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Young et al.

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[54] **LIQUID SHOCK ABSORBING BUFFER**

[72] Inventors: **Bruce O. Young; Grant W. Walker,** both of Sacramento; **Duane B. Ford,** Placerville; **Wan Seegmiller,** El Dorado, all of Calif.

[73] Assignee: **Energy Absorption Systems, Inc.,** Chicago, Ill.

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[21] Appl. No.: **74,736**

[52] **U.S. Cl.** ....**188/1 B,** 61/48, 9/8, 104/254, 104/256, 114/219, 188/32, 256/1, 256/13.1, 267/116, 267/139, 293/1, 293/60, 293/64

[51] **Int. Cl.** **E02b 3/22,** F16f 5/00, F16f 9/08

[58] **Field of Search** ....61/46, 48; 104/249, 254, 256; 114/219; 188/1 B, 1 C, 32, 129, 266, 298; 256/1, 13.1; 267/116, 139; 293/1, 70, 71 R, 71 P, 60, 64; 9/8

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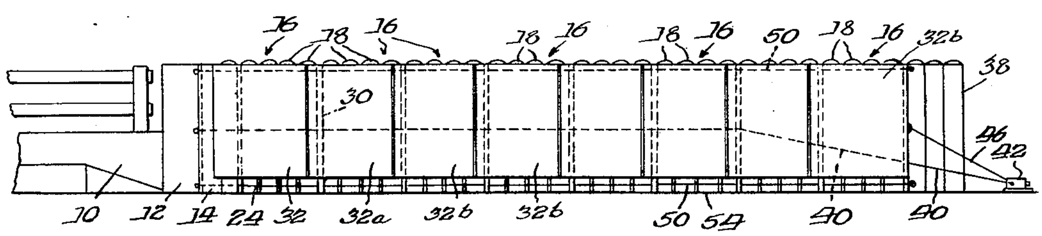
Primary Examiner—Arthur L. La Point
Assistant Examiner—Howard Beltran
Attorney—Hume, Clement, Hume & Lee

[57] **ABSTRACT**

A reuseable impact attenuation construction designed to protect fixed objects near highways or vehicular traffic routes from damage due to high velocity impact. The invention comprises a plurality of collapsible, incompressible fluid filled energy absorbing and dissipating buffer elements separated by collapsible panel and diaphragm means whereby the force of impact of a colliding vehicle compresses the aforesaid structure, causing a pressure build-up in the fluid filled buffer elements which are sandwiched between the panel and diaphragm means. The energy of impact is dissipated in said buffer elements by the controlled escape of fluid therefrom through a series of sharp edged orifices. The internal pressure in the buffer elements creates a resisting force which dissipates the kinetic energy of the impacting vehicle and brings it to a safe, controlled stop without damage to said fixed object and without injuring the occupants of the vehicle.

16 Claims, 14 Drawing Figures



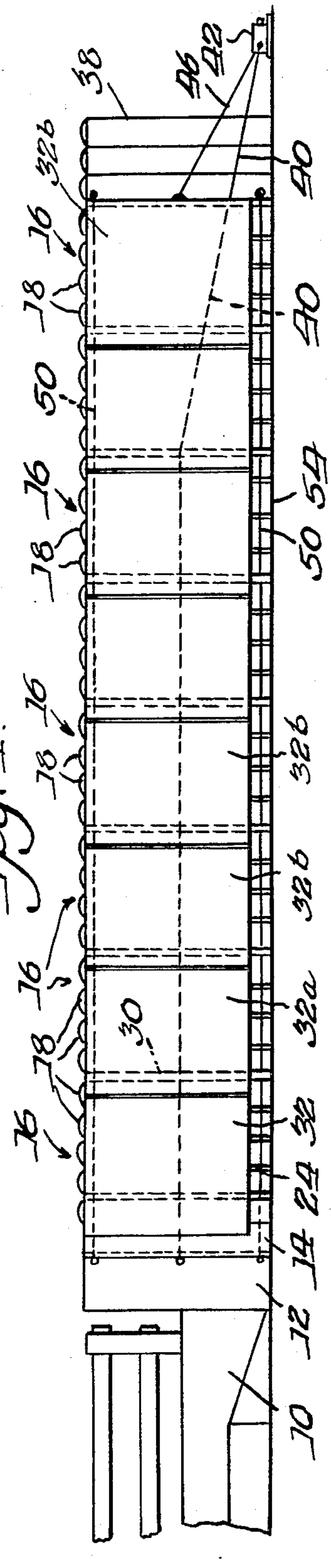


Fig. 1

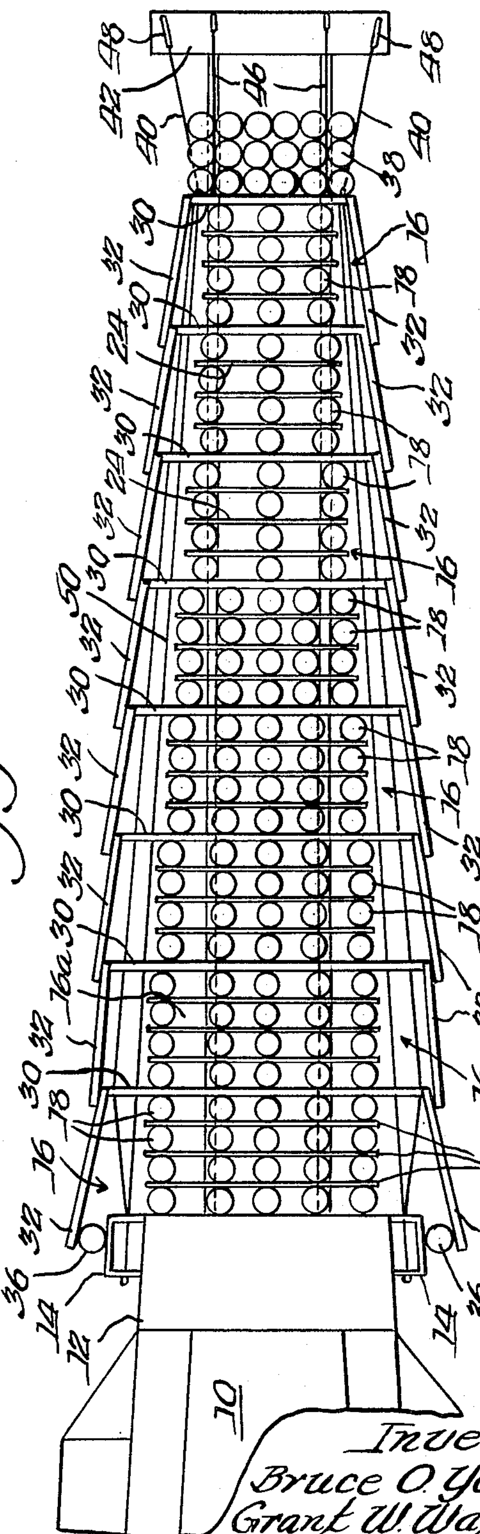


Fig. 2

Inventors.
Bruce O. Young,
Grant W. Walker,
Duane B. Ford, &
Wan Seegmiller.
By. James B. Blanchard, & Howard B. Rockman.
Attys.

