

Stabilizer for Spar Buoy

The present invention relates to a device for suppressing or preventing a spar buoy installed in the water from inclining or yawing due to tidal currents, waves, and the like.

Pull-in mooring type spar buoys, which are so arranged that a buoyancy body is provided halfway on a marker mast, the bottom end of the marker mast being moored to a sinker sunk at a water bottom by a mooring device, and that the buoyancy body is pulled in the water so that the water line comes halfway of the marker mast above the buoyancy body, thus allowing the spar buoy to erect in the water by buoyancy, are less in separation length and relatively less in yawing. Therefore, they have been used in navigational aids, boring equipment, and the like.

However, the marker mast is erect over a range from nearly the water bottom to the water surface in installation, thus subject to direct effect of tidal currents and waves, such that the spar buoy may incline or yaw. When the spar buoy is used in relatively shallow waters, the spar buoy will more likely undergo such inclination and yawing.

According to the present invention there is provided a spar buoy having a stabilizer comprising a buoyancy body provided halfway on a marker mast, the bottom end of the marker mast being adapted to be moored to a sinker sunk at a water bottom by a mooring device, and the buoyancy body being pulled in the water so that the water line comes halfway of the marker mast above the buoyancy body, at least two arms, extending in opposite directions to each other from the marker mast below the buoyancy body, and blades provided at end portions of the arms, so that the blades incline downward from inner edges to outer edges of the blades with respect to the arms, thereby forming angles between the arms and the blades.



Preferred embodiments of the invention will now be described by way of example with reference to the drawings in which:

Figure 1 is a side view showing a state in which a prior-art spar buoy is installed in water current;

Figure 2 is a side view showing a state in which a spar buoy provided with a stabilizer according to the present invention is installed in a water current;

Figure 3 is a side view showing a state in which the spar buoy provided with the stabilizer of the invention is perfectly stabilised in its erected state in a water current;

Figure 4 is a side view showing a state in which a spar buoy having blades attached thereto without providing an angle of attack to the arms is installed in a water current;

Figure 5 is a side view for explaining the yawing about the spar buoy's center of gravity;

Figure 6 is a side view for explaining the yawing about the spar buoy's mooring point;

Figure 7 is a side view for explaining the prior-art example for suppressing the yawing about the spar buoy's center of gravity;

Figure 8 is a side view more concretely showing an example of the spar buoy provided with a stabilizer of the present invention;

Figure 9 is a plan view showing a state in which four arms are protruded at 90 degree intervals with respect

to the marker mast and a blade is attached to the end of each arm;

Fig. 10 including graphs showing the result of effect verification tests on the stabilizer of the invention, Fig. 10 (a) shows tide-resistance characteristics and Fig. 10 (b) shows wave-resistance characteristics;

Fig. 11 is a view showing a modification of the blade;

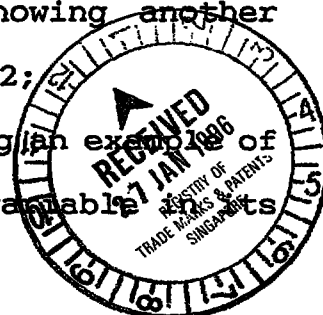
Fig. 12 is a schematic view showing examples of the mechanism for folding the arm at its base portion and the mechanism for securing the arm in its laterally stretched state;

Fig. 13 is a schematic view showing another example of the mechanism as shown in Fig. 12;

Fig. 14 is a schematic view showing an example of the mechanism that allows the blade to be variable area;

Fig. 15 is a schematic view showing another example of the mechanism as shown in Fig. 14; and

Fig. 16 is a schematic view showing yet another example of the mechanism other than shown in Figs. 14 and 15.



For example, referring to a case where a mooring rope is used as the mooring device, the spar buoy is normally urged upward by buoyancy, giving rise to a possibility that the spar buoy may show two modes of yawing as shown in Figs. 5 and 6. Mode 1 yawing (Fig. 5) is a pitching about the spar buoy's center of gravity, while Mode 2 yawing (Fig. 6) is a pitching about the mooring point. When another mooring device is used, there may occur another yawing that the spar buoy turns about its center axis.

