

[54] LIQUID SHOCK ABSORBING BUFFER

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[56] **References Cited**

UNITED STATES PATENTS

2,722,906 11/1955 Tweddell 61/48 X

3,447,786	6/1969	Bigni.....	256/13.1
2,974,934	3/1961	White	256/13.1
2,062,919	12/1936	Maas	114/219
3,503,600	3/1970	Rich.....	293/1 X
970,848	9/1910	Patronaggio.....	114/219
1,623,888	4/1927	Pasini	114/219
3,602,151	8/1971	Walker et al.	104/256

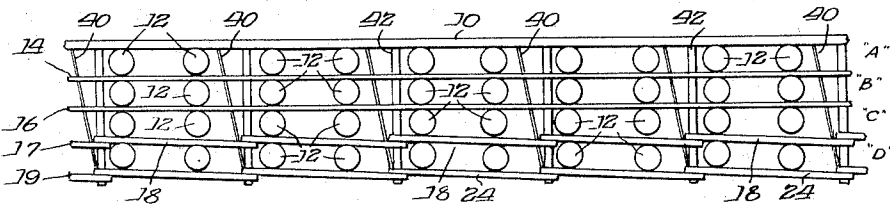
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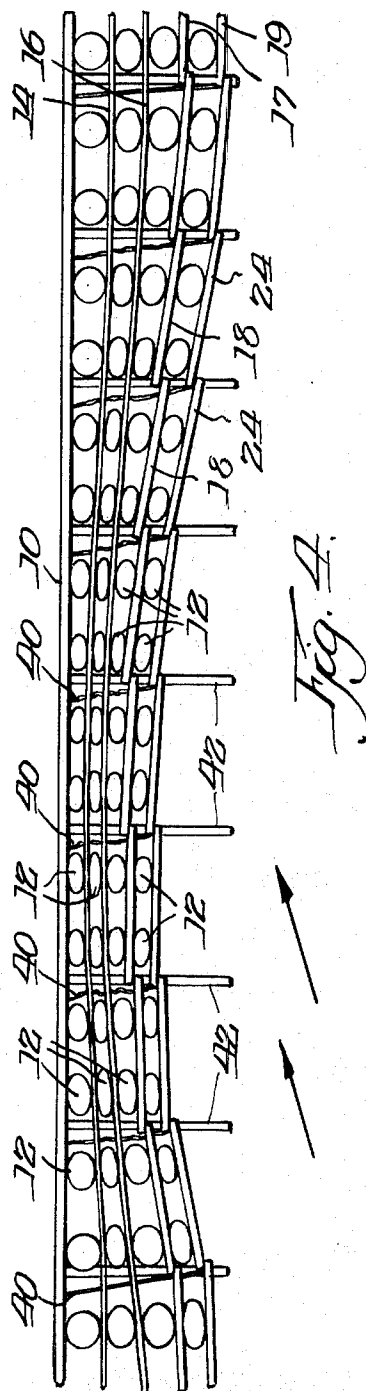
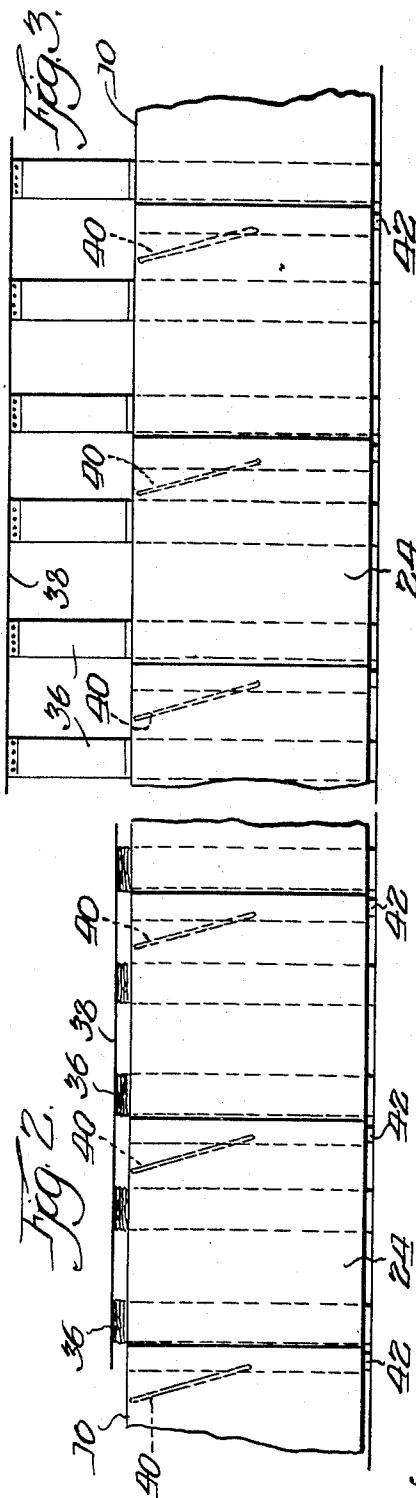
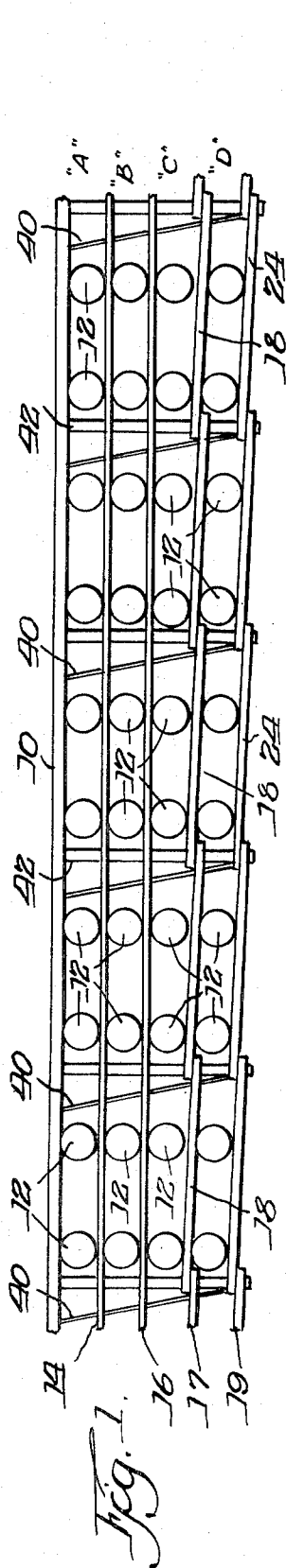
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[57] **ABSTRACT**

