May 11, 1965 G. W. LEHMANN 3,182,623

STRUCTURE FOR SUBMARINE JET PROPULSION

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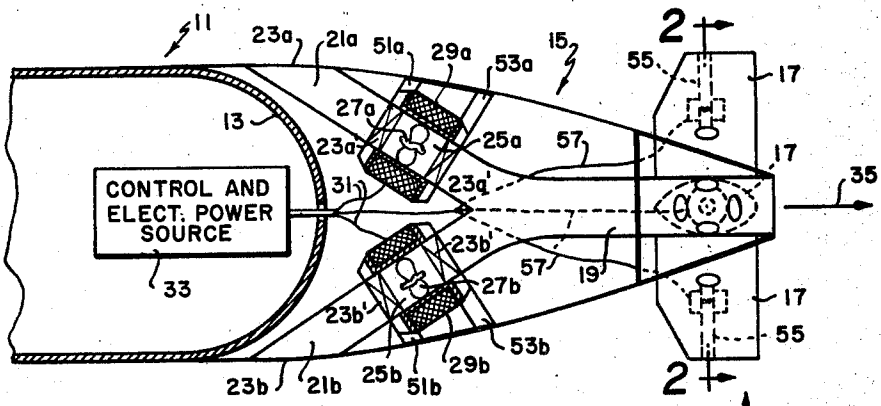

FIG. 1.

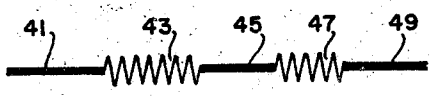

FIG. 3.

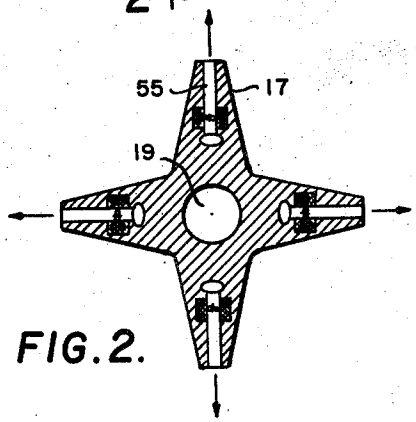

FIG. 2.

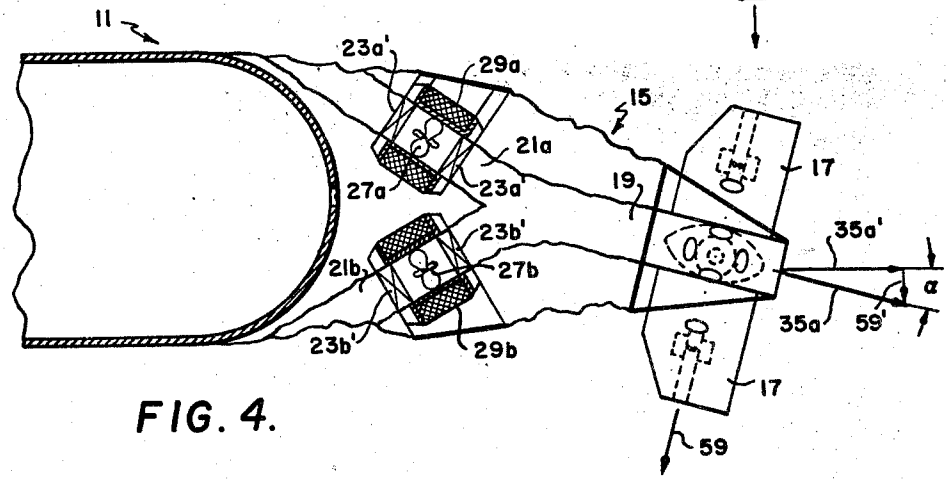

FIG. 4.

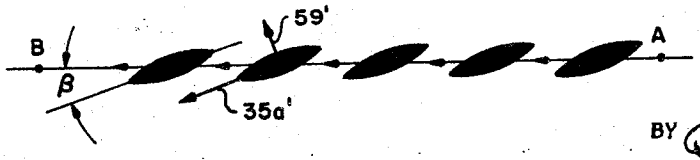

FIG. 5.

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STRUCTURE FOR SUBMARINE JET PROPULSION

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2 Claims. (Cl. 114—16)
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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 therfor.

This invention relates to submarines and propulsion equipment associated therewith and more particularly to jet-type propulsion systems for submarines.

