United States Patent [19]

Pickett et al.

[11] **Patent Number: 4,463,701**

[45] **Date of Patent: Aug. 7, 1984**

[54] **PARAVANE WITH AUTOMATIC DEPTH CONTROL**

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

[21] Appl. No.: **125,735**

[22] Filed: **Feb. 28, 1980**

[51] **Int. Cl.**[3] **B63B 21/00**

[52] **U.S. Cl.** **114/245**; 114/331

[58] **Field of Search** 114/244, 245, 274, 331, 114/332, 126

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,709,981	6/1955	Wilcoxon	114/245
3,703,876	11/1972	Michelsen	114/244
3,842,770	10/1974	Hedbawny et al.	114/245 X
4,019,453	4/1977	Boswell	114/245
4,215,862	8/1980	Yoshikawa et al.	114/245 X

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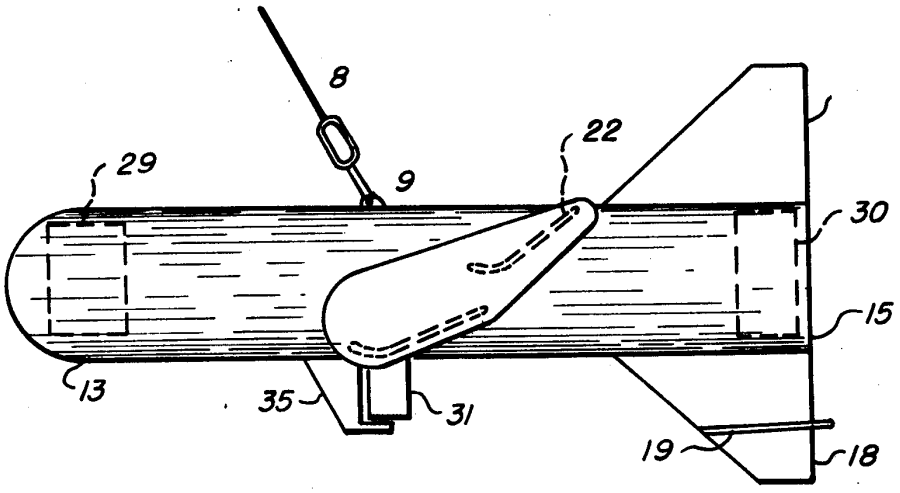
[57] **ABSTRACT**

A paravane includes an elongated fuselage; a wing section of spaced wing members attached to an intermediate portion of the fuselage; stabilizer fins for maintaining the paravane lined-up with the direction of tow; a depth control flap positioned adjacent the wing section and having a pivot axis extending closely adjacent to the towing point; and depth control means for controlling the position of the control flap. The wing members have a straight leading edge portion, a straight trailing edge portion and a curved intermediate portion wherein the wing members are arranged such that the chord lines extend at oblique angles with the longitudinal axis of the fuselage and such that the resultant hydrodynamic lift force vector acting on the wing section passes through the tow point.

