Aug. 27, 1963 P. M. WENDT 3,101,691

UNDERWATER SLED

Filed Oct. 20, 1961

Fig. 1

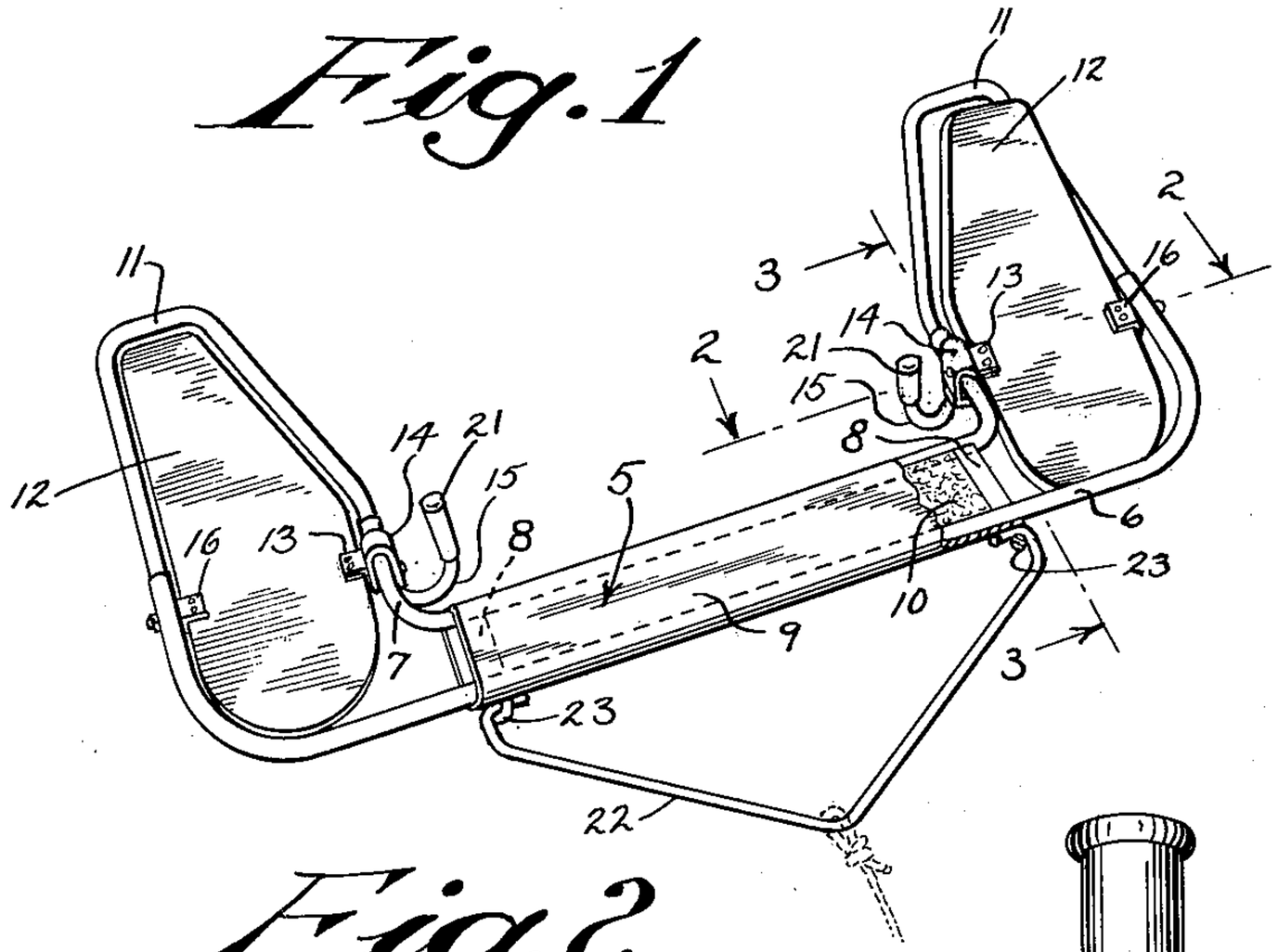