Conventional propeller driven submarines cause problems relating to noise radiation, vibration, and sealing of the propeller shaft, particularly at deep submergence. A submarine propelled by a conventional shaft-driven propeller is also subject to being made inoperative if the aft hull structure is distorted or the shaft jammed due to explosive charges being detonated in the vicinity of the submarine.

The present invention is aimed at avoiding the aforesaid disadvantages of such conventional propeller-driven submarine craft. In accordance with this invention there is provided a shaftless jet-type propulsion system which is, aside from the power source, wholly contained outside the submarine pressure hull. The jet system is mounted within a floodable tail structure through which the jet propulsion ducts run.

Accordingly, it is an object of the present invention to provide a submarine propulsion system capable of operating even after severe damage.

Another object is the provision of a deformable hull system aft of the pressure hull for the propulsion plant of a submarine whereby the propulsion system remains operative even after permanent distortion of the hull.

A further object is to provide a submarine propulsion system which obviates the need for deep submergence shaft seals.

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 drawings in which like reference numerals designate like or corresponding parts throughout the figures thereof and wherein:

FIG. 1 is a fragmentary, partially schematic cross-sectional view in elevation of a submarine embodying the present invention;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a schematic representation of the elastic system of the structure shown in FIG. 1;

FIG. 4 is a cross-sectional view of the aft portion of the submarine of FIG. 1 in distorted condition due to shock damage;

FIG. 5 is a force and course plan of a submarine with a stricken aft section.

Referring now to the drawings there is shown in FIG. 1 a submarine illustrated generally by the numeral **11**. The submarine **11** comprises a pressure hull **13** to which is fixedly connected a tail section **15** having a plurality of stabilizing fins **17** at the aft end thereof. There is provided within the tail section a main jet propulsion duct **19** having a plurality or at least a pair of branches **21***a* and **21***b* which terminate at the outer surface of the tail section in a plurality of water intakes **23***a* and **23***b*.

Mounted within each of the duct branches **21***a* and **21***b* by any suitable bearing or retaining means are

rotatable tubes **25***a*, **25***b* in which are mounted impellers **27***a*, **27***b*. The impellers **27***a* and **27***b* are fixed to the rotatable tubes **25***a* and **25***b* by attachment of the blade tips to the inner surfaces of the tubes. Affixed to the outer surface of the pair of tubes **25***a* and **25***b* are the rotors of a pair of electromotors **29***a* and **29***b*, respectively. The stators of the motors **29***a* and **29***b* are, of course, positioned around the rotors and held against rotation by rigid connection to structural members.

The electromotors **29***a* and **29***b* are of the shaftless submersible type, such as for example, the type shown in copending application Serial Number 225,943, filed September 24, 1962. A power cable **31**, which passes through the pressure hull **13**, connects the motors to a control and electrical power source **33** within the submarine pressure hull. When energized, the motors rotate the tubes **25***a* and **25***b* causing the impellers **27***a* and **27***b* to also rotate thereby producing a jet propulsion stream through the ducts **21***a*, **21***b* and **19**, as shown by the arrow **35**. The jet propulsion stream **35** produces a thrust which propels the submarine forward. Backing can easily be accomplished by reversing the rotation of the impellers whereby the duct **19** becomes the intake and ducts **23***a* and **23***b* the jet propulsion stream ejector tubes. It is further understood that 2, 4, 6 or any other number of impellers may be arranged in a star like fashion having the duct **19** in common.

Structurally, the tail section of the submarine is preferably composed of members of different rigidity and elasticity in order to make the propulsion system less vulnerable to depth charges or other underwater explosions particularly those powerful enough to cause permanent structural deformation. FIG. 3 shows diagrammatically the elastic system of the tail structure. The rigid submarine pressure hull **13** is represented by the diagram portion **41**. Attached respectively thereto are a deformable portion **43**, a rigid body **45**, a deformable body **47**, and a rigid body **49** as the aftermost structure. The deformable portion **43** carries the ducts **21***a* and **21***b* which are also deformable. The rigid portion **45** carries the propulsion plant including rotatable tubes **25***a*, **25***b*; impellers **27***a*, **27***b* and motors **29***a*, **29***b*, are supported by high strength rigid foundation members **51***a*, **51***b*, **53***a* and **53***b*. The foundation members transfer the thrust into the hull system.

