United States Patent

Depew et al.

[15] **3,660,807**

[45] **May 2, 1972**

[54] **TOWED BODY VERTICAL ATTITUDE STABILIZATION SYSTEM**

[72] Inventors: **Donald R. Depew; Karl L. Greenman,** both of Jackson, Mich.; **Daniel C. Probert,** Key West, Fla.

[73] Assignee: **Sparton Corporation,** Jackson, Mich.

[22] Filed: **Mar. 14, 1968**

[21] Appl. No.: **713,167**

[52] **U.S. Cl.** .... **340/3 T,** 114/235 B, 340/4 R

[51] **Int. Cl.** **B63b 21/00**

[58] **Field of Search** .... 340/3 T, 4, 5, 2, 8 S, 7; 114/2, 235, 235 B; 244/3

[56] **References Cited**

UNITED STATES PATENTS

3,024,440 3/1962 Pence 340/4

3,027,539 3/1962 Stillman, Jr. 340/5

3,120,208 2/1964 Lawrie .... 114/235 X

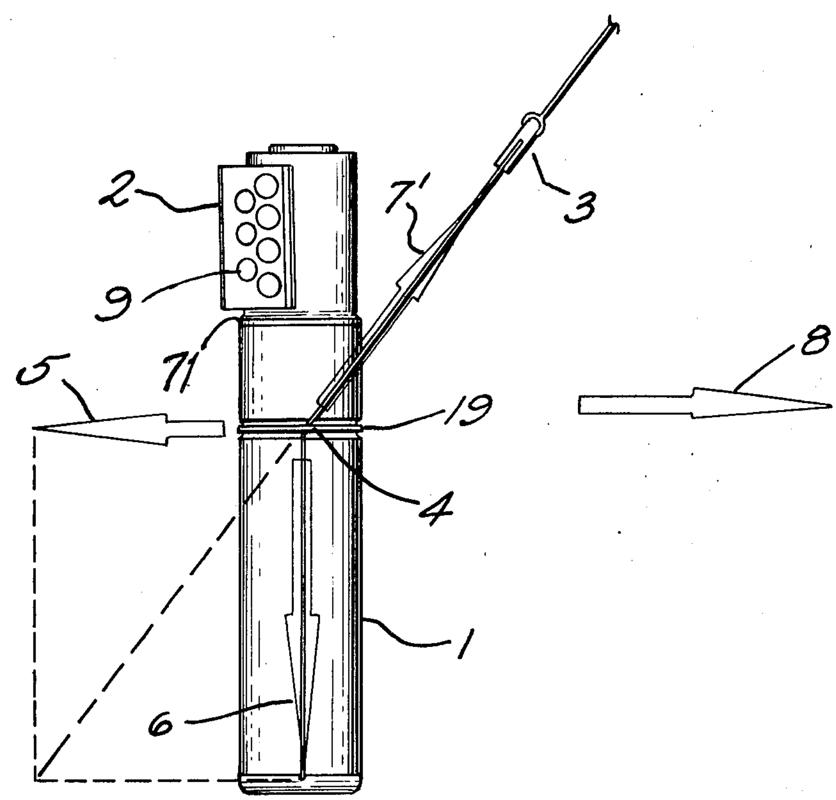
Primary Examiner—Richard A. Farley

Attorney—Beaman & Beaman

[57] **ABSTRACT**

A stowable, automatically deployable system to stabilize a body and which functions passively to maintain a vertical body attitude within a dynamic fluid and to traverse a substantially vertical path while in free descent in the fluid, and which enables the vertical stabilization of an elongated body about its longitudinal axis while being towed through a viscous medium, said system comprising fins and a towing bridle assembly; with the shape, size and body placement of such fins in conjunction with the bridle configuration and body attachment thereof being precisely integrated to affect dihedral effect fluid stabilization.

