

July 3, 1962

J. G. LEE

3,041,992

LOW DRAG SUBMARINE

Filed May 10, 1960

FIG. 1

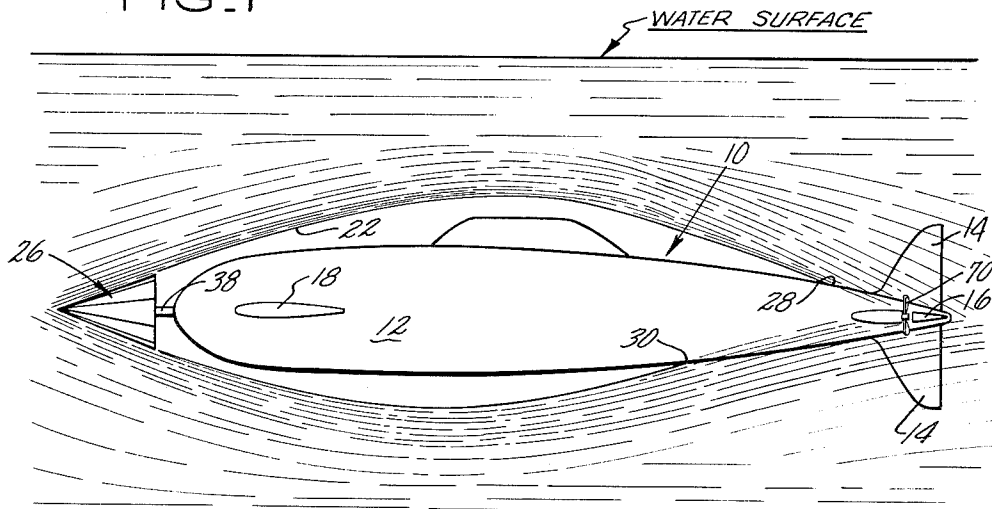


FIG. 2

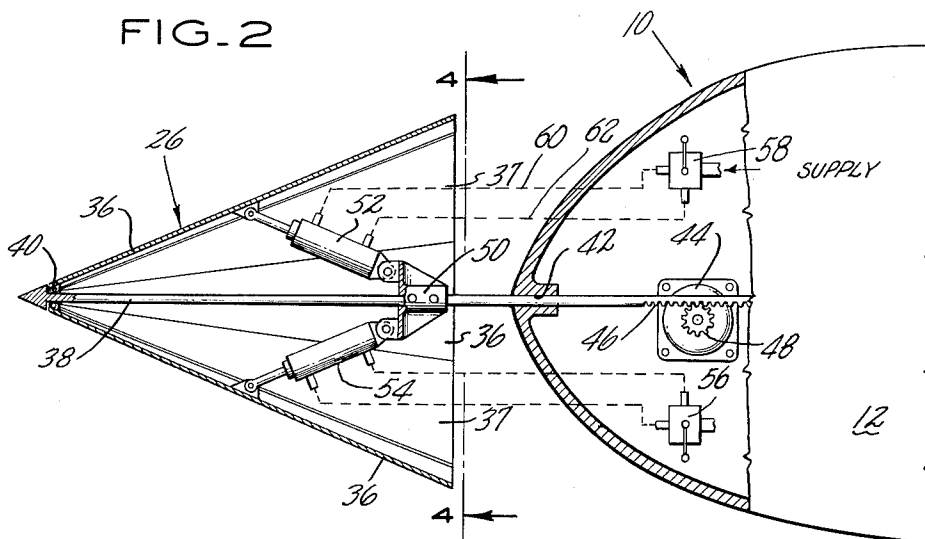


FIG. 3

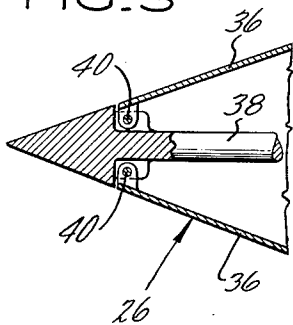
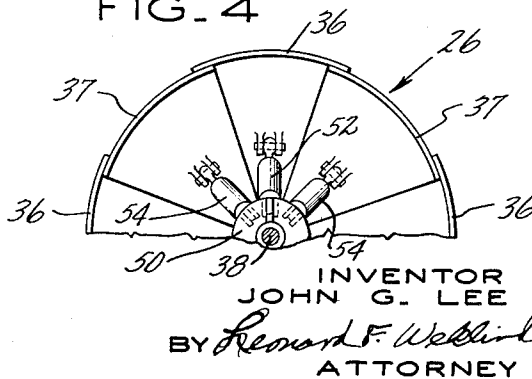


FIG. 4



1

3,041,992

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Filed May 10, 1960, Ser. No. 28,119

4 Claims. (Cl. 114-16)

The invention relates to underwater craft and more particularly to high-speed underwater vehicles.

Present day underwater vehicles, such as submarines and torpedoes or the like, require a considerable amount of power merely to overcome the drag caused by the flow of water over the surface of the vehicle.

It is, therefore, an object of this invention to provide an underwater vehicle having means for greatly reducing skin-friction drag when running submerged.

It is a primary objective of this invention to provide a mechanism adjacent the forward end of an underwater vehicle, which, at the proper speed, will create a cavitation downstream of the device such that a substantial or major portion of the vehicle is traveling in a vapor pocket or bubble.

These and other objectives of this invention will become readily apparent from the following detailed description of the drawings in which FIG. 1 is a schematic illustration of a submarine having a nose element which will form a cavitating bubble.

FIG. 2 is an enlarged detailed schematic of the submarine nose cone.

FIG. 3 is an enlarged detail of the hinge arrangement of the cone flaps.

FIG. 4 is a partial cross section taken along the line 4-4 of FIG. 2.

Referring to FIG. 1, a submarine or other submerged vehicle is generally indicated at 10 as having a substantially streamlined body 12 as well as suitable vertical and horizontal control surfaces 14 and 16, respectively. If desirable, moveable control surfaces 18 may also be provided. These would have to extend sufficiently outwardly to penetrate completely through the vapor bubble defined by the outline 22, when operating at proper speeds.