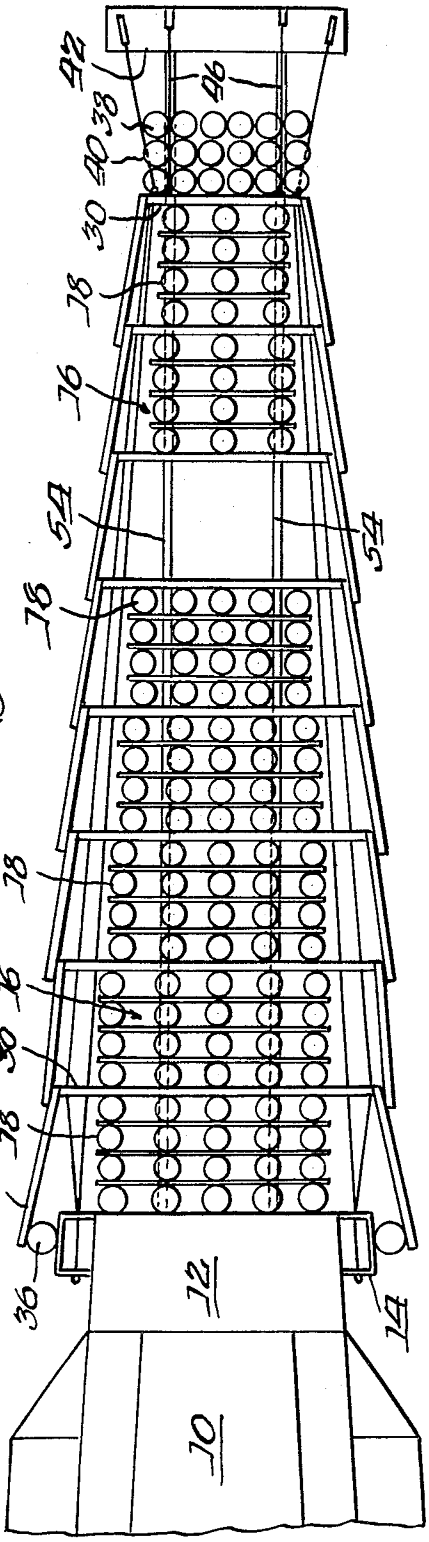


Fig. 3

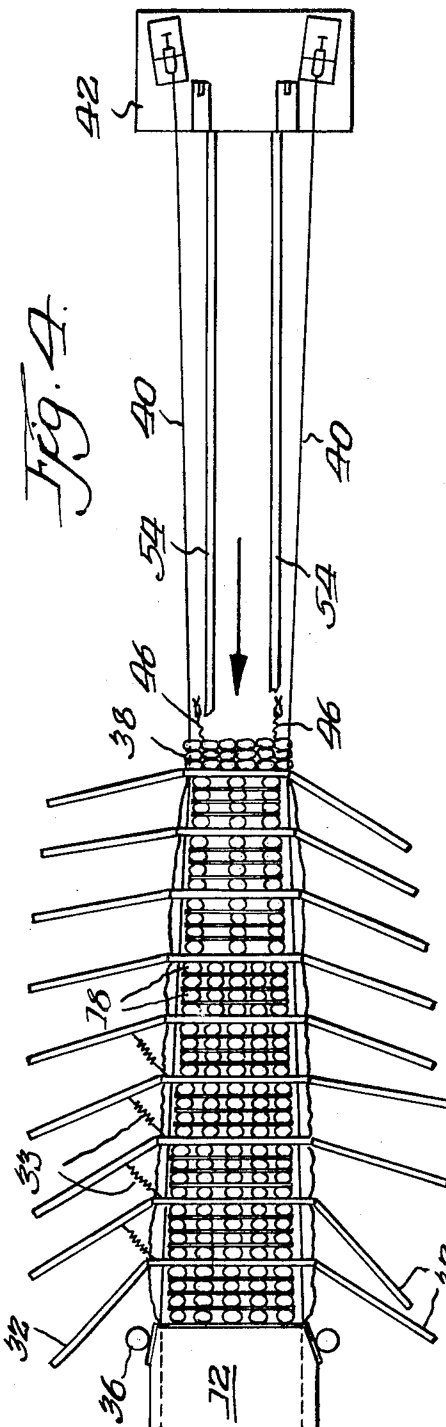


Fig. 4

Inventors.
Bruce O. Young,
Grant W. Walker,
Duane B. Ford, &
Wan Seegmiller.
By James B. Blanchard & Howard B. Rockman.
Attys.