The rigid aftermost structure **49** carries the ejector tube **19** and the plurality of rigid stabilizing fins **17**. As may be seen most clearly from FIG. 2, each of the stabilizing fins **17** is equipped with an independent jet apparatus **55** which may be of a type similar to the main propulsion apparatus. A power cable **57** interconnects the jet apparatus **55** with the control and power source **33**.

The terms "rigid" and "deformable" as used herein mean that the "rigid" bodies deform proportionately even under heavy impact whereas the "deformable" bodies are subject to early plastic deformation. The yield strength of the rigid bodies should be higher than that of the deformable bodies which yield upon being subjected to force just less than that sufficient to distort the rigid bodies **45** and **49**. These properties may be obtained by different dimensioning of structural members and/or by proper choice of materials having different moduli of elasticity.

If the submarine is subjected to a severe underwater explosion, the tail section may assume a distorted shape such as shown in FIG. 4. The deformable portions yield and deform plastically. The propulsion plants thereby may assume a misaligned position but due to the rigidity of the rigid member **45** and attached foundations remain intact and have no deformation. The tail section **49** may also be misaligned.

Under such distorted conditions the propulsion plant

may still be able to produce a jet stream **35***a* through the distorted ducts. The force of the net jet stream **35***a* will probably be of smaller magnitude than the jet stream **35** of an intact duct and will act at an angle α from the longitudinal axis of the submarine at a lever arm **59'** therefrom. This jet stream **35***a* produces an axial thrust **35***a'*, and a transverse force **59'**.

By utilizing the fin jets **55** to produce a jet stream equal and opposite to **59'**, the moments of the jet stream **35***a* may be eliminated, thereby allowing the ship to proceed on a controlled course. Thus, as shown in FIG. 5, a course correction β is required due to the transverse force component of the thrust **35***a'* in order to run the ship on a straight line between points A and B. The course correction β may be in any spatial direction depending on the manner in which the aft section is distorted.

It is to be noted that the propulsion plant is designed to remain intact, even though less efficient, although the aft section is badly distorted. This is accomplished since the sections of different rigidity allow some parts to deform in the plastic range thereby absorbing most of the shock while the more rigid parts carrying the propulsion machinery preserve the operational capabilities of the vessel.

A further advantage inherent in this structure is the lack of sealing problems in the pressure hull since the only device which must pass therethrough is the electrical power cable for the motors. The cable is of course flexible to allow it to follow tail deformation. Since no movement of the cable occurs at the point where it passes through the pressure hull, sealing becomes a relatively simple problem when compared to the sealing necessary around the rotating and reciprocating elements of conventional propulsion and control systems.

It is to be understood that various modifications and variations of the 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.

What is claimed is:

1. A submarine structure comprising:

a rigid pressure hull;

a non-pressure hull tail section secured to said pressure hull and extending therefrom;

said tail section comprising first and second rigid portions and first and second deformable portions, said first rigid portion being connected to said pressure hull by said first deformable portion, and said second rigid portion being connected to said first rigid portion by said second deformable portion; and

jet stream propulsion means housed in said tail section and comprising jet stream impeller means mounted in said first rigid portion and connected by deformable duct means to an intake in said tail section and to a jet stream outlet in said second rigid portion.

2. A submarine structure comprising:

a rigid pressure hull;

a non-pressure hull tail section secured to said pressure hull and extending therefrom;

said tail section comprising first and second rigid portions and first and second deformable portions, said first rigid portion being connected to said pressure hull by said first deformable portion, and said second rigid portion being connected to said first rigid portion by said second deformable portion;

jet stream propulsion means housed in said tail section and comprising impeller means mounted in said first rigid portions, deformable duct means connecting said impeller means with an intake opening in said first deformable portion, and deformable duct means connecting said impeller means with an outlet in said second rigid portion;

a plurality of radially extending fin means mounted on said second rigid portion; and

steering jet stream producing means in each of said fin means, each steering jet stream means comprising impeller means and duct means for directing a jet stream from the tip of the respective fin and radially of said hull structure.

References Cited by the Examiner

UNITED STATES PATENTS

2,644,397	7/53	Katz.	
3,092,060	6/63	Reid	114—16
3,104,641	9/63	Froehlich	114—16

FOREIGN PATENTS

1,134,967	12/56	France.
873,958	4/53	Germany.
20,510	1892	Great Britain.

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