Nov. 13, 1962 MINORU YAMAGUCHI ET AL 3,063,400

FLOATING SHIP FENDER

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FIG. 1

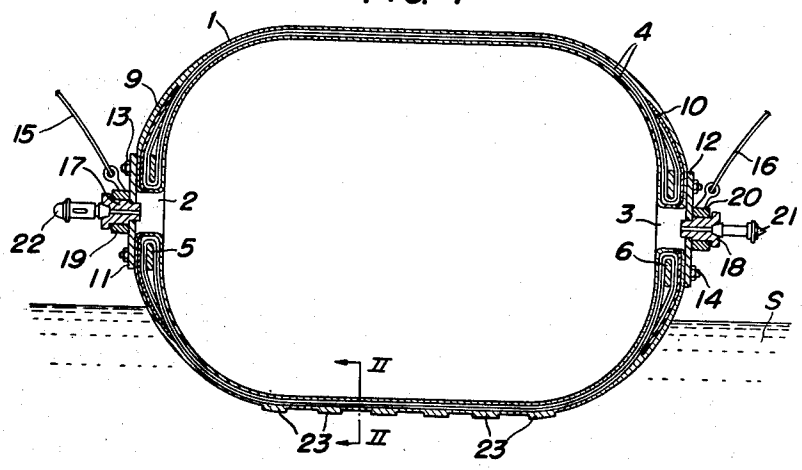


FIG. 2

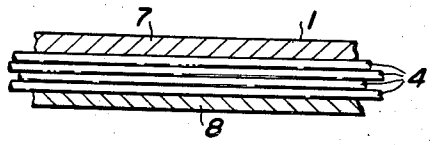
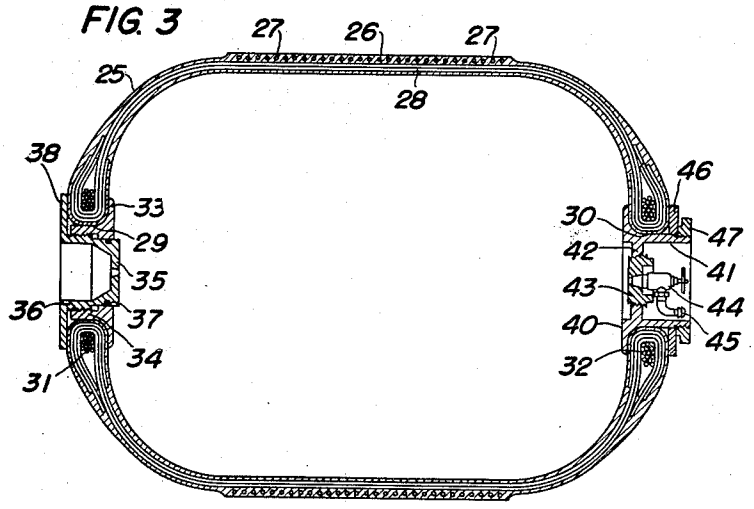


