United States Patent

Narabu

[15] **3,690,280**

[45] **Sept. 12, 1972**

[54] **FENDER FOR LARGE SHIP**

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[21] Appl. No.: **71,722**

[52] **U.S. Cl.** **114/219**

[51] **Int. Cl.** **B63b 21/00**

[58] **Field of Search** 114/219

[56] **References Cited**

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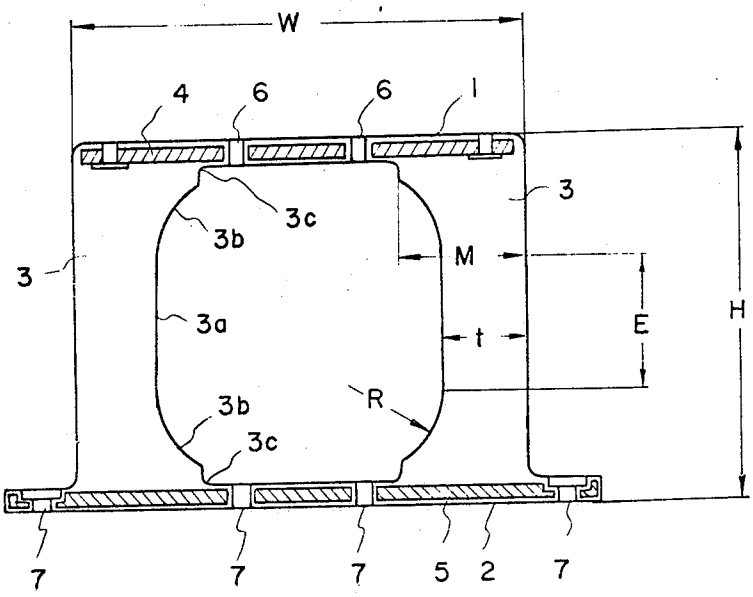
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Assistant Examiner—Gregory W. O'Connor
Attorney—George B. Oujevolk

[57] **ABSTRACT**

In a rectangular tubular fender for large ship, made of elastic material and composed of a buffer, a fixture and two supports provided between said buffer and said fixture, the present invention contemplates an improvement therein wherein the exterior surfaces of said supports being made parallel to each other, the interior surfaces of said supports being flat and parallel to said exterior surfaces in the middle portion, the adjacent parts of said middle portion to said buffer and said fixture being curved, and the junctions between said curved portion and said buffer or fixture being depressed with a notch.

1 Claim, 8 Drawing Figures



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SHEET 1 OF 2

FIG. 1

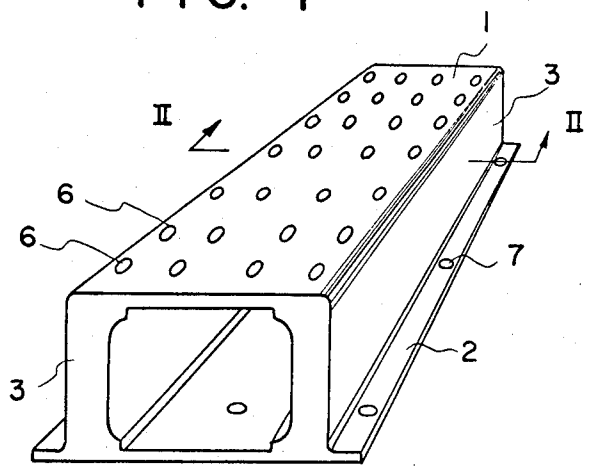
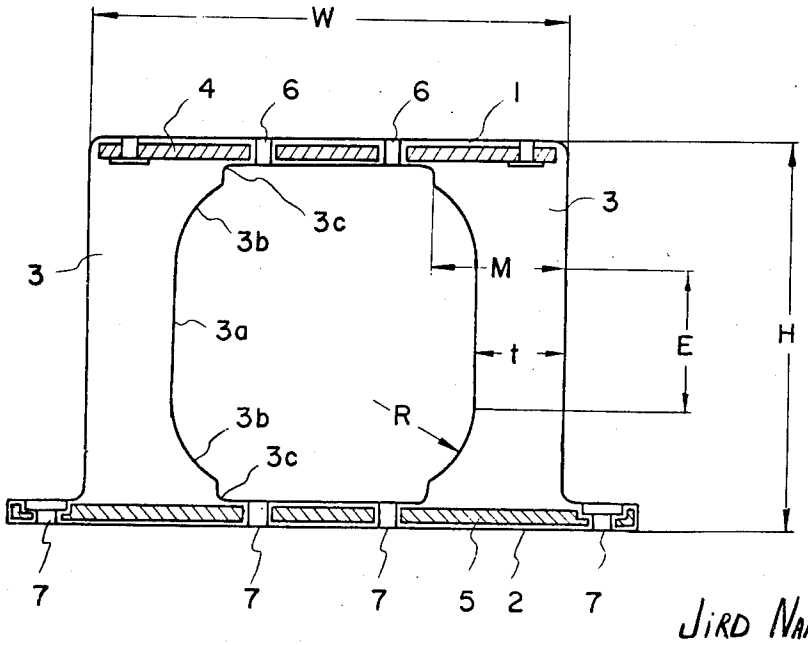