The natural period of these types of yawing of the spar buoy, differing depending on water depth (i.e. size of the spar buoy) and the mooring device's length, is, for example, 2 - 3 sec. for the pitching in Mode 1 and 18 - 20 sec. for the pitching in Mode 2, in the case of a 20 m water depth and a 2 m mooring rope length.

The shallower the water depth, the shorter the natural period of Mode 2, while the shorter the mooring rope length, the shorter the natural period of Mode 1.

The Mode 1 pitching (Fig. 5) will not occur when the mooring device used is a direct-coupled mooring type such as universal joint (rope length: 0). Conversely, it may occur when such a mooring device as a short chain is used in order to facilitate control of water depth or to

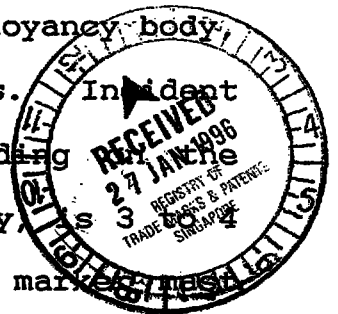
facilitate installation and relocation for use of boring.

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Also, the spar buoy may incline when undergoing a resistance to water currents such as tidal currents. 5 Slow water currents, which cause the spar buoy to less incline, are negligible. However, a little faster water currents will cause a greater inclination, such that a beacon-use spar buoy may result in an inclined lamp and therefore in its deteriorated function as a beacon, or that 10 a boring-use spar buoy may result in an inclined working scaffold with worsened workability.

Also, when a water current impinges upon the marker mast or the columnar portion of the buoyancy body, 15 there may occur Karman vortices or flutters. Incident cycle of Karman vortices, differing depending diameter of marker mast and the flow velocity, is 3 sec. for a flow velocity of 3 knots and a marker diameter of 0.6 to 0.8 m. The flutters, on the other hand, 20 will occur at the natural period of Mode 2. These phenomena will act on the spar buoy as a vibromotive force. Waves also act as a vibromotive force.

Accordingly, when the natural period of yawing of the spar buoy approaches the period of waves or the 25 incident period of Karman vortices due to water currents,



both the waves and the water currents being external forces, there will occur Mode 1 (Fig. 5) and Mode 2 (Fig. 6) yawing, which may impair the function as a spar buoy.

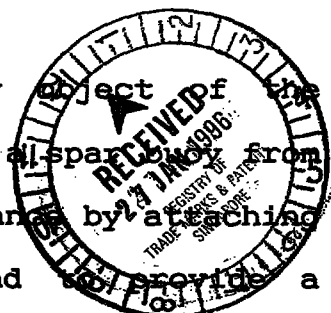
5 A means for suppressing the Mode 1 yawing (Fig. 5) out of the possible two types of yawing of the spar buoy may be to attach totally four sheets of resistance plates a to the marker mast in such a way that they are shaped into a planar cross (see Fig. 7). This arrangement allows
10 the spar buoy to be prevented from Mode 1 yawing and besides suppressed to be inclined.

On the other hand, a means for suppressing the Mode 2 yawing (Fig. 6) may be to attach totally four sheets
15 of resistance plates to the marker mast so that they are shaped into a planar cross, as in the above case, at a portion away from the center of yawing, for example underneath the draft point of the marker mast. With such an arrangement, although the damping force becomes larger,
20 yet the spar buoy is more likely subject to grain movement due to waves, resulting in an increased possibility of yawing. Moreover, water-current resistance applies also to the resistance plates attached to the marker mast, causing the spar buoy to be further inclined. Thus, this means
25 cannot be said proper for the suppressing means.

In particular, spar buoys installed in the seas shallower than a 20 m water depth become smaller in natural period of Mode 2 yawing (Fig. 6), such that it approximates to wave periods of design conditions (e.g. 8 - 12 sec.), entering the resonance range. However, there has been available no effective means for suppressing yawing in such a case up to now, which has been a problem.