According to this invention, a cone-carrying member 26 is provided adjacent to the forward end of the submarine, which when driven at suitable velocity, will cause a cavitation bubble, such as 22, so that a major portion of the submarine body 12 is operating within the bubble, thus greatly reducing resistance. The water surrounding the bubble 22 may reattach adjacent the upper surface of the submarine, as at 28, and adjacent the lower surface of the submarine, as at 30. The contour of the submarine surface at the point of reattachment of the surrounding water and the angle of the reattachment flow will influence the amount of thrust which may be produced at these points due to the variation in pressure upstream and downstream of the point of reattachment.

The reattachment points of the upper and lower surfaces of the submarine are spaced along the longitudinal axis of the submarine inasmuch as the cavitation bubble will have a certain amount of buoyancy by itself and will tend to rise, thus causing the lower point of reattachment 30 to be farther upstream. It will be noted that the cavitation-creating member 26 is in the form of a bulbous discontinuity of the streamlined configuration of the submarine.

Referring to FIG. 2, the cone 26 may be formed of a plurality of flaps 36 which may be connected to a forward probe-like rod 38 (also see FIG. 3) by means of suitable hinges 40. The rod 38 is supported by a suitable bearing 42 and extends aft into the submarine where it is connected to a motor 44 by means of a rack 46 and a pinion

2

48. Thus, the fore and aft position of the cone 26 may be adjusted by suitable control of the motor 44 so as to adjust the size and shape of the cavitation bubble for high forward speeds of the submarine. The rod 38 also carries a support member 50 which carries one or more cylinder-piston arrangements 52, 54, which in turn are each connected to one of a plurality of flaps 36, 37, respectively. The pistons or struts 52 and 54 may be differentially operated, if desired, to cause the cone to become asymmetrical with respect to the longitudinal axis of the rod 38, or they may be simultaneously operated.