12 Claims, 10 Drawing Figures



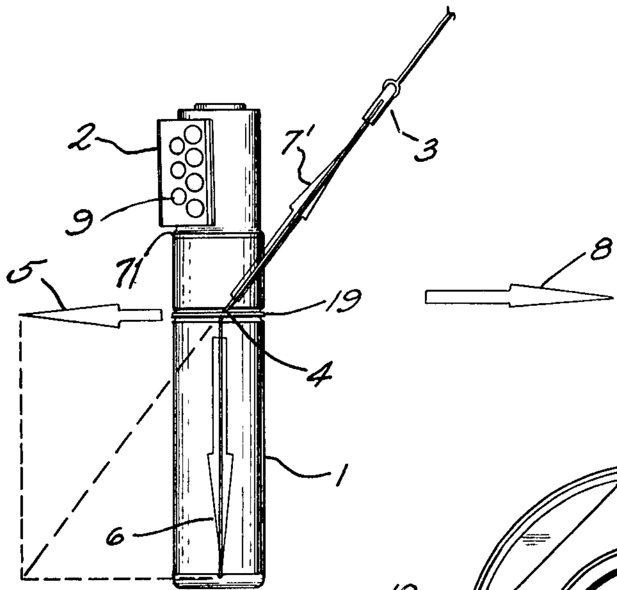


FIG. 1

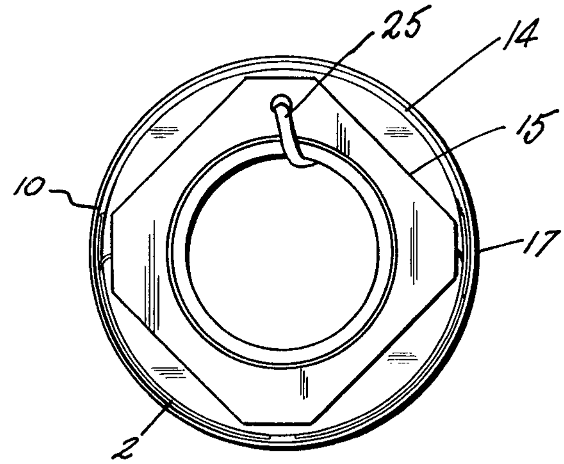


FIG. 2

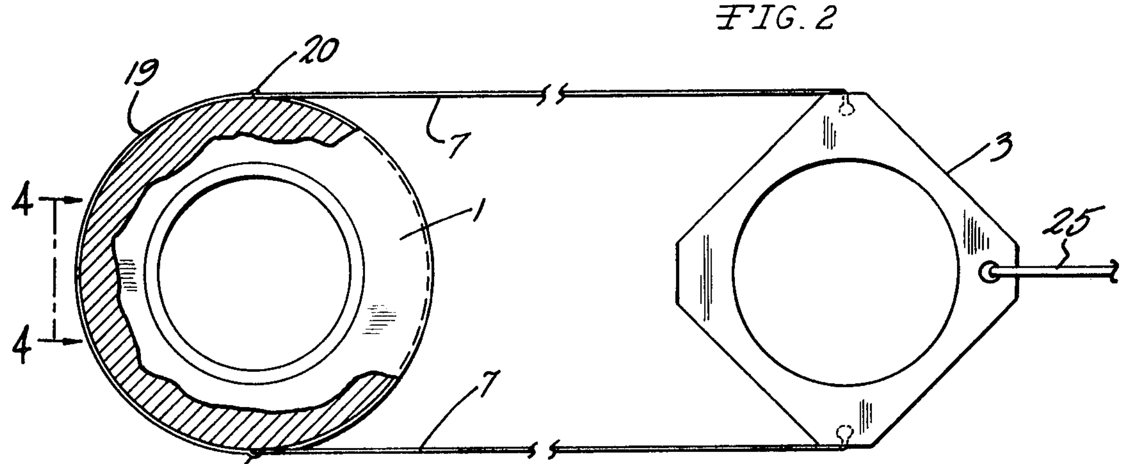


FIG. 3

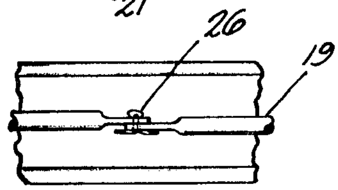


FIG. 4

INVENTORS
DONALD R. DEPEW
KARL L. GREENMAN
DANIEL C. PROBERT

BY Beaman & Beaman
ATTORNEYS

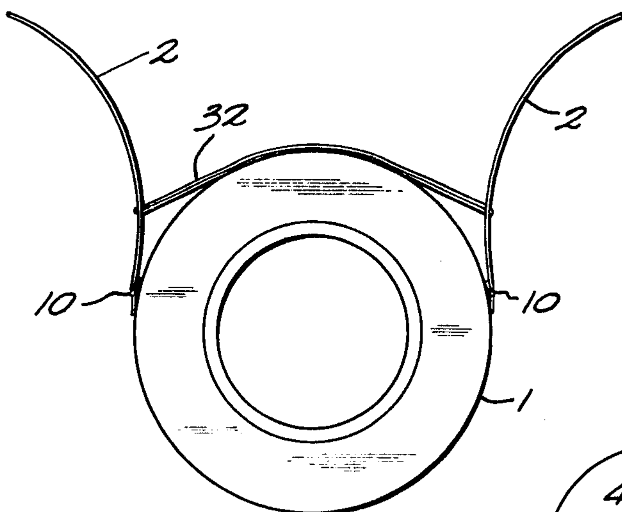


FIG. 5

FIG. 9A

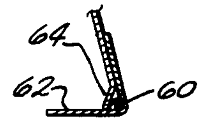


FIG. 9B

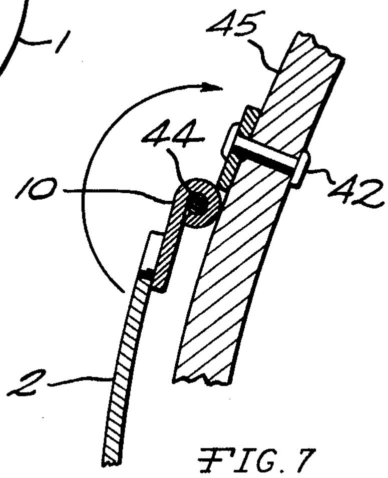


FIG. 7

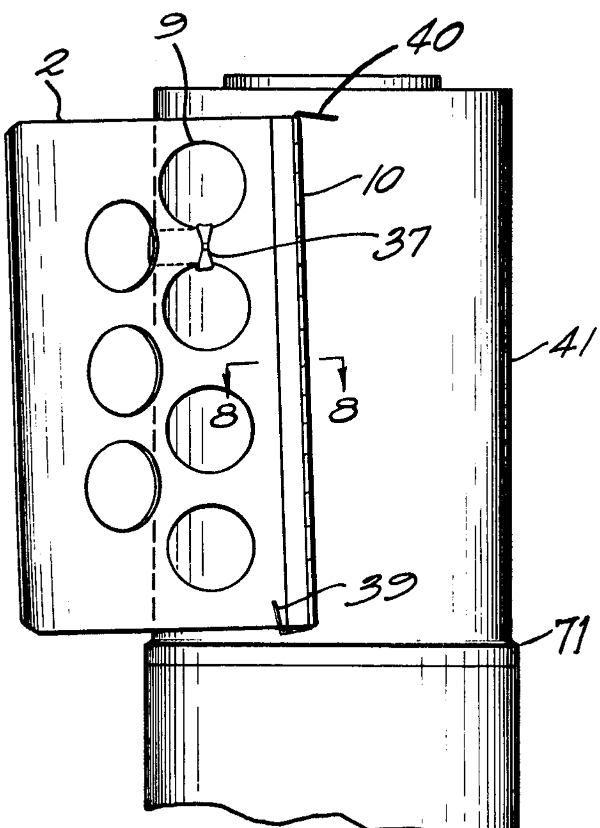


FIG. 6

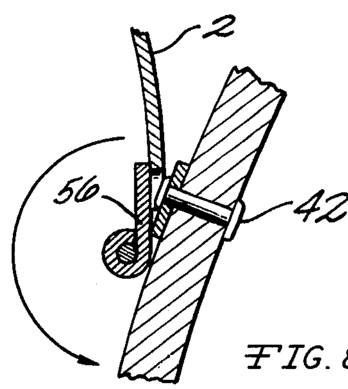


FIG. 8

INVENTORS
DONALD R. DEPEW
KARL L. GREENMAN
DANIEL C. PROBERT
BY Beaman & Beaman
ATTORNEYS

TOWED BODY VERTICAL ATTITUDE STABILIZATION SYSTEM

BACKGROUND OF THE INVENTION

The instant invention relates to a stabilizer system and particularly to a bridled body having at least one fin which provides for vertical stabilization and stabilization about the vertical axis while towed within a fluid. More particularly, the stabilizer system acts by means of a dihedral effect to constrain a bridled body to align itself in a single particular attitude referenced to the direction of an impressed fluid flow.

The stabilizer system of the instant invention is used to provide control in water, air and other fluids. The drag or pressure coefficients and the similarly defined lift coefficients are primarily a function of shape and attitude of the primary body which is under consideration. Under certain conditions, the flow pattern in the vicinity of a fluid suspended body and the nondimensional coefficients, are identical in air, water or in other liquid or gaseous fluids. It becomes obvious, therefore, that the instant invention employs fluid dynamic characteristics of a particular body configuration, the primary example being a cylindrical body, exposed to a flow in a water medium, but the same fluid dynamic characteristics can be also predicted from experiments in a different medium. In some instances, there are certain less defined specific proportions such as compressibility which have only a negligibly small effect upon actual flow patterns and flow forces.

In the instant towed body structure, in at least one and possibly in several particular points on the front of the body exposed to a flow of fluid, the impinging fluid particles come to rest. In other words, their velocity approaches zero at these specific points. During their deceleration, the momentum of the particles is transformed into static pressure. This pressure increment is commonly called dynamic pressure, probably because of its equivalence in terms of a dynamic quantity. In most cases, disregarding the range of very small Reynolds numbers, aero and hydrodynamic pressures and forces are in many conditions and at least predominantly proportional to the dynamic pressures, which can be conveniently related to flow forces. It follows therefore that fluid dynamic forces also change with the size and shape of the body involved.