An impact cushioning device for buffering the impact of a vehicle colliding with a stationary vertical surface. The device comprises a wall of liquid filled flexible, collapsible energy absorbing and dissipating cells disposed between the stationary vertical surface and movable articulated and overlapping diaphragm fender panels which are supported on slide plates. At impact, the fluid in the energy absorbing and dissipating cells is forced upward through a sharp-edged orifice which regulates the release of fluid commensurate with the force of impact. The outermost diaphragm panel is composed of a material having a low coefficient of friction to aid in safely redirecting the vehicle safely subsequent to impact.

8 Claims, 6 Drawing Figures





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Fig. 5.

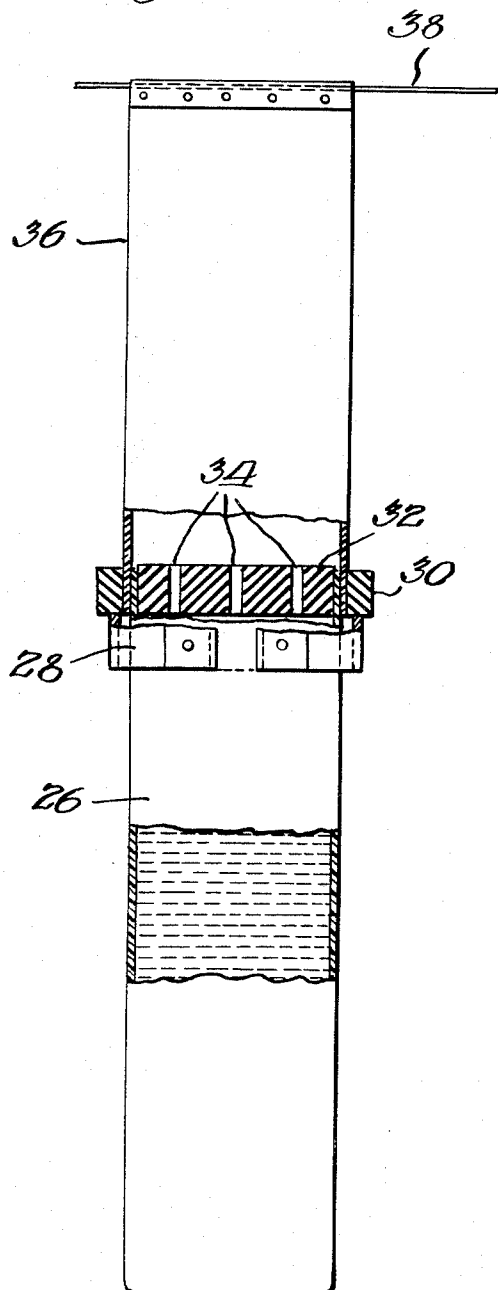
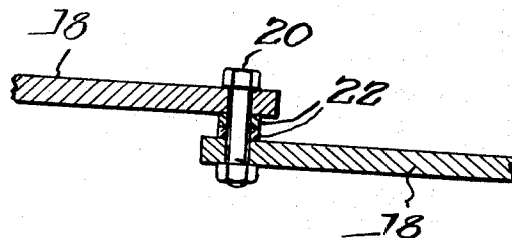


