



US005698817A

United States Patent [19]

Hillenbrand

[11] Patent Number: **5,698,817**

[45] Date of Patent: **Dec. 16, 1997**

[54] **UNMANNED UNDERSEA WEAPON DEPLOYMENT STRUCTURE WITH CYLINDRICAL PAYLOAD DEPLOYMENT SYSTEM**

[75] Inventor: **Christopher F. Hillenbrand, Bristol, R.I.**

[73] Assignee: **The United States of America as represented by the Secretary of the Navy, Washington, D.C.**

[21] Appl. No.: **540,613**

[22] Filed: **Oct. 11, 1995**

[51] Int. Cl.⁶ **B63G 8/28**

[52] U.S. Cl. **114/212; 114/317; 89/1.809**

[58] **Field of Search** **114/21.2, 312, 114/316, 317, 318; 89/1.809, 1.81; 244/3.12; 342/54, 357**

[56] **References Cited**

U.S. PATENT DOCUMENTS

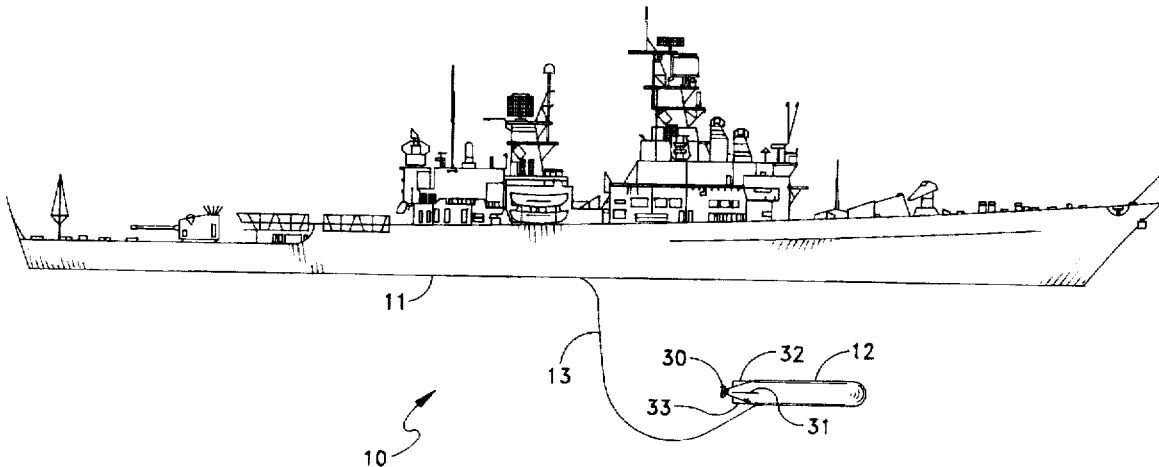
3,499,364	3/1970	D'Ooge	89/1.81
4,455,917	6/1984	Shook	89/1.817
5,076,192	12/1991	Tegel et al.	114/316
5,163,379	11/1992	Chorley	114/317
5,267,220	11/1993	Burt	367/131
5,310,134	5/1994	Hsu et al.	244/3.12
5,448,941	9/1995	Godfrey et al.	89/1.809

Primary Examiner—Charles T. Jordan
Assistant Examiner—Matthew J. Lattig
Attorney, Agent, or Firm—Michael J. McGowan; Michael F. Oglo; Prithvi C. Lall

[57] **ABSTRACT**

An unmanned undersea vehicle system includes a remote-controlled, unmanned undersea vehicle and a mother vehicle interconnected by a communication link. The unmanned undersea vehicle includes a weapon compartment and a control element. Within the weapon compartment are a plurality of weapon deployment devices situated about a central core, each weapon deployment device having a weapon canister for carrying a weapon. The weapon deployment devices are pivotable between a retracted position and an extended position. Each weapon canister includes end caps at opposing ends which are discharged when the weapon contained therein is fired to allow seawater to enter. The control element controls pivoting of the weapon deployment devices between the retracted, non-deployed position and the extended, deployed position to facilitate firing of a weapon, and retraction of the weapon deployment devices after firing. The weapon canisters from which weapons have been fired retain seawater to provide for an axi-symmetrical distribution of mass. The mother vehicle generates command information for controlling the control element and receives unmanned undersea vehicle status information from the unmanned undersea vehicle and processes it for use in generating the command information. The communication link interconnects the unmanned undersea vehicle and the mother vehicle to facilitate transfer of command information from the mother vehicle to the unmanned undersea vehicle and to further facilitate transfer of unmanned undersea vehicle status information from the unmanned undersea vehicle to the mother vehicle.

