March 18, 1952 K. H. WILCOXON 2,589,312

NONBUOYANT PARAVANE

Filed July 6, 1948 2 SHEETS—SHEET 1

Fig. 2.

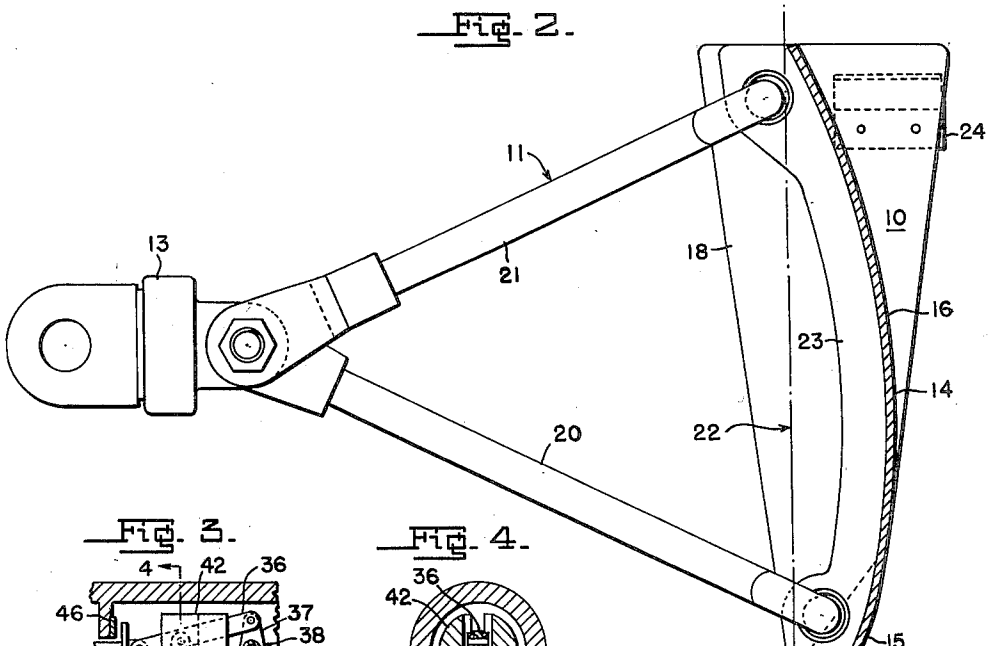


Fig. 3.

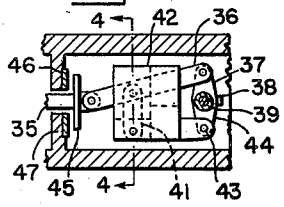


Fig. 4.

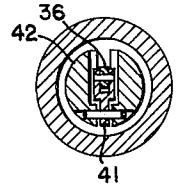
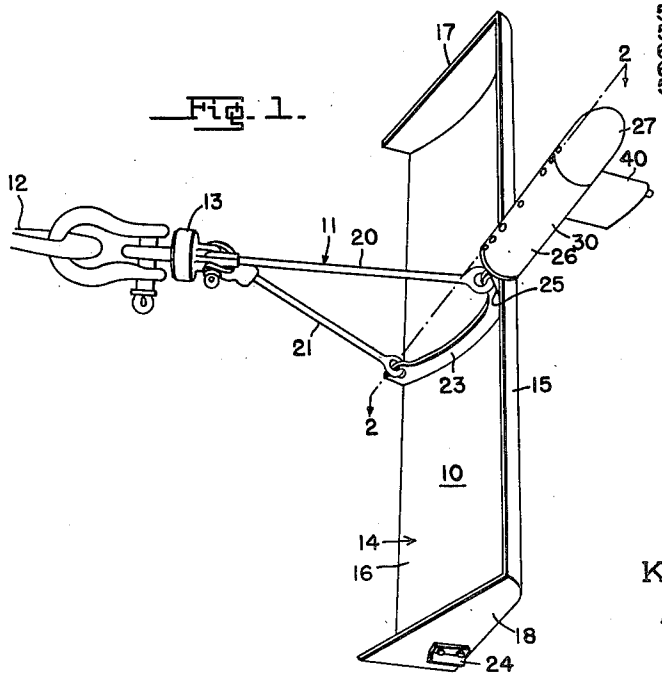
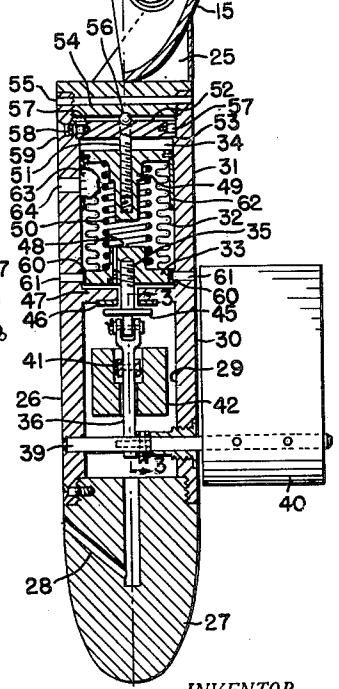


Fig. 1.