FIG. 3



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FIG. 4

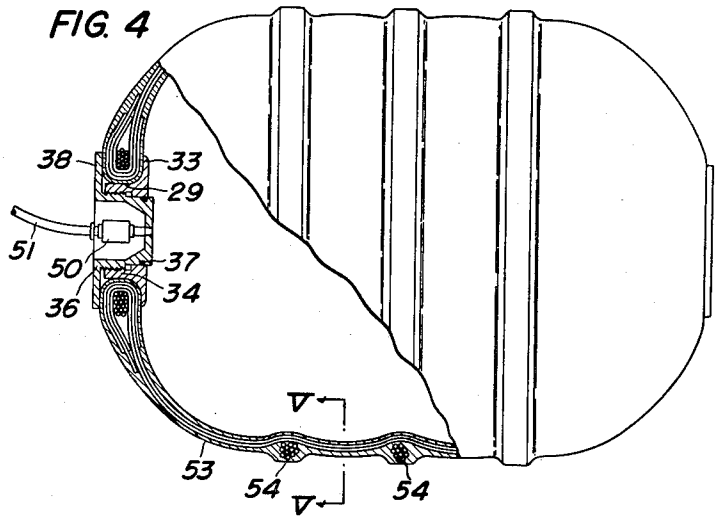


FIG. 5

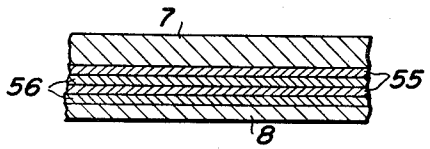


FIG. 6

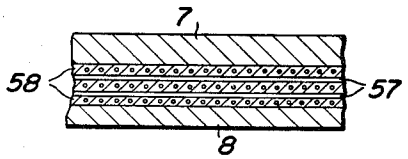
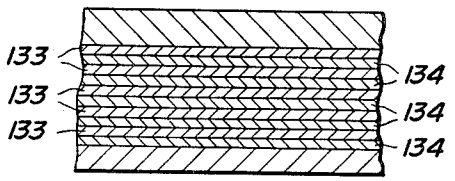


FIG. 11



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FIG. 7

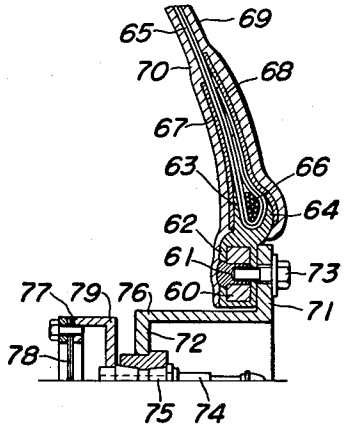


FIG. 8

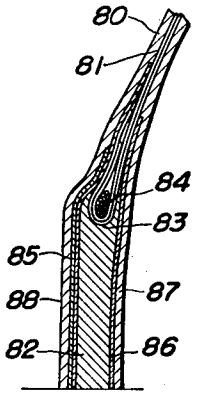
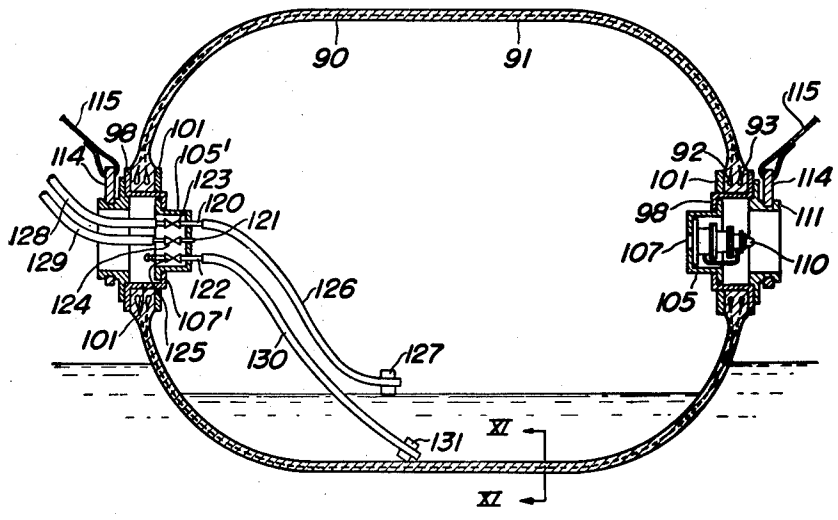