Fig. 6.



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LIQUID SHOCK ABSORBING BUFFER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to constructions for protecting fixed vertical surfaces such as restraining fences or railings from the effects of the force of impact due to a colliding vehicle. More particularly, the invention relates to energy absorbing and dissipating devices for absorbing and dissipating the energy of a collision of a vehicle with a fixed vertical surface and deflecting said vehicle safely away from said fixed surface with minimum injury to the driver of the vehicle and negligible damage to the protected vertical surface.

2. Description of the Prior Art

It is conventional practice to protect stationary vertical structures such as walls and railings from damage due to an impacting vehicle by placing fixed steel or concrete abutments on pipes or the like in front of the wall or railing, whereby the abutment or pipe absorbs the damage, but not the shock of the impact, thus sparing the wall or railing. Such devices are only of limited value since the shock of impact is not absorbed by the pipe or abutment; and the driver and passengers in the impacting vehicle still face possible injury. Further, the vehicle may be deflected back into the vehicular traffic route, or against other fixed structures nearby.

SUMMARY OF THE INVENTION

It has been found that a plurality of incompressible fluid filled energy dissipating and absorbing buffer elements, arranged in a novel structure comprising movable diaphragm fender members supporting said buffers in spaced relation to a fixed vertical surface, provide a device which protects the fixed vertical surface from damage due to the force of an impacting vehicle. Such novel structure also possesses inherent capabilities of absorbing and dissipating the force of impact before it reaches said fixed vertical surface, and of deflecting the impacting vehicle at an angle of approximately 1° to the plane of said fixed vertical surface, enabling the driver to maintain control of the vehicle subsequent to impact. Also, by absorbing the shock of impact, the present invention reduces the forces on the vehicle, thereby reducing materially the degree of physical damage to the vehicle.

Accordingly, it is a primary object of the present invention to provide a novel construction for protecting fixed vertical surfaces such as walls or the like which includes a plurality of collapsible incompressible fluid filled energy absorbing and dissipating buffer members disposed in spaced relation in front of said fixed vertical surface.

It is a further object of the present invention to provide a novel energy absorbing and dissipating construction which includes several energy dissipating buffer elements, each linearly disposed in spaced apart relation in front of the fixed vertical surface, wherein each line or row of buffer elements is separated and supported by movable diaphragm fender members disposed in substantially parallel planes in front of said fixed vertical surface and partly supported by restraining cables which, in combination with said vertical surface, maintain a trapezoidal support configuration for the outermost of said fender members.

A further object of the invention is to provide an impact buffering device comprising at least one outer surface comprised of articulated diaphragm fender panels assembled to overlap adjacent panels whereby a colliding vehicle is deflected from said buffer device at a relatively low angle due, in part, to the articulated, overlapping construction of said outer surface.

Still another object of the present invention is to provide a novel structure for protecting a fixed vertical surface from damage due to impact including rows of energy absorbing and dissipating buffer elements alternately disposed in spaced relation between movable diaphragm fender members in front of said fixed vertical surface, wherein the outermost diaphragm fender member, which comes into contact with the impacting

vehicle, comprises a surface having a low coefficient of friction to aid in properly deflecting said vehicle subsequent to impact.

A further object of the invention is to provide an impact cushioning device comprising a plurality of fluid-filled flexible containers with orifices therein to relieve and regulate internal pressures whereby impact energies which are uniformly distributed amongst the buffer elements by means of the diaphragm fender members are effectively dissipated at safe, controlled rates.