6 Claims, 9 Drawing Sheets



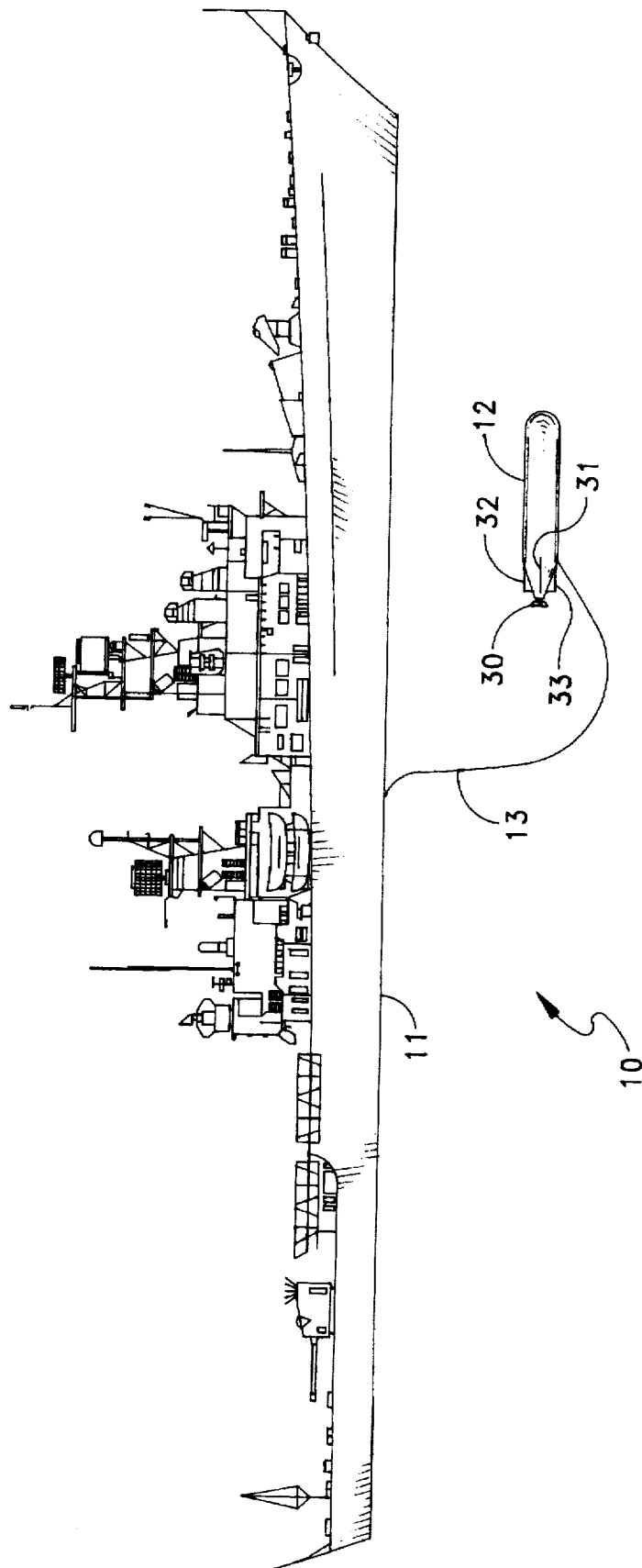


FIG. 1

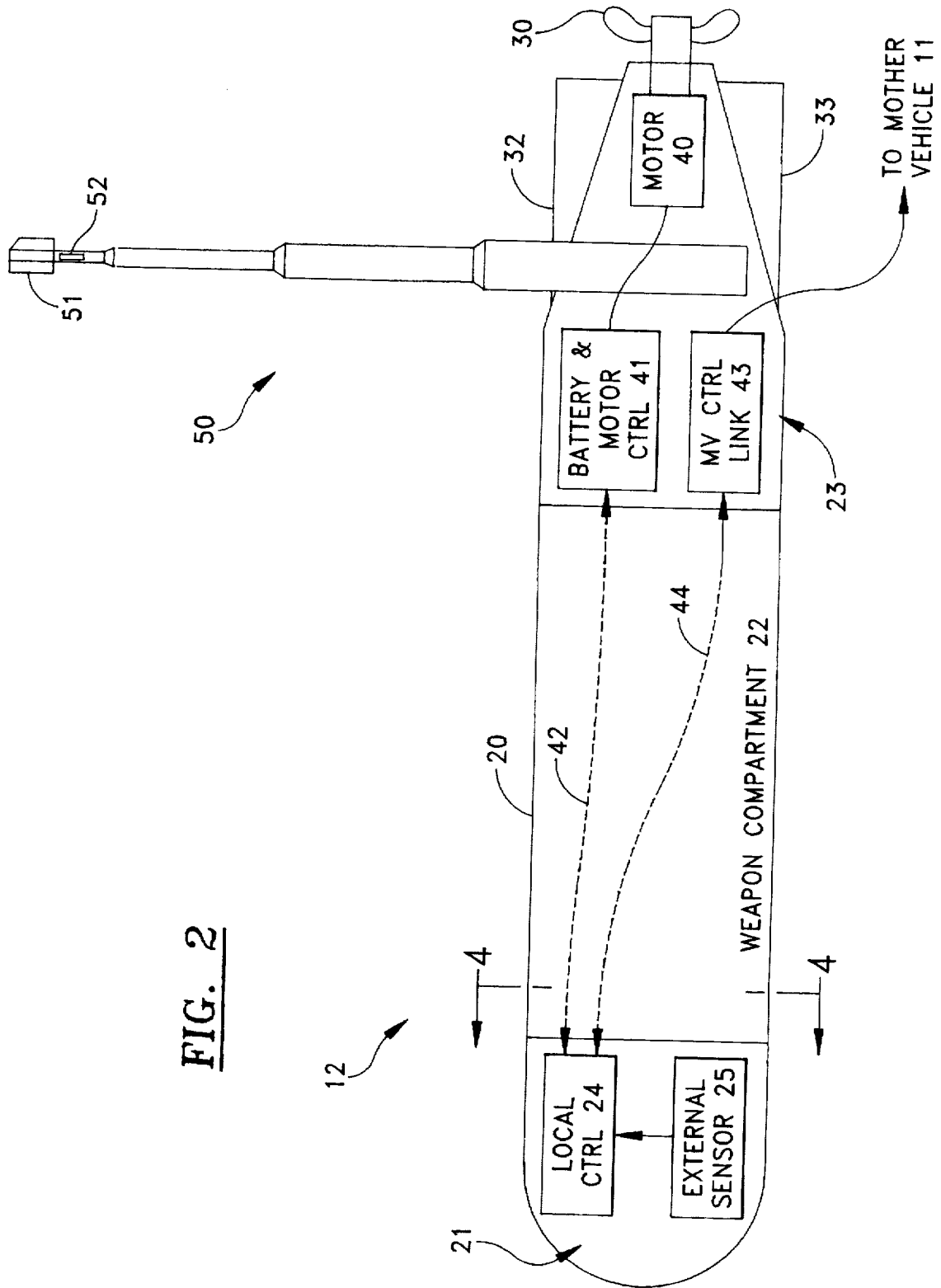


FIG. 2

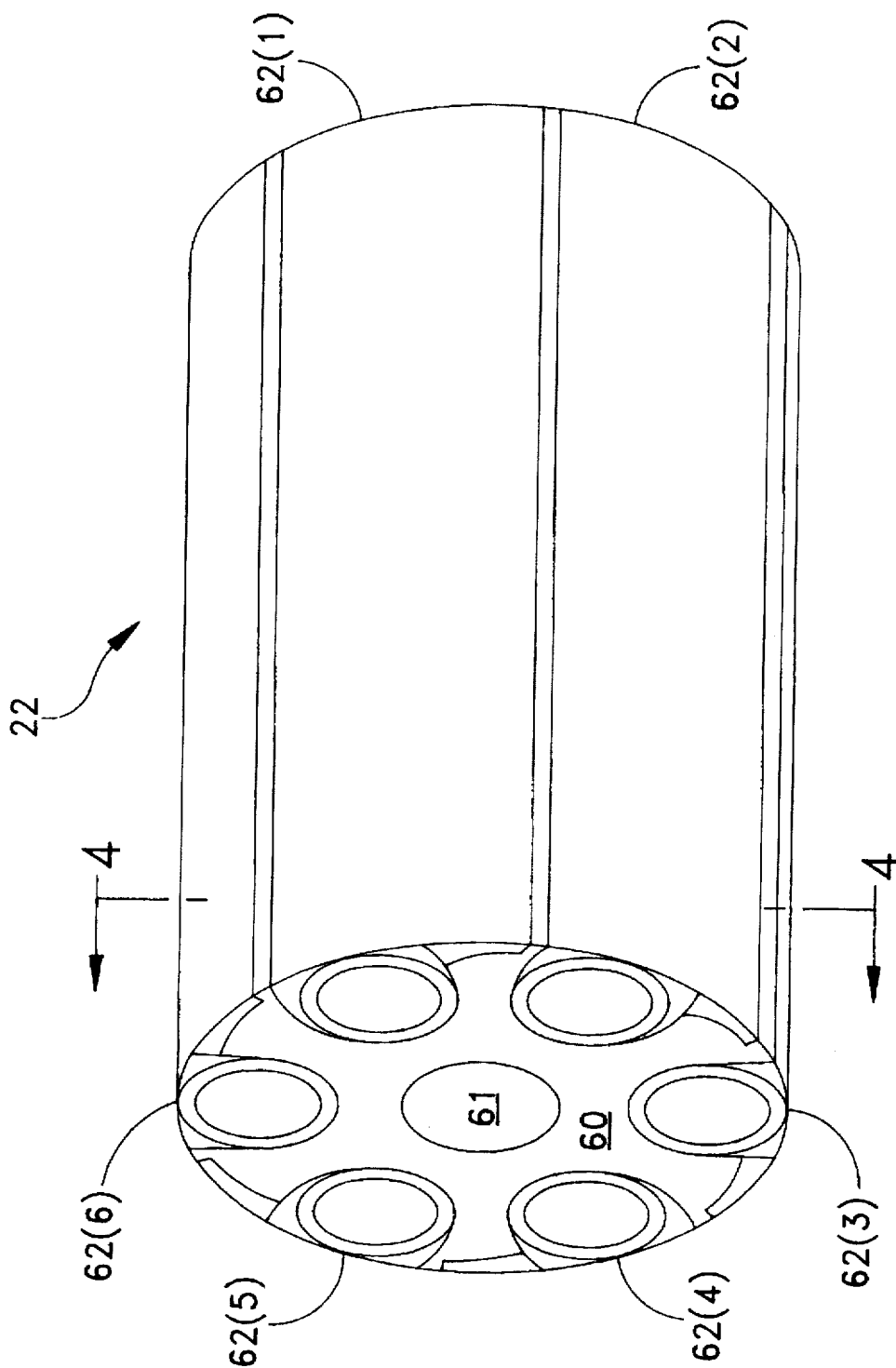


FIG. 3

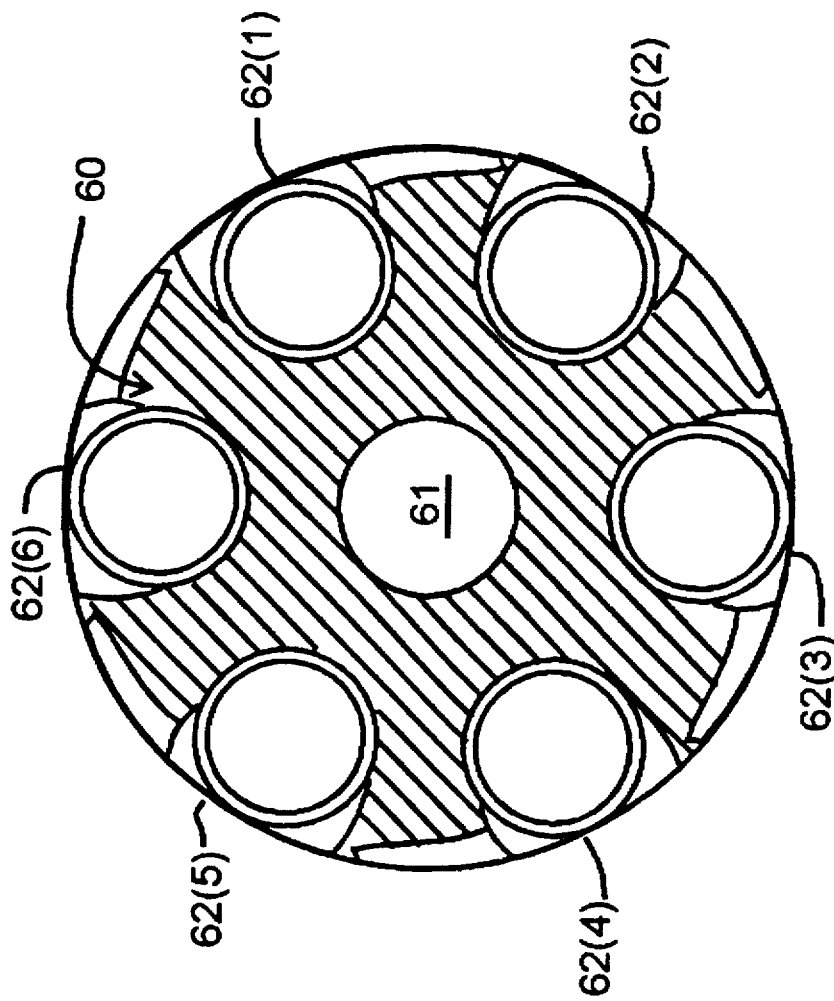


FIG. 4

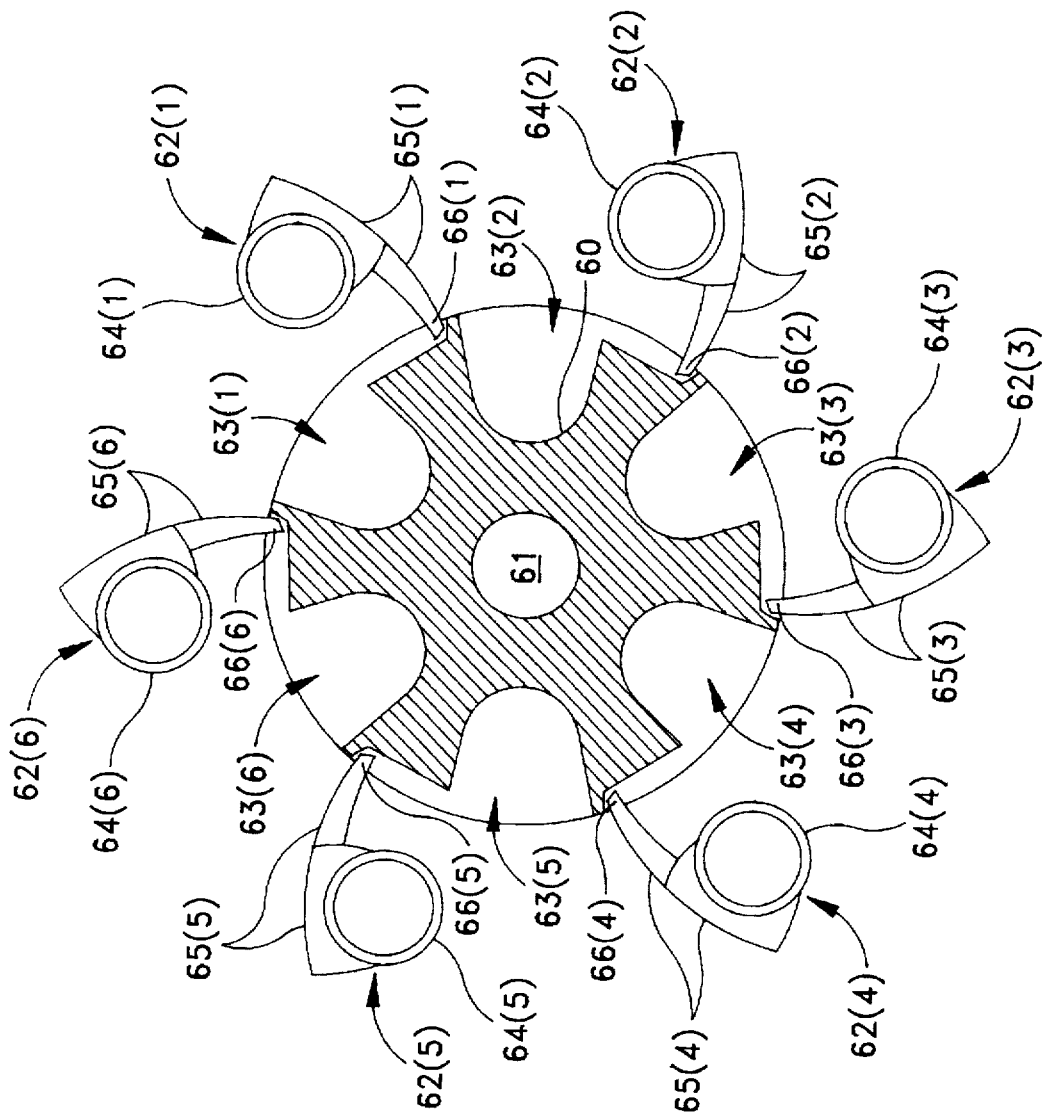


FIG. 5

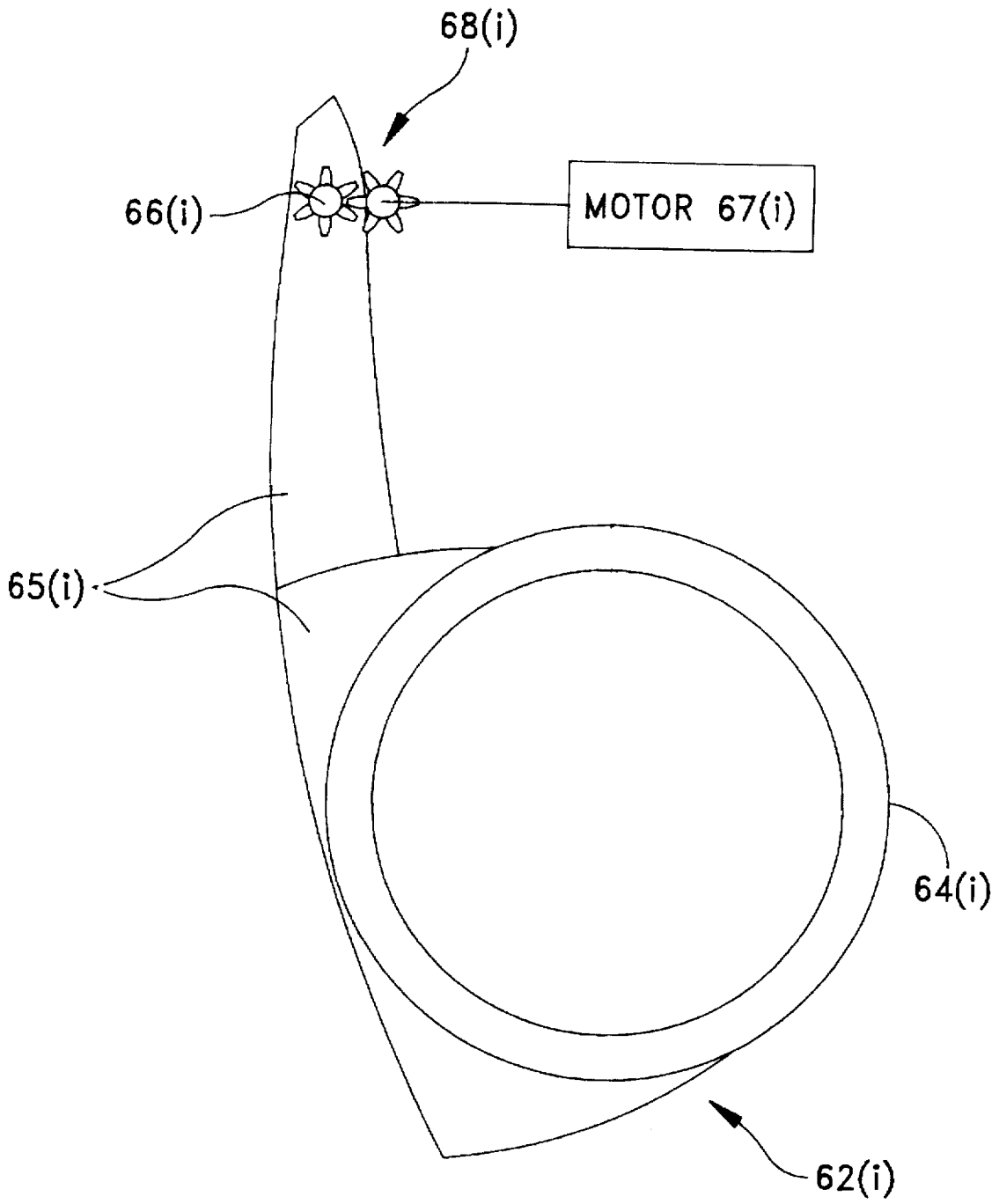


