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OFFICE OF NAVAL RESEARCH
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PROPELLER DEFLECTION SNUBBER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention relates generally to a system for preventing damage to a propeller, and more particularly to an apparatus for preventing a propeller of a countermeasure device from deflecting to the point of being damaged.

(2) Description of the Prior Art

Underwater vehicles, such as torpedoes and countermeasures, such as torpedoes, utilize a propeller system to provide hovering and transit capabilities. An example of such a propeller system is shown in FIG. 1, which is a partial cross-section view of a countermeasure device 100. Countermeasure device 100 includes a
nose portion 102 and a tail portion 104. Tail portion 104 includes a tail cone 106, a shroud 108 and a two-bladed propeller 110 mounted on a shaft 112, which is driven by a motor located within tail cone 106. FIG. 1 shows a cross-section view of shroud 108 only, all other features are shown in full. FIG. 1A shows an end view of countermeasure device 100, including tail cone 106, shroud 108 and two-bladed propeller 110. Shroud 108 includes shroud supports 113 and shroud ring 114. Countermeasure device 100 is mounted inside a launch tube 116 of a vessel 118, as shown in FIG. 2. When countermeasure device 100 is launched, it pushes end cap 120 of launch tube 116 open. Upon the opening of end cap 120, water 122 rushes into launch tube 116 at a pressure which varies depending on the depth in water 122 that the launch tube 116 is located. The difference in pressure between launch tube 116 and water 122 creates a water hammer which can impact propeller 110 and shaft 112 with great force. The force with which the water hammer impacts propeller 110 and shaft 112, both when entering launch tube 116 and after impacting rear wall 124 of launch tube 116 and then exiting launch tube 116, can be great enough to cause propeller 110 and, consequently, shaft 112 to deflect, permanently damaging
propeller 110 and shaft 112, thereby rendering the countermeasure
device 100 less maneuverable or inoperable.

SUMMARY OF THE INVENTION

It is therefore the object of the invention to provide a
system for preventing permanent damage to the propeller and shaft
of a countermeasure device due to the water hammer created when
the countermeasure device is launched. Another object is to
provide a low-cost and mechanically simple system which does not
require launch tube modifications.

The invention includes a tail section having a housing which
surrounds a banded propeller. The housing includes a deflection
snubbing section which provides a physical stop to limit the
deflection of the banded propeller in both the fore and aft
directions. The deflection snubbing section includes a number of
inwardly extending extensions and raised portions, each also
having a compressible liner attached to an inside surface
thereof. The banded propeller is mounted on the shaft of the
countermeasure device so that its band is located between the
extensions and raised portions. When the propeller is subjected
to high forces due to the water hammer created during a launch,
the extensions and raised portions act as physical stops to
prevent the propeller from deflecting enough to permanently
damage the propeller and the shaft.

In a preferred embodiment of the invention, a deflection
snubber assembly for preventing damage to a propeller which is
subjected to instances of high force is disclosed. The propeller
includes a hub for mounting the propeller on a shaft and a number
of blades extending radially outward from the hub. The outer
tips of the blades are interconnected by a continuous, circular
band. The propeller is constructed to accommodate a
predetermined amount of deflection upon instances of high force
before being permanently damaged. The deflection snubber
assembly includes a housing circumferentially surrounding the
propeller, the housing having a number of deflection limiting
members, each of the deflection limiting members limiting
deflection of the propeller to within the predetermined amount of
deflection upon occurrences of the instances of high force.

A method for preventing damage to a propeller which is
subjected to instances of high force is also disclosed. The
method includes limiting the deflection of the propeller within a
predetermined amount upon instant occurrences of high force.
BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the appended drawings, wherein:

FIG. 1 is a partial cross-section view of a conventional countermeasure device;

FIG. 1A is an end view of the tail portion of the countermeasure device of FIG. 1;

FIG. 2 is a partial cross-section view of the countermeasure device of FIG. 1 mounted inside a launch tube of a marine vessel;

FIG. 3 is a perspective view of a banded propeller used in accordance with the present invention;

FIG. 4 is an end view of a countermeasure device including the deflection snubber of the present invention; and

FIG. 5 is a partial cross-section side view of a countermeasure device including the deflection snubber in accordance with the present invention.

Common features of the invention are identified with common reference numerals in the multiple views provided of the invention.
DESCRIPTION OF THE PREFERRED EMBODIMENT

The propeller and deflection snubber assembly of the present invention is illustrated most clearly in FIGS. 4 and 5. As will hereinafter be more fully described, the general basis for the invention is for the propeller and snubber to cooperate to limit the potential deflection of the propeller blades and the propeller shaft to within predetermined limits relative to a longitudinal axis 19 of the countermeasure device, shown in FIG. 5, which will not permanently damage the propulsion system.

Deflection of the propeller blades is generally limited by providing a banded propeller, while deflection of the propeller shaft is limited by enclosing the banded propeller within a housing having a compressible liner.