An additional object of the invention is to provide containment means which coact with the incompressible fluid filled energy absorbing and dissipating buffer elements to prevent the escape of fluid from said buffer members during impact.

A further object of the invention is to provide containment means which coact with the buffer elements to return fluid to said buffer elements subsequent to impact.

Still another object of the invention is to provide slide plates positioned between the diaphragm fender members and the road or track surface to enhance the ability of the fender members to move under impact.

Other objects and advantages of the invention will appear from the specification which follows and from the drawings to which reference is now made.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the construction of this invention shown in place protecting a fixed vertical wall;

FIG. 2 is a frontal elevation view of a portion of the construction of FIG. 1, showing the position of the containment bags prior to impact;

FIG. 3 is a frontal elevation view similar to FIG. 2, showing the position of the containment bags at impact;

FIG. 4 is a plan view of the construction of this invention showing the relative position of the energy absorbing and dissipating buffer elements and diaphragm fender members at the moment of impact;

FIG. 5 is a detail illustration of one of the flexible collapsible incompressible fluid filled energy absorbing and dissipating buffer elements and containment sacks, showing in particular the orificed insert through which fluid flows at impact, and a suggested method of mounting the buffer elements on the diaphragm fender members;

FIG. 6 is a detail plan view of a preferred construction for joining the plate-like elements which form the two outermost diaphragm fender elements.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference is made to FIGS. 1 and 2. A fixed vertical surface such as a restraining wall or railing 10 which is normally located adjacent a vehicular route of travel such as a highway or auto race track is sought to be protected. The main purpose of this invention is to protect the vehicles and the occupants thereof from damage and injury upon collision of such vehicle with a structure such as the wall 10, as well as protecting the wall itself.

A first row "A" of flexible, collapsible incompressible fluid containing energy absorbing and dissipating buffer elements 12 are linearly disposed immediately in front of and adjacent wall 10 along the entire extent of the wall 10 to be protected. On the side of buffer elements 12 opposite the wall 10 is positioned a movable, generally vertical first diaphragm fender member 14. Another row "B" of buffer elements 12 is linearly disposed in front of and adjacent said first diaphragm fender member 14. In a similar manner, a second movable diaphragm fender member 16 is positioned on the opposite side of said second row of buffer elements 12, and a third row "C" of buffer elements 12 is linearly positioned adjacent to and along the extent of the front side of diaphragm fender member 16.

On the opposite side of buffer elements 12 forming row "C," is positioned a diaphragm fender member 17 comprising a series of movable, generally vertical plate-like elements 18

overlapping each other and bolted one to another at the point of overlap as shown in FIG. 6. In the preferred embodiment, bolts 20 extend through apertures in elements 18, which are separated at the point of attachment by two resilient spacers 22, which, by way of example, can be composed of vinyl or a similar substance. This preferred construction permits the members 18 to articulate slightly in a horizontal plane or "swing" relative to each other, as will be explained.

A fourth row "D" of buffer elements 12 is linearly disposed in front of and adjacent diaphragm fender panel 17, and on the opposite side thereof is provided a diaphragm fender member 19 similarly constructed as diaphragm fender member 17, and composed of substantially identical plate-like elements 24, overlapping and fastened for articulated movement as shown in FIG. 6.

In the disclosed embodiment, diaphragm fender member 19 is immediately adjacent the vehicular traffic, and receives the initial force of impact from a colliding vehicle. The outer surface of diaphragm fender member 19 must also be capable of deflecting the impacting vehicle at a low angle relative to the direction of extent of the impact cushioning device of the present invention. Therefore, plate-like elements 24 are preferably formed of 1 1/2 inch thick fiberglassed, wood panels, which is characterized by a low coefficient of friction and high strength.

Since the inner-most diaphragm fender members do not receive the full force of impact delivered to the outer fender member, the three interior panels, for economic reasons, can be made of lesser expensive materials. For example, diaphragm fender member 17 may be made of 1 1/2 inch thick plywood sections, while the interior members 14, 16 may consist of 3/4 or 1/2 inch plywood. It is apparent that varying degrees of strength can be achieved by using fender members of different thicknesses, and the above dimensions are given only by way of example.