FIG. 9



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FIG. 10

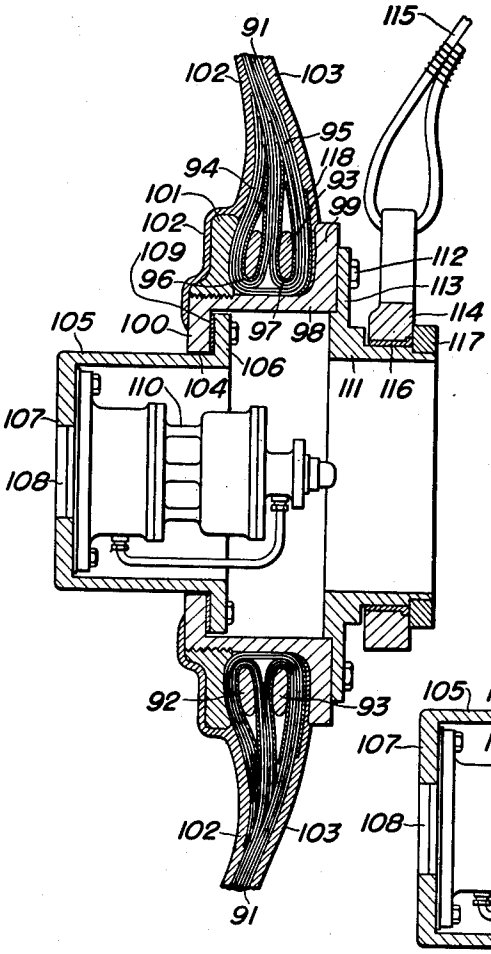


FIG. 12

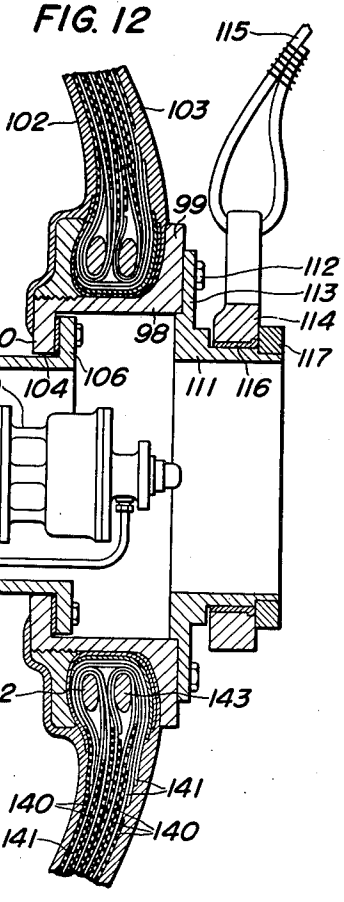
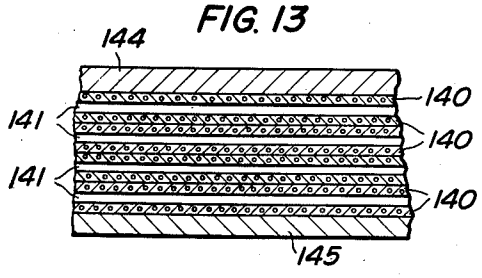


FIG. 13



United States Patent Office

3,063,400

Patented Nov. 13, 1962

3,063,400

FLOATING SHIP FENDER

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Filed Aug. 17, 1960, Ser. No. 50,141
1 Claim. (Cl. 114—219)

This invention relates to ship fenders or devices for absorbing shocks at the time of contact or collision of broadsides of ships with any other objects, such as, for example, quay walls or other ships.

A conventional ship fender is of a type having rubber plugs applied to both end portions of a tubular body made of rubber so that damage by contact of the hull of a ship on the surface of water with other bodies may be prevented by virtue of the resilient force caused by deformation of the rubber layer of the tubular body against the load in the direction perpendicular to the longitudinal axis of the tubular body. The rubber layer must be materially thick to meet the requirement for this type, so that the weight becomes large, the handling becomes inconvenient and the apparent specific gravity becomes high. It is, therefore, difficult to float such a conventional fender by its own buoyancy, and the fender must be tied to the ship or quay wall by a chain or any other means. As the fender is thus fixed with respect to the fluctuation of the draft line of the ship or the rise and fall of the tide, it is very disadvantageous. In addition, its outer diameter is limited to the maximum of about 50 cm.; a fender of such type larger than that is difficult to manufacture.