FIG. 6

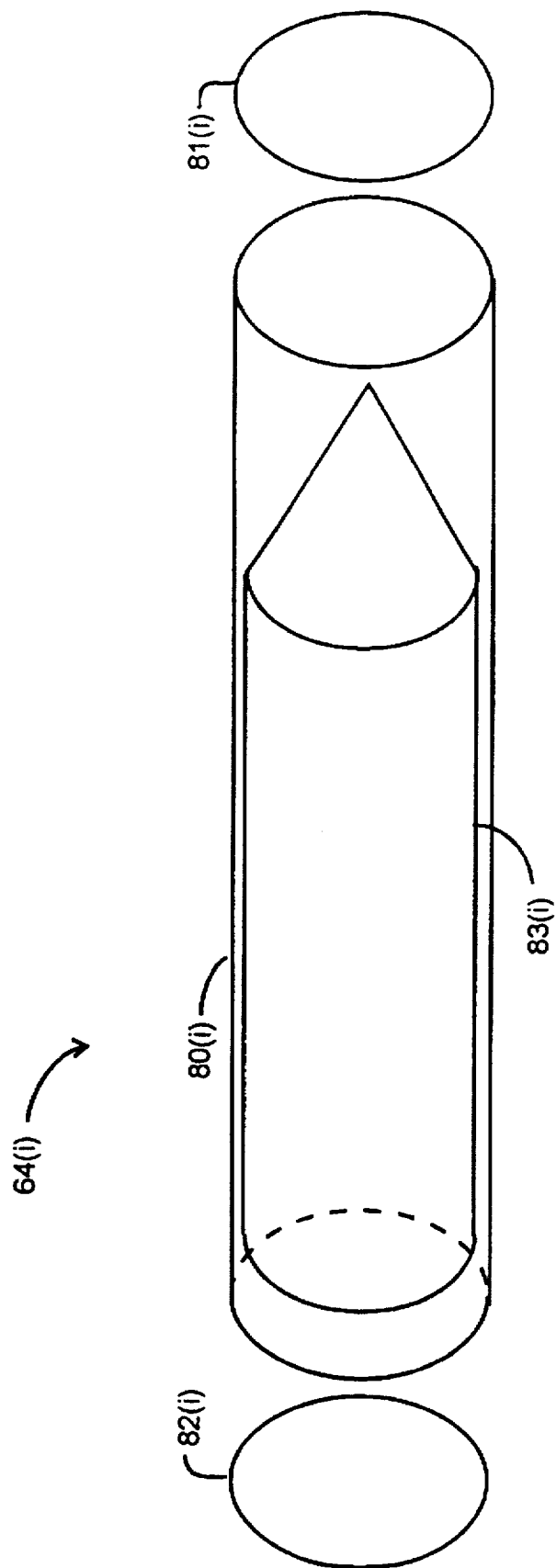


FIG. 7

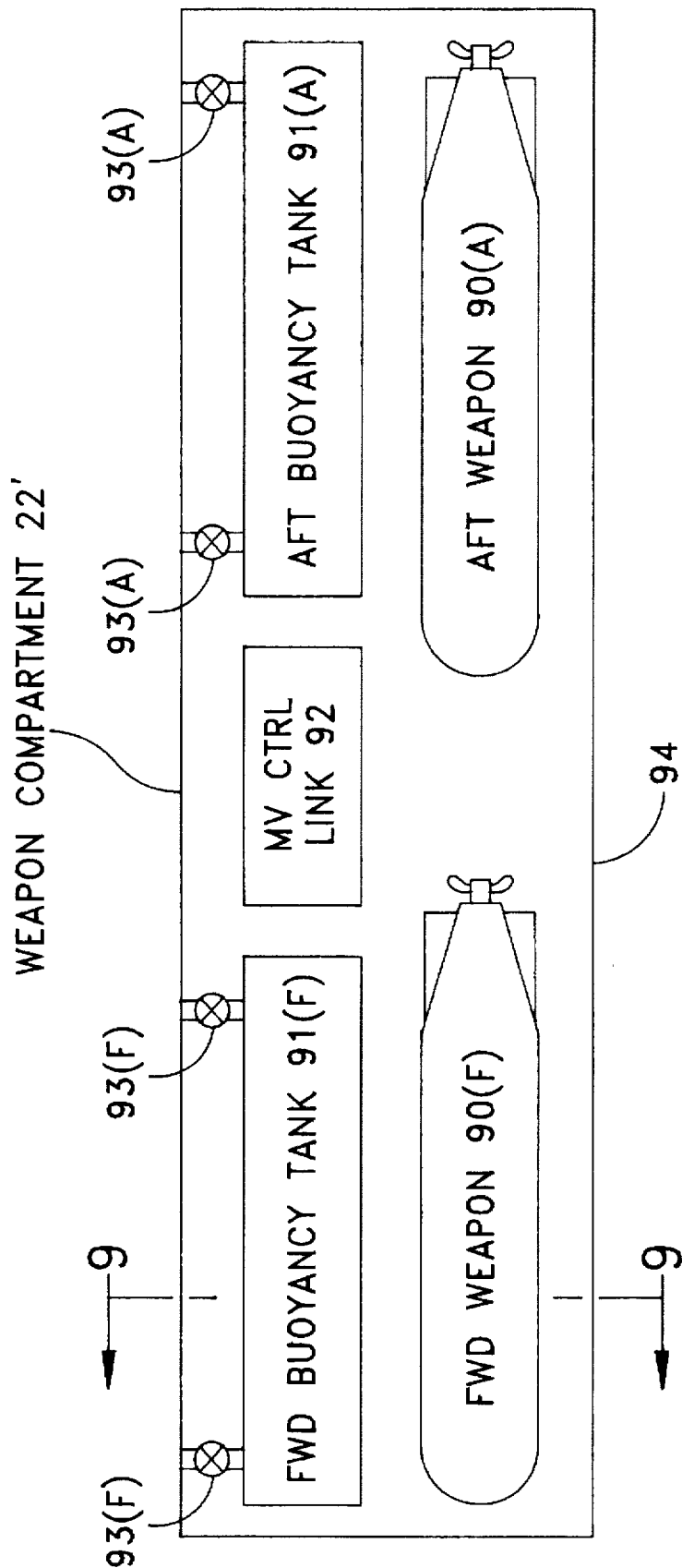


FIG. 8

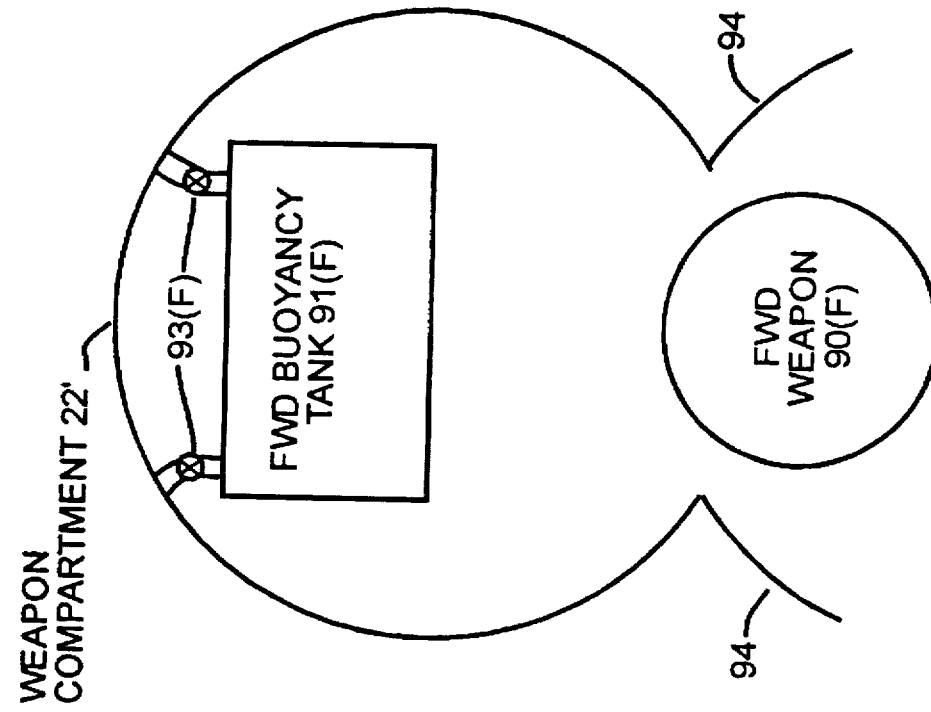


FIG. 9

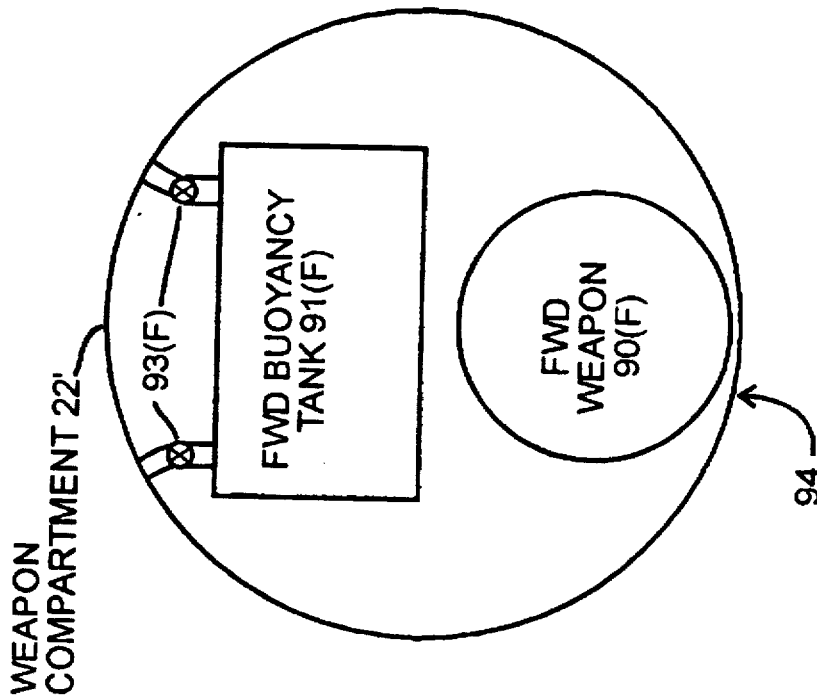


FIG. 10

**UNMANNED UNDERSEA WEAPON
DEPLOYMENT STRUCTURE WITH
CYLINDRICAL PAYLOAD DEPLOYMENT
SYSTEM**

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured by or for the Government of the United States of America for Governmental purposes without the payment of any royalties thereon or therefor.

**CROSS-REFERENCE TO RELATED
APPLICATIONS**

"Unmanned Undersea Vehicle With Keel-Mounted Payload Deployment System", U.S. patent application Ser. No. 08/540,612, filed of even date herewith in the name of Christopher F. Hillenbrand.

"Unmanned Undersea Vehicle With Erectable Sensor Mast For Obtaining Position and Environmental Vehicle Status", U.S. patent application Ser. No. 08/540,608, filed of even date herewith in the names of Christopher F. Hillenbrand and Donald T. Gomez.