Fig. 2

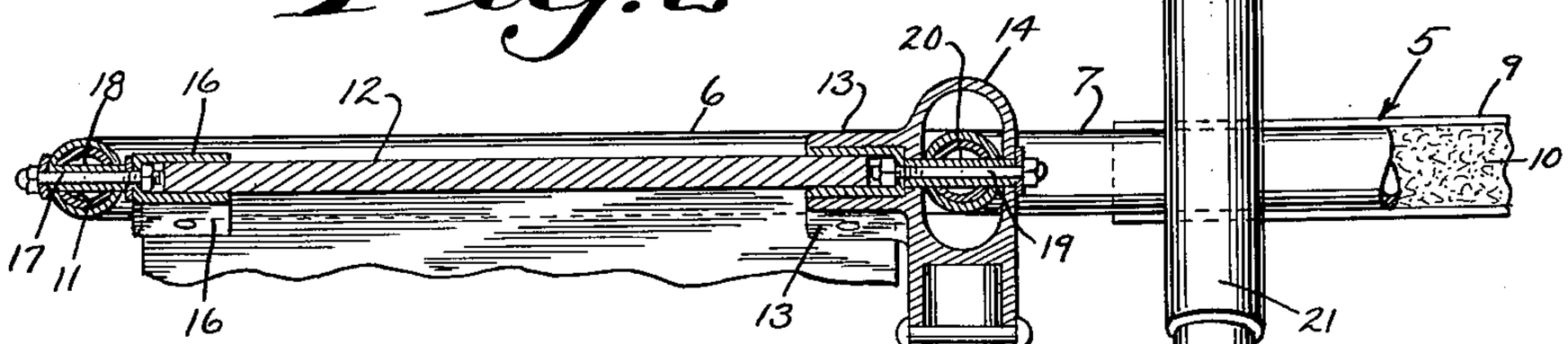
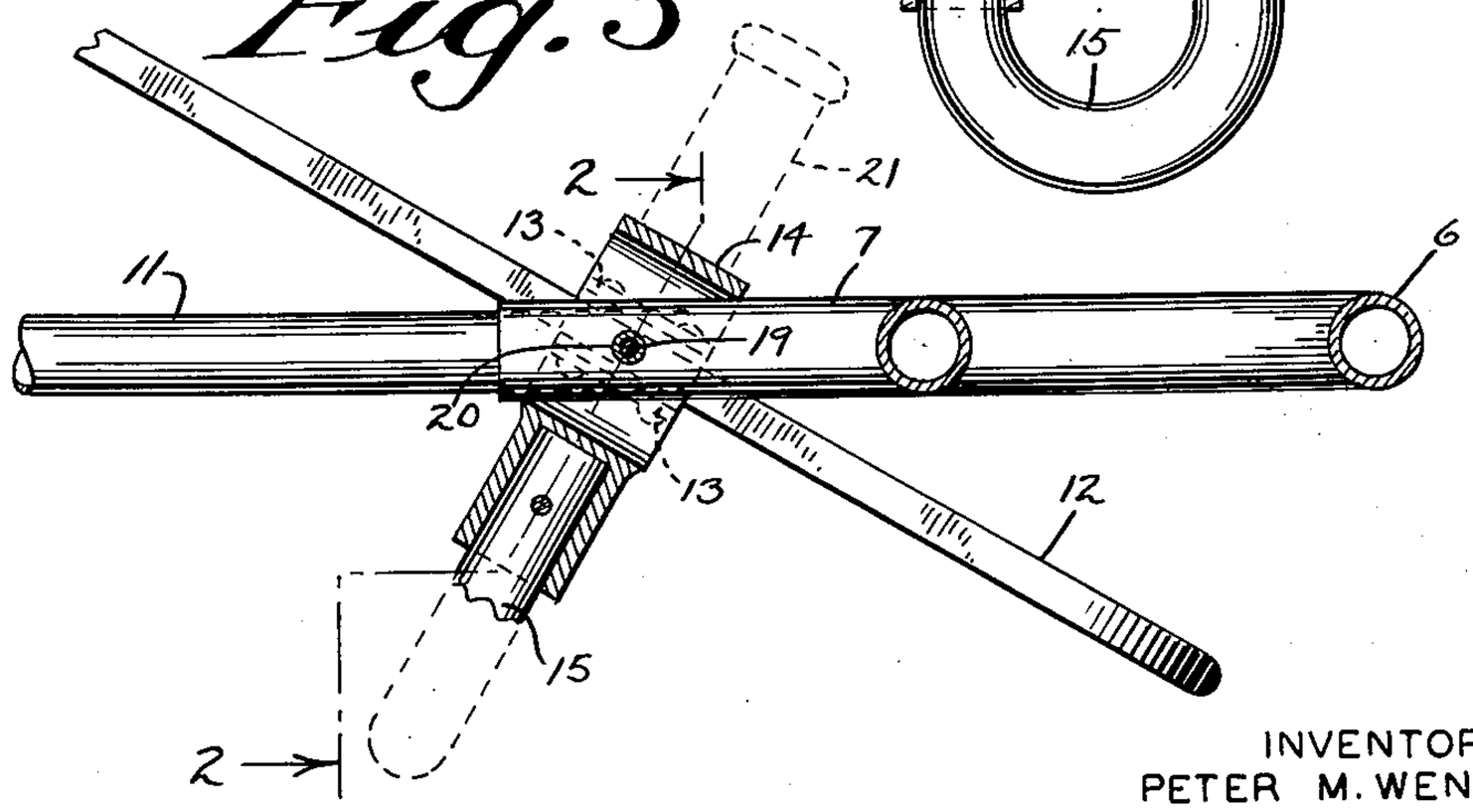