Also, there has not been found out a way for suppressing or preventing the spar buoy's inclination due to water currents. Therefore, up to now, it has been considered impossible to provide such spar buoys as are subject to less inclination to both waves and currents.

Accordingly, it is a primary object of the present invention to suppress or prevent all spar buoy from inclinations due to water-current resistance by attaching a simple device to the spar buoy, and provide a stabilizer for suppressing a spar buoy from yawing of Mode 1 (Fig. 5) and Mode 2 (Fig. 6) as well as such yawing that the spar buoy turns about its center axis, and also provide a device which facilitates the handling of the stabilizer.



The stabilizer of the present invention comprises: at least two arms 8, 8 protruded in opposite directions to each other from a marker mast 2 below a buoyancy body 1, and blades 9, 9 attached to ends of the arms 8, 8 so as to have a positive angle of attack α toward the center of the buoy.

Preferably, the arm 8 is provided with a hinge 10 for folding the arm 8 at its base portion, and a securing means 11 for securing the hinge 10 in such a state that the arm 8 is stretched laterally.

Also preferably, the blade 9 is arranged to be variable in its overall area.

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Function:

The function of the present invention is now described with reference to Figs. 1 through 4.

Fig. 1 is a side view showing a state in which a prior-art spar buoy is installed in a water current, illustrating a case where a restoring moment M_r due to a buoyancy P and an overturning moment M_o due to a water-current drag F are balanced at a tilt angle θ' .

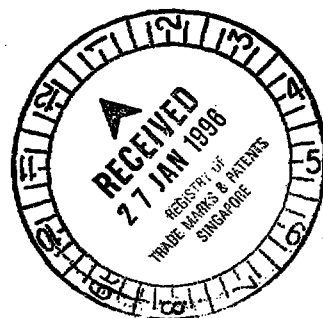
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Fig. 2 is a side view showing a state in which a

buoy equipped with the stabilizer according to the present invention is installed in a water current, illustrating a case where, by providing a positive angle of attack α to the blades 9, restoring moments M_{L1} , M_{L2} due to lifts L_1 , L_2 of the blades 9, a restoring moment M_P due to a buoyancy P , a drag F of the spar buoy, and an overturning moment M_t due to drags D_1 , D_2 of the blades 9 are balanced so that a smaller tilt angle θ results, thus the case being more stable than that of Fig. 1.

Fig. 3 illustrates a case where, by appropriately selecting the length of the arm 8, the area of the blades 9, and the angle of attack α of the blades 9 to the arm 8, a restoring moment M_t and a restoring moment M_L are balanced so that the spar buoy is perfectly stable.

On the other hand, Fig. 4 is a side view showing a state in which a spar buoy having blades 9' attached thereto is installed in a water current without providing an angle of attack to the arm 8, where lifts L_1 , L_2 of the blades 9' act in such a way that moments M_{L1} , M_{L2} cancel each other between upper and down stream sides, without restoring moments being generated, but with an overturning moment increased due to lifts D_1 , D_2 of the blades 9', so that the spar buoy is greatly inclined (tilt angle: θ') as



in Fig. 1. Fig. 4 implies that even if the blades 9' are attached without providing an angle of attack to the arm 8, the spar buoy cannot be restored from inclination, but will be increased in inclination. Therefore, it can be easily understood from this figure that restoring moments cannot be effective without providing a positive angle of attack α to the blades 9 as in the present invention.

It is noted that Figs. 2 to 4 takes a case where the arm 8, 8 protruded in opposite directions to each other from the marker mast 2 are aligned with the direction of current. Taking this case, the principle of the stabilizer of the present invention is described hereinbelow.

Assume that the angle of attack of the blades 9 to the arm 8 is α , the area of the blades 9 is A_w , the flow velocity of water current is V , the length of the arm 8 (distance from the lift center of a blade 9 to the center axis of the marker mast 2) is l_1 , the projection area of the spar buoy below the water surface in the direction of current is A_s , the lift coefficient of the blades 9 is C_l , the lift coefficients of the blades 9 for a spar buoy's inclination of θ are C_{l1} , C_{l2} , the drag coefficient of the spar buoy is C_d , the drag is F , and the distance from the center about which the drag F acts to the mooring point is

l_2 .