"Unmanned Undersea Vehicle System For Weapon Deployment", U.S. patent application Ser. No. 08/540,611, filed of even date herewith in the names of Christopher F. Hillenbrand and Donald T. Gomez.

"System For Deploying Weapons Carried In An Annular Configuration In A UUV", U.S. patent application Ser. No. 08/540,609, filed of even date herewith in the names of Christopher F. Hillenbrand and Donald T. Gomez.

"Unmanned Undersea Weapon Deployment Structure With Cylindrical Payload Configuration", U.S. patent application Ser. No. 08/540,610, filed of even date herewith in the name of Christopher F. Hillenbrand.

"Unmanned Undersea Vehicle Including Keel-Mounted Payload Deployment Arrangement With Payload Compartment Flooding Arrangement To Maintain Axi-Symmetrical Mass Distribution", U.S. patent application Ser. No. 08/540,607, filed of even date herewith in the name of Christopher F. Hillenbrand.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The invention relates generally to the field of nautical weapon delivery systems and more particularly to nautical systems for covertly deploying multiple weapons while eliminating the necessity of having manned ships or submarines present at the deployment site.

(2) Description of the Prior Art

Underwater missiles and torpedoes are currently launched from either the offside of a manned ship or from the torpedo tube of a manned submarine. This current method of deploying underwater weapons requires the actual presence of the ship and/or submarine at the deployment site, thereby posing a number of dangers, including (1) the lives of the people on the ship or submarine, including the equipment itself, are exposed to enemy fire in a danger zone, and (2) ships, as well as submarines in shallow water, are exposed and thereby easily detected by an enemy.

Conventional wire-guided torpedoes are available as generally unmanned vehicles, but there are a number of problems in using them as a weapon system platform. A torpedo does not have an arrangement for compensating for buoyancy when a weapon is released from a torpedo shell. Thus,

the shock to the torpedo carrier when a weapon is launched will result in an unstable carrier. Also, the torpedo carrier itself is not recoverable, and hence can only be used once.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a new and improved system for undersea weapon deployment.

Another object of the invention is to provide such a system which employs an unmanned undersea vehicle to transport the weapon from a mother vessel to a weapon firing site remote from the mother vessel.

Still another object of the invention is to provide such a system having a capability to deploy three or more slim envelope dimensioned weapons.

In brief summary, the invention provides an unmanned undersea vehicle system comprising a remote-controlled, unmanned undersea vehicle and a mother vehicle interconnected by a communication link. The unmanned undersea vehicle includes a weapon compartment and a control means. Within the weapon compartment are a plurality of weapon deployment devices symmetrically disposed about a central core of axi-symmetrical shape and made of positively buoyant material, each weapon deployment device having a weapon canister for carrying a weapon, the weapon deployment devices being pivotable between a retracted, non-deployed position and an extended, deployed position, and configured so that, when in their extended, deployed positions the respective weapon canisters are positioned beyond the vehicle's diameter. Each weapon canister includes end caps at opposing ends which are discharged when the weapon contained therein is fired to allow seawater to enter. The control means controls the deployment of the weapon by expelling the weapon from the weapon compartment and thereafter controls the firing of the weapon. The construction and arrangement of the buoyant central core is chosen to provide a distribution of mass within the vehicle that enhances stability of vehicle motion during deployment and firing of weapons. The mother vehicle generates command information for controlling the control means and receives unmanned undersea vehicle status information from the unmanned undersea vehicle and processes it for use in generating the command information. The communication link interconnects the unmanned undersea vehicle and the mother vehicle to facilitate transfer of command information from the mother vehicle to the unmanned undersea vehicle and to further facilitate transfer of unmanned undersea vehicle status information from the unmanned undersea vehicle to the mother vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention is pointed out with particularity in the appended claims. The above and further advantages of this invention may be better understood by referring to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 depicts an unmanned undersea weapon deployment system constructed in accordance with the invention;

FIG. 2 depicts, in schematic form, the side elevational view of an unmanned undersea vehicle useful in the system depicted in FIG. 1;

FIG. 3 depicts, in schematic form, the side perspective view of a weapon compartment useful in one embodiment of the unmanned undersea vehicle depicted in FIG. 2;

FIG. 4 depicts, in schematic form, the sectional view of the weapon compartment depicted in FIG. 3, taken along the

section line 4—4 in FIGS. 2 and 3, with the weapons being situated in a non-deployment condition;

FIG. 5 depicts, in schematic form, the sectional view of the weapon compartment as depicted in FIG. 4, with the weapons being situated in a deployment condition;

FIG. 6 depicts, in schematic form, a detail of a portion of the weapon compartment depicted in FIGS. 3 through 5, which is useful in understanding the weapon deployment operation;

FIG. 7 depicts, also in schematic form, the detail of a weapon canister used in the weapon compartment depicted in FIGS. 3 through 6, which is useful in understanding the weapon deployment operation;

FIG. 8 depicts, in schematic form, the side perspective view of a weapon compartment useful in a second embodiment of the unmanned undersea vehicle depicted in FIG. 2;

FIG. 9 depicts, also in schematic form, the sectional view of the weapon compartment depicted in FIG. 8, taken along the section line 9—9 in FIG. 8, with the weapons being situated in a non-deployment condition; and

FIG. 10 depicts, also in schematic form, the sectional view of the weapon compartment depicted in FIG. 8, taken along the section line 9—9 in FIG. 8, with the weapons being situated in a deployment condition.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 depicts an unmanned undersea weapon deployment system 10 in accordance with the invention. With reference to FIG. 1, the system 10 includes a "mother vehicle" 11 and an unmanned undersea vehicle 12 constructed in accordance with the invention, which are interconnected by a communication link 13 such as an optical fiber. The mother vehicle 11 may be a conventional manned nautical ship (either a surface ship or a submarine), to which may be added (if necessary) mounting means (not separately shown) for holding and releasing the unmanned undersea vehicle into the ocean and for retrieving it from the ocean as described below, and means (also not separately shown) for communicating with the unmanned undersea vehicle to facilitate control of the unmanned undersea vehicle by the mother vehicle as described below.

FIG. 2 depicts, in schematic form, the side elevational view of the unmanned undersea vehicle 12 which is useful in the system 10 depicted in FIG. 1. With reference to FIG. 2, the unmanned undersea vehicle 12 includes an axis-symmetrical torpedo-shaped outer hull 20 which houses a forward control system compartment 21, a weapon system compartment 22 and an aft "control effectors" compartment 23. The central portion of the outer hull 20 is generally cylindrical, with a forward rounded nose (to the left in FIG. 2) and a tapered tail (to the right in FIG. 2). Extending rearwardly of the tail portion is a propeller 30 used to drive the unmanned undersea vehicle 12 selectively in a forward or rearward direction. Extending vertically and horizontally from the tail portion are four fins 31—33. Two of the fins, one identified by reference numeral 31 (shown in FIG. 1) on opposing sides of the tail portion extend horizontally therefrom (the second horizontally-extending fin is not shown), and two fins, identified by reference numerals 32 and 33, on opposing sides extend vertically therefrom. The angular orientation of the fins relative to the longitudinal axis of the unmanned undersea vehicle 12 is adjustable to permit steering of the unmanned undersea vehicle horizontally and vertically.

