May 11, 1954 J. L. HEWITT 2,677,936

BUFFER OR LIKE ENERGY-ABSORBING DEVICE

Filed Dec. 4, 1950

4 Sheets-Sheet 1

Fig. 1.

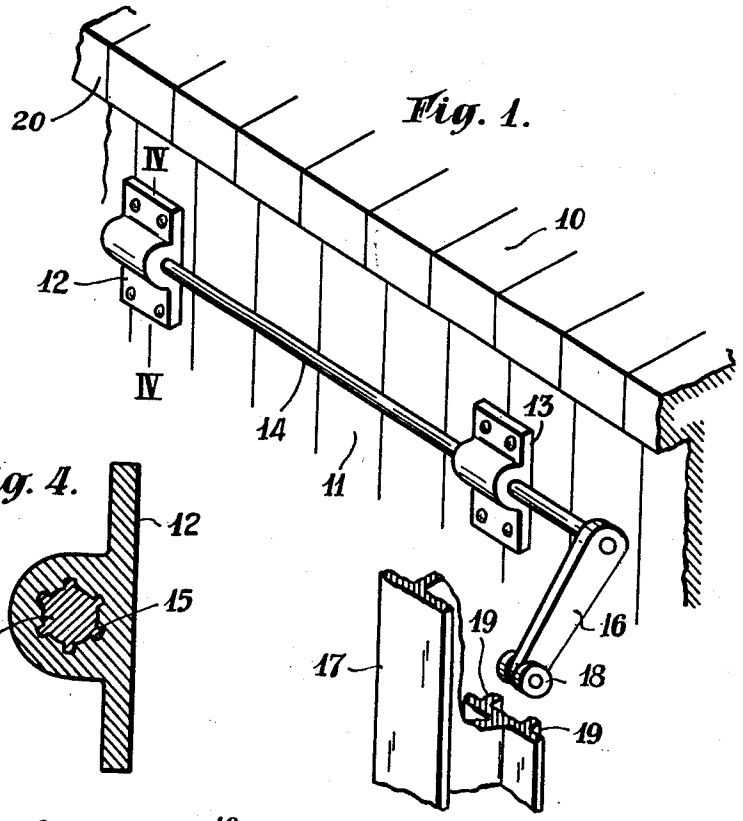


Fig. 4.

Fig. 2.

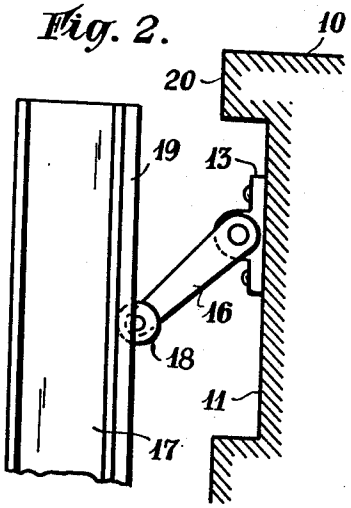
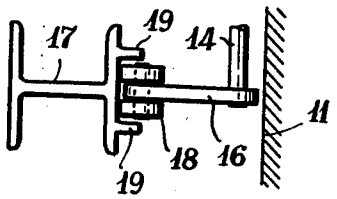


Fig. 3.



