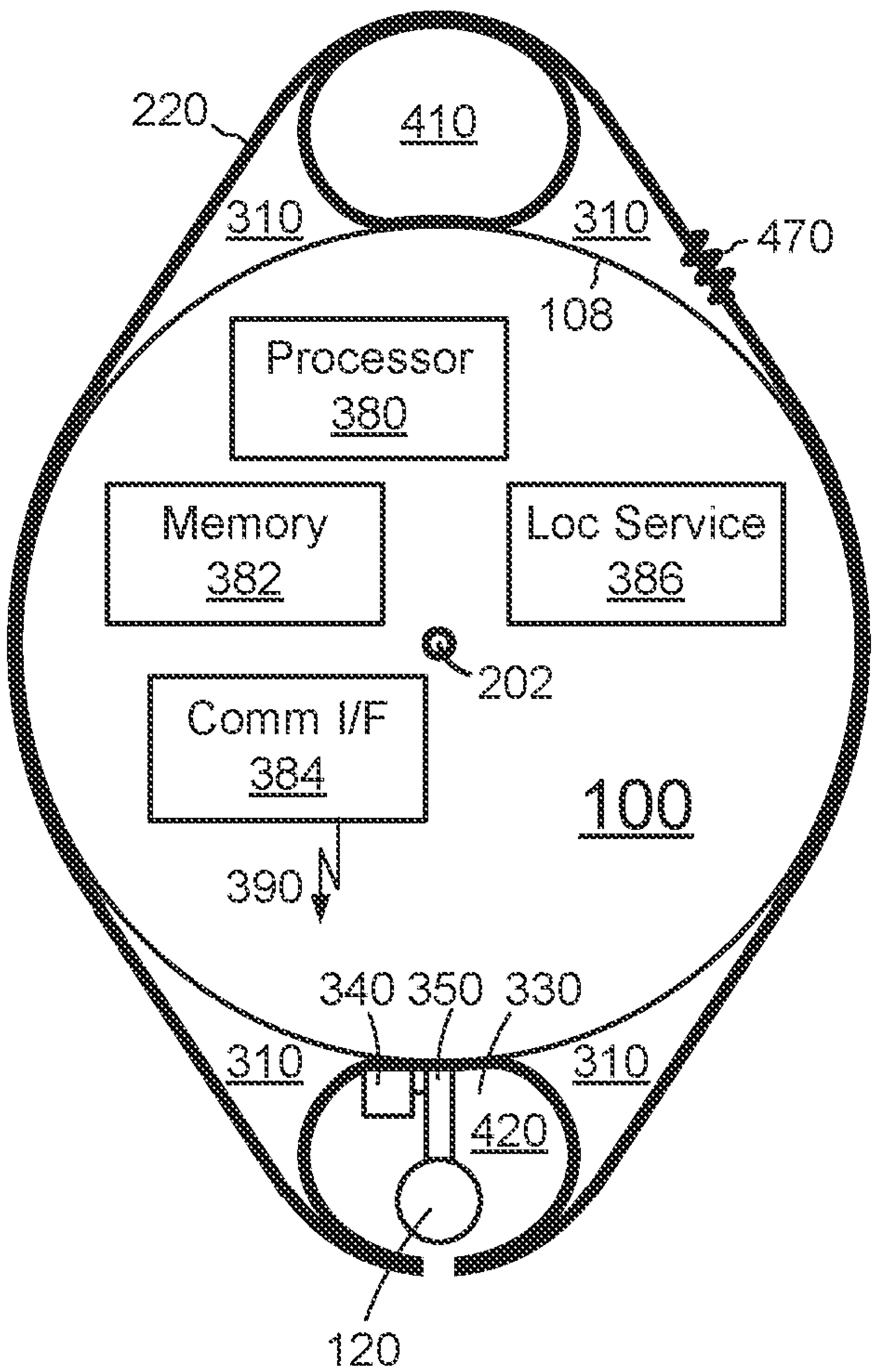

220
410
310
310
470
108
Processor
380
Memory
382
Loc Service
386
202
Comm I/F
384
100
390
340 350 330
310
310
420
120