The struts 52 and 54 may be controlled in any suitable manner by control valves 58 and 56, respectively. High and low-pressure control lines schematically illustrated at 60 and 62 may be arranged in any convenient manner so that they can conduct fluid under pressure to the struts. If necessary, the central rod 38 could be made hollow to carry the lines or separate flexible lines could be used.

The arrangement of the flaps 36 is best shown in FIG. 4 where it is seen that adjacent flaps may overlap in any desirable fashion to achieve the greatest strength to weight ratio.

The angles made by the sides of the cone 26 may be differentially adjusted also to obtain optimum cavitation for given operating conditions. This will permit controlling the reattachment of the bubble, which in turn may be used to control the direction of the submarine. It should be noted further that the submarine may obtain a dynamic lift by planing, in effect, on the lower surface of the bubble.

It should be understood that although a propeller drive 70 is shown at the aft end of the submarine, high-powered rockets or other suitable reaction power plants may be used in order to achieve the speed necessary to produce sufficient cavitation behind the cone 26.

As a result of this invention, it is readily apparent that a high-speed, extremely low-drag underwater vehicle has been provided which will operate at a minimum drag condition. As a result, high-speed, long-range operation may be achieved because of the relatively low drag encountered while the vehicle is being driven through the water.

Although one embodiment of this invention has been illustrated and described, it will be apparent that various changes may be made in the construction and arrangement of the various parts without departing from the scope of this novel concept.

What is desired by Letters Patent is:

1. A vehicle adapted to operate completely submerged in a liquid, means for propelling said vehicle at relatively high speeds, while submerged in said liquid, means for reducing friction drag on the outer surface of said vehicle comprising a streamlined body forming a bulbous discontinuity on the leading edge of the vehicle for forming a gaseous cavity enveloping a substantial portion of the vehicle immediately downstream of said discontinuity, means for adjusting the relative position of said bulbous portion along the longitudinal axis of the vehicle, and means for varying the contour of said bulbous discontinuity about said axis.

2. A vehicle according to claim 1 wherein the contour of said bulbous discontinuity may be differentially altered to provide a controllable cross-sectional shape for the gaseous cavity.

3. A vehicle adapted to operate completely submerged in a liquid, said vehicle having a longitudinal axis, means for propelling said vehicle at relatively high speeds, while submerged in said liquid, means for reducing friction drag on the outer surface of said vehicle comprising a streamlined body forming a bulbous discontinuity on the leading edge of the vehicle for forming a gaseous cavity

3

enveloping a substantial portion of the vehicle immediately downstream of said discontinuity, said bulbous discontinuity including a plurality of members having portions thereof movable transversely of said axis for varying the contour of said portion, and means for adjusting the relative position of said bulbous discontinuity along said axis of the vehicle.

4. A submarine vehicle adapted to operate completely submerged in water, said vehicle having a longitudinal axis, means for propelling said vehicle at relatively high speeds while submerged in the water, means for reducing friction drag on the outer surface of said vehicle comprising a streamlined body forming a bulbous discontinuity on the leading edge of the vehicle for forming by cavitation a gaseous cavity enveloping a substantial portion of the vehicle immediately downstream of said discontinuity, said bulbous discontinuity including a plurality of overlapping members arranged about the periphery of said discontinuity and pivotally connected together at the

4

forward apex thereof having portions thereof movable transversely of said axis for varying the contour of said portion, means for adjusting the relative position of said bulbous discontinuity along said axis of the vehicle, and control means comprising streamlined surfaces extending laterally from said vehicle and having a span sufficient to extend beyond the gaseous cavity and penetrate the adjacent water.

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