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ELECTROLYSIS APPARATUS AND A METHOD OF HYDRODYNAMIC
CAVITATION PROTECTION

Earl Quandt, et al

Department of the Navy
Washington, D. C.

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**ELECTROLYSIS APPARATUS AND A METHOD OF HYDRODYNAMIC
CAVITATION PROTECTION****ABSTRACT**

Method of and apparatus for protecting the surfaces of hydrodynamic members subjected to a cavitating fluid environment such as seawater. A conductive metal insert is affixed to and electrically insulated from the surface of the member where cavitation damage is most likely to occur. A variable d-c voltage is connected between the metal insert (cathode) and the hydrodynamic member (anode). As the voltage is applied, a protective layer of hydrogen gas bubbles is formed over the conductive metal insert to thereby cushion the shock of the collapse of the cavitation voids.

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 therefor.

BACKGROUND OF THE INVENTION

This invention relates to fluid reaction surfaces and more particularly to a method of an apparatus for protecting hydrodynamic surfaces susceptible of cavitation damage.

In the past, many attempts have been made to minimize

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1 the damage to hydrodynamic members from the eroding and
2 pitting effects of cavitation. Fabricating the member
3 from costly cavitation-resistant materials has the dis-
4 advantage that, in most instances, only a small region
5 of the mechanical surfaces of the members are susceptible
6 to damage, thus, fabrication of the entire member from
7 such materials is not justified. Moreover, no material
8 has been found which is completely cavitation damage
9 proof. Another means used to protect cavitating surfaces
10 from damage is to weld a cavitation-resistant material
11 into regions susceptible to damage. One disadvantage
12 of this approach is that considerable skill is required
13 to insure that the welding process does not alter de-
14 sirable properties of the cavitation-resistant material
15 because of high welding temperatures. Still another
16 prior art protective measure is to coat surfaces sub-
17 jected to cavitation with an elastomeric coating.
18 Under intense cavitation, however, the coating has the
19 tendency to peel away from the surface.

20 In U.S. Patent 2,803,428 air at atmospheric or
21 higher pressure is introduced into the low pressure
22 areas or cavities caused by the cavitation of the blades
23 of a hydrodynamic turbine. The air introduced prevents

1 the collapse of the voids or cavities and provides an
2 absorbent cushion to thereby reduce erosion of the
3 blade. A disadvantage of this approach is the difficulty
4 of insuring that the injected air is introduced precisely
5 into the cavitating regions. Furthermore, an excess of
6 air injection may result in an increase of cavitation
7 intensity or an enlargement of the cavitation region
8 which may produce a reduction in the efficiency of the
9 hydrodynamic machinery.

10 SUMMARY OF THE INVENTION

11 In accordance with the present invention, a con-
12 ductive metallic plate or insert is embedded in and
13 electrically insulated from that portion or portions of
14 the surface of a hydrodynamic member susceptible of
15 cavitation. With the member immersed in water, a d-c
16 voltage is applied between the insert (cathode) and the
17 surface (anode) to electrolytically form a protective
18 layer of hydrogen gas over the plate. By varying the
19 voltage the degree of cavitation protection may be
20 varied. The invention may be used to protect a wide
21 variety of hydrodynamic surfaces such as for example
22 hydraulic turbines, hydrofoils, hydrofoil struts, marine
23 propellers and hydraulic ducting including inlets and

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1 outlets. One advantage of the present invention is that
2 gas is locally and precisely introduced into a region
3 of known cavitation damage.

4 OBJECTS OF THE INVENTION

5 It is therefore an object of the present invention
6 to protect hydrodynamic surfaces from cavitation damage
7 by electrolytically forming a protective gas layer over
8 the regions where cavitation damage is expected.

9 Another object of the invention is to provide a
10 simple yet effective means to minimize cavitation damage
11 which has wide applicability to a variety of hydrodynamic
12 surfaces.

13 Other objects, advantages and novel features of the
14 invention will appear from a reading from the following
15 detailed description when considered in conjunction with
16 the accompanying drawings.