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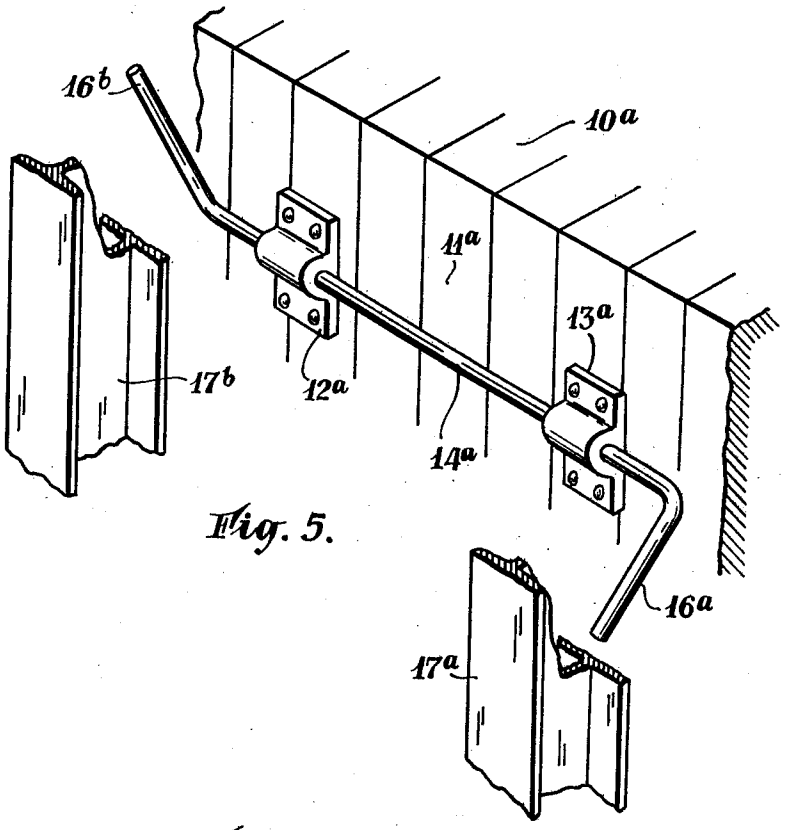
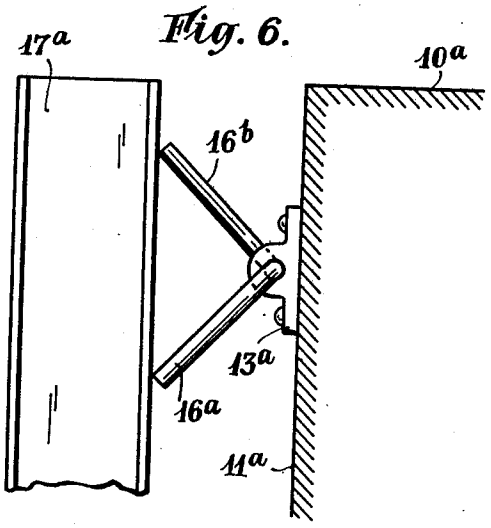


Fig. 5.

Fig. 6.



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4 Sheets-Sheet 3

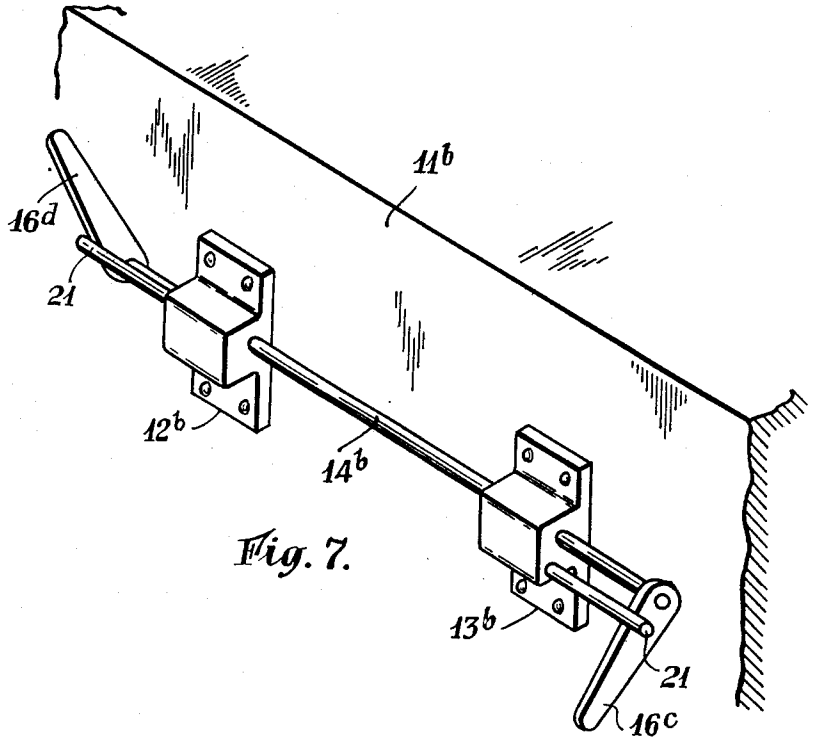


Fig. 7.

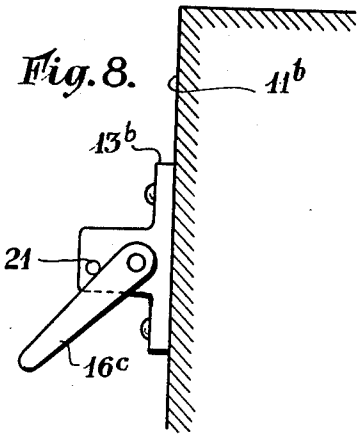


Fig. 8.