Fig. 3



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UNDERWATER SLED

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This invention relates to a towed underwater sled, and more particularly to an underwater sled having a rigid tranverse member extending across the front of the sled with independently operated elevators mounted at either end and extending aft thereof and having control bars affixed to the elevators, said elevators and control bars being pivotally mounted on a framework extending from the transverse member.

Underwater sleds are used by divers or swimmers for transportation under water either for sport or for occupational purposes. They differ from submarines in that underwater sleds do not enclose or house the operator .

Underwater sleds are generally used when the operator wishes to cover a large area or a very long distance. For example, underwater sleds are commonly used to search for a submerged object the exact location of which is unknown. The diver will usually map out a search pattern covering the area where the object is suspected to be lying, and then he will travel along his preplanned routes until the search is completed. Such an operation requires the diver to cover long distances, preferably in as short a time as possible. Therefore, it is desirable to have some form of transportation which can move the diver through the water faster than he can swim and at the same time conserve his energy. The underwater sled which performs that function of transporting the diver may either contain its own motive force or it may be towed from a conventional surface craft, usually a motorboat.

This invention relates to the form of underwater sled that is towed from a surface craft and the invention is intended to eliminate several difficulties encountered in their use. Such underwater sleds may be generally described as consisting of some form of horizontal control surface, the angular position of which can be manipulated by the operator, means for attaching a tow rope to the sled, handles whereby the operator can pivot the control surface or surfaces and means for suspending the operator while pulling him through the water, which may be the same handles by which he pivots the control surfaces.

Persons operating underwater sleds while suspended from the control handles have experienced rather rapid fatiguing of the forearms and wrists. On the other hand, those devices which suspend the operator by means other than the handle grip present the ineherent danger of entangling an inexperienced operator in the apparatus possibly causing serious injury. This invention alleviates the arm fatigue without sacrificing the safety factor inherent in having the operator suspended from the control handles.

This invention also provides an underwater sled which can be easily controlled. This invention provides an underwater sled which allows the operator to have one hand free while guiding it through the water. Finally, the present invention provides a means whereby the operator can call into play additional control surfaces, not ordinarily needed, in order to effect radical underwater maneuvers when desired.

Accordingly, it is an object of this invention to provide a towed underwater sled capable of increased maneuverability and control.

It is another object of this invention to provide a towed underwater sled constructed for maximum safety in operation and for reduction in operator fatigue.

It is a further object of this invention to provide an

operator controlled towed underwater sled which utilizes the natural drag of the operator's body to assist in control of the sled.