The appearance of voids which are filled with vapor instead of water, commonly called cavitation, can be encountered in water, and in other liquids, at high velocities. Under low velocity towing conditions, cavitational effects on the body and its stabilizer system need not be considered.

In addition to cavitation, perhaps the most important effect which makes flow patterns in water different from those in a lighter fluid such as air, is that of the free surface. Bodies positioned in a substantially vertical position, penetrating through the water surface, must be considered with regard to drag through wave and spray. If the surface piercing solid has a streamlined shape, its friction or profile drag is comparatively small. As the towed structure speed increases, water piles up at the front and a certain hollow forms in the fluid directly behind the towed body, with the resulting additional drag being called wave drag. Another form of drag involving surface piercing solids is that concerned with water piling up along the forebody of the towed structure which continues upward and sideways into the air, thus forming a spray or jets of water shot into the air.

It may be thus seen, that the problems inherent in providing a stabilizer system for a towed body maintained in the vertical attitude, are extremely complex and require rigorous design analyses. It is only recently, with the advent of computerized study, that the effect of drag has been reasonably understood and made possible the towable structures of the instant invention which can be axially controlled.

Empirical studies, while inadequate by present day standards, have resulted in prior art foil structures which have inadequately provided for some vertical stabilization of towed bodies. In the prior art rapid vertical fluid descent has been traditionally achieved by means of uniformly spaced fins, commonly four in number, which do not lend themselves to the further function of towing stabilization. Cable supported probes have been supported by attachment to their top ends, rather than at their transverse drag centers, thus deriving no benefit from elevating the drag center by means of additional fluid flow surfaces.

It is also known that towed bodies can be stabilized to maintain a particular attitude referenced to the direction of fluid flow by means of aircraft type tail and foil structures, although no solution has been available respecting the requirement for the stabilization of a substantially elongated cylindrical body and to maintain it in a vertical attitude during horizontal towing through a fluid. The requirement that the stabilizer system must stow in a narrow annular space and be automatically deployable makes the problem vastly more difficult. Unlike the instant invention, conventional towed bodies are not stabilized by dihedral effect. Other prior art attempts to provide for vertical attitude stabilization have been ineffective and often require long trailing plates and streamlined afterbodies to reduce the effects of fluid vortex shedding, neither of which are compatible herein with the requirements of compact packaging and descent stabilization during fluid drop. Typical towed body stabilization systems are disclosed in U.S. Pat. Nos. 3,159,806 and 3,327,968.

SUMMARY OF THE INVENTION

It is the purpose hereof to make possible stabilized bodies which are subject to fluid dynamics. The demands not only of aerospace environments but also of miniaturization and dense packing requirements have demanded a new level of design sophistication heretofore unknown in the industry. The stabilizer system of the instant invention represents a departure from the hereinabove discussed designs of the prior art. The invention is a result of a detailed study of the complex mechanisms and the symbiotic elements involved in towed body stabilization. The invention overcomes the foregoing limitations of the prior art and provides for a novel system which is technologically an advance in the art, with this design being economically capable of implementation by current manufacturing techniques.

It is accordingly, an object of this invention to overcome the foregoing limitations and to provide a novel stabilizer system for bodies to be towed in a vertical attitude through a fluid.

It is a further object of the invention to provide for a novel fin structure in combination with a bridle assembly to provide for vertical attitude body stabilization.

It is a still further object of the instant invention to provide a fin stabilizer mechanism which is stowable in a narrow annular space surrounding a cylindrical body, and which is rapidly deployable in an automatic fashion to stabilize the body in a substantially vertical attitude during fluid descent, with such descent being along a substantially vertical helical trajectory.

Another object of the instant invention is to provide for a bridle and fin combination; the bridle serving to link the main body to a supporting member, with the bridle and fins acting in combination to stabilize a cylindrical body to maintain said body in a vertical attitude while under the influence of transverse fluid flow.

A still further object of the invention is to provide for a fin and bridle assembly which increases righting moment of a body during passage of said body through a fluid, causing said body to maintain a vertical attitude under disturbing fluid flow conditions.

Another object of the invention is to provide for a folding fin assembly with a hinge axis along an element of the parent body.

Another object is the provision of a towable body having a fin and hinge assembly with said hinge including spring loading means to provide for torsion spring hinge action whose opening is fixed by positive stop fin tabs.

Another object of the instant invention involves providing for flow controlling perforations as part of the fin structure to minimize vortex shedding fluid disturbing forces, said fin perforations being part of stabilizer fin surfaces which produce directional stability by means of dihedral effects on drag plates.

