March 16, 1971 G. W. WALKER ET AL 3,570,257

DOCK AND DOLPHIN PROTECTOR

Filed Sept. 17, 1968 2 Sheets-Sheet 1

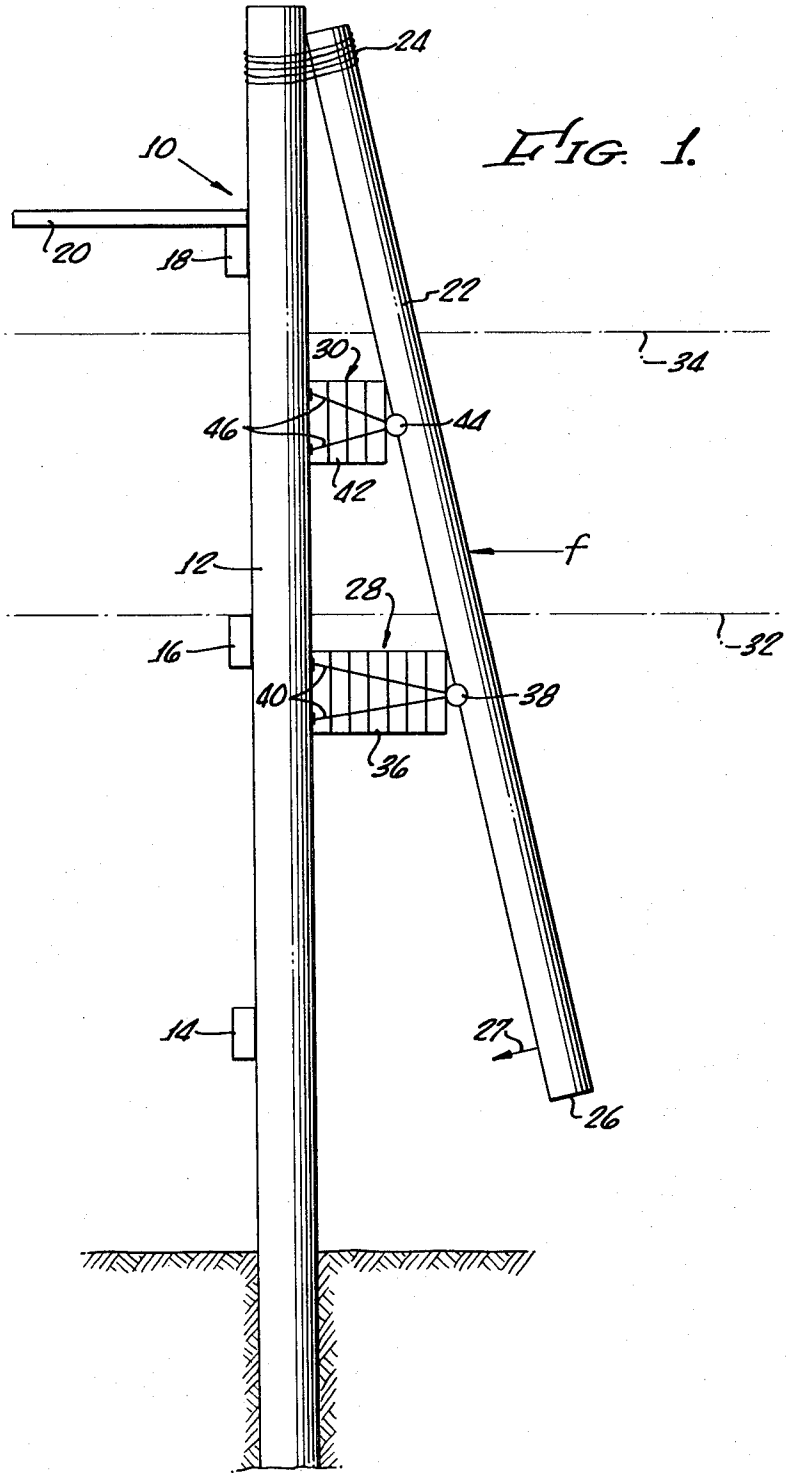


FIG. 1.

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FIG. 2.