The foregoing and other objects will appear in the description to follow. In the description, reference is made to the accompanying drawing which forms a part hereof and in which there is shown by way of illustration a specific embodiment in which this invention may be practiced. Such embodiment will be described in sufficient detail to enable those skilled in the art to practice this invention, but it is to be understood that other embodiments of the invention may be used and that structural changes may be made in the embodiment described without departing from the scope of the invention. Consequently, the following detailed description is not to be taken in a limiting sense; instead, the scope of the present invention is best defined by the appended claims.

In the drawing:

FIG. 1 is a view of a preferred embodiment of the invention in perspective, with a partial cut-away to illustrate the internal structure of the transverse wing, and showing one elevator in its normal position and the other in a diving attitude,

FIG. 2 is a view in section of one elevator taken in the plane of the line 2—2 of FIG. 1 and FIG. 3, illustrating the U-shaped control and suspension bars, and the mounting of the elevator,

FIG. 3 is a view in section of the same elevator taken in the plane of the line 3—3 of FIG. 1, further illustrating the structure of the U-shaped control and suspension bar.

Referring to the drawing, a rigid transverse wing 5 having a rectangular shape, is formed by tubular frame members 6 and 7 in its leading and trailing edges, respectively, which are supported by struts 8 extending between the tubular frame members 6 and 7 and a sheath 9 which covers the framework providing a continuous surface to the wing. In this preferred form of the invention, the tubular frame members 6 and 7, the struts 8 and the sheath 9 are made of aluminum to provide a light, but strong, structure. In the spaces between the frame members 6 and 7, struts 8 and sheath 9, blocks of foamed, closed-cell polystyrene 10 have been placed to impart additional buoyancy to the sled, but it is to be emphasized that any means for creating a trapped air cavity which would not flood when the sled is immersed in water could serve the same purpose. This added buoyancy is sufficient to bring the sled to the surface when it is not manned.

The tubular frame members 6 and 7 extend outward and aft of the ends of the transverse wing 5. Generally U-shaped tubular frame members 11 have their ends telescopically received within the adjacent open ends of the frame members 6 and 7 to form a watertight seal therebetween. A pair of elevators 12, which in this embodiment consist of rigid, plastic plates, are mounted in the spaces defined by frame members 6 and 7, and the frame members 11. The elevators 12 may be constructed in the form of any of a number of known types of control surfaces in order to suit the purposes of this invention. While, at the speeds at which an underwater sled moves, the area of the control surfaces of the elevators is not critical to a precise measurement, it is to be understood that if the control surfaces are too small their usefulness as control surfaces will be negligible, and if the control surfaces are too large, the elevators 12 and thus the entire underwater sled will become unmanageable. In the embodiment shown in the drawing the inside edges of the elevators 12, and thus of the corresponding U-shaped frame members 11, have been tapered outward toward the after end. While that particular shape is not critical to the invention, it nevertheless allows increased clearance between the operator's arms and the sled.

It is important to note that the elevators 12 have a sub-

stantial control surface area both forward and aft of their pivotal axes. The substantial control surface area aft of the pivotal axis imparts a characteristic of weathervaning to the elevators **12**, that is, each elevator **12** will adopt to a rotational position parallel to the streams of water flowing around its surface. This allows the operator to release one handle when he wants to adjust his gear or perform some other act, and still maintain control over the sled with the other elevator. Substantial control surface area forward of the pivotal axis assists the operator in rotating the elevators **12**. Preferably, the pivotal axes of the elevators **12** approximately bisect the control surface areas of the elevators **12**.

Referring to FIG. 2, the elevators **12** are supported by flanges **13** extending from an eye member **14** secured to one upright leg of a U-shaped control bar **15**, and by flanges **16** which are fastened to a shaft **17** which is rotatably held in a bearing **18** extending through each frame member **6**. Each eye member **14** is mounted in pivotal relationship on a frame member **7** by means of a shaft **19** extending through the side walls of the eye member **14** and through a bearing **20** in the frame member **7**. The free standing leg of each U-shaped control **15** forms a handle which extends well above and below the level of the shaft **19** to provide substantial handle areas above and below the pivotal axis of the elevators **12** as defined by the shafts **19**. A tow hitch bar **22** is secured to the sled by a pair of eyelet members **23** which are anchored in the struts **8** and permits attachment of a tow rope.