Another provision of the instant invention is to make possible the vertical stabilization of a substantially elongated cylindrical body within a fluid while maintaining said body stable while under the influence of steady-state fluid flow at various speeds.

Another important objective of this invention is to make possible an efficient design for the economic manufacture of a towed body stabilization system, with the stabilizer system comprising fins which are self-deployable and capable of establishing and maintaining a deployable attitude.

A particular object of the invention is to provide for stabilization of a long cylindrical body to tow in a vertical attitude while under the influence of dynamic fluid flow and which provides for directional stability by means of a dihedral effect as a result of fluid drag.

The manner of construction, assembly, and use of the invention can be more clearly understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a preferred embodiment of the stabilizer system as related to a underwater cylindrical structure; and

FIG. 2 is a top view of the sub-surface probe; and

FIG. 3 illustrates a top view of the sub-surface probe illustrating the bridle attachment thereto; and

FIG. 4 is a partial section of the probe taken along lines IV—IV of FIG. 3; and

FIG. 5 shows the top view of the sub-surface probe with extended fins; and

FIG. 6 is a side view showing the hinged fin assembly; and

FIG. 7 shows a cutaway of the fin attachment to the underwater probe; and

FIG. 8 is a cross section side view of the fin hinge assembly in the towing mode taken along section VIII—VIII of FIG. 6; and

FIGS. 9A and 9B is a cross sectional side view of the preferred hinge and fin assembly tab.

DETAILED DESCRIPTION OF STABILIZER SYSTEM EMBODIMENT

FIG. 1 illustrates the forces imposed and the attitude assumed by the sub-surface probe 1, the fins 2 functioning to stabilize the body as referenced to an impressed fluid flow thereupon, in conjunction with the supporting and towing bridle shown in FIG. 3, while the system being totally submerged in water, being towed in the direction noted by arrow 8. The towing bridle cable 7 and towing bridle spreader 3 being attached to a second cable 25. The towing bridle attachment located along sub-surface probe 1 at 4, is located at the center of the horizontal fluid dynamic drag 5 of the sub-surface probe as shown by the arrows in FIG. 1. The bridle attachment point locating the placement of such metal band 19 is positioned horizontally at the bridle attaching horizontal level.

The net gravity force (identified by arrow 6) acts upon the towed body in the illustrated manner. The supporting and towing cable tension force is represented by arrow 7' aligned with towing bridle cable 7. The three forces, 5, 6, and 7', as represented by the arrows, are in static equilibrium during fluid flow acting upon the sub-surface probe and its fin assembly. The fin perforations 9 provide flow control forces with respect to the body. These holes 9 are preferably circular and located close to the hinge assembly. They may be slotted or elongated in shape, but preferably are shaped as illustrated to achieve superior results. The finned bridle system employs a combination of fluid flow controlling surfaces and apertures, such as the fin openings 9 which annihilate the cyclic vortex-generated fluid mass shedding which is associated with transverse fluid flow past the cylindrical body 1, to provide for the reduction of disturbing forces produced by such unbalanced fluid mass flows, as illustrated in FIG. 1 above.

The instant stabilizer system incorporates a two-leg 7 supporting bridle system as shown in FIG. 3 which is secured to an elongated cylindrical body 1 at its transverse drag center 20 and 21 such that no moment is produced between the supporting force and any drag force, inasmuch as such moment would induce the body 1 to pitch away from a vertical attitude. Fin devices 2 are provided in the preferred embodiment in the form of complementary pairs, shown in FIG. 5, and are joined to the parent body 1 by a hinge assembly 10 so that they will readily fold to a nested position as shown in FIG. 2, thus stowing in a narrow annular space immediately adjacent and contiguous with the parent body 1. While the prior art does provide for other folding stabilizer devices that could conceivably stow into annular space nested close to the parent body, because of their chordal hinge mechanisms these devices such as rotochutes and dive brakes do not stow entirely within an annular space similar to 14 nested immediately adjacent the parent body 1, as herein described.

As shown by the elevation view in FIG. 2, the fin hinges 10 are precisely located on the sub-surface probe exterior portion enabling the fins to swing to a nested position in the narrow annular space 14 provided thereat. The fins 2 shown in FIG. 2 are in their stowed position. This novel design enables the entire probe assembly with bridle and fins to be stowed or packaged within a tube prior to launching. The towing bridle spreader 3 along with the bridle cable 7 is also shown in its stowed position on top of probe assembly 1, with envelope 17 depicting the package in which the folded equipment must stow.