Fig. 5

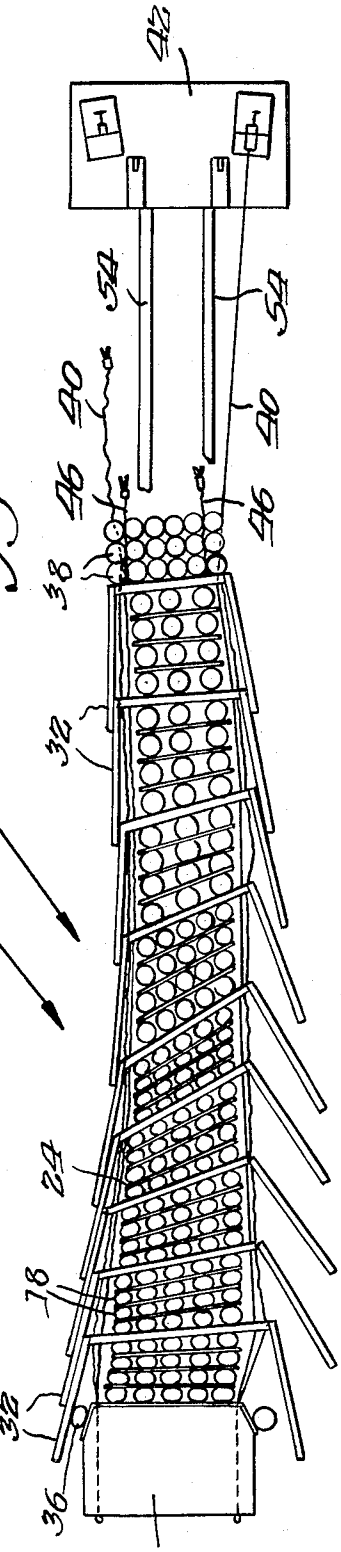
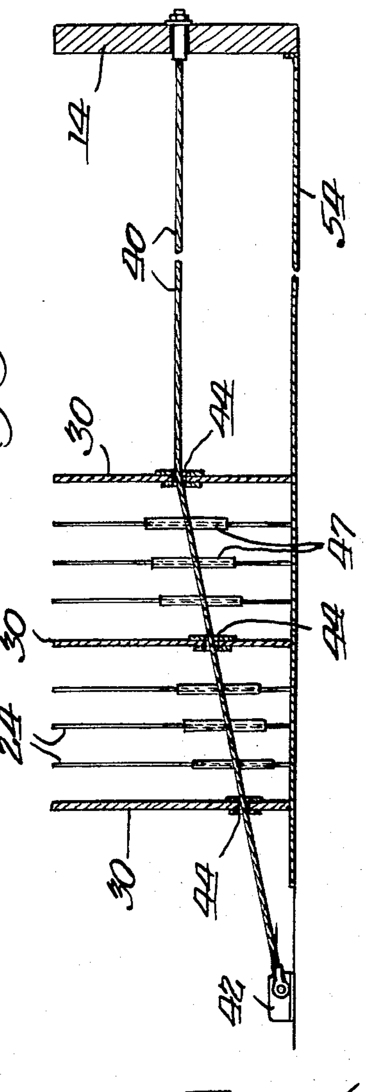


Fig. 6



Inventors.
Bruce O. Young,
Grant W. Walker,
Duane B. Ford, &
Wan Seegmiller.
By James B. Blanchard &, Howard B. Rockman
Attys.

Fig. 7.

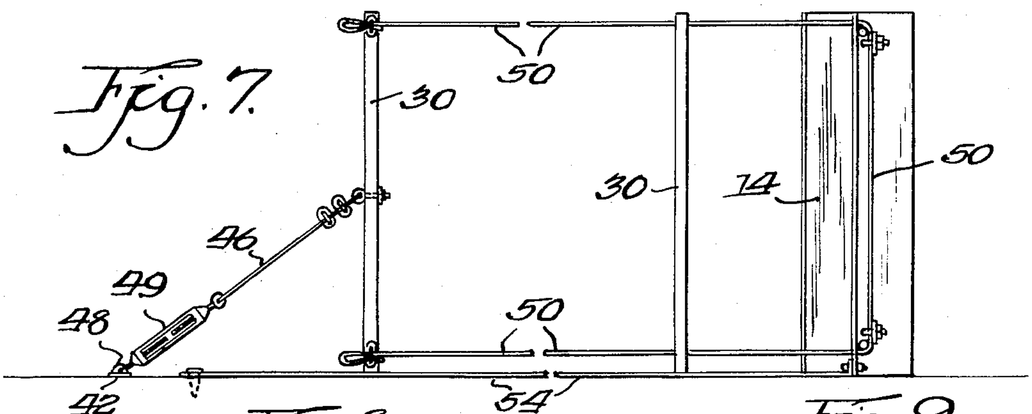


Fig. 8

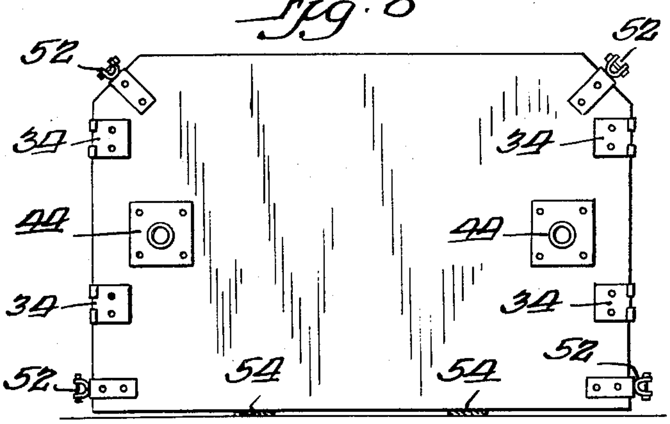


Fig. 9.

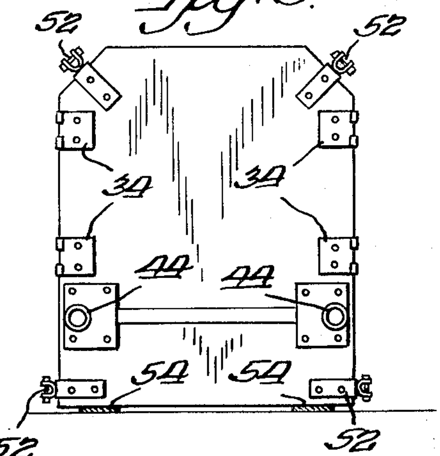


Fig. 10.

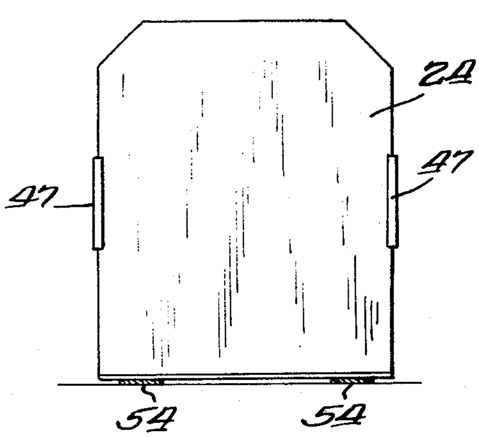
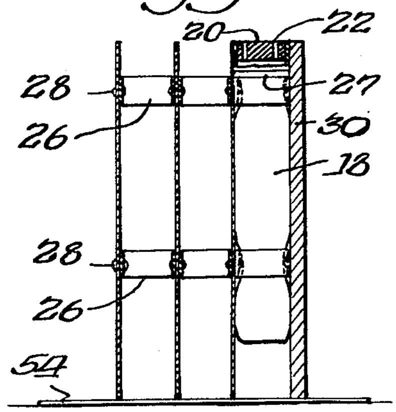


Fig. 11.