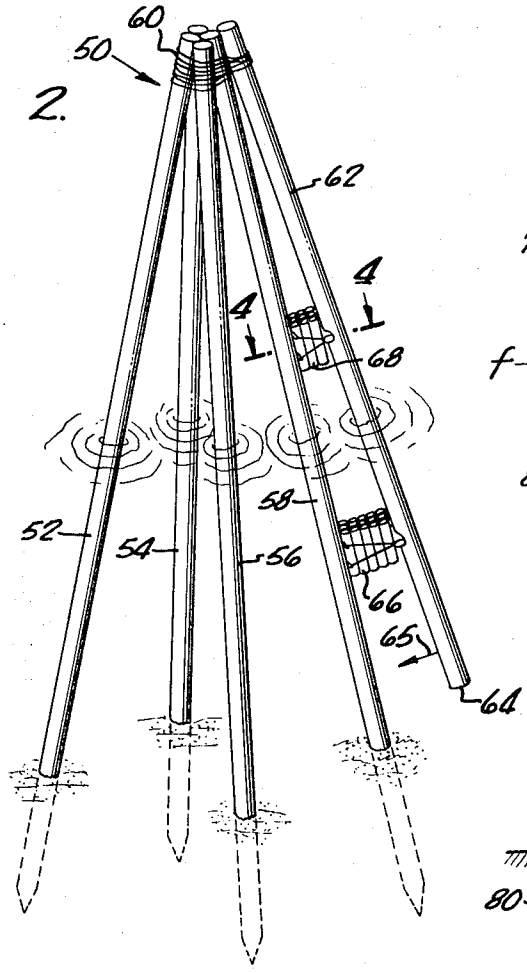
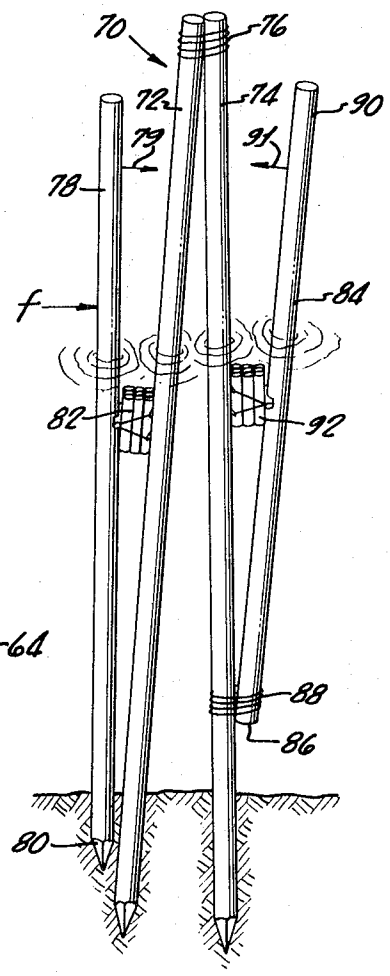


FIG. 3.



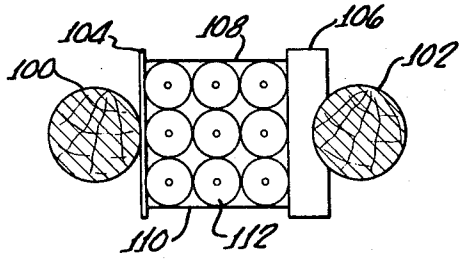


FIG. 4.

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DOCK AND DOLPHIN PROTECTOR

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Int. Cl. E02b 3/22
U.S. Cl. 61—48 1 Claim

ABSTRACT OF THE DISCLOSURE

A protector for fixed marine structures such as docks, dolphins, etc., which comprises a movable shaft pivotally mounted at one end and freely movable at the other and at least one non-energy storing energy absorption unit between the fixed marine structure at the shaft, the energy absorbing unit comprising a plurality of hollow bodies formed of mildly resilient material normally filled with water and having an orifice which is sized and disposed to permit escape of water from the body at a limited rate commensurate with the severity of impact of a vessel against the movable shaft is disclosed.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to fixed structures and to fixed marine structures in particular. More specifically, this invention relates to energy absorbing and dissipating protectors for such fixed structures.

Description of the prior art

Resilient energy storing devices for protecting docks from the impact of a colliding vessel are well known in the art. There have been a few attempts, in addition, to provide devices for protecting such structures from impact energies by dissipating portions of the impact energy.