The bridle attachment point locating band 19, preferably of steel construction, shown in FIGS. 3 and 4 is secured by means of pin 26 at the ends thereof. Towing bridle cable 7, preferably of high tensile strength steel, is secured to the precise towing point by band 19 while metal or plastic towing spreader 3 provides for ease of attachment to towing line 25. Cable 25 may also perform the function of a strain relief attachment member. With specific reference to an application in combination with an AN/SSQ-50 (XN-1) sonobuoy of 4.5 inches diameter at the bottom portions of body 1, and 4.25 inches diameter at its upper portions 41 (at the section where the fins 2 are fixed), the body 1 being 27.2 inches in length, it was determined that the optimum tow point for this water sub-surface probe is located 4.19 inches (16.91 inches from the bottom of body 1) below the weld bead 71 of the cable housing assembly, and illustrated generally by FIG. 1. The stabilization system employed a ring spreader 3 of 4.38 inches width (distance between cables 7). The tow model sonobuoy included a one pound cable canister, a two pound dummy sonar package contained in body 1 along with a 19.5 pound transducer and 2.25 pound dummy battery inclinometer assembly. In the upper 4.25 inch diameter section 41 was placed a 5-pound dummy cable coil in shallow configuration. The established tow point 20 and 21 is that fixed point on a towed body 1 through which the action line of the towing force is always directed, as in FIG. 1. In the aforedescribed specific tow point determination, it becomes the midpoint of the chord connecting the two towing bridle points 20 and 21. These tow points can be readily identified with respect to sonobuoy applications as a specific distance below some arbitrary point on the sub-surface assembly 1, and more specifically with reference to the AN/SSQ-50, the weld bead 41 on the standard cable housing assembly. The stabilizer fin 2 configuration employed for the testing program of the hereinabove embodiment had a taped hinge with a 9.0 inch span; having a 3.5 inch chord, a 2.12 inch radius, 6.0 inch length, and three 1.0 inch diameter round holes located adjacent hinge 10 and spaced the length thereof. It has been found that stability is improved by using a seven hole structure. In this embodiment, the tow harness employed consisted of two 30-inch flexible legs anchored at the extremity of the body and recessed into diametrically opposed milled slots along its length, with their point of emergence, the tow point, being adjusted axially by a sliding clamp ring **19**. The two legs **7** were separated by a spreader ring **3** constructed of a rigid plastic. A steel cable **25** was used for towing. A series of test programs respecting this embodiment provided voluminous data and computer reduction and analysis which provided the determination that pitch can be independent of tow speed within a fluid if the proper tow point is established. Functionally, this has thereby provided that the moments of the hydrodynamic drag forces about this optimum tow point for each body and system can be established in balance and will thereafter remain in balance for all speeds. As shown in FIG. **4**, the steel bridle cable connecting band **19** surrounding the probe housing **1**, is secured at the ends thereof by pin **26**. Other means of connection, as well as other types of securement to the probe **1** can be employed, however, it has been found that ease of assembly and the required precise attachment of towing cable **7** to the housing **1** can be realized by use of the illustrated band structure.

In FIG. **5**, the fins **2** are shown in their operating position and attached to the probe **1** at hinges **10**. An elastomer tensile member **32** may be provided for additional fin opening force. As shown in FIG. **7**, a torsion spring hinge pin **44** may be alternately provided to deploy the hinges to their opened operating position. Also illustrated in FIG. **7** is a hinge connection to the sub-surface probe section **45** by use of fastener **42** making attachment to hinge assembly **10** depicted in its stowed position. FIG. **8** shows the towing position of fin section **2** while illustrating the hinge stop contact **56** which limits the travel thereof. In a preferred embodiment (FIGS. **9A** and **9B**), a novel rigid tab **64** integral with the fins **2** is provided to accurately position and maintain the desired operating fin angle. The abutting tab **64** makes direct contact with the body **62** to precisely provide for the desired deployed fin **2** angle. Hinge pins **60** and tabs **64** are preferably of hardened steel.

In the physics respecting this invention, the applicants have found that a right cylinder **1** towed with its axis essentially normal to the stream, discharges vorticity at a rate dependent upon its diameter, its speed of tow, the free fluid stream turbulence, and the motion of the cylinder per se. The cylinder **1** is subject to variable forces (FIG. **1**) acting normal (lift and parallel drag) to the relative fluid stream and acting normal to the axis of the cylinder. As a result thereof, the cylinder **1** responds by oscillating at the same frequency as the imposed forces and with an amplitude governed by the various elastic and inertial impedances that are present.

For Reynolds numbers (defined in the art as the value of the ratio VD/ν; with V being the velocity; D being the diameter; and v being the kinematic viscosity), below about 2×10^5 the discharge of vorticity is assumed periodically with $f=0.2V/D$. With higher Reynolds number values, the frequency is no longer descrete but is characteristically random.