FIG. 4

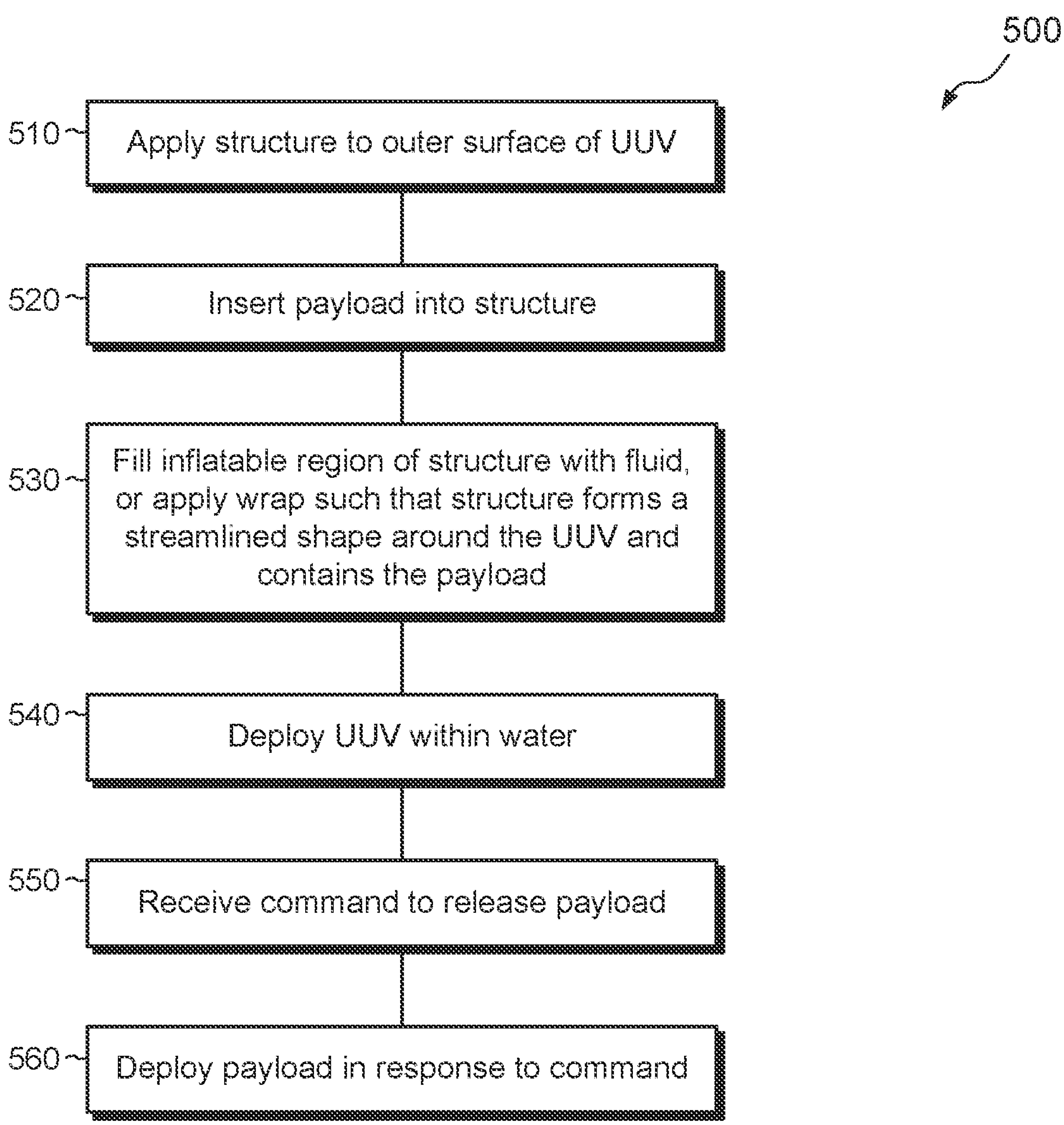

500
510
Apply structure to outer surface of UUV
520
Insert payload into structure
530
Fill inflatable region of structure with fluid, or apply wrap such that structure forms a streamlined shape around the UUV and contains the payload
540
Deploy UUV within water
550
Receive command to release payload
560
Deploy payload in response to command

FIG. 5

EXTERNAL PAYLOAD CARRIER FOR UNDERWATER VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/422,236, filed Nov. 3, 2022, the contents and teachings of which are incorporated herein by reference in their entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] This invention was made with government support under contract number N68335 22 C 0036 with the Office of Naval Research for the U.S. Navy. The government has certain rights in the invention.