FIG. 2



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FIG. 3

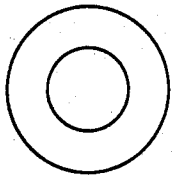


FIG. 4

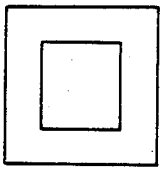


FIG. 5

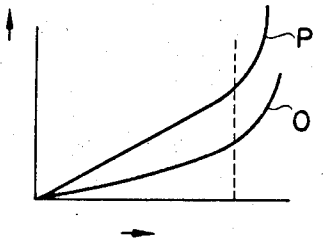


FIG. 8

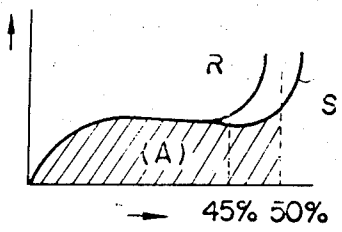


FIG. 6

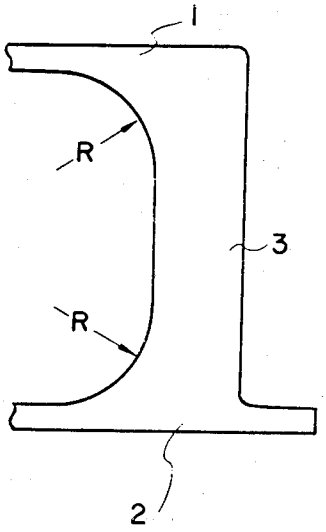
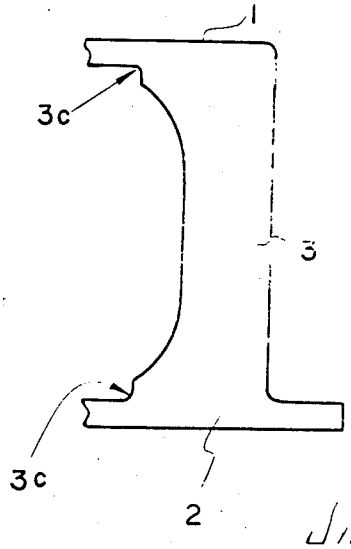


FIG. 7



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FENDER FOR LARGE SHIP

BACKGROUND OF THE INVENTION

The present invention relates to a fender to be fitted to quays, etc., for cushioning a large ship.

BRIEF DESCRIPTION OF THE PRIOR ART

The conventional fender which represents a hollow tube with a trapezoidal cross-section has been effective enough to cushion ships of 150,000 ton class. Recent trend to build increasingly larger vessels, however, has produced mammoth tankers of 300,000 to 500,000 ton class with relatively low strength of outside plating. To cushion such vessels, the fender must have a low reaction per unit area.

SUMMARY OF THE INVENTION

The objective of the present invention is to offer a fender with great energy absorption in which only the displacement increases, without the reaction being increased under shock. Broadly stated, in a rectangular tubular fender for a large ship, made of elastic material and composed of a buffer, a fixture and two supports provided between said buffer and said fixture, the present invention contemplates an improvement therein wherein the exterior surfaces of said supports being made parallel to each other, the interior surfaces of said supports being flat and parallel to said exterior surfaces in the middle portion, the adjacent parts of said middle portion to said buffer and said fixture is curved, and the junctions between said curved portion and said buffer or fixture being depressed with a notch. Other objectives of this invention will be apparent by reading the description of the following embodiment with reference to the accompanying drawings.