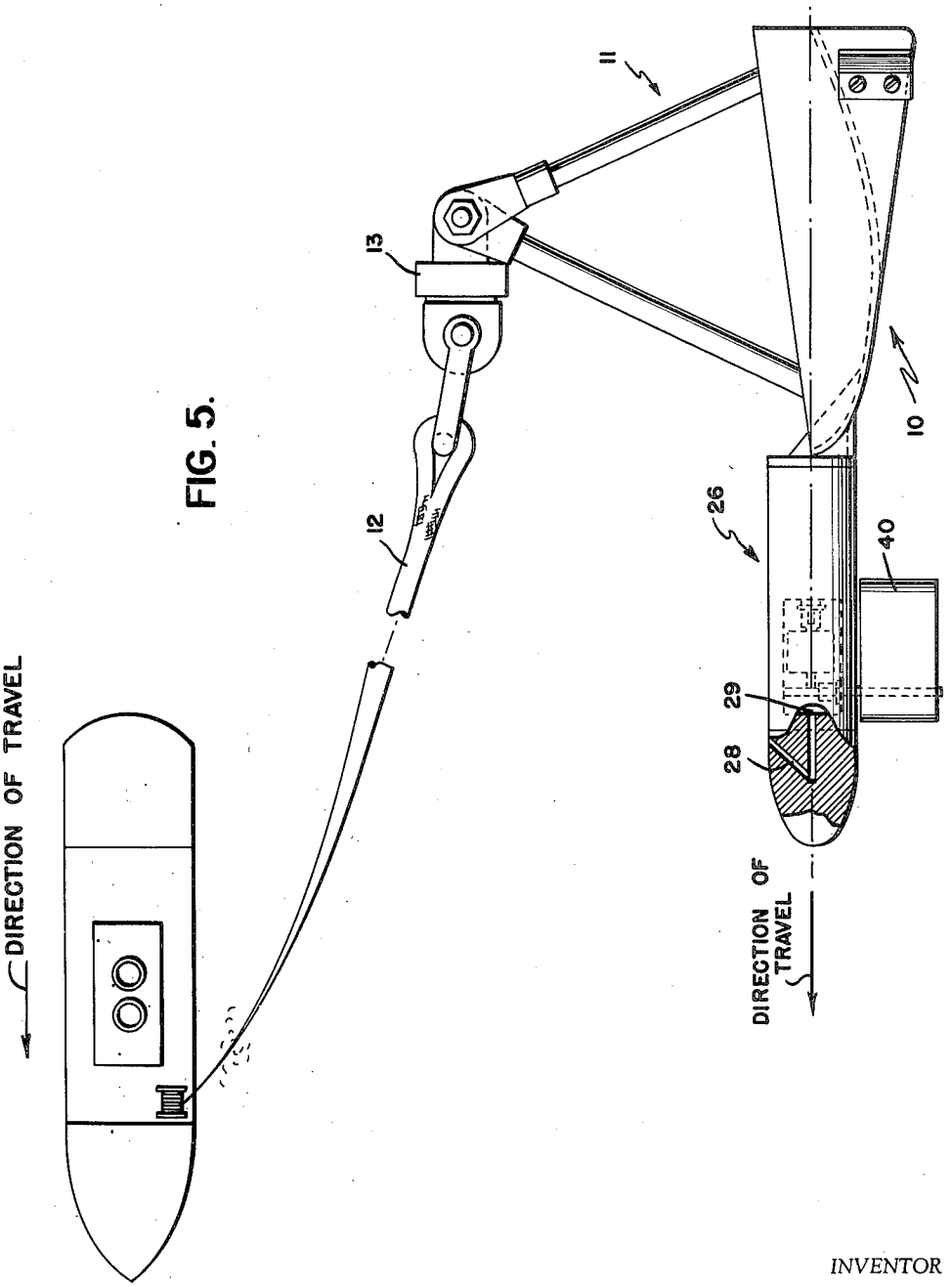
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FIG. 5.



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UNITED STATES PATENT OFFICE

2,589,312

NONBUOYANT PARAVANE

Kenneth H. Wilcoxon, Cabin John, Md.

Application July 6, 1948, Serial No. 37,177

3 Claims. (Cl. 114—235)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention relates to improvements in paravanes and more particularly to an improved protector paravane.

The primary object of the invention is to provide a protector paravane that will run at high or low speeds at a predetermined depth with a minimum of oscillation.