Buffer elements 12, which are shown in detail in FIG. 5, each comprise a flexible, collapsible fluid-filled container 26 supported on an adjacent diaphragm fender member 14, 16, 17 or 19 by means of strap 28 and a solid "keeper ring" 30 affixed to container 26. Inside of container 26, located near the open top thereof (in the vicinity of keeper ring 30 in the embodiment of FIG. 5), is positioned an insert 32 firmly secured to the inside of container 26. Sharp-edged orifices 34 are provided in insert 32 to permit fluid to escape from container 26 only at a rate commensurate with the energy of impact of a colliding vehicle. Containment means in the form of flexible bags 36 are affixed to the upper portion of containers 26 above the open end and insert 32 to catch and contain any fluid escaping from container 26 through orifices 34. This feature of the invention is important in installations adjacent auto race tracks, where it is required that water or any fluid substance displaced as a result of impact be kept off of the track. As will be explained, containment bags 36 catch and return the escaped fluid. The tops of containment bags 36 in a given row of buffer elements 12 are joined together by means of a tether line of nylon or other suitable material (FIGS. 3, 4).

To maintain the impact cushioning device of the present invention in an upright position and enhance its ability to safely redirect the colliding vehicle, several restraining cables 40 are fastened at intervals between the top portion of wall 10 and a point intermediate the vertical extent of outermost diaphragm fender members 24. As shown in FIGS. 1 and 2, restraining cables 40 also extend forward (in the direction of vehicle travel) from their attachment point at wall 10 to the point where they are fastened to plate-like elements 24. This results in each plate-like element 24 being held in position in an easily collapsible trapezoidal configuration consisting of wall 10, element 24, and two successive restraining cables 40. As seen in FIGS. 1 and 4, the relative positions of the restraining cables 40 enable diaphragm fender member 19 to collapse inwardly with a component of movement in the direction of travel of the impacting vehicle. This easily collapsible configuration aids in preventing the vehicle from becoming caught or snagged on

the cushioning device, and is also important in properly and safely redirecting the vehicle away from oncoming traffic. Cables 40 also coact to pull panels 24 into engagement with row "D" of buffer elements 12, and holds the entire structure upright by maintaining a compressive force on all parts of the device. Restraining cables 40 pass through apertures (not shown) suitably located in diaphragm fender members 14, 16 and 17.

Movable diaphragm fender members 14, 16, 17 and 19 are slidably positioned atop several slide plates 42, located at suitable intervals along the extent of the wall 10 and perpendicular thereto. As the fender members are forced toward wall 10 during impact, they move laterally and slightly forward due to the aforesaid trapezoidal configuration formed by the attachment of restraining cables 40, on slide plates 42, rather than on the surface of the roadway or race track, which would have a relatively higher coefficient of friction.

The outermost diaphragm fender member 19 presents a "fish scale" effect to an oncoming colliding vehicle due to the manner in which plate-like elements 24 overlap and are bolted together. This further prevents the colliding vehicle from snagging on the sections which make up fender member 19. To take advantage of this "fish scale" construction, the device of the present invention is constructed as shown in FIGS. 1 and 4 for traffic moving from left to right, as represented by the arrows in FIG. 4. For an installation where the vehicular traffic moves in the opposite direction, the overlapping configuration of plate-like elements 24, and 18, is reversed.

OPERATION

As an impacting vehicle, moving in the direction of the arrows in FIG. 4, impacts the cushioning device of the present invention, diaphragm fender member 19 is forced inwardly along slide plates 42, and against buffer elements 12 row "D." This force is transmitted through fender member 17 to row "C" of buffer elements 12, and thence to the remaining two rows of fender members 14, 16 and buffer elements 12. The device assumes the configuration of FIG. 4, with the flexible buffer elements 12 being compressed to their collapsed position. The function of the diaphragm fender members is to more effectively distribute the impact energy uniformly to a larger member of buffer elements 12. The preferred bolt and resilient spacer construction joining elements 24 together (FIG. 6) permits one plate-like element to articulate relative to the adjoining member, thus enabling the outer fender members to "give" without separating.

Responsive to the compressive force acting upon each buffer element 12, fluid in container 26 is directed against the force of gravity upward through orifices 34 in insert 32. Due to the sharp-edged configuration of orifices 34, the fluid in container 26 escapes only at a rate commensurate with the energy of impact, enabling the buffer elements 12 to offer a resistive force which absorbs and dissipates the impacting force.