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Attys

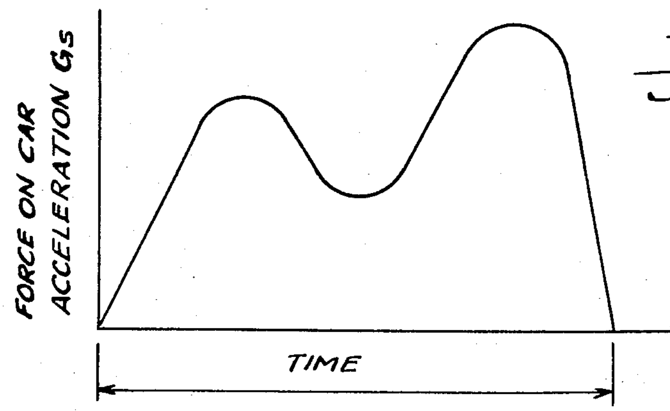


Fig. 12.

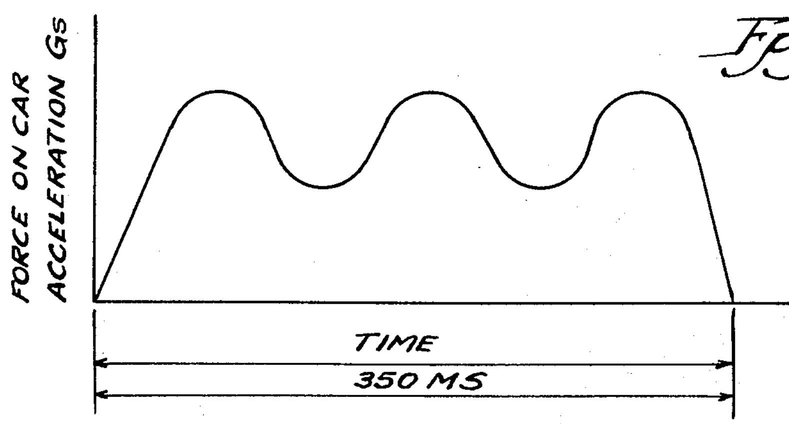
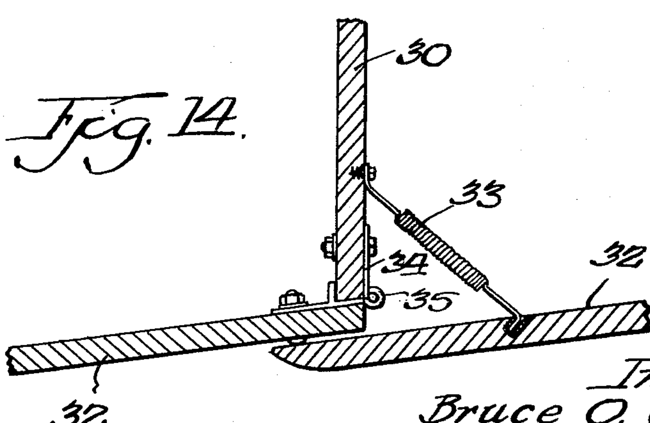


Fig. 13.

Fig. 14.



Inventors.
Bruce O. Young,
Grant W. Walker,
Duane B. Ford, &
Wan Seegmiller.
By James B. Blanchard, & Howard B. Rockman.
Attys

LIQUID SHOCK ABSORBING BUFFER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to constructions for protecting fixed structures from damage resulting from colliding vehicles or the like. More particularly, this invention relates to a reuseable impact attenuation device designed to absorb and harmlessly dissipate the energy of impact of a colliding vehicle or the like with a fixed structure along or near a highway, such as a bridge abutment, parapet, sign or light stanchion or the like.

2. Description of the Prior Art

It is known to put rigid guard rails and similar immovable protective devices alongside vehicular traffic routes such as high speed highways for the purpose of preventing cars, buses, trucks and other vehicles from colliding with fixed structures such as abutments, columns, and sign supports, for example, which may be positioned near or adjacent to such vehicular traffic routes. Common practice is to place a rigid railing between the vehicular traffic route and the fixed structure to deflect the automobile in such a manner that the automobile, or other vehicle, avoids direct impact with the fixed structure. Such devices are of only limited value since they do not attempt to decelerate the vehicle at a controlled, safe rate to provide maximum safety and minimum injury to the occupants of the impacting vehicle. Further, such devices result in the impacting vehicle being thrown back on the highway where it may collide with other moving vehicles.

The present invention utilizes, in part, devices for absorbing or dissipating the kinetic energy of a moving body which are described in the patent application of John W. Rich, Ser. No. 664,333, filed Aug. 30, 1967, now U.S. Pat. No. 3,503,600 and titled "Liquid Filled Buffer for Absorbing Kinetic Energy." A portion of the individual buffer members described in said application, or buffer members somewhat similar thereto, form part of the construction of this invention. Further, this invention is an improvement over the device disclosed in the patent application of Grant W. Walker and Duane B. Ford, Ser. No. 48,950, filed June 22, 1970 and which is a continuation of application Ser. No. 777,329, filed Nov. 20, 1968, titled "Diaphragm Buffer Protective Construction" now abandoned.

SUMMARY OF THE INVENTION

It has been discovered that an improved energy absorbing and dissipating device for protecting stationary structures from damage due to impacting vehicles, while safely bringing the vehicle to a controlled-deceleration stop, can be provided utilizing clusters of energy absorbing buffer members or cells arranged in chambers which sandwich or telescope into each other upon impact, whereby said chambers are partly formed by lateral extending fender panels which aid in properly redirecting the car after lateral impact on the side of the protective device. Accordingly, it is a principal object of this invention to provide a novel construction for protecting a stationary structure which includes at least a cluster of energy absorbing and dissipating buffer elements each arranged in a plurality of chambers defined by diaphragms and laterally extending fender panels such that an edge of each fender panel overlaps one of said diaphragms permitting said chambers to collapsibly telescope into one another upon impact of a vehicle with the protective construction whereby the energy of impact is absorbed and dissipated by the buffer members and the mass of the construction itself.