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4 Sheets-Sheet 4

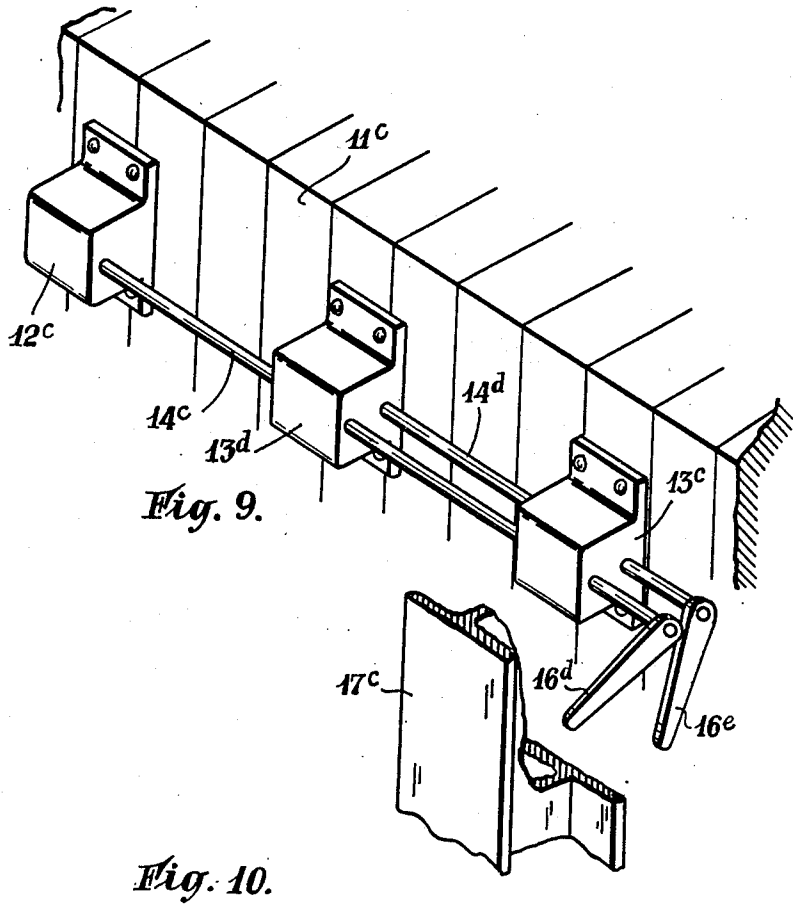
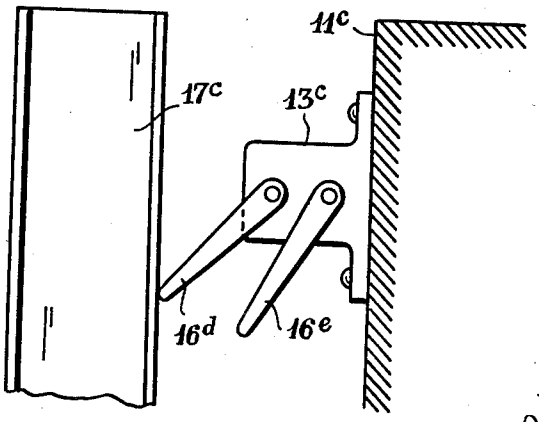


Fig. 9.

Fig. 10.



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BUFFER OR LIKE ENERGY-ABSORBING DEVICE

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Application December 4, 1950, Serial No. 198,963

Claims priority, application Great Britain December 5, 1949

9 Claims. (Cl. 61—48)

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This invention relates to buffers or like energy-absorbing devices and is particularly suited for use in a fendering system for docks, jetties or the like for the purpose of absorbing the large amount of energy, inherent in a moving vessel, during berthing operations. Hitherto the many attempts which have been made for this purpose usually have suffered from serious limitations of one form or another. For example, the gravity type, in addition to being inefficient in operation, is extremely heavy, costly and difficult to install and although the spring buffer which has also been used is capable of giving a fairly large capacity, this is only achieved by having a large final load and a comparatively small action. It is considered preferable to provide that the energy be absorbed over as large a movement as possible, thus reducing the resulting load to ship and fendering system to a minimum.