15 Claims, 6 Drawing Figures



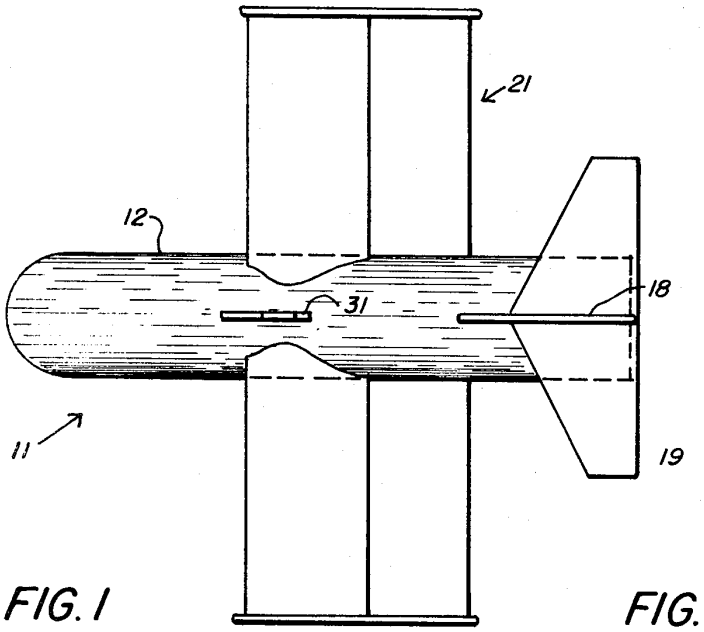


FIG. 1

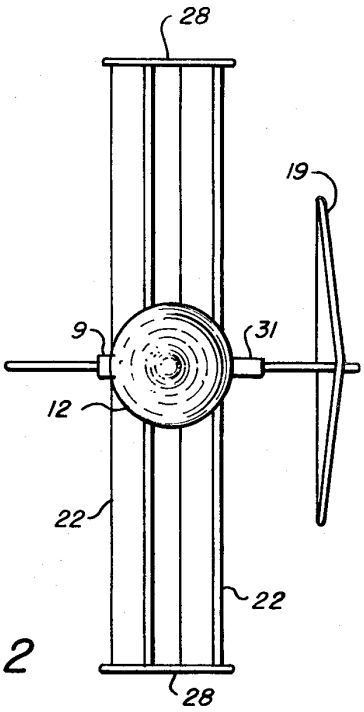


FIG. 2

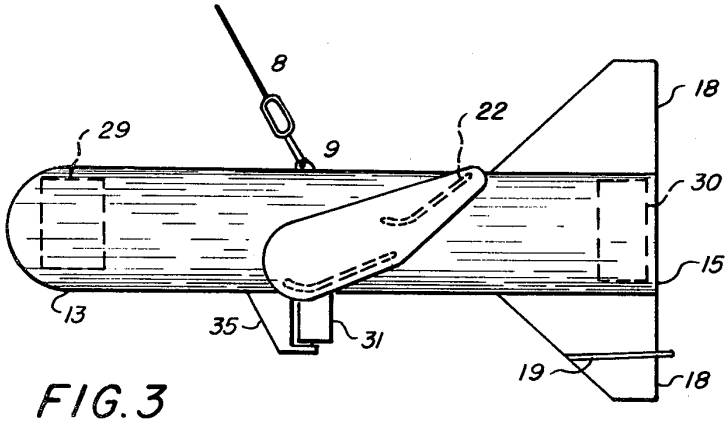


FIG. 3

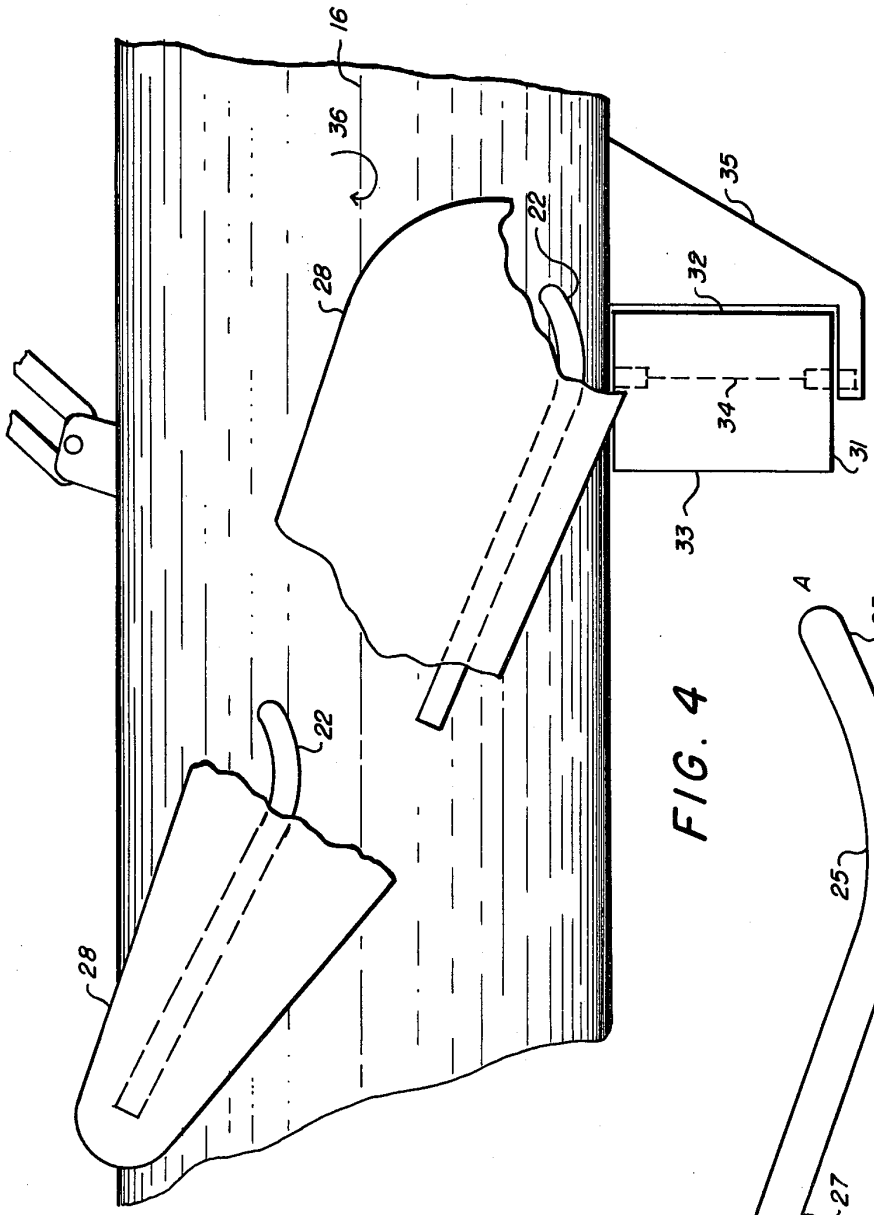


FIG. 4

FIG. 5

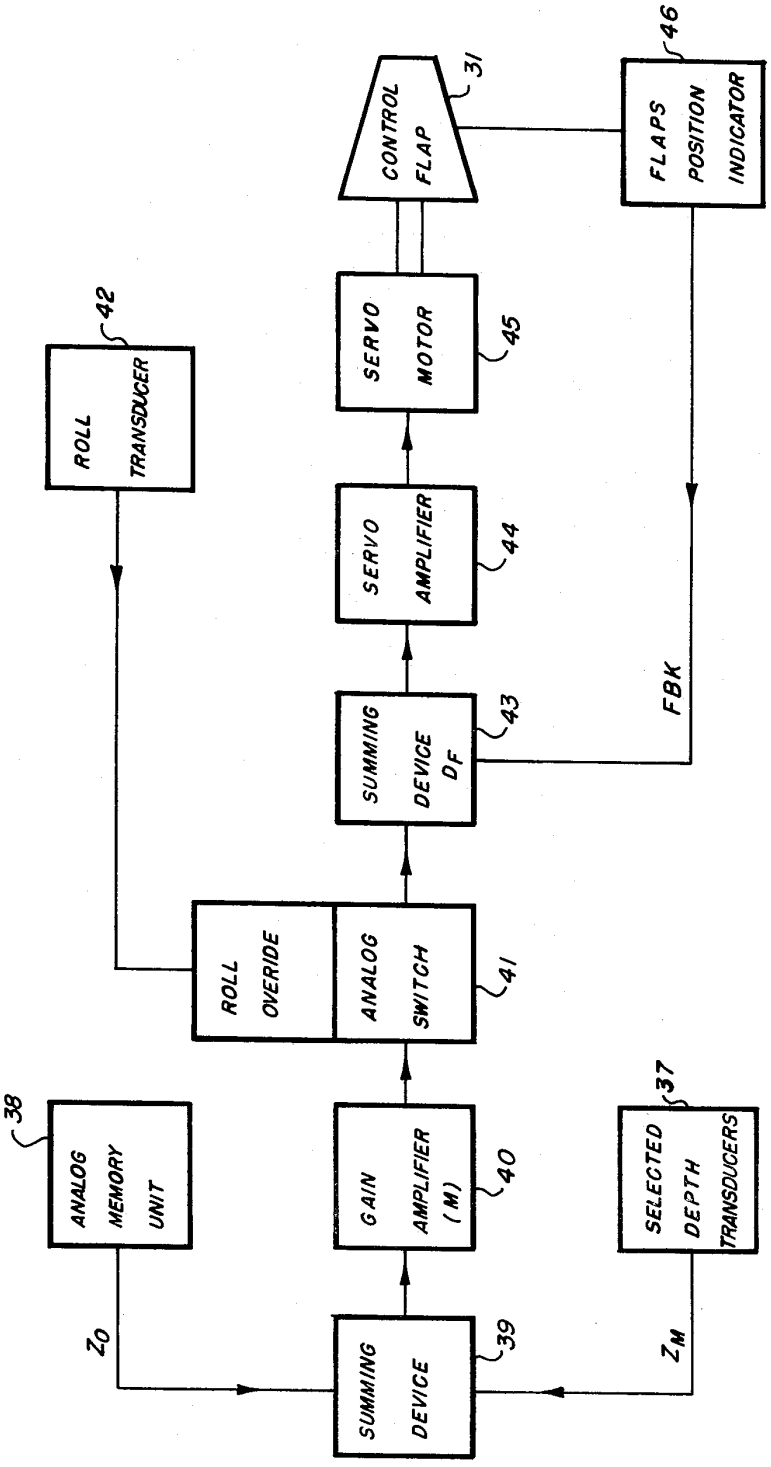


FIG. 6

PARAVANE WITH AUTOMATIC DEPTH CONTROL

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

BACKGROUND OF THE INVENTION

The present invention generally relates to paravanes and other underwater towed apparatus and more particularly to paravanes having wing sections with high lift-to-drag and high lift-to-weight ratios and provided with means for maintaining the paravanes at a predetermined ordered depth.