To the blades 9, 9 there will occur lifts L_1 , L_2 and drags D_1 , D_2 , respectively, where the drags D_1 , D_2 are smaller than lifts L_1 , L_2 . A lift will occur vertically downward to the upstream side blade 9 as indicated by L_2 in Figs. 2 and 3, and upward to the downstream side blade 9 as indicated by L_1 in Figs. 2 and 3. Accordingly, due to these lifts L_1 , L_2 , restoring moments M_{L1} , M_{L2} will act on the spar buoy in such a direction as to cancel its inclination. In addition, when arms are protruded also in opposite directions to each other orthogonal to the current and blades are attached respectively to ends of the arms at an angle α , then the angle of attack of both blades to the water current is 0 (the same as in the spar buoy's erected state), where both blades undergo only drags (no lift occur), but the pressure-receiving area and drag coefficient are so small that the tilt moment even with the tilt moments due to the drags D_1 , D_2 of the blades 9 on the flow-direction side added thereto is substantially smaller than the restoring moment M_L . Therefore, the fluid force that acts on the blades 9 on the flow-direction side acts on the spar buoy as a restoring force, with the result of a reduced inclination angle.

Relations among the drag F of the spar buoy, lifts L_1 , L_2 of the blades 9, 9 on the flow-direction side tilt moment M_t of the spar buoy, and its restoring moment M_r are as represented by the following equations, where if
5 the tilt moment M_t and the restoring moment M_r are approximately balanced by appropriately selecting the values of the area A_v of the blades 9, the length l_1 of the arm 8, and the angle of attack α , it becomes possible to restore or prevent any inclination of the spar buoy
10 irrespectively of the flow velocity:

$$[\text{Formula 1}] \quad L_1 = \frac{\rho}{2} V^2 A_w C_{L1}$$

$$[\text{Formula 2}] \quad L_2 = \frac{\rho}{2} V^2 A_w C_{L2}$$

$$[\text{Formula 3}] \quad F = \frac{\rho}{2} V^2 A_B C_B$$

$$[\text{Formula 4}] \quad M_t = F \cdot l_2 \cos \theta$$

$$[\text{Formula 5}] \quad M_r = (L_1 + L_2) \cos \theta l_1$$

Next, as to pitching due to waves, and rolling in the direction orthogonal to the current due to the
15 vibromotive force of Karman vortices and flutter phenomena that will occur when water currents such as tidal currents

impinge upon the spar buoy, since the blades 9 are located away from the rotational center of the yawing and also away downward from the water surface, there is exerted a damping effect, and since water molecule motions of the waves are small, so that the wave force is small, resulting in a suppressed pitching motion and no occurrence of Mode 1 (Fig. 5) and Mode 2 (Fig. 6) yawing.

The general formula for this motion is as follows:

$$[Formula\ 6] \quad (I+J) \ddot{X} + N \dot{X} + K X = M$$

where X: pitching angle displacement;

$\dot{X}$: pitching angular velocity;

$\ddot{X}$: pitching angular acceleration;

I: moment of inertia of the buoy itself;

J: moment of inertia due to added mass;

N: damping coefficient linearly converted;

K: restoring force coefficient; and

M: an external force moment.

The blades 9 cause J and N to increase. In this case, M increases only a slight extent, so that the pitching momentum is small.

Also, rotational yawing about the marker mast 2



of the spar buoy is suppressed from the same reasons as in the above case, with no occurrence of yawing.

If the arm 8 is provided with a hinge 10 for
5 folding the arm 8 at its base portion and a securing means
11 for securing the hinge 10 in a state that the arm 8 is
stretched laterally, then the arm 8 can be held stretched
laterally as indicated by solid line in Fig. 8 while the
spar buoy is installed, by virtue of the arrangement that
10 the hinge 10 is held secured by the securing means 11.
Conversely, if the securing means 11 is released from the
hinge 10, then the long arm 8 can be folded at the hinge 10
portion as indicated chain line in Fig. 8, allowing the
buoy to be kept floating on the water surface as it is for
15 towing to the installation site, thus advantageous
transport.

