

Aug. 9, 1960

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2,948,251

DIVING PLANE

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2 Sheets-Sheet 1

Fig. 1.

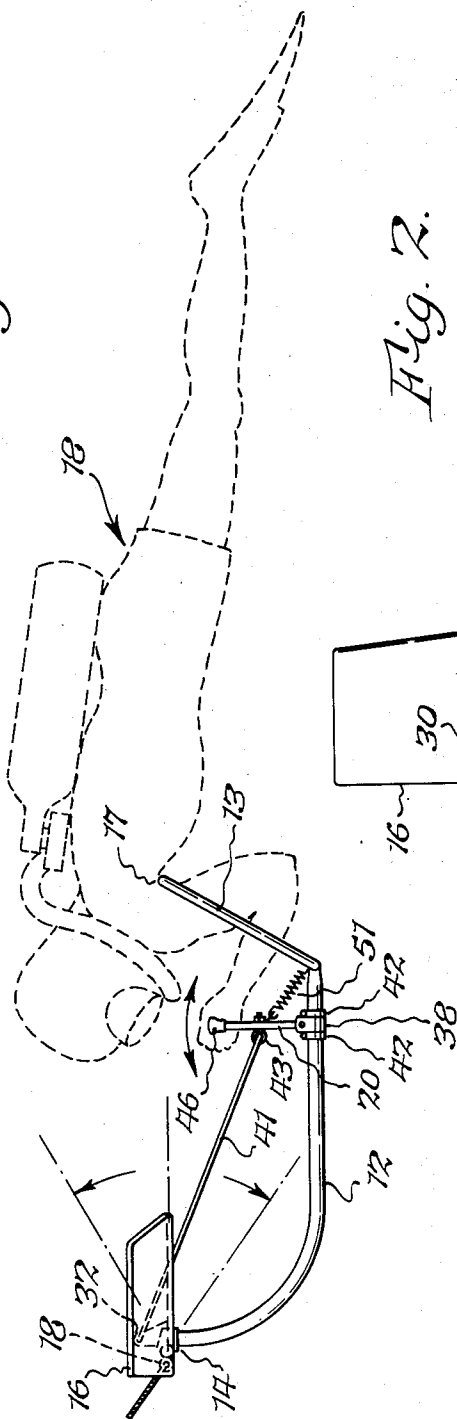
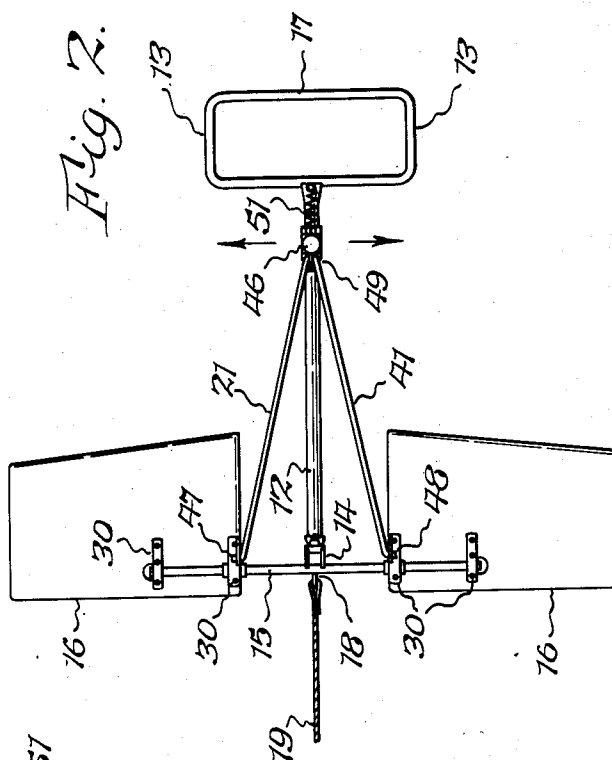


Fig. 2.



