Nov. 1, 1955 E. C. HOFFMAN 2,722,194

ATTENUATOR TO REDUCE SHIP'S PROPELLER VIBRATIONS

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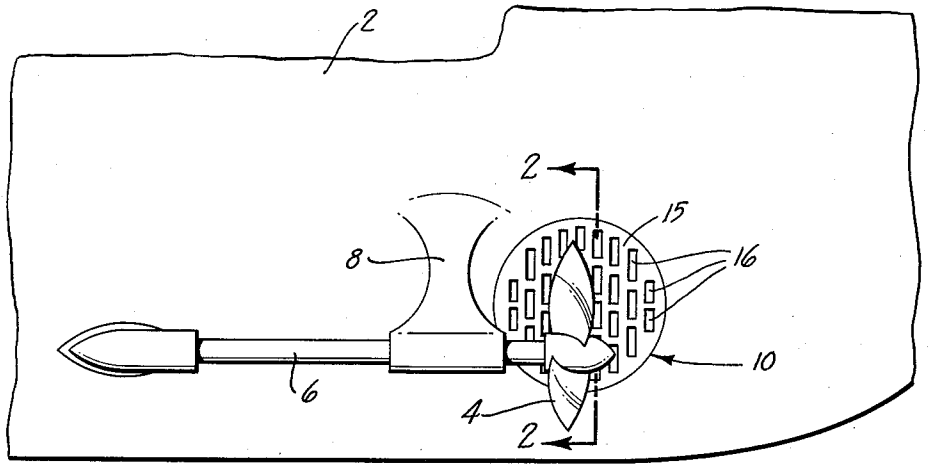


FIG. 1

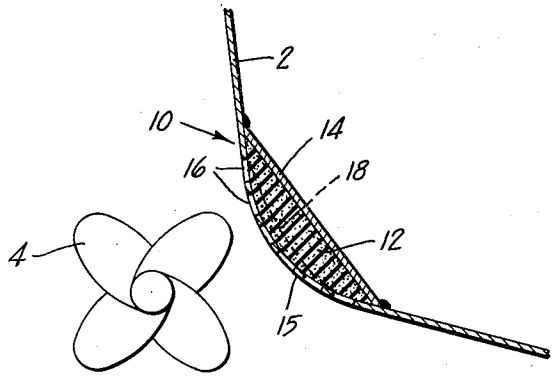


FIG. 2

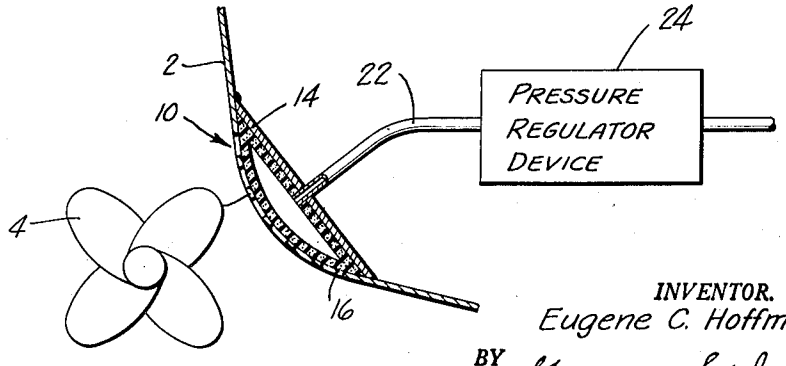


FIG. 3

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ATTENUATOR TO REDUCE SHIP'S PROPELLER VIBRATIONS

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2 Claims. (Cl. 115—34)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention 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 therefor.

This invention relates to ship construction and more particularly to a method and means for reducing hull vibration produced by propulsion.

Vibration on high-powered ships is a serious concern because of its destructive effects on precision or other equipment to the extent of rendering certain shipboard areas useless for their intended purpose. Further, such vibrations are known to produce noises that increase the likelihood of detection by underwater listening sonar equipment as well as interfering with the ship's own sonar equipment. Although a ship's structure is excited by vibration forces both from its machinery and its propellers, the present concern is principally with the vibrational effects of the latter. It has been determined that as the propeller is driven through the water the forward face of each blade causes a negative pressure and the after face a positive pressure, the negative pressure producing about two-thirds of the total thrust. As the propeller blade tips approach the hull, the negative pressure field extends to the hull causing a suction on the hull plates. This pressure change has both horizontal and vertical components, the exciting energy pulsating in direct proportion to the propeller speed, and the number of blades and, of course, when the energy pulses of the propellers are sufficiently in resonance with the frequency of the hull the vibrational effects are amplified and become quite deleterious to efficient operations. Many counteractive devices have been attempted in an effort to provide a vibration-free operation, such, for example, including extra stiffeners or various anti-vibration mounts. These devices, however, have limited value in that they constituted an attempt at dampening vibrations after they were transmitted to the interior of the ship. Although the contrasting procedure of absorbing the vibrations before they enter the hull should be preferred, it does not appear that any successful attempts along this line have been made.

Accordingly, a principal object of this invention is to reduce the vibrations on a ship's hull due to the propulsion means, and, more specifically, attenuate these vibrations exteriorly of the ship to the extent that no deleterious shocks enter the hull.

Another object is to provide a resilient attenuator for reducing these vibrations, and a corrollary object is to provide a resilient means which can be varied in resonance with one or more critical frequencies of the hull or propeller shaft.

Further objects are to provide a small, compact, easily installed and maintained attenuator which will not affect the contour of the hull nor increase to any large extent the frictional resistance of the hull.

Other objects will become apparent from the detail description and the accompanying drawing.