The former type of protector, the energy storing protector, has not generally been found to be satisfactory, except perhaps for preventing damage from very minor impacts. The reason, basically, is that the energy is not dissipated but is rather stored. The stored energy is exerted in one form or another against the fixed structure either immediately upon impact or by forming a second or continuing force following the initial impact. As applied to docks, and the like, this type of protector is less satisfactory for the additional reason that following the initial impact the vessel is propelled away from structure. This is not usualy desirable since it is generally the intent to have the vessel rest against or near the structure.

The latter type of construction, with few exceptions, have been so complicated as to be economicaly and practicably restricted in use and have not gained general acceptance.

It is therefore, an object of this invention to provide a simple construction for absorbing and dissipating the impact energy of vessels colliding with fixed marine structures without significant storage of such impact energy.

SUMMARY OF THE INVENTION

The present invention may be summarized as the combination of a fixed marine structure of the type which includes generally vertically disposed members and means for preventing direct contact of a vessel with the structure, the means generally comprising one or more vertically disposed shafts pivoted at one to a point adjacent the fixed marine structure and having one or more non-energy storing absorption units disposed between the fixed marine structure and the shaft for absorbing and

dissipating the impact energy of the vessel against the shaft, the non-energy storing units comprise a plurality of hollow bodies which are formed with mildly resilient walls, normally filled with water, and having at least one orifice which is sized and disposed to permit the escape of water from the body at a limited rate commensurate with the severity of impact of the vessel against the shaft. The shaft may be pivoted at the upper end or the lower end of the shaft in loose mud at the bottom of the harbor. Pivoting at the upper or the lower end may be provided by lashings or any other conventional means. It is, therefore, a principal object of this invention to provide an improved and simplified means for protecting marine structures from impact by vessels.

A more specific object of this invention is to provide a non-energy storing protective means for marine structures.

A still more specific object of this invention is to utilize non-energy storing normally water filled resilient cylinders having orifices sized and disposed to permit escape of water therefrom at a rate only commensurate with the severity of impact for protecting fixed marine structures.

The specific illustrations and embodiments shown and discussed hereinafter constitute additional and non-limiting objects of the invention.

Other objects will be apparent from the specification and drawings, to which reference is now made.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of the protective construction of this invention as applied to a dock, the dock being shown in simplified form.

FIG. 2 is a side elevational view of the protective means of this invention as applied to a dolphin.

FIG. 3 is a side elevational view of a modified means for protecting a dolphin wherein the shafts are pivoted at the lower end, rather than at the upper end as in the preceding figures.

FIG. 4 is a bottom view looking upwardly at one of the energy absorbing units of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is made now to FIG. 1 which illustrates the application of the protective means of this invention to a dock **10**. The dock comprises at least one generally vertically disposed fixed member, such as a vertical pile **12**. Braces **14**, **16**, **18**, and decking **20** are conventionally provided. Additional bracing and decking, etc., may also be provided according to the needs and conventional constructional principles as applied to marine docks.

Means for preventing direct contact of a vessel with the dock are provided and comprise one or more vertically disposed movable shafts **22** with means, such as lashings **24**, pivotally mounting one end of the shaft at a point adjacent the fixed vertical member of the marine structure. In the illustration, the top of shaft **24** is lashed directly to pile **12**, however, this is merely one simple way of providing the pivoted connection and other methods which are fully equivalent will be apparent to those skilled in the art.

It will be seen that the bottom end **26** on the shaft **22** is free to move inwardly as indicated by arrow **27**. As a vessel moves toward the marine structure it would be prevented from striking the fixed structure by shaft **22**. Upon striking shaft **22** a force would be exerted in the direction indicated by the arrow F in FIG. 1. The impact energy, exerted as indicated by the arrow F, is absorbed by one or more non-energy storing absorbing units **28** and **30** which are disposed between the fixed marine structure and the movable end of the shaft for absorbing and

dissipating the impact energy of the vessel which is transferred to the shaft.

Preferably, two such energy absorbing units are provided one unit **28** is disposed below the low tide water level mark **32** and the other is disposed below the high tide water level mark **34**; however, one such energy absorbing unit **28** below the low water level mark would be sufficient for many applications. Since, in certain areas, such as in bays which extend great distances inwardly, the high and low tides may differ by ten to thirty feet, it is desirable to provide two energy absorbing units to provide a point of energy absorption and dissipation proximate the impact point whether at high tide or low tide.