The control system compartment 21 includes a number of elements, including local control circuitry 24 for controlling

the various elements of the unmanned undersea vehicle 12 in response to commands provided by the mother vehicle 11 (FIG. 1), as well as in response to information as to the unmanned undersea vehicle's external environment as provided by an external sensor 25. The local control circuit 24 may include, for example, a conventional auto-pilot and a suitably-programmed digital computer, as well as electrical circuitry for providing control signals to control other components of the unmanned undersea vehicle 12 as described below. The external sensor 25 may comprise, for example, a conventional Doppler sonar device.

The aft "control effectors" compartment 23 includes several elements for propelling and steering the unmanned undersea vehicle 12 and, in one embodiment, for connecting the unmanned undersea vehicle to the communication link 13 and for reeling the communication link 13 out as the unmanned undersea vehicle moves away from the mother vehicle 11 and reeling it in as the unmanned undersea vehicle 12 returns towards the mother vehicle 11. In particular, the control effectors compartment 23 includes a motor 40 for powering the propeller 30. The motor, in turn, is powered by a battery and motor control circuit 41, which receives motor control information from the local control circuit 24 in the control system compartment 21 over a control link represented by a dashed line 42. The control effectors compartment 23 also includes motors (not shown) for controlling the orientation of the fins 31—33, which are also powered by and under control of the battery and motor control circuit 41. The battery and motor control circuit 41 also provides status information to the local control circuit over the control link 42.

In one embodiment, the control effectors compartment 23 also includes a mother vehicle control link 43, which performs the functions of connecting the unmanned undersea vehicle 12 to the communication link and reeling the communication link 13 out and in as the unmanned undersea vehicle 12 moves away from and toward the mother vehicle 11. The mother vehicle control link 43, in turn, provides the command information it receives from the communication link 13 to the local control circuit 24 over an internal communication link represented by dashed line 44. In addition, the local control circuit 24 provides unmanned undersea vehicle status information, including information as to the unmanned undersea vehicle's position and its environment, to the mother vehicle control link 43 over the internal communication link 44, and the mother vehicle control link 43 will transmit that information over the communication link 13 to the mother vehicle 11.

In one embodiment, the unmanned undersea vehicle 12 also includes an erectable mast 50, which may be extended in a telescoping manner from the control effectors compartment. The far (upper) end of the mast 50 includes sensor equipment which permits acquisition of certain positioning and environmental information. In particular, the mast 50 includes an optical and/or video camera 51, which may be a CCD device, for obtaining image information as to the vehicle's environment. The camera 51 provides the video information to the local control circuit 24, which can process the information and use it locally, and in addition can provide the processed and/or raw video information to the mother vehicle 11. The mother vehicle 11, in turn, can use the information received from the unmanned undersea vehicle 12 in determining the commands to be provided to the unmanned undersea vehicle 12.

In addition, the mast 50 includes a Geodetic Position System ("GPS") antenna 52. The GPS antenna 52 receives signals from the Geodetic Positioning System maintained by

the Federal Government of the United States of America, and provides them to the local control circuit 24 to facilitate determination of the vehicle's location. The Geodetic Positioning System, as is well known, includes a plurality of satellites which revolve around the Earth and transmit signals which a conventional publicly-available GPS receiver can use to identify the location of the receiver in any relevant location on Earth. It will be appreciated that other embodiments may utilize other location positioning systems, such as may be provided by the Federal Government's Loran-C system. In either case, the local control circuit 24 can use the positioning information locally and provide the information to the mother vehicle 11. The mother vehicle 11, in turn, can use the information received from the unmanned undersea vehicle 12 in determining the commands to be provided to the unmanned undersea vehicle 12.

As noted above, the unmanned undersea vehicle 12 further includes a weapon compartment 22. The weapon compartment 22 stores and deploys weapons, in the form of missiles, under control of the local control circuit 24 operating, in turn, under control of the mother vehicle 11. In one embodiment, which will be described below in connection with FIGS. 3 through 7, the weapon compartment 22 deploys a plurality of weapons axially symmetrically about the unmanned undersea vehicle 12. In a second embodiment, which will be described below in connection with FIGS. 8 through 10, the weapon compartment, identified in those FIGS. by reference numeral 22' deploys the weapons downwardly. In both cases, the weapon compartment can carry a number of missiles and deploy them individually in a plurality of locations. As it deploys the individual weapons, the weapon compartment 22 and 22' maintains axial mass symmetry, which simplifies steering of the vehicle as it is propelled through the ocean, as well as simplifying weapon deployment from multiple positions.

FIG. 3 depicts, in schematic form, the side perspective view of weapon compartment 22, and FIG. 4 depicts, in schematic form, the sectional view of the weapon compartment depicted in FIG. 3, taken along the section line 4-4 in FIGS. 2 and 3. Insofar as the invention is presently understood, weapon compartment 22 embodies the preferred mode of invention, with respect to the instant above-entitled invention. In FIGS. 3 and 4, the weapons are shown in retracted, non-deployed condition. FIG. 5 depicts, in schematic form, the sectional view of the weapon compartment as depicted in FIG. 4, with the weapons being situated in an extended, deployment condition. With reference to those figures, the weapon compartment 22 includes a central core 60, formed of a buoyant material, having a central aperture 61 which extends therethrough from the forward control system compartment 21 to the rear control effectors compartment 23. Core 60 may be formed of any suitable buoyant material, such as a buoyant composite. The forming of core 60 out of a buoyant material contribute significantly to providing a distribution of mass within the vehicle which enhances stability of vehicle motion when weapons are deployed and fired. It also provides a significant reduction of the vehicle weight enabling more weight to be allocated to the vehicles payload, namely weapons. The central aperture 61 is co-axial with the weapon compartment 22 and provides a passageway through which the connections extend between the forward control system compartment 21 and the rear control effectors compartment 23.

In addition, around the exterior surface of the central core 60 is formed a plurality of recesses 63(1) through 63(6) (specifically shown in FIG. 5, and generally identified by reference numeral 63(i)). In each recess 63(i) is mounted a

pivotable weapon deployment device 62(1) through 62(6) (generally identified by reference numeral 62(i)). FIGS. 3 and 4 show the weapon deployment devices 62(i) in a retracted, non-deployed position, FIG. 5 shows the weapon deployment devices 62(i) in an extended, deployed position, and FIG. 6 shows a detail of a weapon deployment device 62(1) useful in understanding deployment thereof. Each weapon deployment device 62(i) comprises a weapon canister 64(i) mounted on a pivotable arm 65(i). When retracted, as shown in FIGS. 3 and 4, the weapon deployment canister 64(i) and arm 65(i) fits into the respective recess 63(i). The outer surfaces of the arms 65(i) are contoured to conform to and form the cylindrical outer surface of portion of the hull 20 comprising the weapon compartment 22.

As noted above, FIG. 5 shows the weapon deployment devices 62(i) in their respective deployed positions. As shown in FIG. 5, in the deployed positions, the weapon deployment devices 62(i) are pivoted about respective gear train 66(i) so that the weapon canisters 64(i) are positioned beyond the surface of the hull 20. As shown in FIG. 6, the weapon deployment devices 62(i) are pivoted between the retracted, non-deployed position and the extended, deployed position by respective electrical motors 67(i) through a gear train 68(i). The motors 67(i), in turn, are controlled by the local control circuit 24 (FIG. 1). It will be appreciated that a plurality of motors and associated gear trains may be situated along the length of the weapon compartment 22 to provide for more rapid pivoting of the associated weapon deployment device 62(i) than may be provided by a single motor/gear train.