BACKGROUND

[0003] UUVs (unmanned underwater vehicles) are commonly used for exploring and monitoring underwater environments and for carrying payloads to underwater locations. A typical UUV includes sensors and a location service, such as GPS (Global Positioning Service) and/or DVL (Doppler Velocity Log). Typical payloads include sensors, munitions, and other cargo.

SUMMARY

[0004] Unfortunately, adapting UUVs for carrying various payloads can be engineering-intensive and mission-specific. Indeed, different sizes or configurations of payloads may require different UUV designs, which may involve constructing modifications for inserting payloads into a main body of a UUV. Some have attempted to attach payloads to external UUV surfaces, e.g., using straps or bungee cords, but doing so introduces a host of design issues, including impaired hydrodynamics and imbalanced drag characteristics. What is needed, therefore, is a more versatile approach for carrying payloads by a UUV that is general purpose and does not impair mobility.

[0005] The above need is addressed at least in part by an improved technique for carrying a payload by a UUV. The technique includes providing a structure that extends around an outer surface of the UUV along a length of the UUV. The structure has an outer membrane that forms a streamlined shape around the UUV and contains the payload.

[0006] Advantageously, the structure can be engineered once for accommodating a variety of payloads of different sizes and shapes. The streamlined shape of the outer membrane ensures consistent and efficient hydrodynamic performance even as payloads are changed. Little or no design or engineering expertise is required of operators for provisioning a UUV with a wide range of payloads.

[0007] Certain embodiments are directed to a structure for carrying payloads of a UUV (unmanned underwater vehicle). The structure includes an outer membrane constructed and arranged to (i) extend around an outer surface of the UUV along a length of the UUV, (ii) contain a payload, and (iii) form a streamlined shape around the UUV.

[0008] In some examples, the outer membrane includes a tensioned wrap that extends around the payload on one side of the UUV and around a spacer on an opposite side of the UUV.

[0009] In some examples, the streamlined shape is symmetrical about at least one plane.

[0010] In some examples, the outer membrane is constructed and arranged to form the streamlined shape when an enclosed region between the UUV and the outer membrane is inflated with fluid.

[0011] In some examples, the streamlined shape of the outer membrane when inflated with the fluid is tapered toward the UUV at first and second ends of the outer membrane.

[0012] In some examples, the outer membrane is constructed and arranged to assume a predetermined shape when the enclosed region is inflated with the fluid.

[0013] In some examples, the outer membrane is composed of multiple panels stitched or otherwise fused together.

[0014] In some examples, the structure further includes an inner membrane constructed and arranged to conform to the outer surface of the UUV, the enclosed region being disposed between the inner membrane and the outer membrane.

[0015] In some examples, the inner membrane forms a water-impermeable seal with the outer membrane at the first and second ends of the outer membrane.

[0016] In some examples, the inner membrane and the outer membrane form a watertight container that surrounds the enclosed region.

[0017] In some examples, the outer membrane when inflated with the fluid forms an interior space arranged to contain the payload, and the interior space has an opening through which the payload can controllably be ejected into surrounding water.

[0018] In some examples, the outer membrane is folded in on itself to form the opening of the interior space. The opening is normally closed to contain the payload and to provide a continuous outer surface of the structure directly outside the interior space.

[0019] In some examples, the continuous outer surface is symmetrical with an outer surface of the outer membrane on a diametrically opposite side of the structure.

[0020] In some examples, the structure further includes an actuator constructed and arranged to eject the payload through the opening.

[0021] In some examples, the actuator is constructed and arranged to eject the payload at a velocity sufficient to enable control surfaces of the payload to influence a path of the payload through the surrounding water.

[0022] In some examples, the structure further includes a communications interface constructed and arranged to communicate with the UUV and to eject the payload through the opening in response to a command from the UUV.

[0023] In some examples, the structure has a tunable buoyancy.

[0024] Other embodiments are directed to an apparatus that includes a UUV (unmanned underwater vehicle) having a length and an outer surface, and a structure applied around the outer surface along at least a portion of the length, the structure including an outer membrane constructed and arranged to (i) extend around an outer surface of the UUV along a length of the UUV, (ii) contain a payload, and (iii) form a streamlined shape around the UUV.

[0025] Still other embodiments are directed to a method of carrying and/or deploying external payloads by a UUV (unmanned underwater vehicle). The method includes applying a structure around an outer surface of the UUV, the structure including an outer membrane constructed and arranged (i) to extend around an outer surface of the UUV along a length of the UUV and (ii) to form a streamlined shape around the UUV. The method further includes inserting a payload into the structure and filling the inflatable region with fluid such that the structure forms a streamlined shape around the UUV and contains the payload.

