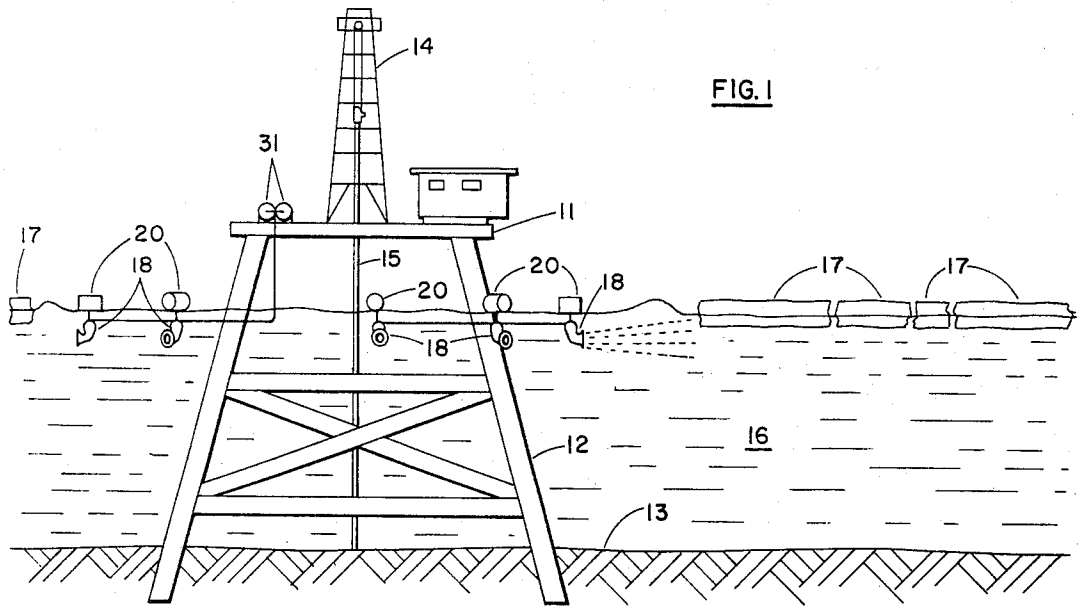
Oct. 15, 1968 J. B. FARR ET AL 3,405,527