When inactive, containment bags 36 fold down on top of buffer elements 12. When activated under impact, the fluid escaping through orifices 34 is transmitted to bags 36. Subsequent to impact, the fluid, under the influence of gravity, returns through orifices 34 and drains back into container 26. As the liquid returns to container 26 after impact, buffer elements 12 regain their original configuration, forcing diaphragm fender members 14, 16, 17 and 19 to return to the positions shown in FIG. 1. Thus, the buffer elements are almost instantaneously ready to receive the next impact.

Several details of construction of the disclosed invention operate severally and jointly to properly deflect the colliding vehicle from the buffer device at a very low angle, thus enabling the driver to maintain control of the vehicle and preventing the vehicle from "bouncing" back into the lane of moving traffic adjacent the wall 10. First, the overlapping diaphragm fender panel construction (FIG. 6) and ability of the panels to articulate with respect to each other aid in

redirecting the colliding vehicle at a low angle of deflection. Second, the low coefficient of friction of fiberglass members 24 comprising diaphragm fender members 19 enables the car to "slide" off the buffer device to a certain extent, and eliminates any "rebounding" effect. Thus, the vehicle is safely redirected at a low angle away from the protected surface 10. It has been found through testing, for example, that the four-layer cushion device of the preferred embodiment disclosed in FIGS. 1-4 has safely withstood impacts of from 40 to 70 miles per hour, while deflecting the vehicle at an angle of approximately 1° from the direction of extent of the buffer device. The vehicle at all times was maintained under control by the driver, without injury to the driver or to protected wall 10. Likewise, only minimal damage to the colliding vehicle occurred due to the energy absorbing and dissipating capability of buffer elements 12.

The embodiments disclosed are exemplary of the type of configuration which may be used with ordinary fixed vertical structures which are adjacent or near routes of vehicular traffic. The most common type of such structures are restraining walls and railings. However, the device of the present invention may be used to protect bridge abutments, traffic signals, and similar devices. It will be apparent to the skilled engineer that the configuration of the diaphragms and the buffer element arrangement will to some degree be dictated by the configuration of the construction with which it is to be associated. Such adaptations of configurations are well within the skill of the art and are within the spirit and scope of the invention as defined in the following claims.

We claim:

1. An impact absorbing safety barrier for a rigid elongated vertical member such as a restraining wall or the like, comprising:

energy absorbing and dissipating means comprising a plurality of collapsible members extending along said vertical member and forwardly thereof in a series of adjacent rows;

diaphragm means comprising a plurality of diaphragm panels disposed intermediate preselected ones of said series of rows, the forwardmost of said diaphragm panels in a direction removed from said vertical member being comprised of a multiplicity of panel sections positioned in overlapping relation and resiliently joined to one another for permitting articulation of said panel sections and enhancing the ability of said safety barriers for effecting deflection at a relatively low angle;

and non-rigid means coupling said forwardmost diaphragm panel to said vertical member at spaced intervals for retaining said safety barrier in assembled relation.

2. The impact absorbing safety buffer of claim 1 wherein:

said non-rigid means comprises a plurality of restraining cables extending between said vertical member and said forwardmost diaphragm member such that a trapezoidal configuration is formed by said vertical member, said outermost diaphragm fender member, and an adjacent two of said restraining cable means whereby an impact will cause said outermost diaphragm member to move in a forward as well as a lateral direction so as to safely redirect said vehicle subsequent to impact.

3. The impact absorbing safety buffer of claim 1 including:

slide plate means positioned beneath said movable diaphragm members whereby an impact will cause said fender members to slide along the surface of said slide plates.

4. The impact absorbing buffer of claim 1 wherein:

said collapsible members are flexible cylindrical structures containing an incompressible fluid and each having orifice means therein for releasing said fluid at a rate commensurate with the energy of impact applied to said structures.

5. The impact absorbing safety buffer of claim 4 including:

containment means associated with each of said cylindrical structures for capturing and returning the fluid released from each of said cylindrical structures of said energy absorbing and dissipating means whereby fluid is prevented from escaping from said energy absorbing and dissipating means during an impact by entering said containment means.

6. The impact absorbing safety buffer of claim 1 wherein:

said diaphragm fender members at the outermost position from said vertical member are relatively thicker than said diaphragm fender members at the innermost positions from said vertical member.

7. The impact absorbing safety buffer of claim 6 wherein:

the outer vertical surface of the movable diaphragm member furthest removed from said vertical member comprises a material having a relatively low coefficient of friction which aids in effecting deflection from said furthest removed diaphragm member at a substantially low angle.

8. The impact absorbing safety buffer of claim 7 wherein said material is fiberglass.

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