The present invention is to provide a ship fender which can seal and contain a very large volume of air therein. It has a rubber layer to seal air and has an appearance like a drum or a straw bag provided with a tire cord layer or a metallic wire cord layer to reinforce the rubber layer so that the energy due to any external pressure may be absorbed by the contraction of the compressed air contained therein. It can be towed on water with sufficient buoyancy. In a very large fender to be used especially for a large ship, the thickness of the rubber layer is reduced so as to reduce the total weight and tire cords or particularly nylon cords high in strength and deformability are used for the reinforcing layer. Therefore, the rate of deformation as in the case of collision can be taken to be high enough to increase the cushioning capacity.

Compressed air is fed in advance into the barrel portion formed of such thin layer and a fixed pressure high enough to well endure the deformation at the time of collision, for example, a pressure of about 0.8 kg./cm.^{2}, is established therein so that, due to the compression at the time of collision, the internal pressure may be elevated to damp the large energy. For this purpose, the barrel portion is made of a rubber inner layer well reinforced with metallic wire cords or tire cords so as to cope with the internal pressure caused at the time of collision, for example, a pressure of about 1.5 kg./cm.^{2}. The air chamber communicates with the atmosphere through a valve. Air can be fed or discharged through this valve. This valve may be of the same structure as is used in a tire tube. The valve makes it possible to well feed compressed air into the air chamber even when the fender is floating on water. For this purpose, a so-called rotary joint which is rotatable is provided in one end portion of the ship fender for carrying the valve thereon. The rubber inner layer reinforced with tire cords or metallic wire cords is lined with a liner made of an air-impermeable material on the side facing the air chamber so as to prevent the internal air from leaking out, and is covered with a hard rubbery material high in oilproofness and wearproofness over the portion to be in contact as a

fender with the broadside of a ship or with a quay wall so as to increase the strength and to make it easy to seal air without containing any inner tube. As the reinforcing means, metallic wire cords or ropes can be annularly wound on the barrel portion so as to surround the tire cord layer inside the outside rubber layer, pressureproofness may be increased. There are two methods of winding the above mentioned tire cords. In one of the methods, the tire cords are arranged in the longitudinal direction of the fender and in the circumferential direction perpendicular to the longitudinal direction so as to intersect with each other. In the other method, the tire cords are arranged in bias at an angle of inclination of about 55 degrees to the longitudinal direction of the fender. In either of the methods, the end portions of the tire cords are folded back through a metallic flange-shaped ring or a ring made of metallic wires and the folded portions are further reinforced with a fabric layer so that not only the strength of the end portion may be perfectly prevented from leaking out by holding the folded portions. Further, the flange for sealing has an annular rotating part so that the fender floating on water may be rotatable. By fastening a towing rope to this part, the fender can be tied so as to be only rotatable.

An object of the present invention is to provide a floating type ship fender wherein a barrel portion made of a thick rubber layer reinforced with tire cords or metallic wire cords has metallic rings or metallic wire rings as cores so as to seal and contain compressed air within, the ends of the reinforcing cords of said barrel portion are folded back through said metallic rings at both ends of the barrel portion, each end of said barrel portion has a metallic lid to seal the air chamber in the barrel, and said metallic lid is provided with a valve to pour air into or out of the air chamber.

There are other objects and particularities of the invention, which will be made clear from the following descriptions of preferred embodiments with reference to the drawings, wherein:

FIGURE 1 shows an axial longitudinal section of an embodiment of the ship fender according to the present invention;

FIGURE 2 shows a fragmental longitudinal section at the portion II in FIG. 1;

FIGURE 3 shows an axial longitudinal section of another embodiment of the present invention;

FIG. 4 shows a further embodiment of the invention, partly in elevation and partly in section;

FIG. 5 shows a fragmental longitudinal section at the portion V in FIG. 4;

FIG. 6 shows a modification corresponding to FIG. 5;

FIG. 7 is a sectional elevation showing a modified form of the end portion of the fender;

FIG. 8 is a partial sectional view showing a modified end portion of the fender;

FIG. 9 shows an axial longitudinal section of another embodiment of the invention;

FIG. 10 is an enlarged sectional view of one end portion of the fender shown in FIG. 9;

FIG. 11 shows a fragmental longitudinal section at the portion XI in FIG. 9;

FIG. 12 shows a modification of FIG. 10; and

FIG. 13 shows a fragmental longitudinal section of the barrel wall of the embodiment shown in FIG. 12.