The object of the invention is the provision of a simple device requiring little or no maintenance, which can easily be installed in existing structures at low cost, of which the stroke, load and energy absorbing capacity can be varied to suit specific requirements, and which is capable of a large extent of movement.

A further object is to provide an energy absorbing device incorporating a torsion bar and means mounting said torsion bar on a supporting surface, the torsion bar having a lever at one end constituting a load receiving element adapted, under load applied thereto, to apply a twisting moment to the torsion bar against a resistance to said twisting moment imparted to the other end of the bar by means associated with said other end, thereby to cause the torsion bar to absorb the energy of the applied load.

A further object is to provide that the resistance to twisting moment of the torsion bar of the device may be imparted by fixedly mounting one end of the bar so as to resist twisting moment applied to the other end of said bar.

A further object is to provide that the torsion bar be freely mounted for rotatable movement on its axis and a lever be associated with each end of said bar to which a load, when applied to both of said levers, effects opposing twisting moment at the opposite ends of the bar.

A still further object is to provide that a cumulative or progressive increase in absorption of the energy of the load may be obtained by providing a plurality of the energy absorbing devices adapted to come into operation one after another.

A still further object is to provide an energy

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absorbing device and associated separate impact or load receiving member in which said impact receiving member transmits the load to the load receiving element of the torsion bar of the device on flexion or other movement of said member towards said device due to impact upon said separate member by a moving body.

Yet another object is to provide, in the energy absorbing device, torsion spring means including a torsion bar and means on a supporting surface for rotatably supporting said torsion bar throughout its length and to which twisting moment is applied from each end by levers thereon constituting load receiving elements whereby the torsion bar takes the energy of the load while relieving its supporting means from stresses of the load.

These and other objects will be apparent from the following description in which reference is made to the accompanying diagrammatic drawings.

Fig. 1 is a perspective view of one form of energy absorbing device made in accordance with this invention.

Fig. 2 is an end elevation of the device shown in Fig. 1.

Fig. 3 is a part plan view of Fig. 2.

Fig. 4 is a vertical section drawn to an enlarged scale on line IV—IV of Fig. 1.

Fig. 5 is a perspective view of an alternative form of energy absorbing device.

Fig. 6 is an end elevation of Fig. 5.

Fig. 7 is a perspective view of a further alternative form of device.

Fig. 8 being an end view thereof.

Fig. 9 is a perspective view of a still further alternative form of device.

Fig. 10 is an end view of Fig. 9.

In Figs. 1, 2, 3 and 4, the energy absorbing device is shown as part of a fendering system for a dock the numeral 10 representing the dock of which the vertical face constitutes an abutment or supporting face 11 to which is fixed, at horizontally spaced points thereon, a pair of brackets 12, 13 supporting a torsion bar 14. One end of the torsion bar is fixedly mounted in the bracket 12 by having splined engagement therewith as shown at 15 in Fig. 3 and the other end extends through and is rotatably supported by the bracket 13, the exposed length of the torsion bar 14 at the rotatable end thereof carrying dependingly, at its extremity, an attached lever 16 which is welded to said torsion bar so as to be fast thereto.

Disposed in spaced relation to the vertical face

11 of the dock 10 is a pile-like impact-receiving member 17 fixedly mounted at its lower end with the rear face of its free upper end in such engagement with the free end of the depending lever 16 that it exerts a small initial load upon said lever which in turn applies a twisting moment to the torsion bar 14 with the result that the torsion bar is pre-loaded.

As will be seen, the end of the lever 16 is provided with a pair of rollers 18 contacting the rear face of the pile-like impact-receiving member 17 within vertical guides 19 thereon.

The torsion bar 14 and its mounting brackets 12, 13 are shrouded by an overhead projecting face 20 of the dock 10.

In use, on impact upon the front face of the pile-like member 17 by a vessel (not shown) berthing at the dock 10, such impact is transmitted to the pre-loaded lever 16 by flexion of said member 17 and as the lever 16, in consequence, moves towards the dock face 11, said lever applies further twisting moment to the torsion bar and sets up a reactive force therein to the applied load consequent upon the resistance of the fixed end of the torsion bar to such twisting moment with the result that said torsion bar absorbs the energy of the load applied by the impact upon the member 17.

In the alternative construction shown in Figs. 5 and 6 where the energy absorbing device is again depicted as applied to a fendering system for a dock 10*a*, the torsion bar 14*a* is rotatably carried near its opposite ends in the brackets 12*a*, 13*a* mounting said bar on the supporting face 11*a* of the dock.