It has been further discovered that when the device of the present invention is constructed comprising several clusters of energy absorbing buffer elements in a plurality of chambers spacially disposed throughout the extent of said device, a controlled dispersion of an impact shock wave created in said device can be obtained by reducing the capability of the device to directly transmit the shock wave therethrough. Accordingly, it is an important object of one embodiment of the present invention to provide at least a single chamber void of

buffer elements, whereby direct transmission of the impact shock wave is interrupted and partially dispersed by said void chamber.

It has further been discovered that in a device such as disclosed herein with at least a void chamber, additional shock absorbing means can be provided in the portion of the device between said void chamber and the protected stationary structure to absorb and dissipate the effect of the remaining impact shock wave passing beyond the void chamber. Therefore, it is still another object of this invention to provide an energy absorbing and dissipating device to protect a stationary structure comprising clusters of buffer elements arranged in spacially disposed chambers defined in part by diaphragms wherein maximum impact shock wave attenuation is achieved by leaving one chamber void of buffer elements and increasing the mass of at least one of the diaphragms between the void chamber and the stationary structure.

An additional object of the invention is to provide greater control in positioning the resisting mass of the unit and in diminishing its effect upon the vehicle during deceleration.

Still another object of the present invention is to provide an improved impact attenuation device which produces a satisfactory deceleration wave upon impact.

A further object of the present invention is to provide an impact attenuation device comprising laterally disposed fender panels to effectively deflect an impacting vehicle away from a protected stationary structure at a low angle relative to the normal direction of vehicle travel.

An additional object of the present invention is to provide an impact attenuation device comprising restraining and pull-out cable means attached to various members thereof which resist deformation of such device when impacted laterally by a colliding vehicle.

The novel construction illustrated in the drawings and described hereinafter constitutes more specific objects of the invention, but the invention is not deemed to be limited to the exact construction illustrated.

Other objects and advantages of the invention will appear from the specification which follows with reference to the drawings wherein:

FIG. 1 is a side elevational view of the cell sandwich impact attenuation device forming the present invention in place protecting an abutment;

FIG. 2 is a top plan view of the impact attenuation device of FIG. 1;

FIG. 3 is a top plan view of a modified embodiment of the present invention wherein one chamber is void of buffer elements;

FIG. 4 is a top plan view of the impact attenuation device of FIG. 1 as it appears after a head-on impact by a moving vehicle or other object;

FIG. 5 is a top plan view of the impact attenuation device of FIG. 1 as it appears after a side-angle impact by a moving vehicle or other object;

FIG. 6 is a detail side elevational view of the restraining cable and backup plate construction, showing the relative location of the forward diaphragm, interior panels, and slide straps;

FIG. 7 is a detail side elevation view of the secondary cable and pull-out cable construction of the present invention;

FIG. 8 is a detail view of a typical diaphragm, including fender panel hinges, pull-out cable clips, and restraining cable eye guides;

FIG. 9 is a detail view of the front diaphragm;

FIG. 10 is a detail view of a typical interior panel;

FIG. 11 is a detail side elevational view of a preferred manner of fixing the buffer elements or cells to the structural rings and interior panels;

FIG. 12 is a plot of acceleration forces on the impacting vehicle in *g*'s versus time in milliseconds using the impact attenuation device of FIG. 2;

FIG. 13 is a plot of acceleration forces on the impacting vehicle in *g*'s versus time in milliseconds using the modified impact attenuation device of FIG. 3;

FIG. 14 is a detail plan view of a preferred manner of connecting the fender panels and diaphragms.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is made to FIGS. **1** and **2** for a description of the first embodiment of the invention.

A fixed structure such as an abutment **10** which is normally located adjacent or near a route of vehicular travel, such as a street or highway, is sought to be protected. This protection encompasses one of the main objects of the invention, along with the protection of a vehicle and the occupants thereof from injury upon collision of the vehicle with a fixed structure such as abutment **10**.

If the existing concrete or steel stationary structure **10** is not capable of resisting the imposed forces brought into play by the impact of a colliding vehicle with the cell sandwich unit, a rigid backing member **12** is provided to reinforce the stationary structure. The rigid backing member **12** comprises two cable fastening means **14** firmly secured to backing member **12**. Positioned in front of and in contact with backing means **12** are a plurality of clusters **16** of energy absorbing and dissipating buffer members **18** partially filled with an incompressible fluid material which is preferably water. However, any fluent material which is essentially incompressible may be used. Buffer members **18** are collapsible flexible cell cartridges which have the characteristic of remaining flexible and water tight in extremes of heat and cold. As an example, and not by way of limitation, buffer members **18** may comprise a vinyl coated nylon fabric cylindrical body with an open end and a diameter of approximately 5 ½ inches. The length may vary as required by the installation, but lengths of 24, 30 and 36 inches have found to be satisfactory for most installations. The base fabric of buffer elements **18**, by way of example, may consist of 6.1 ounces of nylon and 16 ounces of vinyl to produce a total weight of 22 ounces per yard. This provides a material which is capable of offering a hydrostatic resistance of 300 psi or better. An insert **20** (FIG. **11**) containing sharp-edged orifices **22** to regulate the rate of release of water from the buffer elements **18** is affixed to the open end of the buffer elements. Upon impact, the release of water from the elements **18** by turbulent viscous flow is controlled by orifices **22** which put a limit on the hydraulic pressure by venting the fluid after buildup to a maximum pressure, in the manner taught in the application of John W. Rich, Ser. No. 644,333, filed Aug. 30, 1967, titled "Liquid Filled Buffer for Absorbing Kinetic Energy." As a result, the escape of fluid from buffer elements **18** occurs only at a rate commensurate with the impact force applied thereto. The sizes of orifices **22** will be established pursuant to requirements of speed limits, weights of vehicles, desired deceleration rate, etc.

The clusters **16** of elements **18** are formed by placing the buffer elements in lateral rows which are held in a spaced relation by interior panels **24**, which may be composed of overlaid plywood or any other suitable material. As shown in FIG. **2**, an exemplary cluster towards the rear of the protective device comprises four rows of elements **18** separated by three interior panels **24**. At the forward end, where the lateral dimensions of the cell sandwich unit are not as great, each row comprises a lesser number of buffer elements **18**. Elements **18** are secured to the interior panels **24** by structural rings **26** (FIG. **11**) which are attached to the interior panels by suitable means such as bolts **28**. Flexible elements **18** are held in rings **26** by the force of friction, or the elements **18** may comprise an upper flanged portion such as keeper ring **27** to prevent the cells from falling through the structural rings. Since the buffer elements **18** are not self-supporting, interior panels **24** hold the cells erect.