DETAILED DESCRIPTION

FIG. 1 is a perspective end view of the fender contemplated herein;

FIG. 2 is a view along lines II—II of FIG. 1;

FIG. 3 shows one type of tubular cross-section of the prior art;

FIG. 4 illustrates another type of tubular cross-section of the prior art;

FIG. 5 graphically shows the characteristics of the tubular cross-sections shown in FIGS. 3 and 4;

FIG. 6 is a modification of the tubular cross-section shown in FIG. 4;

FIG. 7 is a further modification of the tubular cross-section shown in FIG. 4; and,

FIG. 8 again graphically shows the characteristics of the tubular cross-sections shown in FIG. 6 and FIG. 7.

FIGS. 1 and 2 illustrate a fender made in accordance with this invention. This fender represents a hollow cylinder with rectangular cross-section. This cylindrical body is made of an elastic material like rubber, and it consists of a buffer 1 which comes into contact with the ship side; a fixture 2 which contacts the quay wall and runs parallel to said buffer; and two supports 3 which are inserted between said buffer 1 and said fixture 2 and are flat on the outside surface, these two flat surfaces being parallel to each other. Said buffer 1 and said fixture 2 have embedded reinforcing plates 4, 5.

Holes 6 bored on the surface of said buffer are intended for attachment of another buffer, while holes 7 bored on the surface of said fixture are intended for attachment of the fender to the quay wall, etc.

Interior surfaces of said supports 3 have their middle portion 3*a* flat and parallel to the exterior surface; the adjacent portions 3*b* of said middle portion 3*a* to the buffer and to the fixture are curved; and the junctions 3*c* between said curved portions 3*b* and the buffer and fixture are depressed with a notch.

The fender according to this invention is designed as a rectangular tube for the purpose of enlarging the contact area with the ship and reducing the reaction per unit area. Its sectional profile is dictated by the pressure-receiving area and its internal shape is selected to make the reaction small and the displacement large. Tubular fenders with cross-sections, as illustrated in FIGS. 3 and 4, have been publicly known. One illustrated in FIG. 3 shows a characteristic curve, like O-curve in FIG. 5, while one illustrated in FIG. 4 does a characteristic curve, like the P-curve of FIG. 5. In these fenders, however, the reaction rise is sharp and the energy absorption is extremely poor.

The fender of FIG. 4 has two supports parallel to each other and the present inventor tried to improve this fender. As shown in FIG. 6, leaving the flat portion 3*a* of the support as it is and providing a curved portion 3*b* between the buffer and the fixture, he obtained a characteristic curve, like the R-curve in FIG. 8. When, with the thickness of support kept constant, the radius of curved surface was increased and the flat portion 3*a* was reduced, however, the displacement of support did not increase and the "rise" of the characteristic curve became steep. Conversely, when the radius was reduced and the flat portion 3*a* was enlarged, the reaction dropped, but the "rise" of the characteristic curve remained relatively steep.

By providing a notched depression 3*c*, as shown in Fig. 7, between the curved part and the buffer and fixture, only the displacement could be made as large as about 50 percent, as given by the S-curve in FIG. 8.

As testified by various experiments, the recommendable H(height) vs. W(width) relation is $2H \geq W \geq 1.25H$. The desirable thickness (t) of the support, depending on the mutual relation between the radius (R) of curved surface, the length (E) of the flat portion (3*a*) and the distance (M) of the notched depression from the outside surface of support, is $t=(0.20 - 0.26)\cdot H$. The desirable range of E is $E=(0.3 - 0.4)H$, that of R being $R=(0.22 - 0.30)H$ and that of M being $M=0.265^{\cdot b}$

A fender meeting these conditions has, as indicated in FIG. 8, a low reaction, a large displacement and a great absorption energy (A).

The fixture in this example represents a flat plate, but it may be separated by an open groove cut in the middle.

What is claimed is:

1. In a rectangular tubular fender to be fitted to quays for docking a large ship, made of elastic material and composed of a buffer (1), a fixture (2) and two supports (3) provided between said buffer and said fixture, the improvement therein wherein the exterior surfaces of said supports are made parallel to each other, the interior surfaces of said supports being flat and parallel to said exterior surfaces in the middle portion (3*a*) , the adjacent parts (3*b*) of said middle portion to

said buffer and said fixture being curved, and the junctions (3*c*) between said curved portion and said buffer or fixture being depressed with a notch, said fender meeting the following conditions:

$$2H \geq W \geq 1.25H,$$

$$t=(0.20-0.26)H, E=(0.3-0.4)H,$$

$$R=(0.22-0.30)H, M=0.265.H\pm 10\%,$$

where H is the height, W is the width, t is the thickness of the middle portion of the support, E is the length of flat portion of the support, R is the radius of the curved surface, and M is the distance of notched depression from the exterior surface of the support.

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