If the overall area of the blades 9 is arranged
to be variable, lifts L_1 , L_2 , which are one of the elements
20 serving to restore or prevent inclination of the spar buoy,
can be easily increased or decreased by appropriately
selecting the area of the blades 9 after the spar buoy has
been installed.

25 Embodiments:

Embodiments of the present invention are described with reference to Figs. 8 through 16.

The stabilizer of the present invention can be applied to spar buoys for derricks, spar buoys for marker
5 lamps, spar buoys as platforms for marine observation use or platforms for leisure use such as sea-fishing and observatories, and the like. Fig. 8 illustrates a case in which the stabilizer of the present invention is attached to a spar buoy for use of derricks.

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The spar buoy for use of derricks as shown in Fig. 8 is to be used for geological surveys or boring work. In the spar buoy, a center pipe 3 is provided so as to penetrate a buoyancy body 1 and a marker mast 2, the lower
15 end of the center pipe 3 reaching the bottom plate of the marker mast 2 to open in the water, the upper end of the center pipe 3 being located at least above the water line. The center pipe 3 has a boring pipe (e.g. a boring casing pipe, rod, sampler, or the like) inserted through
20 within the center pipe 3 as designated by numeral 4. The marker mast 2 and the center pipe 3 are of double pipe construction, the exterior of the center pipe 3 being watertight and hollow so as to increase the buoyancy of the spar buoy, and the interior of the center pipe 3 allowing
25 water to enter up to the draft line. Further, at the top



of the marker mast 2 there is provided a working-use platform 5.

This spar buoy, as shown in Fig. 8, is installed in such a way that the lower end of the marker mast 2 is moored to a single sinker 7 sunk at the sea bottom by a proper mooring device 6, and the buoyancy body 1 is pulled in the water so that the water line comes halfway on the marker mast 2 which is upward of the buoyancy body 1. Then the boring pipe 4 inserted through within the center pipe 3 penetrates also the sinker 7 serving to moor the spar buoy, reaching ground G, which is the sea bottom and further extending into the ground, allowing the implementation of boring and sampling.

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At least two arm 8, 8 are protruded outward in opposite directions to each other from the marker mast 2 below the buoyancy body 1 (see Fig. 8). Also, a blade 9 is attached to the end of each arm 8 so as to have a positive angle of attack α toward the center of the buoy.

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The stabilizer of the present invention comprises at least two arms 8, 8, and the blades 9, 9 attached to the end of each arms 8, 8 so as to have a positive angle of attack α toward the center of the buoy referred to above.

The arms 8. 8 protruded in opposite directions to each other from the marker mast 2 may be at least two in number, whereas they may also be arranged four in number at 90 degree intervals with respect to the marker mast 2 as detailed on Fig. 9. Further, the number may be increased to 6, 8 and so on.

As shown in Fig. 9, a spar buoy in which four arms 8 were arranged at 90 degree intervals with respect to the marker mast 2 and a blade 9 is attached to the end of each arm 8 and a prior-art spar buoy having no such stabilizer were installed at a water depth of 18m. With this arrangement, their effect verification test were conducted. Results are shown in Fig. 10.

Fig. 10 (a) is a graph showing tide resistance characteristics, where the vertical axis represents buoy inclination (unit: degree), and the horizontal axis represents tide velocity (unit: knot). As apparent from the figure, the spar buoy provided with the invention stabilizer results in an inclination of the buoy of 1 degree at a tidal current of 2 knots (1.03 m/s). Thus, it can be understood that the inclination is substantially suppressed or prevented compared with the case in which the spar buoy has no stabilizer.