[0026] In some examples, the method further includes deploying the UUV within a body of water, receiving, by a communications interface within the structure, a command from the UUV to release the payload, and releasing the payload in response to the command. Releasing the payload in response to the command is responsive to determining a time at which to release the payload based on a current location of the UUV within the body of water and a location of a desired target.

[0027] The foregoing summary is presented for illustrative purposes to assist the reader in readily grasping example features presented herein; however, this summary is not intended to set forth required elements or to limit embodiments hereof in any way. One should appreciate that the above-described features can be combined in any manner that makes technological sense, and that all such combinations are intended to be disclosed herein, regardless of whether such combinations are identified explicitly or not.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0028] The foregoing and other features and advantages will be apparent from the following description of particular embodiments, as illustrated in the accompanying drawings, in which like reference characters refer to the same or similar parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of various embodiments.

[0029] FIG. **1** is a front-side view of an example UUV having a structure for carrying an external payload.

[0030] FIG. **2** is a top-left perspective view of an example structure of FIG. **1**.

[0031] FIG. **3** is a cross-sectional view of a UUV and structure according to a first embodiment.

[0032] FIG. **4** is a cross-sectional view of a UUV and structure according to a second embodiment.

[0033] FIG. **5** is a flowchart showing an example method of carrying and/or deploying external payloads by a UUV.

DETAILED DESCRIPTION

[0034] Embodiments of the improved technique will now be described. One should appreciate that such embodiments are provided by way of example to illustrate certain features and principles but are not intended to be limiting.

[0035] An improved technique for carrying a payload by a UUV (unmanned underwater vehicle) includes providing a structure that extends around an outer surface of the UUV along a length of the UUV. The structure has an outer membrane that forms a streamlined shape around the UUV and contains the payload.

[0036] FIG. **1** shows an example UUV **100** with which embodiments of the improved technique can be practiced. Here, the depicted UUV **100** has a length **102**, a nose **104**, and a tail **106**. A propeller may be mounted to the tail **106**. The depicted UUV **100** has a substantially cylindrical shape, which is defined by an outer surface **108**. One should appreciate that UUV designs can vary, however. Some may have different shapes from the one shown, and some may have tail fins. The illustrated UUV **100** is merely an example.

[0037] As further shown in FIG. **1**, a structure **110** is applied to the UUV **100** around the outer surface **108**. The structure **110** is constructed and arranged to contain a payload **120**. FIG. **1** shows an example cylindrical payload **120** in three states of deployment from the UUV **100**. The depicted payload **120** may have one or more control surfaces **122** to guide it through water along a controlled, predictable path. The payload **120** may have any shape and features, however, and it may have a range of sizes and masses. Although the depicted payload is deployable from the structure **110**, other payloads may be non-deployable, e.g., certain payloads may be designed to remain within the structure **110**.

[0038] The structure **110** may be placed at any desired location along the length **102** of the UUV **110**. Structures **110** that are larger or smaller than the one shown may be provided, and multiple structures may be applied at different locations along the length **102**. Preferably, the structure **110** is placed such that it does not interfere with sensors within the UUV **100**. The structure **110** is further placed such that it has a minimal impact on mobility and maneuverability of the UUV **100**, e.g., by placing the structure **110** near a center of mass of the UUV **100**.

[0039] Preferably, the structure **110** is streamlined to promote efficient hydrodynamics and to minimize drag. The structure **110** preferably has uniform drag characteristics, so that the UUV **100** does not veer in any direction when under way. The structure **110** also preferably has a defined, stable external shape, which is maintained at all expected speeds through water. Ideally, the structure **110** has minimal impact on the handling and control characteristics of the UUV **100**. For example, a control system of the UUV **100** may require few if any modifications for accommodating the structure **110**. If the control system does require modifications, such modifications would need to be made only once for use with a particular structure **110** (assuming the location of the structure **110** does not change), even if payloads of different sizes and/or shapes are provided. The structure **110** preferably has controllable initial buoyancy, which may be adjusted, for example, through the use of floats or ballasts, and/or by filling internal spaces of the structure **110** with various fluids, such as with water of different salinities.