It has also been observed through applicant' invention that the results reported for Reynolds numbers below 2×10^5 are not perfectly periodic, and consequently suggest a condition of exhibiting a strong peak in the spectral density near the value 0.2 for the ratio fD/V. It has been further found that the motion of the main cylinder tends to impress a predominant shedding frequency on the vorticity discharge. Axial testing of the stabilizer system indicates that a broad range of excitation frequencies exists, and that a band of frequencies containing the bulk of the energy is dependent upon the Reynolds number, the impedance of the cylinder itself, and the turbulance of the fluid medium. It is also dependent on the cylinder shape, the vorticity discharge not being usually coherent along the cylinder length.

It is thereby seen that the performance factors of applicants' invention are a result of a broad array of influences. These influences are critical to the performance and vertical alignment of the towed body **1**. A large number of tests have been made respecting variations in the fin **10** design, location point, angle of attachment, size, as well as their relationships with respect to body **1** diameter and length, as a function of fluid flow rates. During the testing program it was learned that more dihedral tended to correct the slight sweepback of the fins which allowed water to become piled up and released in large masses during towing. Other tests showed that the preferred cant might be caused by flow through a centrally located slot **9** in the fin, with the flow passing over the back side of the fin, thereby holding it canted by air foil action. Also observed was turbine blade effects with respect to fluid flow spilling off the canted side of the buoy-fin assembly. In such cases, the tow force must be adequate to balance the net dihedral force taken in combination with all flow reaction forces impinging upon the entire assembly.

Due to the requirements of packaging inherent in air droppable sonobuoys and other sensor systems, the transducer element per se must ordinarily be of a cylindrical configuration. This shape does not lend itself immediately to a towed body application. Shear currents common to many oceans tend to establish a condition of tow in which the submerged transducer is towed along by the surface transmitting or telemetering buoy. Because of the narrow beam nature of the directional sonobuoy transducer, it must be stabilized to tow in a vertical attitude under all current conditions, in other words, under all dynamic fluid environments. The applicants' theoretical analysis shows that a vertical tow attitude can be maintained in static equilibrium if the body is towed from the force center; and that no other attachment point will yield a tow attitude independent of tow speed. However, the applicants also have found that the dynamic nature of the water flow about the cylindrical body introduces disturbing forces which tend to make the body unstable in a dynamic environment (in tow), especially at speeds at which vortex shedding becomes sympathetic with the natural frequency of the system, as hereinbefore discussed.

These disturbing forces are resisted by the stabilizing forces inherent in the righting moment produced by the elevation of the buoyancy center over the gravity center as referred to in FIG. **1**, and by the righting moment produced by the elevation of the tow point over the gravity center. This latter righting moment is increased by the addition of extended surface fins **2** at the top portion **41** of the transducer which act to raise the center of drag and thus elevate the tow point **4** above the fixed mass to resist the disturbing vortex shedding forces. The hinged fins **2** which would rest about the upper portion **41** of the cylindrical body **1** are provided such that they spring open after deployment from a tubular container so that each fin **2** assumes a sweptback attitude of approximately 135° from the forward direction. To further control the fluid flow and reduce fluid shedding off the fins **2**, openings **9** near the body were found necessary.

In another invention embodiment, the body **1** in FIG. **1** was fitted with fins **2** being of 4 ¾ inches long and 2 ⅞ inches wide onto a body **1** of 4 ¼ inches diameter and having a total length of 27 inches. Seven fin openings **9** were provided with the configuration as shown in FIG. **1**. The tow point was selected as located 14 ½ inches from the lower end of body **1**, with the center of fins **2** being located 3 ¼ inches from the body **1** top surface. The fins **2** were located 1 ¼ inches back of the body **1** center line and separated from each other by 4 ½ inches along the body **1**. This particular probe assembly **1** is commonly known as AN/SSQ-50.