Also, Fig 10 (b) is a graph showing wave



resistance characteristics for a 3 m wave height, where the vertical axis represents buoy yawing (unit: degree) and the horizontal axis represents wave cycle (unit: sec.). As apparent from this figure, the spar buoy provided with the invention stabilizer results in a buoy yawing of 4 degrees at a 3 m wave height and a wave cycle of 8 sec. Thus, it can be understood that the yawing has been substantially reduced compared with the case in which the spar buoy has no stabilizer.

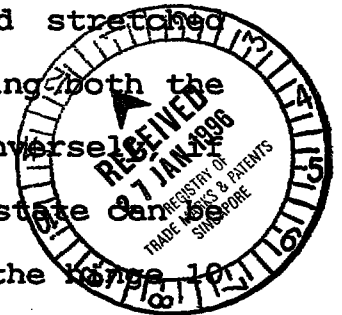
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The blade 9 as shown in Figs. 8 and 14 through 16 is a plate rectangular as viewed planarly and streamlined at its center portion as viewed laterally, but its shape is not limited in particular. Further, a mirror plate of circular shape as viewed planarly as shown in Fig. 11 is utilized as the blade 9.

The arm 8 is provided with a hinge 10 for folding it at its base portion as shown in Figs. 12 and 13, and a securing means 11 for securing the hinge 10 in a state that the arm 8 is stretched laterally. This allows the arm 8 to be stretched laterally as indicated by solid line in each of Figs. 8, 12, and 13, when the spar buoy is installed, by virtue of the arrangement that the hinge 10 portion is secured by the securing means 11. Conversely, if the

securing means 11 is released from the hinge 10, the long arm 8 can be folded at the hinge 10 portion as indicated by chain line in each of Figs. 8, 12, and 13. Thus, the spar buoy can be held as floating on the water surface for towing to the installation point, which is advantageous in transport.

The securing means 11 as shown in Fig. 12 is of the so-called flange type in which a securing plate 12 such as a liner is fixed at the base of the arm 8 by welding while another securing plate 13 is fixed also on the marker mast 2 side by welding, both securing plates 12, 13 being brought into contact and fixed by fixing devices such as bolt and nut. If it is arranged that the securing plates 12, 13 are in contact with each other with the arm 8 stretched laterally, the arm 8 can be held stretched laterally from the marker mast 2 only by fixing both the securing plates 12, 13 by fixing devices. Conversely, when the fixing devices are released, the securing state can be released, allowing the arm 8 to be folded at the hinge 10 portion as indicated by chain line.



Further, the securing means 11 as shown in Fig. 13 is of the color type in which a cylindrical body 14 is fitted on the outer periphery of the arm 8. If the

cylindrical body 14 is slid so as to come to the outer portion of the hinge 10 as indicated by chain line, the arm 8 can be held stretched laterally from the marker mast 2. Conversely, if the cylindrical body 14 is slid as indicated by solid line from the position indicated by chain line, the above fixed state can be released, allowing the arm 8 to be folded at the hinge 10 portion as indicated by chain line.

10 It is noted that the means for securing the hinge 10 so that the arm 8 is stretched laterally has been exemplified by referring to two cases, but the securing means is not limited only to these.

15 On the other hand, the blade 9 attached to the end of the arm 8 is preferably variable in its overall area. This is to allow the lifts L_1 , L_2 , which are one of the elements for restoring or preventing the spar buoy from its inclination, to be easily increased and decreased after
20 the spar buoy has been installed.

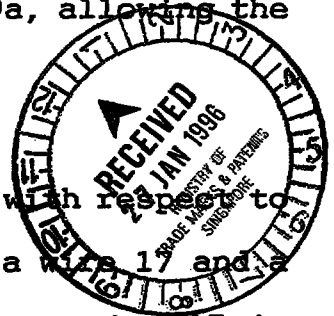
To make the blade 9 variable in its area, it is proper to divide the blade 9 into two sheets as designated by 9a, 9b so that with respect to a sheath-like blade 9a
25 another blade 9b can be slid, as shown in Figs. 14 to 16.