[0040] FIG. **2** shows an example structure **110** in additional detail. The illustrated structure **110** has an outer membrane **220** having a defined shape. The outer membrane **220** has a first end **110*a*** and a second end **110*b***, as well as a top **220*t*** and a bottom **220*b***. The outer membrane **220** is sized and arranged to fit against the outer surface **108** of a UUV at the first end **110*a*** and the second end **110*b***. Although the first end **110*a*** and the second end **110*b*** are described as ends of the outer membrane **220**, one can see that they also identify respective ends of the structure **110** overall.

[0041] The outer membrane **220** has a streamlined shape, which tapers down at the ends **110*a*** and **110*b*** and bulges out from a central axis **202** in the middle. In some examples, the bulging can be tuned to optimize drag, size, length, volume, shape, and/or mass characteristics. In an example, a space within the bottom region **220*b*** contains a payload **120**, and an opposite space within the top region **220*t*** contains a spacer or other material, which in some examples may be fluid. Preferably, the top and bottom regions **220*t*** and **220*b*** are symmetrically shaped, such that they induce equal drag and keep the overall drag forces of the structure **110** coincident with the central axis **202**. In some examples, the outer membrane is composed of multiple panels, which may be stitched or otherwise fused together. The upper spacer within the top region **220*t*** is not required in some embodiments, as the carrier UUV may have the ability to accommodate a non-symmetric addition of volume and drag surfaces, or a given payload might not require it for balancing hydrodynamic loads.

[0042] Some embodiments may further include an inner membrane **210**, which is constructed and arranged to conform to the outer surface **108** of a UUV and to be held tightly against the surface **108** by friction. In such examples, the inner membrane **210** may be joined with the outer membrane **220** at the first and second ends **110*a*** and **110*b***.

[0043] The example of FIG. **2** is intended to be applicable to the embodiments shown in both FIGS. **3** and **4**. Those embodiments and their similarities and differences will now be explained.

[0044] FIG. **3** shows a first embodiment of an example structure **110** applied around an example UUV **100**. In this cross-sectional view, the structure **110** includes both an inner membrane **210** and an outer membrane **220**. The inner membrane **210** extends around the outer surface **108** of the UUV **100**, where the inner membrane **210** is held in place by friction. Alternatively, a positive attachment may be provided. Friction has been found to be sufficient, however, for maintaining location and orientation of the structure on the UUV outer surface **108**. The outer membrane **220** extends around the inner membrane **210**. No direct attachment can be seen between the inner membrane **210** and the outer membrane **220**, but the two membranes are fused together at the ends **110*a*** and **110*b*** (FIG. **2**). An enclosed region **310** is formed between the inner membrane **210** and the outer membrane **220**.

[0045] In this embodiment, the inner membrane **210** is composed of a liquid-impermeable material, which may be flexible. The outer membrane **220** is also composed of a liquid impermeable material, which may be flexible, but it is also preferably inextensible, such that it does not stretch under expected pressures. Examples of suitable materials for both membranes may include polyester sheets, rubber-infiltrated fabrics, and the like.

[0046] In this embodiment, the enclosed region **310** provides a liquid-tight container between the first membrane **210** and the second membrane **220**, and the container formed by the enclosed region **310** may be filled with fluid. For example, fluid may be pumped from an external source via a fluid coupling **370**. The fluid may be gas or liquid, such as water. Water of a particular salinity may be chosen for providing a desired level of buoyancy. In some examples, the fluid may simply be seawater pumped into the enclosed region **310** prior to launch.

[0047] As can be seen, the fluid can flow completely around the UUV **100**, equalizing pressure in all contained regions. Provided that all air has been evacuated, the structure once filled with liquid becomes incompressible and can withstand substantial depths in water. Preferably, sufficient pressure is achieved to inflate the outer membrane **220**, such that it assumes the predefined shape (e.g., FIG. **2**) and maintains that shape under varying conditions and at speed. The applied pressure also pushes the inner membrane **210** firmly against the outer surface **108** of the UUV, strengthening the frictional engagement.

[0048] As further shown, the outer membrane **220** has a top region **220*a*** and a bottom region **220*b***. The bottom region **220*b*** includes a payload **120** and associated componentry. The top region **220*a*** is empty in this example, but alternative arrangements could include a spacer and/or ballast in this region. In further arrangements, asymmetry is permitted and the top region **220*a*** conforms to the inner membrane **210** (no space is provided).