Each of the energy absorbing and dissipating units comprises a plurality of hollow bodies **36** and **42** which include mildly resilient walls. These hollow bodies are normally filled with water and have, in the bottom, at least one orifice which is sized and disposed to permit escape of water from the body at a limited rate only commensurate with the severity of the impact of the vessel against the shaft. These hollow bodies are secured together in bundles by bolts, other fasteners, or the like, or they may be molded together in a single unitary construction, as desired. A cross member **38** is normally provided for exerting a uniform pressure against the hollow bodies and flexible means such as cable **40** are provided to limit the movement of the shaft from the fixed pile **12**.

The construction of the upper absorbing unit **30** is similar in all respects, comprising a plurality of hollow bodies **42**, a pressure exerting assembly **44**, and a cable **46** for limiting the movement of the shaft. The operation of the two absorbing units are, of course, identical when they are submerged or partially submerged below the water level.

The construction of FIG. 2 illustrates the application of the same general type of protective means as described in FIG. 1 as applied to a marine dolphin structure **50**. Such a structure comprises a plurality of piles **52**, **54**, **56**, and **58**, lashed together at the top as at **60**. Pivotally secured by the lashing **60**, or by equivalent means, is a shaft **62** having a bottom free end **64** which is free to move toward the dolphin as indicated by arrow **65**. One or more energy absorbing units **66** and **68** are provided. The construction of these units is the same and the operation is identical with those previously described.

FIG. 3 illustrates an alternative construction for securing the protective means to dolphins. This construction may also be applied to piers, docks, and the like if desired. In this embodiment the dolphin **70** comprises a plurality of piles **72** and **74**, and, of course, may include additional piles, lashed together at the top as at **76**. One of the protectors comprises a vertical shaft **78** which is free to move at its upper end toward the dolphin, as indicated by arrow **79**, and whose lower end **80** is pivotally mounted adjacent the dolphin simply by driving it into the soft mud at the bottom of a harbor, where the harbor bottom is of this medium. The shaft **78** may be buoyant, i.e. a wooden pile, or it may be heavier than water. Where the mud at the bottom of the harbor is very soft, it is generally desirable to provide a heavier-than-water shaft **78**. An energy absorbing unit **82**, of the type previously described, is illustrated being partially compressed by the force F which may be exerted by a vessel.

In a functionally identical construction, a shaft **84** having its lower end **86** pivotally secured by lashings **88** to the dolphin is illustrated. The upper end of the shaft **90** is free to move toward the dolphin as indicated by arrow **91** and the free shaft **84** is separated from the fixed construction **74** by means of the non-energy storing absorption unit **92**.

FIG. 4 illustrates in greater detail the construction of the absorption units previously referred to. **100** represents a fixed pile or part of a fixed marine structure, **102** is a movable shaft of the type described and the energy absorbing unit comprises elements **104–112**. **104** is a backing plate assembly which is secured to the fixed structure. **106** is a pressure exerting assembly which is secured to the shaft. **106** may simply be a log secured perpendicularly to the movable shaft **102** or it may be a plurality of logs or boards to provide the necessary uniform pressure exertion on the cells. Movement apart of the movable shaft **102** and the fixed structure **100** is limited by cables **102** and **110** which lash the backing plate assembly and pressure exerting assembly **104** and **106** together. A plurality of cylindrical hollow bodies which are normally filled with water for operation are provided, one of which being indicated at **112**. As indicated, each of these cylindrical hollow bodies is provided with an orifice, or a plurality of orifices, preferably disposed in the bottom part thereof. This orifice or these orifices are, as previously described, sized and disposed to permit escape of water from the body at a limited rate commensurate with the severity of impact of a vessel against the shaft.

In the marine protective construction of this invention, the orifice or orifices may be disposed either in the top or the bottom of the cylinder; however, most advantageous characteristics are achieved when the orifice is in the bottom. With respect to the energy absorbing unit which may be above the low water line, it is desirable to provide a very small passageway in the top of each of the cylinders so as to permit water to flow into the orifices at the bottom of the cylinder as the water level raises. These passageways are generally large enough only to permit air to escape at a very slow rate and are not functional insofar as dissipating energy is concerned. These passageways may, for example, be only one-eighth inch or less in diameter.