The procedure used in deploying and firing missiles from the weapon compartment 22 will be described in connection with FIG. 7, as well as FIGS. 3 through 6. Initially, the local control circuit 24, under control of the mother vehicle 11, has guided the unmanned undersea vehicle 12 to a position in which a missile is to be deployed and fired. While the unmanned undersea vehicle 12 is being propelled to the deployment and firing position, the weapon deployment devices 62(i) will be in the retracted, non-deployed position. After the unmanned undersea vehicle 12 arrives at the deployment and firing position, the local control circuit 24, if commanded by the mother vehicle 11 to actually deploy and fire one or more of the weapons, will actuate the motors 67(i) that are associated with all of the weapon deployment devices 62(i) and enable them to pivot the weapon deployment devices 62(i) to the deployed condition. By deploying all of the weapon deployment devices 62(i) symmetrically about the axis of the unmanned undersea vehicle 12, the unmanned undersea vehicle 12 is assured that it will not be forced from the deployment position.

After all of the weapon deployment devices 62(i) have been pivoted to the extended, deployed position, missiles contained in one or more of the weapon canisters 64(i) may be fired. The firing process will be described in connection with FIG. 7. With reference to FIG. 7, the weapon canister 64(i) comprises a cylindrical canister body 80(i), a forward end cap 81(i) and a rear end cap 82(i). Prior to firing, the end caps 81(i) and 82(i) are affixed to the canister body 80(i) to form a housing for a missile 83(i). When affixed to the canister body 80(i), the end caps 81(i) and 82(i) seal the interior of the canister 64(i) from seawater surrounding the canister.

When the missile 83(i) inside of the weapon canister 64(i) is fired, air pressure from the combusted gases generated during the firing process builds up inside the canister 64(i), which enables the end caps 81(i) and 82(i) to be blown off the canister body 80(i). When the end caps 81(i) and 82(i)

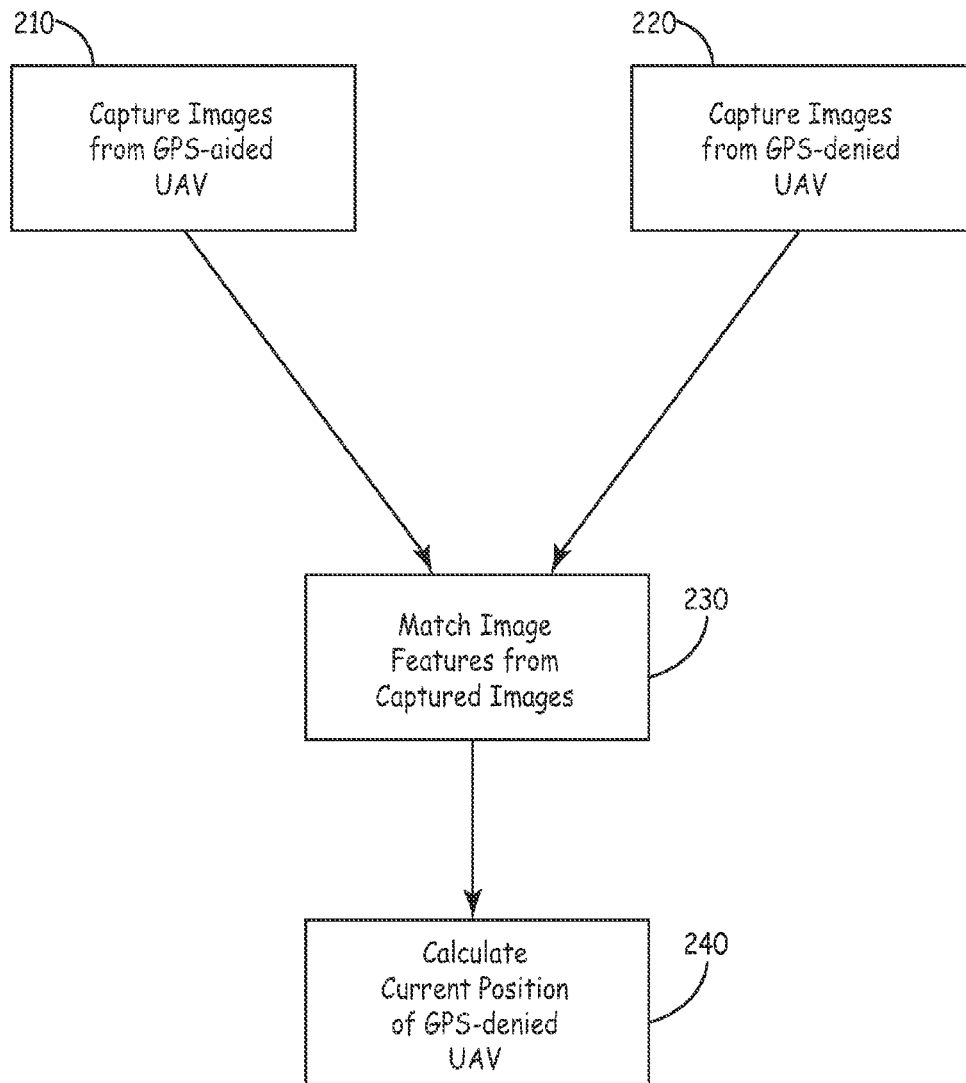


FIG. 2

metrically formed about the vehicle longitudinal axis, each weapon deployment device having a weapon canister for carrying a weapon, the weapon deployment devices being pivotable between a retracted, non-deployed position and an extended, deployed position, and configured so that, when in their extended, deployed positions the respective weapon canisters are positioned beyond the vehicle's diameter, each weapon canister having a sidewall conforming to the shape of the weapon contained therein, and end caps at opposing ends, the end caps being discharged when the weapon contained therein is fired to allow seawater to enter, and (ii) control means for controlling pivoting of the weapon deployment devices from the retracted, non-deployed position and the extended, deployed position to facilitate firing of at least one weapon, and further controlling pivoting of the weapon deployment devices from the extended, deployed position to the retracted, non-deployed position after firing, the weapon canisters from which weapons have been fired retaining seawater so as to provide for a generally axi-symmetrical distribution of mass as among those weapon deployment devices whose weapons have been fired and those weapon deployment devices whose weapons have not been fired;

a mother vehicle for generating command information for controlling the control means and for receiving

- unmanned undersea vehicle status information from said unmanned undersea vehicle and processing it for use in generating the command information; and
- a communication link for interconnecting said unmanned undersea vehicle and said mother vehicle to facilitate transfer of command information from said mother vehicle to said unmanned undersea vehicle and to further facilitate transfer of unmanned undersea vehicle status information from said unmanned undersea vehicle to said mother vehicle.
- 2. An unmanned undersea vehicle system as defined in claim 1 wherein the control means fires the weapons so as to maintain a bilateral symmetry on opposing sides of a vertical reference plane through the vehicle's axis.
- 3. An unmanned undersea vehicle system as defined in claim 1 wherein each weapon deployment device has a surface which, when the weapon deployment device is in its retracted, non-deployed positions, conforms to the vehicle's cylindrical shape.
- 4. An unmanned undersea vehicle system as defined in claim 1 in which the communication link is an optical fiber.
- 5. An unmanned undersea vehicle system as defined in claim 1 in which the mother vehicle is a submarine vehicle.
- 6. An unmanned undersea vehicle system as defined in claim 1 in which the mother vehicle is a surface vehicle.

* * * * *