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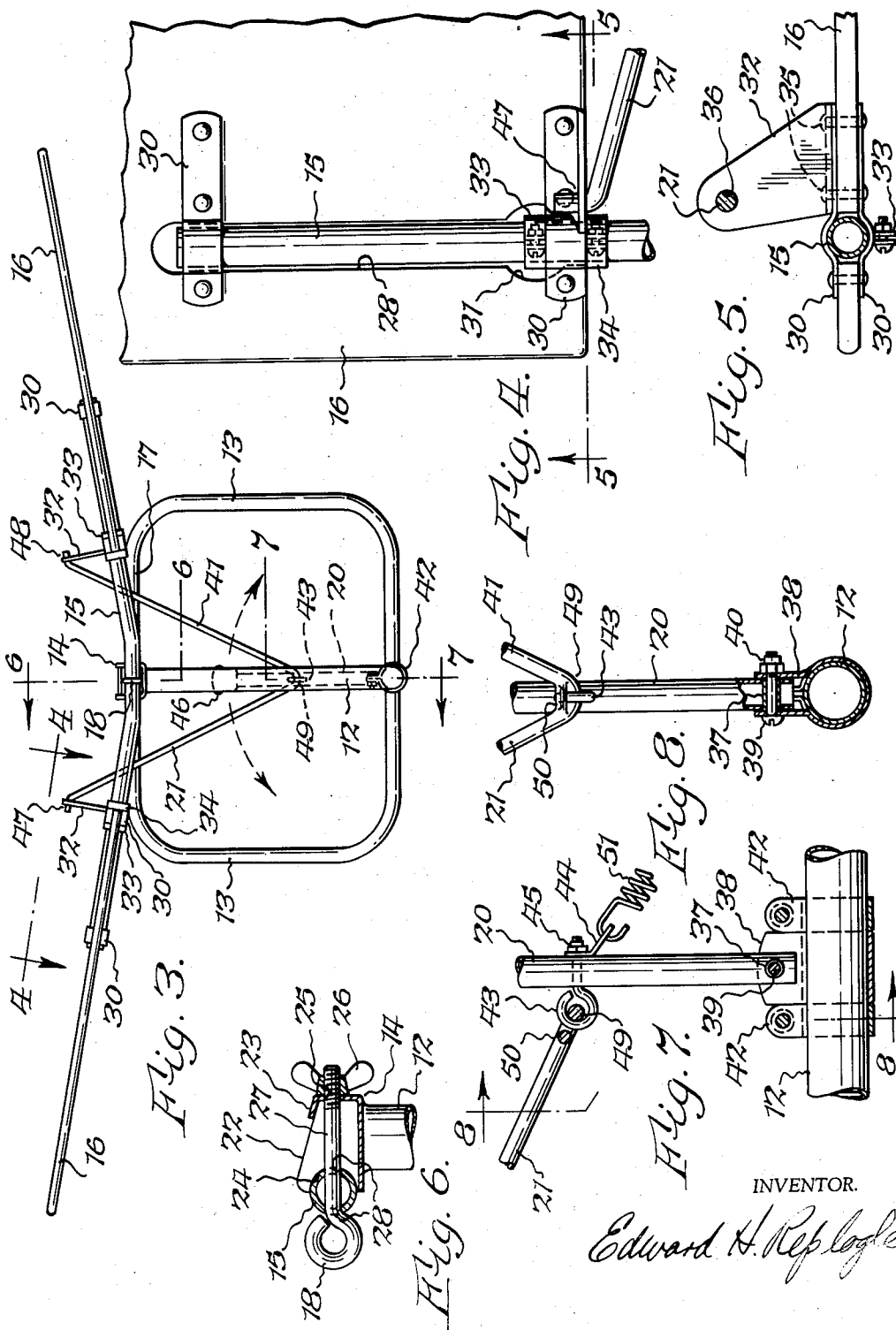
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7 Claims. (Cl. 115—6.1)

This invention relates to underwater diving apparatus, and more particularly to a diving plane for use in towing one or more divers at various depths beneath the surface of the water.

The towed diving planes of the prior art, especially those designed for use by more than one occupant, are generally of large size and complex design, awkward to carry in a small boat or other conveyance, often require both hands to operate, and are usually quite expensive.