It is important to note here that the upper and lower walls of the eye member **14** will limit the rotational movement of the eye member **14** with respect to the frame member **7**, so that the elevators **12** can pivot only that amount necessary for normal underwater maneuvers (see FIG. 3). The extent to which rotational movement of the elevators with respect to the transverse wings will be limited depends on several factors. An important determinant is the size of elevator control surfaces. Thus, for a given transverse wing size and for a particular operator, the larger the area of the control surface a smaller movement is required of that surface to effect a given maneuver. The range of rotation found to be most effective lies between approximately thirty to ninety degrees total movement.

The limitation in the relative rotational movement of the elevators **12** allows the operator to engage the transverse wing **5** as an additional control surface for more rapid diving or surfacing. The maneuverability of any such device in a fluid depends upon its speed with respect to the fluid, the amount of control surface, and the amount of radial deflection of that control surface. When the operator turns the bars **15** beyond the built-in limitation of roattional movement with respect to the transverse wing **5**, he then rotates the transverse wing **5** as well as the elevators **12**, thereby increasing the control area and the deflection of the control area in one movement.

It is important to this invention that the handles **21** formed as a second leg of the U-shaped control bars **15** extend both well above and well below the pivot point in eye member **14**. The handles **21** serve two purposes. As already indicated they are the means by which the elevators **12** are controlled and thus the means for controlling the direction of the sled. Also, they are the means by which the operator suspends himself from the sled when it is moving through the water.

In prior underwater sleds, the two uses of the handles **21** are conflicting, for the strain of the body drag placed on the handles **21** would prevent the operator from effectively controlling the device by the same handles. However, here the two uses complement each other, for the operator may use the drag of his body in order to move the elevators. This characteristic of the invention, it was discovered, greatly alleviated operator arm fatigue.

When the sled is pulled through the water, the sled will

tend to follow the rope to the surface. Thus, in this invention the transverse wing **5** will tend to hold itself in a climbing attitude at all times. The tendency of the sled to surface must be countered by holding the elevators **12** in a diving attitude sufficient to overcome the lift of the tow rope. Prior to the present invention the control surfaces were trimmed to counter those tendencies by the operator exerting a twisting force on the control handles with his wrists and arms.

When the operator of the novel sled disclosed here has arrived at the desired depth, he then need only move his grip downward on the handles **21** until the drag of the weight and friction of his body pulling on the handles **21** rotates the elevators **12** to the proper attitude to maintain the desired depth. The trim can be easily corrected whenever necessary by raising or lowering the position of the grip on either or both handles. If the operator wishes to surface he need only move his grip upward towards the top of the handles **21** and the drag of his body will force the elevators **12** into a climbing attitude allowing him to surface as rapidly as he desires.

Again, the position of the rotational axes on the elevators **12** approximately bisecting the area of the control surfaces aids the operator. If the rotational axes of the elevators were toward their leading edges so that a preponderance of the control surface were aft of the axes, the force of the water moving over the surface would resist any attempts to rotate the elevators. If the rotational axes were along the trailing edge of the elevators, the force of the water would tend to rotate the elevators. By having approximately equal areas of control surface fore and aft of the axes, the effect of the water moving over the surfaces is neutralized, and control of the sled is greatly facilitated.

I claim:

1. In an operator controlled, towed underwater sled the combination comprising: a rigid transverse member; a pair of frames each secured to an end of said transverse member and extending aft therefrom; a pair of elevators each pivotally mounted on a frame and extending aft of the trailing edge of said transverse member, said elevators being spaced to allow the operator to lie between them; control bars pivotally mounted on said frames and secured to said elevators at the pivotal axes of said elevators for common rotation therewith, said control bars having handle portions disposed generally normal to the pivotal axes of the control bars and extending above and below such pivotal axes; and means for attaching a tow rope to said sled.