[0049] Looking at the bottom of FIG. **3**, an example mechanism is shown for containing and selectively deploying the payload **120**. Here, the bottom **220*b*** of the outer membrane **220** is split into first and second jaws, **320*a*** and **320*b***. The jaws **320*a*** and **320*b*** are normally closed, such that a bottom surface **360** of the structure **110** is closed and continuous. For example, the bottom surface **360** has substantially the same shape as a diametrically opposite top surface **360*a***, which is a continuous material that is not able to open. The first and second jaws **320*a*** and **320*b*** define an interior space **330**, which contains the payload **120** and the associated componentry.

[0050] In the example shown, an actuator **350** is configured to eject the payload **120** from the structure **110**. For example, the actuator **350** pushes down on the payload **120**, causing the jaws **320*a*** and **320*b*** to open and causing the payload **120** to pass through. Once the payload **120** has exited through the opening formed between the opposing jaws **320*a*** and **320*b***, the jaws close back to their original positions, shutting the opening and restoring the original shape.

[0051] In some examples, the actuator **350** ejects the payload **120** at a velocity and trajectory sufficient to enable control surfaces **122** (FIG. **1**) of the payload **120** to influence a path of the payload **120** through the surrounding water. This feature helps to prevent the payload **120** from bumping into tail fins or propellers of the UUV **100**. It also promotes a predictable descent of the payload **120** through the surrounding water, which can be useful if the payload **120** is intended to intersect a desired target or location.

[0052] In some examples, the actuator **350** operates in response to a command **390** issued by the UUV **100**. To this end, the UUV **100** may include electronic control circuitry, such as a processor **380**, memory **382**, a wireless communications interface **384**, and location services **386**, such as GPS and/or DVL. The UUV **100** may operate its control circuitry to time the deployment of the payload **120**. For example, the memory **382** may store a program which, when executed by the processor **380**, calculates a time and location at which to drop the payload **120**. The program may base its determination of time and location on the current location of the UUV **100** (e.g., latitude, longitude, and depth) and on a known location of a desired target. When the determined time for dropping the payload **120** arrives, the processor **380** directs the communications interface **384** to send the command **390**. The command **390** travels a short distance and is received by a communications interface **340** within the structure **110**, e.g., within the interior space **330**. Preferably, the communications interface **340** is placed close to the inner membrane **210**, such that there is little water or other fluid between the two interfaces **384** and **340** that could attenuate the wireless signal. It is noted that this use of wireless communications between the UUV **100** and the interface **340** avoids the need to pass cables through the wall of the UUV or through the membranes.

[0053] Although not shown, a power source (e.g., a battery), is assumed to be present for powering the interface **340**. The actuator **350** may also require power. In some examples, the actuator **350** is spring-loaded. For instance, an operator loading the payload **120** may compress a spring of the actuator **350** and engage a latch, such that the payload **120** can be ejected with significant force just by releasing the latch and allowing the spring to expand.

[0054] One should appreciate that various mechanisms for containing and releasing payloads are contemplated. Thus, the example shown is intended to be illustrative rather than limiting.

[0055] FIG. **4** shows a second embodiment of an example structure **110** applied around an example UUV **100**. In the cross-sectional view of FIG. **4**, the structure **110** includes an outer membrane **220** but no inner membrane **210**. Rather than holding its shape based on fluid pressure, as in FIG. **3**, the outer membrane **220** of FIG. **4** holds its shape based on tension. The tension may be applied by one or more springs, which may be provided along a seam **470**. Additionally or alternatively, the material from which the outer membrane **220** is composed may itself have an elastic character. In this example, the outer membrane **220** may be provided as a sheet that may be wrapped around the UUV, with the two ends of the sheet fastened together at the seam **470**. There is no need in this embodiment for the outer membrane **220** to be liquid-impermeable.

[0056] In this arrangement, the defined shape of the outer membrane **220** is maintained using spacers **410** and **420**, such as bladders, foam, or other components or materials. If bladders are used, such bladders may be filled with fluid, such as water, air or any other liquid or gas, or any combination of liquids and/or gases as needed to establish desired buoyancy and compression resistance. Deployment of a payload **120** may proceed similarly to that described in connection with FIG. **3** above.

[0057] FIG. **5** shows an example method **500** of carrying and/or deploying external payloads by a UUV **100**. The method **500** may be performed, for example, by a human operator of the UUV (or a robot, machine, etc.), by a remote operator, by the UUV, and/or by the structure **110** itself. Although the acts of method **500** are shown as occurring in a certain order, that order is presented herein as an example and may be varied.