FIG. 1 shows a fender of relatively a small size, say 2 metres or less in diameter of the barrel portion. The barrel portion 1 has its longitudinal length somewhat larger than its diameter, and has circular openings 2 and 3 at the opposite ends.

The barrel portion 1 is of a flexible and resilient construction, formed of an outer and an inner layers 7 and 8

(FIG. 2), and a reinforcing layer 4 interposed therebetween. The outer and inner layers 7 and 8 are formed of rubber or similar material, while the reinforcing layer 4 is formed of juxtaposed and superposed rubberized tyre cords. The outer layer 7 is preferably made of anti-wear rubber of high weather-proofness, while the inner layer 8 must be made of rubber impervious to air. The three layers are bonded together to form an integral structure. The reinforcing layer may alternatively be formed of rubberized metal cords.

Around the circular openings 2 and 3, metallic supporter rings 5 and 6 are disposed respectively, and the end portions of the reinforcing tyre cords are passed through the openings of rings 5 and 6, respectively, and folded back on themselves. The extreme end portions of the reinforcing tyre cords folded back as above-mentioned are covered by rubberized cloths 9 and 10, respectively.

The end openings 2 and 3 are closed air- and watertight by end plates of metal 11 and 12, respectively. The end plates are secured in position by bolts 13 and 14 and nuts cooperating therewith, respectively. The bolts are fixed to the corresponding supporter rings 5 and 6, respectively.

Each of the end plates 11 and 12 is provided with a small hole which is closed by a plug 17 or 18 welded to the end plate. Plugs 17 and 18 are respectively provided with peripheral flanges, and between these flanges and the end plates, annular rings 19 and 20 rotatably encircle the plugs and are held in position. The rings 19 and 20 are connected to mooring cables 15 and 16 through suitable means such as eyebolts.

The plug 18 has a longitudinal through bore, and at the outer end of the bore is attached a valve 21 for controlling the supply of compressed air into the air chamber defined by the barrel portion 1. The valve 21 may be of the type for use with tyre tubes.

The plug 17 is also provided with a longitudinal through bore which is closed by a safety or release valve 22 which operates to discharge the compressed air to the atmosphere when the inner pressure exceeds a predetermined safe value.

The barrel 1 is normally filled with compressed air at a pressure of 0.5 to 1.5 kg./cm.^{2}. The air is fed through the feed valve 21 from a suitable source, not shown.

The fender is kept floating on the surface of the sea S. If desired, the sea water may be introduced into the air chamber in such a quantity that the draft line of fender may be adjusted as desired. If desired also, the air chamber may be filled with sponge rubber blocks.

The thickness of the outer protective layer 7 should be such that any expected external dangerous objects, such as nails, cannot penetrate through the layer 7 to reach the inner layer 8.

If required, the barrel portion 1 may further be reinforced circumferentially by providing a number of circumferential external ribs arranged in spaced parallel relation along the longitudinal direction.

Referring to FIG. 3, the barrel portion 25 of the fender is further reinforced by metal wires 27 wound externally around the barrel portion. These wires 27 are embedded in a boss 26 of rubber formed integral with the outer rubber layer of the barrel portion.

In the embodiment shown in FIG. 3, the circular openings 29 and 30 of the opposite ends of the barrel are encircled by annular supporters 31 and 32 formed of wound metal wire cords or piano wires, around which the reinforcing cords or wires 28 are folded back as hereinabove explained with reference to supporter rings 5 and 6 in FIG. 1.