The basic concept and operation of the individual cylinders is described by John W. Rich in application Ser. No. 664,333, filed Aug. 30, 1967, now Pat. No. 3,503,600. Basically, the concept is that if a properly constructed container for a liquid or fluent material is provided and the container has passageways of restricted size disposed properly relative to the liquid in the container, then the kinetic energy of a moving body such as a boat is dissipated by being transferred to the liquid as the liquid is expelled through a comparatively small passageway or orifice against the force of gravity. There are a number of physical forces at work in this operation, however. First, there is the viscosity of the liquid which fills the hollow body. A substantial fraction of the kinetic energy of a moving body, upon impact, is absorbed by the energy required to overcome the reacting force of viscous flow and to expel the liquid through the comparatively small orifice or passageway. The force necessary to cause turbulent and viscous flow through one or more small passageways is a major physical factor in dissipating the energy of impact.

It is important to note that it is not desirable merely to store up the kinetic energy of the vessel impact, as occurs in springs, pneumatic devices, and the like, since this tends to give a second direction of movement to the vessel. once the initial impact is over. It is, therefore, important that the buffer member be constructed of a material which, while being mildly resilient, is easily deformable and tends to return to its normal configuration rather slowly. Stated differently, it is important that the hollow body be constructed of an essentially non-energy storing resilient material. The body, of course, must be made of a material which is sufficiently strong and resilient to resist the impact of a collison at a variety of temperatures and it is important that the material retain its flexibiliy and strength at low temperatures.

Reference is made to the aforementioned application for John W. Rich for a more complete discussion of the theory and operation of devices of this type, the complete disclosure of which is incorporated herein at this point. Constructionally, the cylinders are preferably made of heavily plasticized vinyl chloride, copolymers of vinyl chloride, etc., and may be from about three to about ten inches

in diameter, although size is not a critical limitation. These cylinders may be from about two feet to about ten feet in length, but again, the length is not critical. Orifice sizes vary from one-half inch to two inches in diameter, preferably from about three-fourths inch to about one and one-half inches in diameter. The number of orifices, of course, determines the size along with the expected severity of impact energies.

In the embodiments of FIG. 1, for example, the cylinders may be four feet in length, six inches in diameter, and each may have one orifice therein at the bottom one inch in diameter. The shaft **22** will range from twenty to forty or fifty feet in length normally.

While the foregoing description and the drawings are related to specific embodiments and applications of the invention, it will be apparent that many variations and modifications thereof may be made based upon the teachings of this specification without departing from the spirit and scope of the invention, as defined in the following claim.

We claim:

1. In combination with a fixed marine structure of the type which includes at least one generally vertically disposed member, means for preventing direct contact of a vessel with said fixed structure, said means comprising:

at least one generally vertically disposed movable shaft;

means pivotally mounting one end of said shaft at a point adjacent said vertically disposed member of said marine structure;

at least one non-energy storing energy absorbing unit disposed between said fixed marine structure member and the freely movable end of said shaft for absorbing and disspiating the impact energy of a vessel against said shaft, said non-energy storing energy absorbing unit comprising at least one hollow body including a mildly resilient wall, being normally filled with water, and having at least one orifice proximate the bottom thereof sized and disposed to permit escape of water from said body at a limited rate commensurate with the severity of impact of a vessel against said shaft;

a backing plate assembly secured to the fixed structure;

a pressure exerting assembly secured to the shaft;

and flexible movement limiting means interconnecting said backing plate assembly and said pressure exerting assembly, said hollow bodies being disposed between said assemblies and said assemblies being so constructed and disposed as to exert substantially uniform pressure on said hollow bodies;

and wherein each of the hollow bodies comprises a cylinder having at least one very small passageway near the top thereof so as to permit water to flow into the orifice at the bottom thereof as the water level rises, said small passageway being large enough only to permit air to escape at a very slow rate and that not being functional insofar as dissipation of energy is concerned, whereby the kinetic energy of a moving body such as a boat is dissipated by being transferred to the liquid as the liquid is expelled through at least one orifice proximate the bottom of said cylinder, a substantial fraction of the kinetic energy of the moving body being absorbed by the energy required to overcome the reacting force of viscous flow of liquid through the orifice proximate the bottom of the cylinder.

References Cited

UNITED STATES PATENTS

1,300,606	4/1919	Hagenbuch	61—48
2,420,677	5/1947	Peterson	61—48
2,722,906	11/1955	Tweddell	61—48X
3,141,655	7/1964	Platt	293—52X
3,284,122	11/1966	Rich	293—1

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U.S. Cl. X.R.

114—219; 293—1