[0058] At **510**, a structure **110** is applied to the outer surface **108** of the UUV **100**. With the embodiment of FIG. **3**, the structure **110** may be applied over the nose **114** of the UUV **110** and slid partway down the length **102** of the UUV **100** to a desired location, which is preferably clear of any sensors or control surfaces, and which does not excessively disrupt the maneuverability of the UUV **100**. With the embodiment of FIG. **4**, the structure **110** may be applied by wrapping the outer membrane **220** around the UUV **100** at a desired location along the length **102**, inserting the spacers **410** and **420** if needed, and closing a seam **470** that joins the two ends of the membrane **220** together. The seam **470** may be tied, zippered, or fastened in any suitable way.

[0059] At **520**, a payload **120** may be inserted into the structure **110**. For example, a payload **120** may be slid into the interior region **330** from an end of the structure **110** and pushed forward to a desired position. If a spring-loaded actuator **350** is used, the spring may be compressed such that the actuator **350** becomes armed. Alternatively, the payload **120** may be inserted during step **510**, or at a later time.

[0060] Step **530** applies only to the FIG. **3** embodiment. Here, the enclosed region **320** is inflated with fluid, pressurizing the outer membrane **220** and pushing the inner membrane **210** against the outer surface **108** of the UUV **100**. The outer membrane **220** thus assumes the predefined shape. Pressurizing fluid may be obtained from seawater at the launch site, or it may be provided from other sources.

[0061] At **540**, with the structure **110** applied (and pressurized, if needed) and the payload **120** inserted, the UUV **100** is deployed in the water at the launch site. The UUV **100** then proceeds through the water on its mission. One should appreciate that the UUV may be deployed from shore, from a ship at sea, from a submarine, or from any other location.

[0062] At **550**, the structure **110** receives a command to release the payload **120**. For example, the UUV **100** may compute a time and location for dropping the payload **120**. When the time arrives at the determined location, the UUV **110** issues a command **390** via the wireless interface **384**. The interface **340** within the structure **110** then receives the command **390**.

[0063] At **360**, in response to the command **390**, the structure **110** and triggers or otherwise activates the actuator **350**, causing the actuator **350** to force the payload **120** out of the structure **110** and along a descent path.

[0064] An improved technique has been described for carrying a payload **120** by a UUV **100**. The technique includes providing a structure **110** that extends around an outer surface **108** of the UUV along a length **102** of the UUV. The structure has an outer membrane **220** that forms a streamlined shape around the UUV **100** and contains the payload **120**.

[0065] Advantageously, the structure **110** can be engineered once for accommodating a variety of payloads **120** of different sizes and shapes. The streamlined shape of the outer membrane **220** ensures consistent and efficient hydrodynamic performance even as payloads **120** are changed. Little or no design or engineering expertise is required of operators for provisioning a UUV **100** with a wide range of payloads.

[0066] Having described certain embodiments, numerous alternative embodiments or variations can be made. For example, although the FIG. **3** embodiment uses both an inner membrane **210** and an outer membrane **220**, some variants of this embodiment may dispense with the inner membrane **210**. For example, the outer membrane **220** may be adhered to the outer surface **108** of the UUV **100** at the first and second ends **110***a* and **110***b*, effectively forming a sealed compartment bounded from below by the UUV and bounded from above by the second membrane **220**.

[0067] Further, although features have been shown and described with reference to particular embodiments hereof, such features may be included and hereby are included in any of the disclosed embodiments and their variants. Thus, it is understood that features disclosed in connection with any embodiment are included in any other embodiment.

[0068] As used throughout this document, the words “comprising,” “including,” “containing,” and “having” are intended to set forth certain items, steps, elements, or aspects of something in an open-ended fashion. Also, as used herein and unless a specific statement is made to the contrary, the word “set” means one or more of something. This is the case regardless of whether the phrase “set of” is followed by a singular or plural object and regardless of whether it is conjugated with a singular or plural verb. Also, a “set of” elements can describe fewer than all elements present. Thus, there may be additional elements of the same kind that are not part of the set. Further, ordinal expressions, such as “first,” “second,” “third,” and so on, may be used as adjectives herein for identification purposes. Unless specifically indicated, these ordinal expressions are not intended to imply any ordering or sequence. Thus, for example, a “second” event may take place before or after a “first event,” or even if no first event ever occurs. In addition, an identification herein of a particular element, feature, or act as being a “first” such element, feature, or act should not be construed as requiring that there must also be a “second” or other such element, feature or act. Rather, the “first” item may be the only one. Also, and unless specifically stated to the contrary, “based on” is intended to be nonexclusive. Thus, “based on” should be interpreted as meaning “based at least in part on” unless specifically indicated otherwise. Although certain embodiments are disclosed herein, it is understood that these are provided by way of example only and should not be construed as limiting.