The main object of this invention is to provide a diving plane that is of small size, relatively simple in structure, and inexpensive to manufacture.

A further object of this invention is to provide a diving plane that has stability of operation and ease of control.

Still another object of this invention is to provide a diving plane that may be used simultaneously by more than one person.

Another object of the invention is to provide a diving plane that may be controlled by one hand so that the other hand is free for other uses.

A further object of the invention is to provide a diving plane that provides protection from collision with the sea bottom, or collision with other obstacles due to poor visibility.

A still further object of the invention is to provide a diving plane that will automatically return to the surface if the diver releases it so that the tow boat operator can observe the approximate location of the diver.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawings in which:

Fig. 1 is a side elevation of the diving plane in use with an occupant shown in dotted lines.

Fig. 2 is a plan view of the plane viewed from the top of Fig. 1.

Fig. 3 is a front elevation viewed from the left of Fig. 1.

Fig. 4 is a fragmentary view of the wing mounting as indicated by line 4—4 in Fig. 3.

Fig. 5 is a sectional view of the wing mounting as indicated by line 5—5 in Fig. 4.

Fig. 6 is a fragmentary cross section of the towline fitting indicated by line 6—6 in Fig. 3.

Fig. 7 is a fragmentary side elevation partly in section of the control stick as indicated by line 7—7 in Fig. 3.

Fig. 8 is a fragmentary front elevation partly in section of the control stick as indicated by line 8—8 in Fig. 7.

Referring to Figs. 1 and 2, it may be seen that a diving plane illustrative of an embodiment of the invention includes a horizontally disposed ski shaped frame 12 to which is attached at the rearward end an upwardly canted loop 13 incorporating an upper laterally disposed bar 17 which by means of underarm retention enables the occupant, or occupants, to be towed by the plane. On the upwardly curved forward end portion of frame 12 is mounted a saddle fitting 14 which serves the dual purpose of supporting a lateral wing beam 15 and a towline

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fitting 18 to which is attached a towline 19. A pair of wings 16 are pivotally mounted one on each end of the wing beam 15. A control stick 20 is pivotally mounted on the frame 12 in a position convenient to the occupant, and is connected to the wings 16 by connecting links 21 and 41 which serve to pivot the wings 16 about beam 15 both codirectionally so as to provide depth control, and differentially so as to provide roll or lateral control. The frame 12 is preferably made from a piece of tubing bent to a large radius at its forward end so as to afford protection and minimum resistance in the event of collision with the bottom. This function has been found to be very important, since when diving under conditions of poor visibility, the bottom is often reached suddenly and unexpectedly or large boulders on the bottom suddenly appear ahead of the plane allowing insufficient time for maneuvering away from them.

It has been found that a rearwardly placed laterally disposed bar such as 17 is all that is needed to form a comfortable retention means for one or more occupants. The preferred method of supporting this tube by means of the upwardly and aft canted loop 13 was selected for reasons of simplicity and safety. The simplicity is apparent in that loop 13 including bar 17 may be bent from a single bar or tube. As may be envisioned by studying Fig. 1, in order to mount the plane the occupant merely needs to swim forwardly and over the plane so that bar 17 is under his armpits, then lower and draw back his elbows inside of loop 13 and grasp the control stick 20 with one hand. In order to leave the plane, he needs merely to throw his arms forward and he is free. Likewise in the event of two occupants, they would ride side by side; in the preferred design where bar 17 is only about as long as one shoulder width, the right side occupant would hook only his left arm over bar 17, while the left occupant would hook his right arm over bar 17, one of the two controlling the plane with his arm which is inside of the loop 13. The two occupants may hold on to the upright portions of loop 13 with their unused hand if they desire additional support. It may be seen that bar 17 could be made long enough for any desired number of occupants. In order to leave the plane while it is under way, the multiple occupants like the single one merely need to throw their arms forward. In this connection the preferred design of loop 13 was selected for reasons of safety since the closed loop feature eliminates any projecting tube ends which might entangle in the diver's harness and interfere with his leaving the plane when expediency so dictates.