A sleeve 34 having an external flange 33 at the inner end is inserted into the end opening 29 from inside, and a plug 36 having a bottom 35 is screwed into the sleeve 34 from outside. A sealing ring 37 is disposed between the sleeve 34 and the plug 36. The plug 36 is provided with an external flange 38. When the plug 36 is screwed into the sleeve 34, the flanges 33 and 38 grasp the portion of the barrel end that surrounds the opening 29 and compress that portion therebetween to establish a hermetical closure for the opening 29.

The other end opening 30 is closed by a sleeve 41 having an external flange 40 at the inner end. The sleeve 41 is provided inside with an annular boss 42 in which a valve support 43 is secured by screw thread engagement. The valve support 43 carries an angle valve 44 screwed thereinto. The angle valve 44 is provided with a hose connecter 45 to which a flexible hose, not shown, is connected for supplying compressed air into the barrel.

Around the sleeve 41, a fastening ring 46 is disposed and held firm in position by a nut member 47 screwed on the outer end of sleeve 41. The end portion of the barrel that surrounds the opening 30 is compressed between the flange 40 and the ring 46.

The fender shown in FIG. 3 is enclosed within a net of knitted wire rope or manila rope, through which the fender is moored or towed.

Referring to FIG. 4, the bottom 35 of plug 36 shown in FIG. 3 is provided with a central hole which is closed by a rotary joint 50 for connection with a flexible hose 51, through which compressed air may be supplied into the barrel. The barrel is circumferentially reinforced by a plurality of circumferential bands 54 formed of bundled wires.

When the barrel diameter is smaller than 1.5 metres, the reinforcing layer of the barrel may be made of four superposed layers of rubberized nylon cords 55 and 56 stitched together as shown in FIG. 5, the cords of layers 55 and 56 extend at about 55 degrees to the longitudinal axis of the barrel and at about 110 degrees to each other.

The barrel portion may be reinforced by any other suitable means. Now, as shown in FIG. 6, the reinforcing layer of the barrel portion is formed by superposed layers of cords 57, 58 sandwiched between rubber layers 7 and 8, cords of layer 57 and 58 extending at right angles to each other, one longitudinally and the other circumferentially.

FIG. 7 shows a modified construction of one end portion of the fender. A metallic support 60 of annular form surrounds one end opening. The support 60 is provided with insert nuts 61, and semi-cured rubber element 62 wholly encloses the support 60. The semi-cured rubber element 62 is provided with a bifurcated peripheral flange whose two legs 63 and 64 are outwardly tapered, and between two legs 63 and 64 is disposed a supporter ring 66 of bundled cords or piano wires, around which the reinforcing tyre cords 65 of nylon or rayon are folded back as already explained. The folded back end portions of the reinforcing cords 65 are covered by reinforcing cloths 67 and 68 which also cover the legs 63 and 64.

The end portions of outer and inner rubber layers 69 and 70 of the barrel portion cover the above-described end construction, and during the molding vulcanization process, the structures are wholly cured and bonded together.

The end opening is closed by a metallic closure member 76 surrounded by the support 60. The closure member is of a cylindrical form, having an external flange 71 which is hermetically secured to the support 60 by means of bolts 73 screwed into insert nuts 61 and cooperating nuts, the rubber layer of element 62 being effective to form a hermetical seal.

The closure member 76 has a bottom 72 having a central hole which is closed by a plug 75 welded to the bottom. An air valve 74 of the type for tyre tube use is provided and mounted in the plug 75 therethrough. The plug 75 also carries a filter support 79 which has an in-

ternal flange 77 for supporting a filter screen 78. Thus, the compressed air fed through the valve 74 is filtered.

The fender represented by FIG. 7 is adapted for use when great resiliency and compressibility are desired. For this purpose, the closure structure comprising ring 60 and 76 is preferably made small in diameter. In practical constructions, the above-mentioned diameter is 1/6 to 1/15 of the barrel diameter.