Adjacent the outermost row of elements **18** in any cluster **16** is a movable diaphragm **30** which, along with fender panels **32** pivotally attached to and extending laterally and rearwardly from two lateral sides of each diaphragm **30**, forms a chamber housing each cluster **16**. As shown in FIG. **2**, each preceding chamber located from back-up member **12** is of lesser width than the succeeding chamber. This construction enhances the ability of the chambers to telescope one into the other upon impact. Diaphragms **30** may be fabricated, as an example, from 1 ½ inch thick laminated wood, coated on both sides with fiber-glass. Fender panels **32**, for example, may be constructed of any suitable material such as ¾ to 1 ¼ inch plywood, and are preferably coated on both sides with fiberglass. It is to be understood that the thickness of the diaphragms **30** and fender panels **32** may be varied from these dimensions depending upon the force of impact against which the invention is designed to protect. The exterior surface of fender panels **32** is coated with a "floated" resin material or the like, to reduce the coefficient of friction for purposes to be explained. Fender panels **32** are held in a longitudinally extensive, or inward, position by means of springs **33** (FIG. **14**). Fender panels **32** are fastened to diaphragms **30** by means of loose pin hinges **35**, thus facilitating the replacement of damaged fender panels.

Fender panels **32** are pivotally attached to diaphragms **30** by means of hinges **34** (FIGS. **8**, **11**). The free swinging end of each fender panel **32** abuts the pivotal end of the succeeding fender panel in an overlapping manner, and lies on the outside thereof. It can be seen that upon compression due to impact of the chambers housing clusters **16**, each fender panel **32** will slide outside of the succeeding fender panel, causing the chambers of clusters **16** to telescope into each other. (FIG. **5**). The most rearward fender panels **32** on each side of the protective device abut a buffer element **36** (FIG. **2**), which is similar to that described in the aforesaid patent application of John W. Rich. If the force of impact from a head-on collision is great, the force against the protective structure comprising this invention causes fender panels **32** to pivot outwardly against the force of springs **33** as the chambers housing clusters **16** are telescoped inwardly, as shown in FIG. **4**.

At the forward, or nose, end of the impact attenuation structure, immediately adjacent the first diaphragm **30**, is a cluster of buffer elements **38** substantially similar to the buffer elements disclosed in the aforesaid patent application of John W. Rich. These buffer elements **38** preferably comprise hollow, vinyl plastic cylinders substantially filled with an incompressible fluid. An insert similar to insert **22** shown in FIG. **11**, containing sharp-edged orifices to regulate the release of fluid from the cylinder at a rate commensurate with the force of compression upon impact, is secured to an open end of the cylinders. The material comprising buffer elements **38** shall be chosen to possess high strength while retaining flexibility at both high and low temperatures.

A series of cables are provided to assist in supporting the impact attenuation device of the present invention, and to further enhance the impact absorbing and dissipating capabilities of the structure. Two restraining cables **40** are securely fastened at a point beyond the forward end of the cell sandwich unit to a fixed cable anchorage **42**, and pass through reinforced apertures **44** in movable diaphragms **30** (FIGS. **6**, **8**). As shown in FIGS. **6** and **9**, apertures **44** in the forward two diaphragms **30** are nearer the ground since restraining cables **40** pass through the two forward diaphragms **30** as they are rising from cable anchorage **42**. Restraining cables **40** also pass along the lateral edge of each interior panel **24**, which comprise a reinforced portion **47** (FIG. **10**) which contacts the restraining cables **40** and protects the interior panels from excessive wear.

Restraining cables **40** rise from cable anchorage **42** in a vertical plane to the third diaphragm **30** counting from and including the forward diaphragm, passing through apertures **44** in all diaphragms through which the restraining cables pass. From the third diaphragm, restraining cables **40** pass through apertures **44** of the remaining diaphragms, and are ultimately firmly anchored to cable fastening means **14**. In the horizontal plane, as seen in FIG. **2**, restraining cables **40** extend inwardly from cable anchor **42** to the forward diaphragm **30**, from where they flare outwardly to fastening means **14**. This flared traverse of restraining cables **40** assists in maintaining the cell sandwich unit in place during lateral impacts.

As shown in FIG. 7, a secondary set of cables 46 are provided, which are fastened at one end to cable anchor 42 by means of shear pins 48, which break upon impact. The opposite ends of secondary cables 46 are firmly attached to the forward diaphragm 30. Turnbuckles 49 are provided to maintain secondary cables in a taut condition. Upon impact, shear pins 48 break as forward diaphragm 30 is forced back in the direction of abutment 10. (FIGS. 4, 5).

In addition to the aforementioned restraining and secondary cables, two pullout cables 50 are attached to the corners of each diaphragm 30. (FIGS. 1, 7). For this purpose, cable clamps 52 are provided at the four corners of each diaphragm to which pullout cables 50 are attached. Pullout cables 50 act during a lateral impact to provide an internal compressive force which acts on the buffer elements 18, to which the energy of impact is ultimately transferred for absorption and dissipation. Further, the unit may be substantially returned to its original shape after an impact by applying a tension force to pullout cables 50. Turnbuckles 49 also assist in keeping the pullout cables 50 in a taut condition.

Slide straps 54 are provided on the ground along the length of the cell sandwich unit beneath diaphragms 30. Upon impact, the diaphragms are readily movable along slide straps 54.

The embodiment of the invention disclosed in FIG. 3 differs from the embodiment of FIGS. 1, 2, 4 and 5 in that the third chamber counting from the forward, or nose end is void of buffer elements 18. It has been discovered that by leaving a void chamber, a modified shock wave pattern is produced in the transmittal of the impact wave to the back-up plate 12. This is diagrammatically illustrated in FIGS. 12 and 13. FIG. 12, which was charted using the device of FIGS. 1 and 2, shows, in a plot of the acceleration (*g*) forces on the impacting vehicle versus time (milliseconds) how an initial shock wave and then a secondary shock wave of slightly higher amplitude are produced prior to a reduction of the forces on the vehicle to zero. FIG. 13 shows a plot of the same acceleration forces versus time developed using a device constructed in accordance with the embodiment of FIG. 3, with the third chamber void of buffer elements. The shock wave produced in an equivalent time period comprises an additional " hump," however, the average amplitude of the impact force is less than that produced in the structure of FIGS. 1 and 2. Therefore, while the embodiment of FIGS. 1 and 2 will be sufficient for most applications, additional attenuation of the overall shock wave may be produced using a void chamber such as disclosed in the embodiment of FIG. 3.