17 BRIEF DESCRIPTION OF THE DRAWINGS

18 FIG. 1 is a diagrammatic view showing the general
19 concept of the present invention.

20 FIG. 2 is a cross-section view showing an embodiment
21 of the invention as applied to a marine propeller.

22 DETAILED DESCRIPTION OF THE INVENTION

23 Referring now in detail to the drawings there is

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1 illustrated in FIG. 1 a hydrodynamic member 10 the surface
2 12 of which is subjected to a cavitating fluid medium
3 such as seawater. A conductive metal insert 14 is
4 embedded in a cavity 16 formed in the surface 12 of the
5 member 10. Location of the cavity 16 and insert 14 is
6 established by determining the position of cavitation-
7 susceptible surface regions of the member 10. The
8 metal insert 14 is bonded to and electrically insulated
9 from the member 10 by an epoxy adhesive 18 or other
10 suitable material. The metal insert 14 may be fabricated
11 of stainless steel or other conductive metal and coated
12 with a thin film of noble metal such as platinum or
13 other suitable conductive film to enhance its electrolytic
14 qualities. The negative side of a d-c source 20 is
15 electrically connected to the metal insert 14 to form
16 the cathode. The positive side of source 20 is connected
17 through a potentiometer 22 to the member 10 to form the
18 anode. Upon application of voltage, hydrogen gas bubbles
19 24 are formed on the exterior surface of metal insert
20 14. The hydrogen gas fills the low pressure areas and
21 voids caused by cavitation at the surface 12 to thereby
22 cushion and absorb the energy of the pressure shocks
23 resulting from the collapse of the cavitation voids.

1 The rate of hydrogen gas generation may be controlled
2 by varying the setting of potentiometer 22.

3 In FIG. 2 there is shown a portion 26 of the hull
4 of a marine vessel. A hollow shaft 28 extends through
5 an opening 30 in the hull and is journaled in bearing 32.
6 A marine propeller 34 is attached to one end of the shaft
7 28 in any conventional manner. The propeller blades 36
8 are each provided with metal inserts 38 embedded flush
9 with the surfaces thereof in regions of expected cavitation
10 damage. The metal inserts 38 are bonded to and insulated
11 from the blades 36 by an epoxy adhesive 40. Wires 42
12 are electrically connected to the insert 38 and extend
13 through conduits 44 formed in the blades 36 and into the
14 interior of hollow shaft 28. Inside the hull of the vessel
15 a slip ring 46 is arranged concentrically of the shaft
16 28 and is connected to the wires 42 in a manner well-
17 known in the art. The wires 42 are electrically insulated
18 from the blades 36 and shaft 28 and are connected through
19 slip ring 46 to the negative side of a d-c source 48.
20 The positive side of source 48 is connected through
21 potentiometer 50 to another slip ring 52. Slip ring
22 52 is electrically connected to the shaft 28 and thus to
23 the propeller 34. Application of the voltage to the

1 circuit causes current flow between the insert 38 and
2 the blade 36 through the seawater medium. Since the
3 insert 38 is at a negative potential, i.e. cathodic,
4 hydrogen gas bubbles will be formed over the surface
5 thereof by the well-known phenomenon of electrolysis.
6 Variation of the setting of potentiometer 50 will cause
7 a variation of the rate of generation of hydrogen gas
8 at the surface of insert 38.

9 As will be apparent to those skilled in the art,
10 the present invention may be advantageously utilized
11 to protect many forms of hydrodynamic surfaces from
12 cavitation damage. Likewise, the invention may be
13 effectively used to minimize cavitation damage to surfaces
14 exposed to other liquid mediums from which a gas may
15 be electrolytically liberated with apparatus similar to
16 that above-described.

17 As hereinabove described and illustrated in the
18 accompanying drawings, the present invention provides
19 a novel method of an apparatus for minimizing cavitation
20 damage to hydrodynamic surfaces. ~~Many modifications and~~
21 ~~variations of the present invention are possible in~~
22 ~~light of the above teachings and within the purview of the~~
23 ~~appended claims without departing from the spirit and~~