PROTECTING MARINE STRUCTURES FROM FLOATING OBJECTS

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FIG. 1



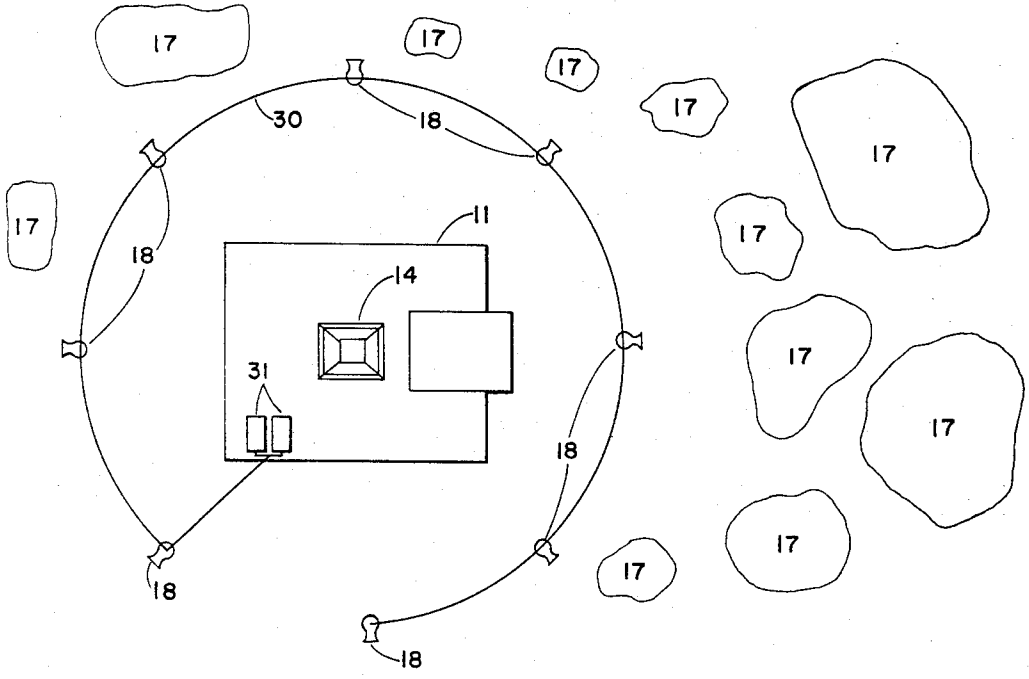


FIG. 2

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PROTECTING MARINE STRUCTURES FROM FLOATING OBJECTS

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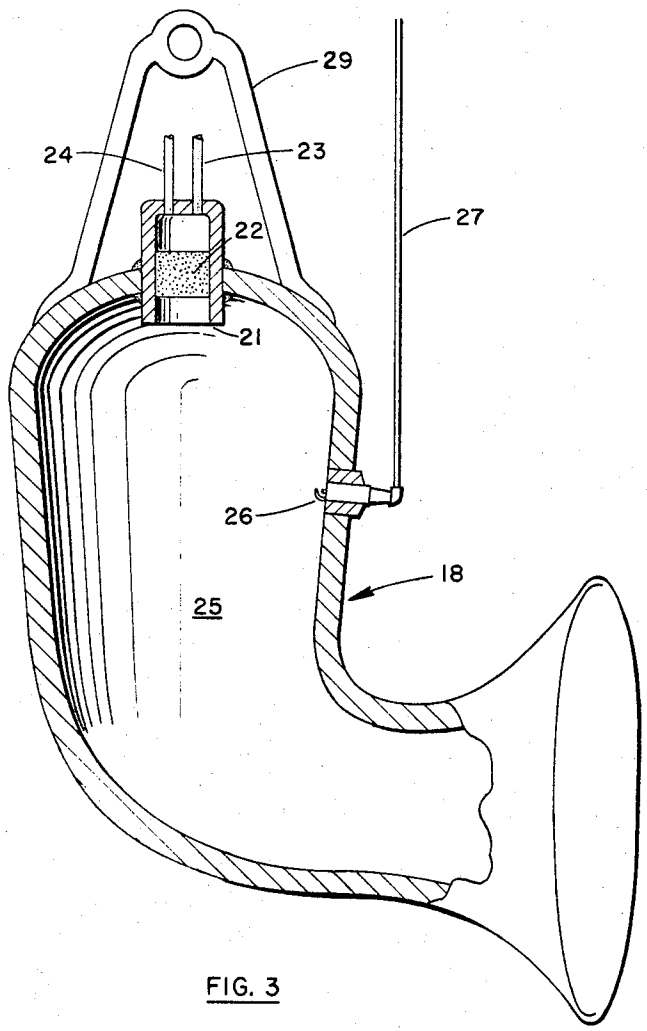


FIG. 3

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3,405,527

PROTECTING MARINE STRUCTURES FROM FLOATING OBJECTS

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3 Claims. (Cl. 61—1)

ABSTRACT OF THE DISCLOSURE

Marine structures suffer from possibility of destruction, in whole or in part, due to impacts of floating objects. While it is possible to protect against boats and similar floating objects, it is a much more difficult task to prevent impingement of floating logs, ice, etc. This invention provides protection against floating objects by repeatedly producing explosions at a number of points near but below the surface of the water to set up a standing wave pattern near the structure. This standing wave pattern inherently produces a component of force radially outward acting on any floating objects near the structure and, accordingly, tends to cause such objects to drift away from the structure. Preferably, the standing wave pattern is caused by uniform detonation of explosive at a plurality of points at an approximately uniform distance from the marine structure to be protected.

This invention is used to protect a drilling platform, floating vessel, or other marine structure from mechanical damage due to impact from floating objects, such as driftwood, ice floes, or the like. It is particularly well adapted to protect a drilling platform in water involving a current, in which case considerable damage can result from floes or pan ice striking the structure. We find that protection can be given such structure by creating a standing wave pattern or patterns in the water by repeated sudden application of pressure near the structure. The pressure waves tend to shatter any brittle objects, such as ice. The standing wave produces a difference in elevation of the water surface, resulting in a force at least in part radially outward, tending to move the floating objects away from the structure. Such force may be due in part to outgoing currents resulting from release of gases causing frothing, bubbling, aeration, etc., around the structure.

It is an object of this invention to protect a marine structure against damage due to floating objects. Further objects will be apparent from this specification.

The invention is illustrated with drawings in which the same reference numeral indicates the same or a corresponding part. In these drawings:

FIGURE 1 shows in diagrammatic form a cross section through a body of water containing a marine structure and a protective system suitable to keep floating objects from impinging on the structure;

FIGURE 2 is a plan view of the same region shown in FIGURE 1;

FIGURE 3 shows a gas gun suitable for use with this invention.

Referring now to FIGURES 1 and 2, a drilling platform **11** is supported on a plurality of legs or caissons **12** driven into the marine floor **13**. A drilling rig **14** equipped with a drill string **15** is being used to tap subsurface formations. Current in the water **16** has brought a number of ice floes **17** close to the marine structure **11**. Since ice floes in an inlet, estuary, or the like may be several feet thick and acres in extent, it is apparent that even at low velocities, impact of such a mass on the structure **11** might seriously damage it.

Accordingly, we have provided the marine structure **11** with a plurality of gas guns **18**, the use of which will be more apparent subsequently. These guns are usually located outward from the structure. They are below the surface **19** of the water **16**. They may be near the surface or remote from it. As is shown in more detail in FIGURE 3, each gas gun is essentially a closed piece of pipe into which an explosive mixture can be introduced for subsequent detonation. Each gun **18** is supported either from the marine structure or (preferably) by means of a float **20** so that it is maintained at a roughly constant level of the order of two to five feet below the surface of the water. We prefer to face these guns outward, though nearly any configuration would do.