[0069] Those skilled in the art will therefore understand that various changes in form and detail may be made to the embodiments disclosed herein without departing from the scope of the following claims.

What is claimed is:

1. A structure for carrying payloads of a UUV (unmanned underwater vehicle), comprising:

an outer membrane constructed and arranged to (i) extend around an outer surface of the UUV along a length of the UUV, (ii) contain a payload, and (iii) form a streamlined shape around the UUV.

2. The structure of claim **1**, wherein the outer membrane includes a tensioned wrap that extends around the payload on one side of the UUV and around a spacer on an opposite side of the UUV.

3. The structure of claim **1**, wherein the streamlined shape is symmetrical about at least one plane.

4. The structure of claim **1**, wherein the outer membrane is constructed and arranged to form the streamlined shape when an enclosed region between the UUV and the outer membrane is inflated with fluid.

5. The structure of claim **4**, wherein the streamlined shape of the outer membrane when inflated with the fluid is tapered toward the UUV at first and second ends of the outer membrane.

6. The structure of claim **4**, wherein the outer membrane is constructed and arranged to assume a predetermined shape when the enclosed region is inflated with the fluid.

7. The structure of claim **6**, wherein the outer membrane is composed of multiple panels stitched or otherwise fused together.

8. The structure of claim **6**, further comprising an inner membrane constructed and arranged to conform to the outer surface of the UUV, the enclosed region being disposed between the inner membrane and the outer membrane.

9. The structure of claim **8**, wherein the inner membrane forms a water-impermeable seal with the outer membrane at the first and second ends of the outer membrane.

10. The structure of claim **8**, wherein the inner membrane and the outer membrane form a watertight container that surrounds the enclosed region.

11. The structure of claim **8**, wherein the outer membrane when inflated with the fluid forms an interior space arranged to contain the payload, the interior space having an opening through which the payload can controllably be ejected into surrounding water.

12. The structure of claim **11**, wherein the outer membrane is folded in on itself to form the opening of the interior space, the opening normally being closed to contain the payload and to provide a continuous outer surface of the structure directly outside the interior space.

13. The structure of claim **12**, wherein the continuous outer surface is symmetrical with an outer surface of the outer membrane on a diametrically opposite side of the structure.

14. The structure of claim **11**, further comprising an actuator constructed and arranged to eject the payload through the opening.

15. The structure of claim **14**, wherein the actuator is constructed and arranged to eject the payload at a velocity sufficient to enable control surfaces of the payload to influence a path of the payload through the surrounding water.

16. The structure of claim **11**, further comprising a communications interface constructed and arranged to communicate with the UUV and to eject the payload through the opening in response to a command from the UUV.

17. The structure of claim **1** wherein the structure has a tunable buoyancy.

18. An apparatus, comprising:

a UUV (unmanned underwater vehicle) having a length and an outer surface; and

a structure applied around the outer surface along at least a portion of the length, the structure including an outer membrane constructed and arranged to (i) extend around an outer surface of the UUV along a length of the UUV, (ii) contain a payload, and (iii) form a streamlined shape around the UUV.

19. A method of carrying and/or deploying external payloads by a UUV (unmanned underwater vehicle), comprising:

applying a structure around an outer surface of the UUV, the structure including an outer membrane constructed and arranged (i) to extend around an outer surface of the UUV along a length of the UUV and (ii) to form a streamlined shape around the UUV;

inserting a payload into the structure; and

filling the inflatable region with fluid such that the structure forms a streamlined shape around the UUV and contains the payload.

20. The method of claim **19**, further comprising:

deploying the UUV within a body of water;

receiving, by a communications interface within the structure, a command from the UUV to release the payload; and

releasing the payload in response to the command,

wherein releasing the payload in response to the command is responsive to determining a time at which to release the payload based on a current location of the UUV within the body of water and a location of a desired target.

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