In the embodiment of FIG. 3, the shock wave in the device picks up again when it passes the void chamber. By adding mass to the device of FIG. 3 by the use of thicker and heavier diaphragms 30 and/or interior panels 24 between the void chamber and the back-up plate 12, these thickened units will act as shock absorbers without transmitting the shock wave to the back-up plate.

OPERATION

A vehicle impacting the cell sandwich unit head-on first contacts the buffer elements 38 located ahead of the nose portion of the device. Since cable anchorage 42 is almost level with the ground, the vehicle rides over the anchorage without being impeded thereby. A portion of the impact energy of the moving vehicle is absorbed and dissipated by the regulated flow of fluid in buffer elements 38 through the sharp-edged orifices located at one end of each buffer element.

As the vehicle continues its impacting movement, nose cluster 38 is forced rearward, and the remaining impact energy is transferred to forward diaphragm 30 which moves on slide straps 54 and compresses the buffer elements 18 in the chamber directly behind the forward diaphragm. A further portion of the energy of impact is absorbed and dissipated by buffer elements 18 as fluid in said elements is discharged through orifices 22 (FIG. 11) at a rate commensurate with the impact force applied thereto. Diaphragms 30 and interior panels 24 act to uniformly distribute the force of impact amongst a series of buffer elements in a single row in each of the chambers.

As buffer elements 18 are compressed in the first chamber, a force is applied to the succeeding diaphragm 30, which moves along slide straps 54 and applies a compressive force to the next cluster 16 of buffer elements 18. The energy absorbtion and dissipating process described above is repeated by each cluster of buffer elements 18, with any remaining force of impact being transmitted to the succeeding adjacent diaphragm 30. This succession of diaphragm movements and buffer element energy dissipation continues until the kinetic energy of the vehicle has been completely dissipated, and the vehicle brought to a safe stop. The heavier the vehicle and the faster it is going, the further along the length of the cell sandwich unit it will travel before reaching zero velocity. Therefore, the energy of impact is dissipated as the walls of buffer members 38 are collapsed initially by the impact of the vehicle upon the nose cluster, and by the subsequent movement of the respective diaphragms and interior panels forcing the collapse of successive clusters of buffer members 18 positioned between the diaphragms 30, interior panels 24 and backing plate 12.

Since each diaphragm is successively wider than the preceding one, a stepped or telescope effect is provided. The larger mass of the elements of the cell sandwich unit nearer the back-up plate 14 gives the rear portion of the unit a higher degree of shock or energy absorbing capability. Therefore, as the vehicle moves toward back-up plate 14, the resistive forces acting to bring it to a halt increase.

As best shown in FIG. 4, a head-on impact force will cause fender panels 32 to swing outwardly on hinges 34 due to the movement of the diaphragms 30 towards each other and the inertia of the fender panels themselves. The outward movement of these fender panels requires the expenditure of energy, which is obtained from the kinetic energy of the impacting vehicle, thereby assisting the unit further in dissipating the energy of impact.

As diaphragms 30 move towards each other while compressing buffer elements 18 during impact, restraining cables 40 guide and control the movement of the diaphragms. The outward flare in the restraining cables 40 compensates for any slack that may develop due to geometric position changes of the diaphragms, maintains tension, and aids in redirecting the car at a low angle during a side impact. Cables 40 also prevent the cell sandwich unit from buckling in the lateral and vertical directions.

The secondary cables 46, which are used primarily to maintain the forward diaphragm 30 in an upright position while the cell sandwich unit is in place (FIG. 7), are broken loose from cable anchorage 42 upon impact. The tension in secondary cables 46 causes shear pins 48 to break, thereby permitting forward diaphragm 30 to move along slide straps 54 as previously described.

The cell sandwich unit also works extremely well on side angle impact, as diagrammatically illustrated in FIG. 5. Due to the force exerted by the impacting vehicle, fender panels 32 remain in an inwardly position and act as fenders to deflect the vehicle away from the unit. This deflection, however, does not direct the vehicle back to the lane of oncoming traffic. Tests have shown that a vehicle travelling at 55–60 mph and side-impacting the cell sandwich unit at an angle of 15° was effectively fendered away at an angle of ejection within two degrees of being parallel to the side face of the unit. Thus, the vehicle safely comes to a stop near the cell sandwich unit, which is located along side the main traffic route, and not in the lane of moving traffic.

Two factors are primarily responsible for enhancing the effectivity of the unit during side impacts. First, the two pretensioned restraining cables 40 are positioned high for stability and near the center of mass of the unit and of the impacting vehicle. Cables 40 resist extensive lateral movement, yet yield sufficiently to reduce the force of impact reacting against the vehicle. When the cell sandwich unit is impacted by a heavy vehicle, such as a loaded truck or the like, or at high velocity and steep angle, the shear pin anchoring the cable **40** nearest the impact wall break, releasing that cable as shown in FIG. **5**. However, the remaining cable is sufficient to resist lateral movement of the unit and aids in halting the vehicle.

The second factor enhancing the effectiveness of the cell sandwich unit during a side impact is the low coefficient of friction of the outer surface of the fender panels **32**. This enables the vehicles to slide more easily along fender panels **32** following impact. Since the amount of penetration of the vehicle into the unit is small, and since there is only a small frictional force developed between the vehicle and the panels, the vehicle is gently redirected and does not pocket and spin out.

Further resistance to deformation during side angle impacts is afforded by pull-out cables **50** which are firmly attached to each diaphragm **30**, and prevent movement of said diaphragms in a direction away from each other, thereby maintaining pressure on buffer elements **18** during impact.

Generally summarizing the operation of the cell sandwich unit, when the unit is impacted head on, it compresses, causing a pressure build-up in the buffer elements **18** which are sandwiched between diaphragms **30** and interior panels **24**. The internal cell pressure multiplied by its area of contact with the interior panels and diaphragms equals a resisting force. This resisting force multiplied by the distance through which the unit acts is a measure of the energy dissipation during impact. The mass-inertia phenomenon renders the cell sandwich unit self-adjusting as a higher mass vehicle automatically produces a higher hydraulic pressure to absorb impact.

The energy absorption system of the present invention functions to dissipate the energy of impact in several ways. First, the transfer of momentum involved in moving the fluid in the buffer elements through the orifices and into the atmosphere requires the expenditure of energy. Second, there is created in the buffer elements **18** a force opposed to the build-up of hydraulic pressure which eventually yields, but nevertheless, opposes impact prior to yielding. Also, the shock wave generation through the fluid in the buffer elements increases the temperature of the fluid, which further absorbs energy. Further, the mass of the impacting vehicle and the mass of the structural parts of the cell sandwich unit, such as diaphragms, cell units, interior panels, cables, etc., absorb part of the force of impact. The vinyl housing comprising the buffer elements also expands during impact, and this expansion additionally absorbs part of the energy of impact.