In another embodiment, 6 inch fins **2** having a 2 ¾ inch arc, were used on a 4 ½ inch diameter probe assembly **1** commonly known as AN/SSQ-47, to provide for fins opening at an angle of 135° ± 10°. In this embodiment the fins **2** are located off-center and positioned at a 2 degree (plus-or-minus one degree) angle from the vertical, the top of the fin hinge **10** being further aft than the bottom thereof. The off-center position of the fins **2** creates a disturbing drag force which causes the probe to gyrate and slow the descent rate. The slight fin angle is significantly important since it counteracts this condition to provide for a smooth helical glide pattern. An improvement thereover enabling the use of the same fin **2**, whether it be right or left hand fin **2**, has been accomplished which further provides for manufacturing efficiency and assembly cost reductions. The material used is a cold rolled steel of 0.031 inches thickness, with appropriate spring steel being used for the tab **64** welded portion (FIG. **9A**), and spring wire **60** used in the spring hinge **10** assembly. While the hinge illustrated in FIG. **9A** and **9B** is preferred, the spring tabs **39** and **40** may also be conveniently employed, although less effectively due to less precise positioning of fins **2**. The spring device is of the wire torsion type which enclosed within the loops of the hinge **10** and cranked to bear on the fin at one end **39** and on the body at its other end **40**, acts both as the deployment spring and the hinge pivot pin. Once deployed, the various spring hinged devices of the invention cause the fin to bear against a positioning stop to thus establish and maintain the deployed fin attitude. Also illustrated in FIG. **6** is elastic member tie down **37**, more conveniently shown in FIG. **5** wherein elastic band **32** assists in fin **2** deployment.

It may thus be seen that the cooperating relationships hereof are critical. Also realized herein is the stabilization of a long cylindrical body to tow in a vertical attitude, whose stowable folding fins **2** have a hinge **10** axis along an element of the parent body **1** rather than along a chord thereof. Also efficiently realized is the utilization of two off-center tail fins to stabilize vertical descent of a body by inducing a steep helical glide slope. To provide for towing there is herein described a compact, flexible gimbaling bridle assembly. Any deviation in the symbiotic elements hereof must be carefully regarded so as to maintain the hereinabove described critical cooperating relationships.

It is thus apparent to those skilled in the art that various modifications of the invention can be made without departing from the concept hereof, and since various changes can be readily made as a matter of choice or desire, it is intended that all matter contained herein shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A self deployable fluid stabilization system comprising, in combination,

a. a cylindrical body,

b. an elongated probe mounted within said body, said probe and said body defining a narrow annular cavity therebetween,

c. fins stowed within said cavity, said fins being hinged to said probe with the hinge axis being along an element thereof,

d. spring means cooperating with said hinge to deploy said fins upon probe ejection from said body, and

e. tab stop means adapted to position said fins in a deployed attitude.

2. A system for the stabilization of an elongated probe within a fluid as defined in claim **1** wherein said fins are hinged to the probe along an element thereof, the hinge line being positioned off-center along the probe and pitched at an angle from the vertical, to thereby provide dihedral effect stabilization.

3. A system for fluid stabilization as in claim **1** wherein a flexible gimbaling bridle assembly is attached to said probe at the transverse drag center thereof.

4. A method of stabilizing an elongated cylindrical body while being towed in a vertical attitude through a dynamic fluid wherein the body has defined thereon upper and lower portions comprising the steps of attaching a towing bridle to the body at the transverse drag center of the body, towing said body by means of said bridle wherein substantially the forward one half of the body throughout its length and with respect to the direction of movement will be subjected to pressure from the fluid, stabilizing the upper portion of said body while towing by means of fins affixed to the upper portion and trailing said body forward half, and regulating vortex shedding disturbing forces occurring at the fins.

5. A method of stabilizing an elongated cylindrical body while being towed as in claim **4** including the step of resiliently biasing the stabilizing fins to the operative stabilizing position during towing.

6. A towed body stabilization system comprising, in combination,

a. an elongated cylindrical body having upper and lower portions and a transverse drag center,

b. a flexible gimbal bridle assembly attached to said body at said transverse drag center,

c. hinge means affixed to said upper portion having a pivot axis extending in the general direction of the length of said body, and

d. a pair of stabilizing fins connected to said hinge means for pivotal movement with respect to said body about said axis, said fins being disposed on opposite sides of the center of said body and extending rearwardly from said body with respect to the towing direction.

7. A system as in claim **6** wherein said bridle assembly includes a pair of flexible cables each having first and second ends, cable spreader means, means connecting said cable first ends to said spreader means, means connecting said cable second ends to said body transverse drag center, said cable second ends being connected to said body at substantially diametrically opposed locations defined at the sides of said body with respect to the direction of towing, and a tow cable attachment defined on said spreader.

8. In a system as in claim **6** wherein said hinge means comprise a pair of hinges on said body, a fin being connected to each hinge and the axes of said hinges being substantially parallel to the longitudinal length of said body.

9. In a system as in claim **6** wherein a plurality of perforations are defined in said fins for minimizing the vortex shedding disturbing forces occurring at said fins.

10. In a system as in claim **9** wherein said fins are of a concave configuration with respect to the direction of towing.

11. In a system as in claim **6**, spring means associated with said fins biasing said fins to the operative tow stabilizing position.

12. In a system as in claim **11**, stop means defined on said fins adapted to engage said body and position said fins relative to said body under the influence of said spring means.

* * * * *