On the forward end of frame member 12, I have chosen to provide the saddle fitting 14 as shown in detail in Fig. 6 in order to attach the tow line fitting 18 and the wing beam 15. This fitting is formed from a single sheet of material having a pair of upturned ears 22 each being furnished with a semi-circular notch 24 in its forward edge so as to form a stable saddle-like retention for wing beam 15. A rearward ear 23 is bent upwardly and then forward at its upper edge to form a rigid channel-like rear face to the fitting, the ends of which bear on the rear edges of side ears 22, and the center of which is provided with a hole 25. Eyebolt 18, the eye of which forms the tow line fitting and also serves as a bolt head, is used to attach the beam 15 to the fitting 14. The shank 27 of the eyebolt is passed completely through aligned drilled holes 28 in tubular beam 15, and hence through hole 25 in ear 23 so that a wing nut 26 may be applied and firmly tightened to rigidly retain the entire assembly.

By referring to Figs. 4 and 5, it may be seen that the pivotable mounting of the wings 16 onto the wing beam 15 is accomplished, in this case, by inserting the wing beam 15 into a slot 29 of intimate proportions

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and restraining it in a direction normal to the wings by straps 30 which serve to, when applied in pairs on opposite wing surfaces, form a journal for tubular beam 15, and restore part of the structural integrity of the wing 16 lost as a result of the removal of material to form slot 29. As may be seen, the outboard pair of straps 30 are located near the end of the slot and beam, the inboard pair at the root of the wing. The wing is retained laterally on the beam 15 by clamps 33 and 34. These clamps are of a type commonly known as hose clamps and are positioned on either side of the inboard straps 30 so that they may be drawn tight around beam 15 and effectively restrain any lateral movement of straps 30 and consequently the wing 16, but so that pivotal motion of the wing assembly is not interfered with. It will be noted that an area of the slot 29 is widened to form a clearance area 31 around clamp 33 so as to permit clearance and free rotation. An operating arm 32 is provided with a hole 36 near the end to receive the bent tip of control rod 21. It may be seen that forward motion of rod 21 (to the left in Fig. 5) will rotate the wing 16 around beam 15 to a nose down position, while rearward motion of rod 21 will rotate wing 16 to a nose up position.

Referring to Figs. 7 and 8, the control stick 20 consists of a tube which normally in its centered position is disposed in a substantially vertical position. Near its lower end a transverse hole is drilled through the tube, so as to accept a spacer bushing 37 which is slightly longer than the diameter of the tubular stick 20. A strap fitting 38 is formed to match the diameter of the tubular frame 12 but with upstanding vertical legs, the spacing between which matches the length of spacer bushing 37. With strap fitting 38 installed over frame 12, bushing 37 inserted through the hole in the stick 20, and a bolt 39 inserted through holes in the upstanding legs of fitting 38 and through bushing 37, a nut 40 may be applied on bolt 39 and pulled down tightly. In such manner the legs of 38 are clamped firmly against bushing 37 thus forming a rigid integrated fitting around frame 12, but one which does not bind stick 20 against turning on bushing 37 because of the excess length of 37 over the diameter of stick 20.

The fitting 38 is now restrained against sliding along frame 12 by the installation and tensioning of a pair of hose type clamps 42. It may now be seen that fitting 38 and its cooperating parts form a universally pivotable mounting for control stick 20, it being possible to move the upper extremity of the stick fore and aft as it pivots about bushing 37 and laterally as it and fitting 38 rotate about the axis of frame 12.

At the proper distance upward on control stick 20, a fore and aft hole is drilled completely through the tube in order to receive stick eyebolt 43. After insertion of this eyebolt 43 in stick 20, a lug 44, the function of which will be described hereinafter, is inserted over the rear end of the shank and a self locking nut 45 is screwed onto the shank to such a degree as to minimize fore and aft movement but not restrict free rotation of the eyebolt 43 and lug 44. A cap 46 of resilient material is arranged to close the upper end of the stick tube and to act as a hand grip.