Another object of the invention is the provision of a protector paravane that does not require a buoyant shell or other body liable to leak or be crushed, as by an underwater explosion.

Another object of the invention is to provide a protector paravane with a depth control device having a bellows sensitive to static pressure changes but protected against explosion pressures.

A further object is to provide a protector paravane with a depth control device having a bellows sensitive to small static pressure changes but protected against excessive static pressure of a magnitude sufficient to injure the bellows.

A further object is the provision of a paravane with a depth control device disposed forwardly of the paravane wing so as to anticipate and more quickly correct for changes in depth.

A still further object is to provide a depth control device with counterbalancing means compensating for the weight of the bellows and control linkage when the depth control device is tilted forwardly or backwardly.

The invention also aims to provide a protector paravane which is easy to handle aboard ship, which may be launched and retrieved at high speeds, and which may be cut loose and abandoned, if necessary, at a minimum loss.

Additionally, the invention aims to provide a protector paravane that will run at a maximum distance from the towing ship with a given length of tow cable.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

Fig. 1 is a perspective view of the paravane looking at it from a point forwardly of and slightly below the paravane.

Fig. 2 is a view of the paravane partly in top plan and partly in central horizontal section taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary central vertical longitudinal sectional view taken substantially on the line 3—3 of Fig. 2.

Fig. 4 is a central vertical transverse sectional

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view taken substantially on the line 4—4 of Fig. 3.

Fig. 5 is a diagrammatic top plan view of a craft towing the paravane and control in its operating position.

In the drawing which for the purpose of illustration shows only a preferred embodiment of the invention, and wherein similar reference characters denote corresponding parts throughout the several views, the numeral 10 generally designates a water kite including a bridle 11 connected to a tow cable 12 by a swivel 13.

The water kite 10 is in some respects similar to the type shown and described in Patent 2,403,036, granted to K. Wilcoxon and L. Landweber in that it includes a rectangular sheet metal shear plate 14 with an elliptically-curved leading marginal portion 15 and a cylindrically-curved after portion 16, upper and lower stabilizing side plates, 17, 18 rigidly affixed to opposite side edges of the shear plate, and a bridle having rigid forward and aft links 20, 21 which permit limited rolling movement of the kite about an axis in the vicinity of the central chord line 22. The links 20, 21 are connected at spaced points to a central rib 23 fixed to the concave side of the shear plate 14. In the example shown the shear plate has an aspect ratio of approximately 2.4. Fixed to the lower surface of the stabilizer plate 18 at its trailing end portion is a yaw plate 24 creating hydrodynamic drag sufficient to maintain a slight downward yaw of the kite during forward travel.

The swivel 13 may be of the ball-bearing type shown and described in my co-pending patent application Serial No. 789,008, filed December 1, 1947.

Rigidly affixed to the kite forwardly of its leading edge as by a welded bracket 25 is a tubular streamlined depth control housing 26 having its longitudinal axis aligning with the central chord line 22 of the wing. Arranging the depth control wing forwardly of the main lift wing of the kite is preferred because the depth control wing will establish the depth and the main lift wing will follow, thus permitting quicker response and compensation for deviations in the set depth. Formed in the streamlined nose 27 of the depth control housing is a static pressure passageway 28 in communication for operating relationship with an annular region in the flow around the exterior of the housing where the flow pressure is zero and with a static pressure chamber 29 in the central housing portion 30. In order to maintain a reasonably constant depth over a range of speed, it is necessary to have constant pressure

in the depth control, therefore the opening for receiving the static head for depth control is placed in the nose of the housing at a point where the pressure due to flow is at a minimum or zero.

Disposed coaxially within the after portion 31 of the housing is a cylindrical bellows 32 mounted between forward and after end plates 33, 34. Compression of air by the static head of water is the common method of depth control for comparable towed objects. The air-filled bellows 32 was selected rather than a diaphragm or air chamber because its effective area is greater for a given overall diameter, its spring rate is constant and can be varied over a wide range without serious effect. Also the bellows can be made from more durable material than the usual rubber diaphragm. Threaded into engagement with the forward end plate 33 is a stem 35 connected as by a link 36 to one arm 37 of a lever 38. This lever 38 is affixed intermediate its ends to the inner end portion of a shaft 39 extending through and mounted for rotation in the central housing portion 30 at a right angle to the longitudinal axis of the housing. Affixed to the outer end portion of the shaft 39 is a symmetrically-shaped depth control wing 40, disposed at zero angle of attack when the bellows plate 33 is forward. The amount of force the bellows is able to exert with a small change in depth is relatively small, therefore a symmetrical depth control wing was chosen because the center of pressure of the wing remains nearly in the same position through the small angles of attack.