In operation the explosive mixture is introduced into the gas guns and detonated, and the cycle is repeated. Shock waves are radiated outwardly at approximately the speed of sound in water from each gas gun, followed by the discharge of gas from the gun. The shock wave itself has a great tendency to shatter the floes **17**, thus decreasing the mass of any individual floe sufficiently so that it will not contain a dangerous amount of momentum if it should impinge on the marine structure. Both the shock waves and the following slower release of gas by the guns, produce a rise in the sea level radially outward from the structure to be protected. This is the result of reinforcement of the pressure waves from several of the guns detonated substantially simultaneously, and results in what is ordinarily called a standing wave in the medium (the water). Any floe directed by the current flow towards the marine structure being protected experiences a radially outward force due to this local rise in the sea level, which we have found is quite successful in causing these floating objects to pass around the structure.

It is possible to generate shock waves by rapid expansion of gases in several ways, in accordance with this invention. For example, in FIGURE 3 a gas gun **18** has been constructed in the shape of an inverted horn. Into the closed end has been inserted a mixing chamber **21** containing a permeable plug **22** through which gas can flow. This mixing chamber **21** is supplied with a fuel through flexible line **23** and an oxygen-containing gas through a second flexible line **24**. Then fuel and gas vaporized in the mixing chamber pass through the permeable plug **22** and into the main chamber **25** of the gun. A spark plug **26** connected through insulated leads **27** to a source of electricity (not shown) is used to detonate the explosive mixture in chamber **25**. The plug **22** serves as a flash back preventer.

The other end of the gas gun may be closed by a hinged cover which opens after each detonation in chamber **25** to expel the products of explosion and which then closes. However, it is possible to trap sufficient explosive gas in an open-ended gas gun (as shown) so that a detonation of considerable violence is produced which is suitable for contributing to the standing wave pattern already mentioned. The gas gun is supported by a lug **29** containing an eyelet for attachment by a cable to the float **20**, as previously described.

The gas guns **18** are oriented around the platform generally pointing outward and in an approximately circular pattern, ordinarily. It may be desirable (as shown in FIGURE 2) to omit one or two of the guns or arrange to have a section of the protective devices capable of being swung out of the way, to permit entry to the marine structure being protected. The flexible supply tubes **23** and **24** are connected preferably through a ring pipe system **30** and thence to tanks **31** on the marine structure carrying the supply of oxygen-containing gas and fuel.

We have found that one can use a mixture of air and petroleum gas, for example any of the light hydrocarbon gases such as methane or propane, suitably adjusting the

mixture to lie within the explosive limits. We have also found that it is not necessary to create the explosion by oxidation of fuel. For example, one can release highly compressed air very rapidly by so-called quick release valves which are now commercially available. This will generate pressure waves of considerable energy.

Ordinarily we detonate the explosive or release the high-pressure gas about simultaneously at all of the gas guns. This is not a necessary criterion though it does create a standing wave pattern which is roughly circular and furnishes excellent protection for the structure. On the other hand, however, one can detonate the guns at the opposite sides of the circle of these devices a substantial fraction of a wave length (in water) apart, for example, a half wave length, and thus produce maximum vertical agitation on the floes **17**. The explosions are rhythmically created and tend to produce a resonant condition which in a large ice floe will cause the leading edge to be broken successively into small unimportant pieces. We prefer to detonate the explosive mixture or release the high-pressure gas at approximately equal time intervals throughout the season in which protection is required, again with the main object of setting up the standing wave pattern and raising the sea level adjacent the structure to be protected. This also insures that there is an area of high turbulence in the zone tending to deemphasize the effects of currents or the like on the ice or other floating objects drifting in the direction of the marine structure.

It is apparent that many modifications of the system we have shown and described can be made without departing from the spirit of the invention. This invention is best defined by the appended claims.

We claim:

1. A method of protecting a marine structure against floating ice comprising repeatedly creating a plurality of explosions near but below the surface of the water, said plurality being created at least approximately simultaneously and at least approximately at equal radial distances from said structure whereby waves are produced in the adjacent sea level and forces are applied to said ice near said structure at least in part radially outward.

2. A method according to claim **1** in which said explosions are rhythmically created at approximately equal time intervals to produce a standing wave pattern outside said marine structure.

3. A method of protecting a marine structure against floating objects comprising the steps of:

(1) producing an explosive mixture of gases at a plurality of points near but below the surface of the water and at an approximately uniform distance from said structure,

(2) detonating said mixture at said points, and

(3) repeating steps 1 and 2 at substantially uniform time intervals to produce a standing wave pattern in the water near said structure and to produce a radially outward component of force on any such floating objects near said structure.

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EARL J. WITMER, *Primary Examiner.*