According to the invention the vibration effects on

a ship's hull by its propulsion means can be greatly attenuated by providing a resilient external section or diaphragm on the hull adjacent the propulsion means. In the preferred embodiment the contour of the hull is preserved by positioning the resilient section in a recess formed in the hull over which is placed a perforated protective baffle. The resilient section may be made of any suitable material, such as a pad of sponge rubber, neoprene or other synthetic composition, and, most suitably, the material should be selected so as to have a natural resilient response or recovery rate corresponding to hull frequency attained when the magnitude of the vibration is the greatest. That is, the diaphragm must have a natural resilient responsivity such as might enable it to flex and recover at least within the time interval required for a given blade pulse. Such a time interval might, for example, be 16 pulses per second for aircraft carriers having a four-bladed propeller, driven at a shaft speed of 240 R. P. M. (full speed).

If for any reason it is desirable to vary the resiliency of the diaphragm (a contingency that may occur when there are more than one critical hull or shaft frequencies), the diaphragm may be constructed of a gas-filled envelope with the gas pressure controlled by any suitable regulator carried interiorly of the ship. An additional dampening effect on the exciting energy is obtained by providing the protective baffle previously referred to with a plurality of openings which act to throttle the water pressure prior to its impingement on the enclosed diaphragm and such baffle openings, preferably, are vertically elongated to reduce drag.

In the drawing: Fig. 1 is a partial side elevation of a propeller-driven ship provided with the attenuator of this invention; Fig. 2 a cross-section through the hull taken along lines II—II of Fig. 1, and Fig. 3 a similar cross-section of a modified attenuator.

Referring to the drawings, a conventional ship's hull **2** is shown provided with a propeller **4** mounted on a shaft **6** and supported from the hull by a strut **8**. The propeller is illustrated as a four-blade type positioned to one side of the hull as in twin-screw or quadruple-screw ship, although as will be obvious, the invention also may be used on a single-screw vessel and with propellers having more or less blades. With such a drive, the vibrations in question are produced by the pulsating forces of the ship's machinery on the propellers, and when there is resonance or near resonance condition between the frequency of these exciting forces and one of the natural frequencies of the hull structure serious consequences may arise, especially during high speed runs.

One of the major exciting forces contributing to this vibration arises when the propeller blades pass the hull causing negative and positive pressures on the adjacent surface of the hull plates and the principal advantage of this invention lies in the discovery that these exciting forces may be dissipated by providing the hull with a resilient section **10** adjacent each propeller and extending over an area affected by these forces. In Fig. 2 the resilient section comprises a diaphragm **12** confined between a watertight plate **14** and hull **2**, the hull plates adjacent the diaphragm being formed into a baffle **15** having a plurality of apertures **16** by which the water acting on the diaphragm may enter and leave the resilient section. Diaphragm **12** may be made of sponge rubber, neoprene, or other synthetic material which can be tuned, that is, brought into resonance with the frequency of the exciting force to dissipate the energy. In a four-bladed propeller, such as the aircraft carriers exemplified above, the propeller frequency is about 16 pulses per second. Obviously, if a different critical frequency is used, the material must have a corresponding

frequency in order that a resonant or a near resonant condition may exist for obtaining maximum energy dissipation.

Baffle apertures **16** supplement the dampening action of the diaphragm by throttling the water entering and leaving the resilient section, this action absorbing some of the exciting energy and, as stated, these apertures may be in the form of the illustrated elongated slots to reduce the drag on the ship.

In operation, as the propeller passes the resilient section, the exciting forces transmitted by the water pass through the baffle and act on the diaphragm causing it to be compressed to a dotted-line position **18**. As the beat passes, the water is forced out by the diaphragm which then is in a condition to absorb the next beat. Thus, the baffle and diaphragm both serve to attenuate the vibration which otherwise might be transmitted to the hull. There may be a positive pressure pulse greater than the hydrostatic pressure on the hull area, however, the diaphragm should be adequately pressure stabilized to take care of positive as well as negative pulses.

In the embodiment of Fig. 1, the diaphragm is designed to accommodate a single critical frequency. However, where it is desirable to accommodate more than one frequency, this can be achieved by regulating the resiliency of the diaphragm. Such regulation is permissible in the manner shown in Fig. 3 where the diaphragm comprises a gas-filled, resilient envelope **20** connected by hose **22** to a pressure regulator **24** mounted within the hull. The gas may be air taken from the ship service supply and controlled through the pressure regulator **24** mounted within the hull. As in Figs. 1 and 2, hull **2** is provided with baffle **15** having slots **16** through which the water enters and leaves the diaphragm in the same manner as previously described.

Use of an attenuator mounted on the hull adjacent each propeller affords a means for absorbing the exciting energy due to negative and positive propeller pulses. By dissipating these propeller forces acting on the hull, vibrations are eliminated at the critical frequencies that might otherwise create noise, damage equipment, reduce available deck space, or have a disturbing effect on personnel. Further, as explained, the resiliency of the diaphragm may be made variable to accommodate more than one critical frequency, while the perforated attenuator baffle protects the diaphragm and serves to initially dissipate some of the exciting forces by metering the water into the resilient section.

Obviously, many modifications and variations of the present 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.

I claim:

1. A ship comprising a propeller, a hull provided with an external recess formed near said propeller in the path of pulsating pressures created by propeller drive, a resilient gas-filled envelope mounted in said recess, and means for regulating the gas pressure of said envelope, whereby the rate of resilient recovery of said envelope can be varied in conformity with various rates of pulsating energy created by the propeller drive.

2. A ship comprising a propeller, a hull provided with an external recess formed near said propeller in the path of pulsating pressures created by propeller drive, a resilient gas-filled envelope mounted in said recess, a slotted baffle covering said envelope, and means for regulating the gas pressure of said envelope, whereby the rate of resilient recovery of said envelope can be varied in conformity with various rates of pulsating energy created by the propeller drive.

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