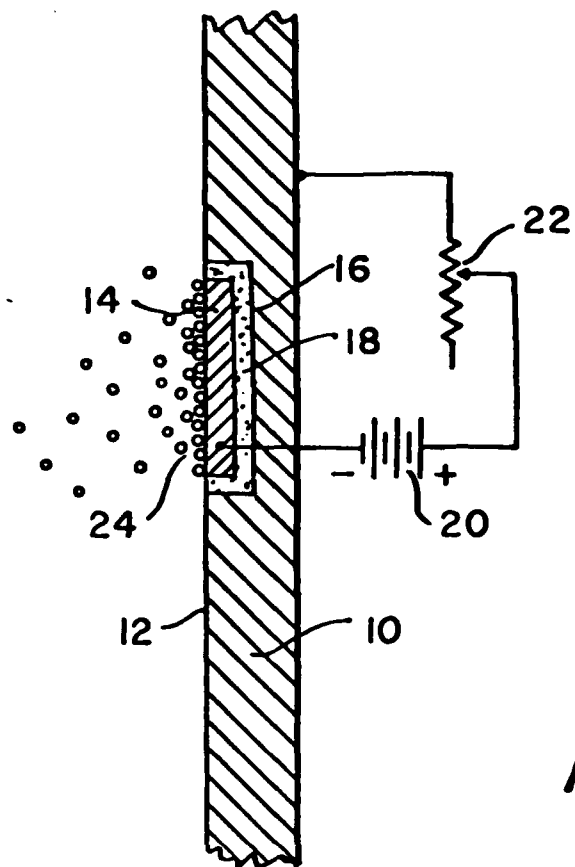


FIG. 1.

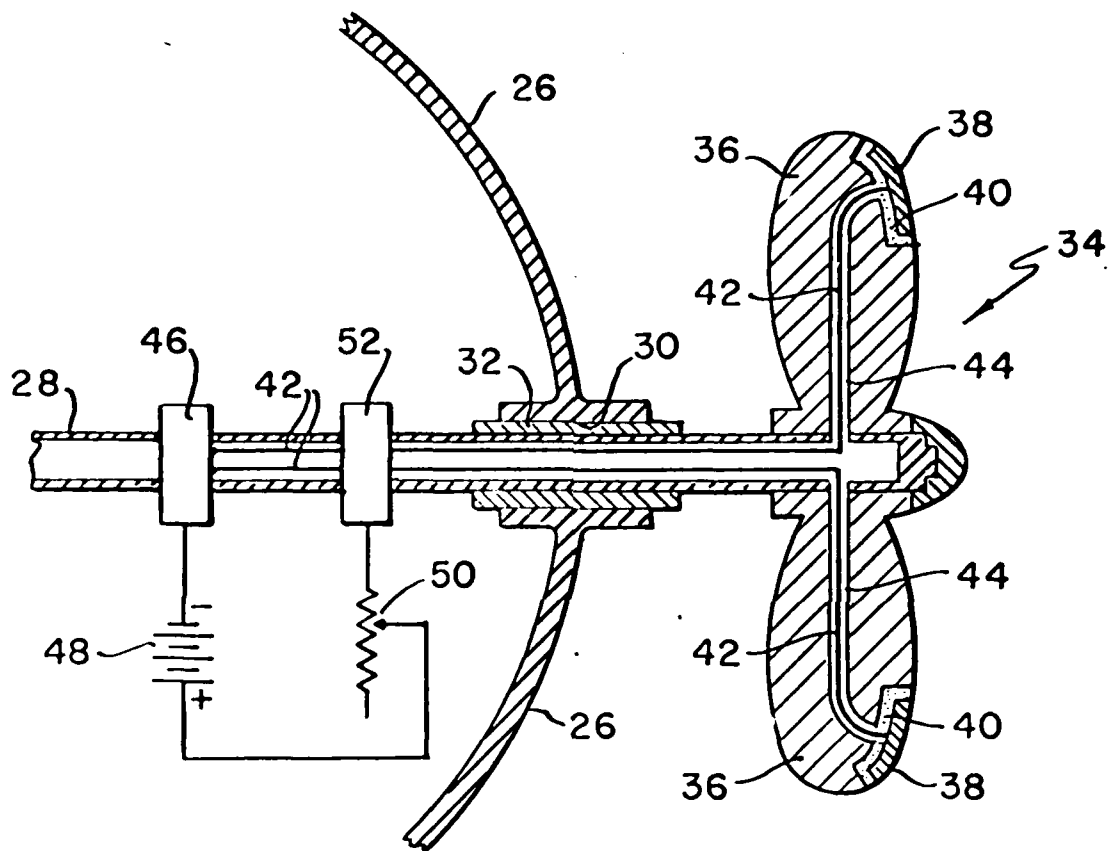


FIG. 2.