Subsequent to either a head-on or lateral impact, the cell sandwich unit may be easily repositioned by a vehicle such as a tow truck or the like pulling against the pull-out cables **50** mounted at the top and bottom and on each side of the unit.

In areas where snow occurs, covers are provided to prevent an accumulation of snow and ice. In freezing climates, antifreeze solutions may be added to the fluid in the buffer elements **18** and **38**.

If desired, architectural designs in varying colors and textures may be affixed to the outer sides of fender panels **32** to make the unit more pleasing in appearance.

The embodiments disclosed are exemplary of the type of configuration which may be used to protect fixed structures near or adjacent routes of vehicular traffic. However, the device may be used to protect any object from another moving object, and it will be apparent to the skilled engineer that the configuration of the diaphragms, panel and buffer element arrangement will to some degree be dictated by space requirements or the configuration of the structure 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 impacting absorbing safety buffer device for a fixed structure comprising:

a rigid backing member adapted to be positioned adjacent said fixed structure;

collapsible, energy absorbing and dissipating means comprising a plurality of individual elements positioned in an ordered array extending forwardly of said backing member;

diaphragm means comprising a plurality of individual diaphragm members interposed in said array at spaced intervals and with the opposed ends of at least preselected ones of said diaphragm members extending laterally outward of said array of individual elements;

fender means comprising panel members pivotally coupled to the opposed ends of said selected diaphragm members, said panel members extending rearwardly from their associated diaphragm member and partially overlapping the panel members associated with the succeeding diaphragm member; and

non-rigid means interconnecting said backing member and said diaphragm means.

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

said diaphragm means and said fender means are constructed to telescope into each other upon impact;

and said panel members of said fender means are normally biased into engagement with the panel members of the succeeding diaphragm member.

3. The impact absorbing safety buffer device of claim 1 wherein:

said individual elements of said energy absorbing and dissipating means are arrayed in a series of adjacent rows between at least preselected ones of said diaphragm panels; and

said diaphragm means further includes interior panels interposed between adjacent rows of said individual elements.

4. The impact absorbing safety buffer device of claim 3 wherein:

said individual elements of said energy absorbing and dissipating means each comprise a fluid filled cavity, and orifice means positioned above said cavity to permit discharge of said fluid from said fluid filled cavity through said orifice means only at a rate commensurate with an impact force applied thereto.

5. The impact absorbing safety buffer device of claim 1 including:

additional collapsible energy absorbing and dissipating means located in front of the forward most diaphragm member.

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

said non-rigid means includes a restraining cable structure rigidly anchored at one end in advance of the forwardmost one of said diaphragm members and at its opposite end to said rigid backing member and passing through apertures in said diaphragm means to guide and control the movement of said diaphragm means during impact.

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

said restraining cable means comprises at least two laterally spaced cables which diverge from each other from the front to the rear of said device to compensate for any slack that may develop due to position changes of said diaphragm means.

8. The impact absorbing safety buffer device of claim 6 wherein:

said non-rigid means further includes a pull-out cable structure attached to said diaphragm means to prevent said diaphragm means from moving in a direction to enlarge said chamber means, said non-rigid means constituting the substantially exclusive means for interconnecting said diaphragm means.

9. The impact absorbing safety buffer device of claim 7 wherein:

each succeeding diaphragm member is laterally wider than the preceding diaphragm member disposed toward said backing member, and said diaphragm members and said clusters of energy absorbing and dissipating means are positioned to form a generally frustro-conical configuration.

10. An impact absorbing safety buffer device for a fixed structure comprising:

a rigid backing member adapted to be secured adjacent said fixed structure;

a plurality of spaced, substantially vertically disposed diaphragm members with laterally disposed fender members pivotally attached to two vertical sides of said diaphragm members;

said diaphragm members being positioned in spaced relation to one another and with said fender members associated with each diaphragm member partially overlapping respective fender members associated with a successive diaphragm member for forming a plurality of chambers spacially disposed in front of said backing member when said fender means are in a longitudinally extensive position;

energy absorbing and dissipating means disposed in said chambers; and

means for interconnecting and partially restraining movement of said diaphragm means consisting essentially of flexible cables.

11. The impact absorbing safety buffer device of claim 10 wherein:

said fender means when disposed in said longitudinally extensive position forms a barrier means which effectively deflects a vehicle impacting laterally with said safety buffer device at a substantially low angle measured along the longitudinal extent of said safety buffer device.

12. The impact absorbing safety buffer device of claim 10 wherein:

the sides of said fender means facing the direction of impact have a surface composed of a material having a relatively low coefficient of friction.

13. The impact absorbing safety buffer device of claim 10 wherein:

said interconnecting and restraining means comprises cables rigidly anchored at one end at a location in advance of the forwardmost of said diaphragm members and at its opposite end to said rigid backing member and passing through apertures in each of said diaphragm members, for resisting lateral deformation of said safety buffer device during lateral impact along said fender members.

14. An impact absorbing safety buffer device for a fixed structure comprising:

a rigid backing member adapted to be secured adjacent said fixed structure;

a plurality of spaced apart diaphragm members with laterally disposed fender members attached thereto forming a plurality of chambers sequentially aligned chambers disposed intermediate respective adjacent pairs of said diaphragm members and spacially disposed in front of said backing member; and

collapsible energy absorbing and dissipating means disposed in only preselected ones and less than all of said plurality of chambers.

15. The impact absorbing safety buffer device of claim 14 wherein:

said device includes eight chambers and said energy absorbing and dissipating means is disposed in all but the third chamber from the front of said device.

16. The impact absorbing safety buffer device of claim 14 wherein:

said energy absorbing and dissipating means includes a cluster of flexible housing members each comprising a fluid filled cavity therein and orifice means positioned above said cavity to permit discharge of said fluid from said fluid filled cavity through said orifice means only at a rate commensurate with an impact force applied thereto.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,674,115 Dated July 4, 1972

Inventor(s) Young, et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 45 change "644,333" to --664,333--.

Column 7, line 5 change "wall" to --will--.

Column 10, line 15 delete first "chambers".

Signed and sealed this 2nd day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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