One end of the barrel portion may be closed completely. FIG. 8 shows an exemplary construction for completely closing one end of the barrel. In FIG. 8, the reinforcing layer 81 of the barrel portion 80 is folded back around the supporter ring 84. The end opening that would be formed at the other end is completely closed by a semi-cured rubber disc 82. The rubber disc 82 has a peripheral groove 83 in which is received the supporter ring 84 and that portion of reinforcing layer 81 which embraces the ring 84. Reinforcing cloths 85 and 86 respectively cover the opposite faces of the rubber disc 82 as well as that portion of the reinforcing layer 81 which surrounds the disc 82 to a suitable extent. The inner and outer rubber layers 87 and 88 of the barrel 80 extend to further cover the opposite faces of the disc 82. The whole assemblage is vulcanized to an integral structure.

All the foregoing fenders are of relatively small size, the maximum diameters of barrel portions being less than 2 metres. The end openings of such small fenders are too small so that it is not practical to manufacture them by a process similar to tyre manufacture utilizing air bags or water bags which cannot be withdrawn out of the barrels after final vulcanization.

According to the present invention, a matrix comforming the desired volume and shape of the air chamber is fabricated by use of corrugated cardboards or plaster. Then, over this paper matrix, the inner rubber layer, the reinforcing layer and the outer rubber layer are applied in the order mentioned. After all the rubber elements as mentioned in any of the foregoing embodiments are assembled, the whole assemblage is vulcanized in an appropriate vulcanizer. After the vulcanization has been completed, water or caustic soda solution is introduced into the assemblage, and the paper matrix is dissolved and removed from the rubber structure. End closure elements of metal are then applied to make the fender complete.

The fenders according to the present invention may be larger than the foregoing examples; the barrel diameters may be far larger than 2 metres.

Referring to FIGS. 9 and 10, a large type of fender comprises a barrel portion 90 formed of a reinforcing layer 91 of rubberized wires or tyre cords, and inner and outer rubber layers, just as in the foregoing embodiments. The superposed wires or cords forming the reinforcing layer 91 are divided into two groups 94 and 95 at the end portions as shown in FIG. 10, and these groups are respectively anchored to two metallic inner and outer supporter rings 92 and 93 by being folded back therearound, with reinforcing cloths 96 and 97 interposed therebetween. The outer face of the folded back portion 95 of the reinforcing layer is covered by another reinforcing cloth 118.

In the end opening of the barrel is mounted a metallic cylindrical member 98 inserted thereinto. The cylindrical member 98 has an external flange 99 at the outer end and an internal flange 100 at the inner end. The folded back portion 95 of reinforcing layer is grasped and compressed between the outer flange 99 and an annular collar member 101 screwed onto the inner end of cylindrical member 98.

After the cylindrical member 98 is assembled as above, the inner rubber layer 102 of the barrel portion is manipulated while in semi-cured state to cover the collar member 101 and the inner flange 100 in part. The end of outer rubber layer 103 may be placed inside the outer flange 99.

After the assemblage has been vulcanized, the centre opening 104 defined by the inner flange 100 is closed by a second cylindrical member 105 inserted therethrough, the member 105 having an external flange 106 for cooperation with the inner flange 100 to form a hermetical seal by use of packing ring 109 interposed therebetween. The two flanges are fastened together by machine bolts as shown.

The cylindrical closure member 105 has an internal flange 107 at the inner end defining a center hole 108 which is closed by a safety valve device 110 hermetically secured to the flange 107. The safety valve device 110 is of a conventional construction and operates to maintain the air pressure within the barrel at a predetermined safe value.

To the outer flange 99 of cylindrical member 98 is secured a cable support 111 by means of external flange 113 and screw bolts 112. The cable support 111 has a cylindrical portion on which an annular ring 114 is rotatably mounted through a bearing metal layer 116. The ring 114 has a radial extension to which a mooring cable 115 is connected. The ring 114 is held in position by a collar member 117 screwed on the outer end of the cable support 111.