In order that the blade 9b is slid with respect to the sheath-like blade 9a, it is proper that one wire 15 is arranged within the sheath-like blade 9a and within the hollow arm 8, and a halfway point thereof is secured to a rod 9c of the other blade 9b, for example as shown in Fig. 14. Pulling either one of inner portions 15a, 15b of the wire 15 allows the blade 9b to be slid with respect to the sheath-like blade 9a, so that the overall area of the blade 9 can be easily changed.

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Further, the blade 9b can be slid with respect to the sheath-like blade 9a also by securing a cylinder 16 on the sheath-like blade 9a side and securing its rod 16a on the other blade 9b side, as shown in Fig. 15. That is, by remotely controlling the cylinder 16, the blade 9b can be slid with respect to the sheath-like blade 9a, allowing the blade 9 to be changed in its overall area.

Further, the blade 9b can be slid with respect to the sheath-like blade 9a also by combining a wire 17 and a spring 18 as shown in Fig. 16. That is, one wire 17 is arranged within the sheath-like blade 9a and within the hollow arm 8 as shown in Fig. 16 (a), and its outer end (right-hand end in the figure) is secured to the other blade 9b while springs 18, 18 are interposed between the



blades 9a, 9b corresponding to right and left sides with respect to the wire 17 as shown in Fig. 16 (b). Pulling the inner side of the wire 17 allows the blade 9b to slide and go into the sheath-like blade 9a against the urging force of the spring 18. Conversely, loosening the wire 17 allows the blade 9b to slide and go out of the sheath-like blade 9a by the urging force of the spring 18. By this arrangement, the blade 9 can be easily changed in its overall area.

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It should be noted that the mooring device designated by number 6 in Fig. 8 comprises two mooring ropes 6a, 6a attached to two points of the lower end of the marker mast 2 in the radial direction via a shackle, two mooring ropes 6b, 6b attached to two mooring rings 7a, 7a of the sinker 7 sunk at the sea bottom at two points planarly 90 degrees away from the two mooring ropes 6a, 6a via a shackle, and one mooring ring 6c for indirectly coupling the mooring ropes 6a, 6a, and 6b, 6b, each two in number for upper and lower ropes. When such a mooring device is used, the spar buoy installed in the seas shallower than 20 m in water depth result in a smaller natural period of Mode 2 (yawing as shown in Fig. 6), approaching the wave period of design conditions (e.g. 8 - 12 sec.) to enter the resonance range, in which case yawing

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may be increased.

According to the preferred embodiments of the invention, there is offered an advantage that the spar buoy can be easily suppressed or prevented from inclination due to water-current resistance when installed, while the spar buoy can also be suppressed from Mode 1 and Mode 2 yawing as well as such yawing that the spar buoy turns about its center axis.

The embodiments offer another advantage, in that since the long arm 8 can be folded at the hinge 10 portion, the spar buoy can be held as floating on the water surface for towing to an installation point, which is highly advantageous in terms of transport.

The embodiments offer a further advantage in that the spar buoy can be easily adjusted so as to be suppressed or prevented from inclination, only as required, by selecting the area of the blade 9 after the spar buoy has been installed, which allows the structure to be downsized.





Claims

1. A spar buoy having a stabilizer comprising a buoyancy body provided halfway on a marker mast, the bottom end of the marker mast being adapted to be moored to a sinker sunk at a water bottom by a mooring device, and the buoyancy body being pulled in the water so that the water line comes halfway of the marker mast above the buoyancy body, at least two arms, extending in opposite directions to each other from the marker mast below the buoyancy body, and blades provided at end portions of the arms, so that the blades incline downward from inner edges to outer edges of the blades with respect to the arms, thereby forming angles between the arms and the blades.
2. A spar buoy having a stabilizer as claimed in claim 1, wherein the arm comprises a hinge for folding the arm at its base portion, and a securing means for securing the hinge so that the arm is stretched laterally.
3. A spar buoy having a stabilizer as claimed in claim 1 or 2, wherein the overall area of the blade is variable.
4. A spar buoy having a stabilizer substantially as described herein with reference to and as illustrated in figures 1 to 3, 5, 6 and 8 to 16 of the accompanying drawings.