2. In an operator controlled, towed underwater sled the combination comprising: a rigid transverse wing; a pair of frames each secured to an end of said transverse wing and extending aft therefrom; a pair of elevators comprised of substantially rigid, horizontal control surfaces, each elevator being pivotally mounted on a frame and extending aft of the trailing edge of said wing, said elevators being spaced to allow the operator to lie between them; control bars pivotally mounted on said frames and secured to said elevators at the pivotal axes of said elevators for common rotation therewith, said control bars having stop members secured thereto in spaced relationship with said frames, said stop members being engageable with said frames after a preselected pivotal movement of said control bars to limit the pivotal movement of the control bars relative to the transverse wing and to integrate the transverse wing as an additional control surface at the limit of pivotal movement of the control bars, said control bars having handle areas extending above and below the pivotal axes of the control bars; and means for attaching a tow rope to said sled.

3. In an operator controlled, towed underwater sled the combination comprising: a rigid transverse wing containing trapped air means to add buoyancy to the underwater sled; a pair of frames each secured to an end of said wing and extending aft of the trailing edge

of said wing; a pair of elevators comprised of substantially rigid horizontal control surfaces, each elevator being pivotally mounted on a frame and extending aft of the trailing edge of said wing, said elevators being spaced approximately a shoulder's breadth apart to allow the operator to lie between them, each of said elevators having substantial areas of control surface both fore and aft of its pivotal axis; control bars pivotally mounted on said frames aft of the trailing edge of said transverse wing and each having a flange securely fastened to an elevator so that said elevators will pivot on a line coaxial with the pivotal axes of said control bars, said control bars having stop members secured thereto in spaced relationship with said frames, said stop members being engageable with said frames after a preselected pivotal movement of said control bars to limit the pivotal movement of the control bars and thereby to integrate said transverse wing as additional control surface beyond the pivotal limit of said control bars relative to said transverse wing, said control bars also having handle areas extending above and below the pivotal axes of said control bars; and means for attaching a tow rope to said sled.

4. In an operator controlled, towed underwater sled the combination comprising: a rigid transverse wing; a pair of frames each secured to an end of said wing and extending aft of the trailing edge of said wing; a pair of elevators comprised of substantially rigid, horizontal control surfaces, each elevator being pivotally mounted on a frame aft of the trailing edge of said wing so that there are approximately equal areas of control surface fore and aft of the pivotal axes of said elevators, said elevators being spaced approximately a shoulder's breadth apart to allow the operator to lie between them; U-shaped control bars each having an oblong eye formed on one leg of said U-shaped bar and which eye is pivotally mounted on a frame aft of the trailing edge of said transverse wing, the top and bottom of said oblong eye being normally spaced from the frame and comprising stop members engageable with the frame after a preselected pivotal movement of the control bar to limit the pivotal movement of the control bars, the second leg of said U-shaped bar forming handle areas extending above and below the

pivotal axes of the control bars, and a flange extending outward from a side of each oblong eye presenting a surface perpendicular to the control bar to which an elevator is securely fastened for pivotal movement of said elevators on a line coaxial with the pivotal axes of said control bars; and means for attaching a tow rope to said sled.

5. In an operator controlled, towed underwater sled the combination comprising: a rigid transverse wing containing trapped air means to add buoyancy to the underwater sled; a pair of frames each including spaced inner and outer members fastened to an end of said transverse wing and extending aft of the trailing edge of said transverse wing; a pair of elevators comprised of substantially rigid horizontal surfaces, and each pivotally mounted between the inner and outer members of a frame; U-shaped control bars each having an oblong eye secured to one leg of the U-shaped bar, said eyes each fitted around the aft extending inner member of a frame and having a shaft journalled through the side walls of said oblong eye and extending through said inner member for pivotally suspending said control bars from said frames, the top and bottom walls of said oblong eyes being normally spaced from said frames and comprising stop members engageable with said frames after a preselected pivotal movement of said control bars to limit the pivotal movement of said control bars, the second leg of said U-shaped control bars having handle areas extending above and below the pivotal axis of the control bar, and said control bars having flanges to which said elevators are securely fastened so that said elevators will pivot on a line coaxial with the pivotal axes of said control bars; and means for attaching a tow rope to said sled.

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