Generally, paravanes towed by minesweepers are connected to a cable system so that the paravanes are positioned behind and laterally offset from the tow point of the minesweeper to maximize the sweep area. Various depth control means have been utilized to maintain the paravanes at a predetermined depth. One type of depth control means utilizes a float device with a length of cable extending between the float and the paravane such that the operating depth of the paravane is controlled by changing the length of the cable. However, the cable length often limits the effective working depth, and the float and cable assembly tends to impose undesirable drag forces on the towing vessel. Another depth control means which overcomes some of the drawbacks with the abovementioned float controls utilizes a depth sensor which is coupled with a rudder or control flap, the movement of which causes the paravane to ascend or descend. However, some of these depth control means as utilized in conventional paravane construction have caused the paravane to oscillate excessively or "hunt" in the water in finding the equilibrium position at the desired working depth. Such oscillating action produces dynamic loads and undesirable stresses in the cable system.

Paravanes and other underwater apparatus which include various depth control means are generally exemplified by U.S. Pat. Nos. 2,709,981; 2,879,737; 2,981,220; 3,560,912; and 3,703,876.

SUMMARY OF THE INVENTION

The present invention overcomes many drawbacks of the prior art by providing a compact, efficient paravane having a high lift coefficient, a low drag coefficient, good stability over a wide range of towing speeds and means for preventing undesired roll motions. This is generally accomplished by attaching a wing section of highly efficient staggered wing members to the fuselage such that the resultant lift force vector for the wing section is favorably arranged with respect to the towing point. The internal space of the fuselage is optimized to accommodate various power and control means as well as lightweight ballasting materials so that the paravane can be made almost neutrally buoyant. Counterweight means can be attached to one of the wing members so that the wing section assumes a vertical orientation in the water. Horizontal and lateral stabilizers are attached to the tail end portion of the fuselage to provide the paravane with stability against pitching and yawing motions. A pivotal control flap is positioned relative to the wing section such that a high degree of roll motion is generated for small deflections of the control flap. Depth control means containing a roll override feature for preventing roll motions greater than a preselected value are provided which enable the paravane to operate with a high degree of stability.

Accordingly, it is an object of the present invention to provide a simple, yet efficient towed underwater apparatus capable of achieving and maintaining a controlled depth, possessing a high degree of stability, and which may be manufactured inexpensively and does not require skilled personnel to operate.

Another object of this invention is the provision of a towed underwater device which develops a high outward lift force relative to its size and buoyancy in water and which is capable of seeking and maintaining a predetermined depth and towing orientation.

A further object of the present invention is to provide a towed underwater apparatus which is highly stable over a wide range of speeds and which is capable of assuming a predetermined orientation irregardless of its initial position.

Yet another object of this invention is to provide a towed underwater apparatus which includes means for stabilizing the apparatus with respect to undesirable rolling, yawing and pitching actions and means for enabling the paravane to maintain a predetermined depth without undue stress on the towing apparatus.

Still another object of the present invention is to provide a towed underwater apparatus which utilizes depth control means, whereby a large vertical lift force can be generated to support the weight of the towing cable and attached devices so that depth can be maintained even at a low towing speed.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIG. **1** is a side view of the paravane in its normal operating position;

FIG. **2** is a front view of the paravane of FIG. **1**;

FIG. **3** is a plan view of the paravane of FIG. **1**;

FIG. **4** is a sectional view, partially broken away, of the paravane, depicting the wing members and the control flap;

FIG. **5** is a sectional view of a wing member; and

FIG. **6** is a diagram of the depth control system employed in the paravane.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, wherein like reference characters designate corresponding parts throughout the several figures, and particularly to FIGS. **1** through **3**, there is shown a paravane **11** attached to a towing cable **8** (see FIG. **3**). The paravane **11**, which resembles a biplane, includes a cylindrical fuselage **12** or body; a wing section **21** of spaced wing members **22** secured to the central portion **14** of the fuselage **12**; and a control flap **31** pivotally connected to the fuselage **12** and extending generally normal to the planes defined by the wing members **22**. A lateral stabilizer **18** is attached to the tail portion **15** of the fuselage **12** and extends in a generally perpendicular relationship with the planes defined by the wing members **22** for maintaining the

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