As may be observed in Figs. 2 and 3, the control rod used to actuate the wings pivotably in response to movements of the control stick 20, is in form of a V and fabricated preferably from light circular stock. The right hand leg of the V is denoted as 21, the left hand leg 41. The tips of legs 21 and 41 are bent abruptly so as to form ends 47 and 48 respectively which are approximately normal to the planes of the operating arms 32 and the said tips are inserted in the holes 36 which are provided near the ends of the arms. The other end of the rod is the apex of the V and is designated by the number 49 (see Figs. 7 and 8). This apex is formed by bending the rod sharply, and in our pre-

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ferred design, the acute angle formed by the bend is fabricated slightly larger than the proper angle called for by the installation so that the tips 47 and 48 are maintained in engagement with arms 32 by the spring pressure produced by the enforced reduction of the acute angle at 49 during assembly. The rod is slipped through the loop of the eyebolt 43 and the apex 49 is maintained within the eyebolt loop by a retainer 50, which may be in the form of a bar placed adjacent to apex 49 and between the bases of legs 21 and 41 as shown in Fig. 8.

By inspection of Fig. 1, it is simple to observe how a forward movement of the control stick 20 will cause a simultaneous nose downward rotation of the wings 16 and consequently result in a tendency for the plane to dive to deeper depths. With further study of views Figs. 2 and 3 it may also be seen that a purely lateral motion of the central stick 20 will cause the wings to rotate differentially. Referring to Fig. 2, a movement of the stick to the right causes apex 49 to move to the right, tends to reduce the cant of the right hand control rod 21 making it lie more directly in a fore and aft direction, whereas the left hand control rod 41 must assume a greater cant than normal. It follows that the reduced cant of rod 21 increases its effective fore and aft length (or its projection on a vertically disposed longitudinal cutting plane) forcing tip 47 forward and right wing 16 to rotate into more of a nose downward position, whereas the increased angle of 41, shorter projection and hence effective length, causes tip 48 to move aft and left wing 16 to rotate to a more nose up position, the result and effect being to cause the plane to roll right wing down as a result of stick motion toward the right. The general aspect of the control stick configuration and the response of the plane to various motions of the control stick has been made to follow aeronautical practice as closely as possible in order to make its operation natural and predictable in the hands of a novice.

In order to fulfill one of the objects of the invention, that of an immediate and stable return to the surface in the event of abandonment of the plane by the occupants, it is necessary to provide a tendency for the plane to climb or go into a nose up attitude when its controls are released. A simple way to accomplish this is to add a spring bias to the control system tending to apply a nose up control movement. In Fig. 1 and Fig. 7 a tension spring 51 is illustrated which is hooked to lug 44 on the control stick assembly and attached to the frame at the juncture of tubes 12 and 13, such spring being designed and stretched to apply the required bias load tending to pull the stick back. It is also necessary to prevent any inadvertent rolls during this unmanned return to the surface since if the plane should become inverted the control bias would then tend to take it to the bottom. A resort to aeronautical principles is made to attain the required lateral stability during the free climb upward. Referring to Fig. 3, it may be seen that the wing beam 15 has been bent upwardly on each side of its mounting at saddle fitting 14 causing a sweep upward of the wing assemblies known as dihedral in aeronautical circles. It is a confirmed theory of aeronautics that such dihedral acting under conditions of positive lift tends to correct any tendency for one wing to drop and maintains lateral stability to a degree dependent upon the amount of dihedral angle. My experiments have shown that an approximate 10 degree angular upsweep of each wing from horizontal has been sufficient for the needs of this plane during its unmanned return to the surface from considerable depths.

Referring to Fig. 1, the towline attachment fitting 18 and the wings 16 have been located closely together while the occupant retention bar 17 has been located remotely aft of the previously mentioned elements for the reason that this general configuration reduces the tendency of the plane to change longitudinal attitudes.