FIG. 3 shows a banded propeller 10 which is used in conjunction with the present invention. Propeller 10 includes a number of blades 12 connected between a hub 14 and a band 16. Hub 14 includes a hole 18 to facilitate mounting propeller 10 on a shaft. While, in this description, propeller 10 is shown having three blades 12, it will be understood that a propeller having any number of blades may be used in conjunction with the present invention.
In general, the propeller 10 and shaft are manufactured from materials having some flexibility so that they can withstand a predetermined amount of flexure or deflection before being permanently damaged.

FIG. 4 shows the deflection snubbing assembly of the present invention. FIG. 5 is a partial cross-sectional view of the present invention, showing propeller 10 in full and a housing 20 in cross-section, taken along line 5-5 in FIG. 4. As shown in FIGS 4 and 5, propeller 10 is mounted on a shaft 24 inside housing 20, which is mounted to tail cone 26 of a countermeasure device.

Housing 20 includes a wall portion 21 and a base portion 22, which is mounted on tail cone 26. Housing 20 is preferably made from aluminum. However, it will be understood that any suitable material can be used in the formation of housing 20. Extending radially inward, over propeller 10, from the top of wall 21 are four extensions 30, located equidistant from each other along wall 21. Extensions 30 have a length which is approximately one-third the distance between wall 21 and hub 14 and a width approximately half of its length. Base portion 22 includes four raised portions 32 which are formed on base portion 22 and positioned along wall 21, under propeller 10, to coincide with
extensions 30. Raised portions 32 have the same dimensions as
extensions 30. A strip 28 of a compressible material, such as
rubber, is attached along the inside surface of each
extension 30, raised portion 32 and the part of wall portion 21
that interconnects each extension 30 to its corresponding raised
portion 32.

The operation of the countermeasure propeller deflection
snubber of the present invention will now be discussed. As
described previously, when a countermeasure device, such as that
shown in FIG. 2, is launched from a marine vessel, the nose of
the countermeasure device pushes the end cap out from the marine
vessel. As a result, water enters the launch tube with enough
force to permanently damage prior art propeller systems. In the
present invention, when the water impacts the propeller 10 upon
its entrance into the launch tube and upon its exit from the
launch tube after impacting the back wall of the launch tube,
damage to the propeller 10 is prevented in two ways. First,
band 16, which connects the outer edges of blades 12, increases
the lateral rigidity of the propeller, thereby making the
propeller less likely to deflect relative to longitudinal axis 19
when impacted with water. Second, in the event that propeller 10
is impacted with enough force to cause propeller 10 to deflect,
extensions 30 and raised portions 32 limit the deflection of
propeller 10 by providing a physical stop for band 16 to snub
deflections of the propeller 10. In other words, when
propeller 10 experiences enough force from incoming water to
deflect an amount that would cause damage to propeller 10,
band 16 will contact either extensions 30 or raised portions 32,
depending on the direction of deflection. Extensions 30 and
raised portions 32 stop the deflection of propeller 10 before the
propeller deflects an amount which will cause permanent damage to
propeller 10 and the shaft 24. Strips 28 prevent damage to
band 16 due to the impact of band 16 with extensions 30 and
raised portions 32.

The distance between extensions 30, raised portions 32 and
wall 21 and propeller 10 and the thickness of strips 28 are
chosen to limit any deflection of propeller 10 to an amount that
will not permanently damage propeller 10 or shaft 24, while
allowing enough space for water to flow around propeller 10. As
can be seen in FIG. 4, extensions 30, which extend inward, toward
hub 14 of propeller and raised portions 32 are also positioned
around the circumference of wall 21 with enough distance between
them to allow proper inflow and outflow of water into housing 20.
to allow propeller 10 to effectively generate the thrust needed
to propel the countermeasure device.

While there is shown and described herein certain specific
structure embodying the invention, it will be manifest to those
skilled in the art that various modifications and rearrangements
of the parts may be made without departing from the spirit and
scope of the underlying inventive concept. For example, the
number, shapes and sizes of the extensions and raised portions
may be varied to accommodate differently sized or constructed
propellers. The material used for the strips 28 and their
thickness may also be varied, depending on the size and
construction of the propeller. Therefore, the invention is not
limited to the particular forms herein shown and described
PROPELLER DEFLECTION SNUBBER

ABSTRACT OF THE DISCLOSURE

A deflection snubber assembly for preventing damage to a propeller which is subjected to instances of high force is disclosed. The propeller includes a hub for mounting the propeller on a shaft and a number of blades extending radially outward from the hub. Outer tips of the number of blades are interconnected by a continuous, circular band. The propeller is constructed to accommodate a predetermined amount of deflection upon instances of high force before being permanently damaged. The deflection snubber assembly includes a housing circumferentially surrounding the propeller, the housing having a number of deflection limiting members, each of the deflection limiting members limiting deflection of the propeller to within the predetermined amount of deflection upon occurrences of the instances of high force.