Disposed in the static pressure chamber 29 and pendantly connected at its after end portion to the link 36 as by a shackle 41 is a counterbalancing weight 42 having its forward end portion pivotally connected at 43 to the lever 38 at its end 44 opposite the depth control arm 37. The weights of the bellows end plate 33 and the connecting linkage are counterbalanced because as the paravane noses down or up these weights tend to fall forward or backward, working against the bellows in both cases.

Fixed on the stem 35 is a valve disc 45 adapted upon predetermined compression of the bellows 32 to seat against a washer 46 carried by an internal annular flange portion 47 of the housing surrounding the stem 35. This valve arrangement protects the bellows against crushing at extreme depths by sealing itself from high static pressure upon predetermined compression of the bellows.

Supported on axial boss portions 48, 49 of the bellows end plates 33, 34 is an expansion coil spring 50 helping to resist static water pressure on the bellows when the paravane is operating in the sea at depths of the order of thirty feet.

Threaded into engagement with the boss 49 is is a stem 51 extending axially from a disc 52 seated in an annular recess defining a shoulder 53 within the after end portion of the housing. Formed integrally with the bracket 25 is a plug 54 releasably secured in threaded engagement with the after end of the housing as by a taper pin 55. Interposed between the disc 52 and plug 54 is a ball thrust bearing 56 seated in shallow concavities centrally of the disc and plug. Formed in the rim of the disc 52 is a plurality of circumferentially-spaced radially-extending holes 57 having threaded walls for selective engagement with a locking screw 58 passing through an aperture 59 in the housing. The forward end plate 33 of the bellows is longitudinally grooved to receive the inwardly projecting ends 60 of pins

61 permitting longitudinal movement of the end plate 33.

Fastened on the after end plate 34 is a forwardly-extending sleeve 62 carrying indicia 63 visible through a sight opening 64 in the housing wall. In order to set the depth control for a selected depth, it is only necessary to remove screw 58, turn disc 52 until indicia 63 corresponding to the selected depth becomes visible through the sight opening 64, and then replace screw 58 in the nearest threaded rim-hole 57.

Before the yaw plate 24 was used, the paravane would operate properly at speeds up to sixteen or twenty knots at which time it would begin to oscillate. The cause of this oscillation at the higher speeds may be explained by the following statement of the theoretical operation of the paravane. The center of gravity of the paravane is forward of its center of pressure. At zero speed the non-buoyant paravane hangs down on the tow-line; as it begins to move forward, the paravane first acts as a depressor. The abnormally high static pressure at paravane depth maintains the valve seated with the bellows partly compressed and with the depth control wing disposed at a positive angle of attack. As the speed of the paravane increases, the hydrodynamic lift of the depth control wing causes the paravane to run to the side, and at eight knots is sufficient to lift the nose of the paravane to the set depth. As the speed is increased beyond eight knots the depth of the paravane tends to decrease slightly, the angle of attack of the depth control wing is decreased by the bellows to maintain the required constant amount of lift and the wing approaches zero angle of attack. At zero angle of attack the center of pressure of the depth control wing is forward of the pivot axis thus tending to keep the wing at an angle of attack. Therefore as the wing is urged into zero angle of attack from a positive angle by the bellows, it immediately shifts to a negative angle which causes the paravane to run deeper. In order for the depth control unit to gain force to move the wing across zero position the paravane must change depth, hence causing oscillation.

The towline effect adds to the oscillation. As the paravane noses down, the tow cable bows up due to its hydrodynamic drag thus causing the paravane to roll which in turn produces downward yaw. When the change in depth is great enough for the depth control device to start the paravane up again all the effects reverse and the paravane will overshoot the desired level. The longer the tow cable the greater the towline effect will be. The yaw plate 24 when added to the bottom side plate of the main lift wing creates sufficient hydrodynamic drag to tip the paravane down slightly so that the depth control wing can always operate at a positive angle of attack.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

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.

I claim:

1. A non-buoyant protector paravane comprising a water kite and hydrostatic-pressure-re-

sponsive depth control means; said kite being formed to provide a wing having a concave face and a convex face respectively; attaching means on said concave face adapted for securement to a tow line, thereby providing means for making a towing connection with a craft; said concave face being positioned in a generally forward position and said kite extending in a generally vertical position when in use; said wing having a forward leading marginal portion and an after trailing marginal portion; said depth control means being attached to a forward marginal portion of said wing and disposed forwardly thereof and forwardly of said concave face.

2. The combination of claim 1 that includes a yaw plate carried adjacent said after portion to cause a slight downward yaw of said kite to be maintained during the forward travel of said paravane in said horizontal plane.

3. The combination of claim 1 wherein said attaching means includes a bridle assembly having an upper rigid link connected at substantially the central part of said leading edge portion and a rigid lower link connected at substantially the central part of said after portion, said links being formed to permit limited rolling movement about said attaching means in a substantially vertical plane.

KENNETH H. WILCOXON.

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