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We know that for any given condition of equilibrium, the towline thrust vector which is coincident with the towline itself where attached to the plane, the wing lift vector which is roughly normal to the wing surface, and the drag vector of the occupant, must find a common intersection, a process that requires adjustment of the attitude of the plane. Of these forces, the occupant's drag is the only one of relatively constant direction being opposite to the direction of travel; the towline thrust vector angle varies considerably with depth and towline length etc.; the wing lift vector varies instantaneously as the controls are operated. By mounting the towline attachment point and the wings intimately we minimize the area through which the common intersection point can travel as these forces vary in direction. The remotely applied, relatively constant direction, drag force may be then made co-intersectional by a relatively small shift in the longitudinal attitude of the plane.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

I claim:

1. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion, a wing mounted on said forward portion for rotation about a lateral axis for depth control purposes, and an underarm occupant retention bar disposed substantially parallel to said lateral axis and arranged above the rearward end of said frame member.

2. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion provided with a towline attachment fitting, a wing mounted on said forward portion for rotation about a lateral axis for depth control purposes, and an underarm occupant retention bar disposed substantially parallel to said lateral axis and arranged above the rearward end of said frame member, said wing and fitting being located closely together and said bar being located remotely aft of said wing and fitting for longitudinal stability.

3. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion provided with a towline attachment fitting, a pair of wings mounted on said forward portion for individual rotation about a lateral axis, an underarm occupant retention bar disposed substantially parallel to said lateral axis and arranged above the rearward end of said frame member, said bar being supported at its ends so as to form a closed loop structure connecting said bar with said frame member, and a control system arranged on said frame member and connected with said wings to pivot the wings codirectionally for depth control and differentially for lateral roll control.

4. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion provided with a towline attachment fitting, a pair of wings mounted on said forward portion for rotation about a lateral axis, an underarm occupant retention bar disposed substantially parallel to said lateral axis and arranged above the rearward end of said frame member, and means arranged on said frame member and connected with said wings to pivot their leading edges upwardly for returning the plane to the surface in the event it is abandoned while submerged.

5. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion provided with a towline attachment fitting, a pair of wings upswept at a dihedral angle for lateral stability and

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mounted on said frame member for individual rotation about a lateral axis, an underarm occupant retention bar disposed substantially parallel to said axis and arranged above the rearward end of said frame member, a control system arranged on said frame member and connected with said wings to pivot the wings codirectionally for depth control and differentially for lateral roll control, and resilient means normally urging said control system to pivot the leading edges of said wings upwardly for returning the plane to the surface in the event the control system is released or the plane is abandoned while it is submerged.

6. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion provided with a towline attachment fitting, a pair of wings mounted on said forward portion for individual rotation about a lateral axis, an occupant retention bar disposed substantially parallel to said lateral axis and arranged above the rearward end of said frame member, a control stick universally pivoted at its lower end on said frame member so that its upper end may be displaced in any direction, and control rods interconnecting said stick with said wings, said control rods being disposed at a considerable angle with the longitudinal centerline of the diving plane so that fore and aft motion of the control stick will pivot the wings codirectionally and lateral motion of the control stick will decrease the angle of one control rod while increasing the angle of the other control rod in such a way as to result in differential pivoting of the wings.

7. An underwater towed diving plane comprising a frame member having an upwardly curved forward portion provided with a towline attachment fitting, a pair of wings upswept at a dihedral angle for lateral stability and mounted on said forward portion for rotation about a lateral axis, each of said wings having an operating arm rigidly mounted thereon, an underarm occupant retention bar disposed substantially parallel to said lateral axis and arranged above the rearward end of said frame member, said wings and fitting being located closely together and said bar being located remotely aft of said wings and fitting for longitudinally stability, a control stick universally pivoted at its lower end to said frame member so that its upper end may be displaced by an occupant's hand in any direction, control rods interconnecting said stick with the operating arms on said wings, said control rods being disposed at a considerable angle with the longitudinal centerline of the diving plane so that fore and aft movement of the control stick will pivot the wings codirectionally for depth control and lateral motion of the control stick will decrease the angle of one control rod while increasing the angle of the other control rod in such a way as to result in differential pivoting of the wings for lateral roll control, and resilient means normally urging said control stick aft to pivot the leading edges of said wings upwardly so as to return the plane to the surface in the event that the control stick is released or the plane is abandoned while it is submerged.

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