At the opposite end, the left hand end in FIG. 9, another cylindrical member 98 is mounted in the end opening just as at the aforementioned righthand end. The center opening of the member 98 defined by the internal flange is closed by a cylindrical cup member 105' having a bottom 107' through which are mounted three tubes 120, 121 and 122 for connection with respective flexible hoses. These tubes are provided at the outer ends with control valves 123, 124 and 125, respectively.

A flexible hose 126 is connected to the inner end of tube 120. The inner end of hose 126 is provided with a float 127 so that the inner end of hose 126 is always held above the level of water contained in the air chamber. The outer end of tube 120 is connected through the valve 123 to a compressed air supply hose 128.

The outer end of the tube 121 is connected to a flexible hose 129 through the valve 124. The hose 129 is connected to a water pump, not shown, for supplying water into the air chamber. To the inner end of the hose 130 is provided a weight 131, so that the hose inner end is always held sunk in the water.

The water is supplied into the air chamber at a pressure higher than that of air in the air chamber. The amount of water contained in the air chamber is determined by the desired draft line of the fender. When the water in the air chamber is to be decreased, the control valve 125 is open. Then, the water is discharged from the air chamber by means of the air pressure therein.

FIG. 11 shows a fragmental longitudinal section of the barrel portion XI shown in FIG. 9. The reinforcing layer comprises alternately superposed cord layers 133 and 134. Cords of layers 133 and 134 extend at an angle of about 55 degrees with respect to the longitudinal axis of the barrel, and at an angle of about 110 degrees with respect to each other.

Referring to FIG. 12, there is shown an end closure structure similar to that shown in FIG. 10, except that the former comprises no mooring cable support. In the present embodiment, the wall construction of barrel includes a reinforcing layer, which is fragmentarily shown in FIG. 13. The reinforcing layer comprises layers of wires or cords 140 extending circumferentially of the barrel and layers of wires or cords 141 extending longitudinally of the barrel, and the longitudinal wires or cords 141 are anchored by folding back as explained hereinbefore to the supporter rings 142 and 143 similar to those shown in FIG. 10. The reinforcing layer is sandwiched between outer and inner rubber layers 144 and 145.

The embodiments shown in FIGS. 9 to 13 can have barrel diameters larger than 3 metres, and may conveniently be fabricated by a process to be described.

In a fender having barrel diameter larger than 3 metres, the end openings are correspondingly large, so that men can enter into the barrel through the end openings. In manufacturing such a large fender, a barrel-like casing is used as a mold having inner diameter corresponding to the outer diameter of the fender barrel. Men enter into the mold barrel and operate to apply onto the inner surface of the mold the outer rubber layer, the reinforcing layer and the inner rubber layer in the order mentioned. Then, the mold is placed in a vulcanization tank and heat treated to complete the vulcanization.

The fender thus formed may have barrel diameter of 3.5 meters and longitudinal length of 7 metres. On the other hand, the fender may be of elongated form of say 70 cm. diameter and 10 m. long. Anyhow, it is important to employ tire cord or wire reinforcement in the barrel portion. If cloth is used for reinforcement, the useful life of fender will be very short. It is also important to fabricate the end portions to a very strong structure by use of metallic supporter rings with folding back of reinforcing layer therearound. The structure has mechanical strength several times higher than that having no folding back feature. Air leakage is also prevented completely. Accordingly to the invention, therefore, the ship fender is not required to comprise inner special tube for preventing air leakage. Consequently, the gross weight of a fender is relatively small, and the fender is economical and effective.

What we claim is:

A floating ship fender comprising a flexible and resilient barrel portion having open opposite ends defining a longitudinal axis, said barrel portion being constituted by an outer rubber layer, an inner rubber layer, and an intermediate reinforcing layer of tire cords, metallic supporting rings at the opposite ends of said barrel portion, and closure means for closing the opposite ends of said barrel portion, said reinforcing cords including end portions anchored to said supporting rings by being folded back therearound, and into face to face relation with the respective cord, said cords extending at about 55° to the longitudinal axis of the barrel and at about 110° to each other, said closure means including valve means adapted for controlling a compressed air supply within said barrel portion.

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