Two load receiving levers 16*a*, 16*b* are provided in this instance and are formed by cranked end lengths of the torsion bar 14*a*, said levers each being pre-loaded and applying opposing twisting moment to the torsion bar at opposite ends thereof by reason of engagement of said levers with separate pile-like impact-receiving members 17*a*, 17*b* the lever 16*a* extending dependingly and outwards from the dock face 11*a* and the lever 16*b* extending upstandingly and outwards from said face 11*a*, said levers thereby being disposed at an angle to one another one at either side of a plane normal to the dock face 11*a* and extending longitudinally through the axis of the torsion bar 14*a* as will be seen in Fig. 6.

In use, therefore, on both members 17*a*, 17*b* being impacted simultaneously at their front faces, the load imposed by the impacts is transmitted by the members 17*a*, 17*b* to their associated levers 16*a*, 16*b*, respectively, and said levers are caused to move in opposing directions towards the dock face 11*a* and thereby apply further opposing twisting movement to the opposite ends of the torsion bar 14*a* and set up therein a reactive force to the applied load consequent upon resistance of the bar to such twisting moment, with the result that said torsion bar absorbs the energy of the load applied by the impacts upon the members 17*a*, and 17*b*.

Should, however, only one of the impact receiving members 17*a*, 17*b* be impacted, its associated lever 16*a*, or 16*b*, as the case may be, is caused to move towards the dock face 11*a* and apply twisting moment to the torsion bar 14*a* at one end thereof and although the other of said levers is not likewise caused to move owing to lack of impact upon its associated impact receiving member, it is caused to press against said member due to twisting moment which has been imparted to the torsion bar at the said one end thereof with the result that an opposing twisting moment is now applied to the other end of the bar which thereby absorbs the energy of the load applied by the particular member 17*a* or 17*b* which has been impacted.

Referring now to Figs. 7 and 8, the torsion bar 14*b* is shown mounted on a supporting surface 11*b* by brackets 12*b*, 13*b* substantially as described with reference to Figs. 5 and 6, that is to say, said bar is rotatably supported by said brackets. The load receiving levers 16*c*, 16*d* are welded to opposite ends of the torsion bar, the one, 16*c* extending dependingly, and the other, 16*d*, extending upstandingly away from the supporting face 11*b*. In this instance, said levers are adapted to be impacted directly by a moving body and are not, therefore, pre-loaded and in order that they shall be appropriately poised for effective operation on receiving impacts, a positioning bar 21 is fixed one to each bracket 12*b*, 13*b* and projecting therefrom in parallel with the torsion bar 14*b* and in such retaining engagement, respectively, with the levers 16*c* and 16*d* as to maintain them from falling, by gravity, from their respective positions while leaving them to function for applying opposing twisting moment to the torsion bar substantially as described with reference to Figs. 5 and 6.

The construction depicted in Figs. 9 and 10 shows a further alternative in which a plurality, for example, two devices made according to this invention are adapted for operation in association with one another. In this arrangement two torsion bars are mounted side by side on the supporting surface 11*c*, the one bar 14*c* being fixedly mounted at one end in the bracket 12*c* and rotatably extending through the bracket 13*c* at its other end and through a further bracket 13*d* mounted on the supporting surface 11*c* intermediate of and spacedly from the brackets 12*c* and 13*c*. The other torsion bar 14*d* is of shorter length than and disposed behind the bar 14*c*, its one end being fixedly mounted in the intermediate bracket 13*d* and rotatably mounted in the end bracket 13*c*. The rotatable end of torsion bar 14*c* is provided with a load receiving lever 16*d* and the bar 14*d* with a similar lever 16*e* disposed behind and directly in line with the lever 16*d* which is pre-loaded by the pile-like impact receiving member 17*c* operably associated therewith. The levers 16*d* and 16*e* are located a sufficient distance along their respective torsion bars so that the impact receiving member 17*c*, when impacted at the front by a moving body, can flex towards and operate upon the levers 16*d* and 16*e* clear of the bracket 13*c*.

In use, on flexion of the member 17*c* due to an impact on the front face thereof, the already pre-loaded lever 16*d* applies further twisting moment to the torsion bar 14*c* and if the energy of the load is such that the lever moves into contact with and operates the lever 16*e*, said lever 16*e* applies a twisting moment to its torsion bar 14*d* with the result that a progressive or cumulative increase in absorbing the energy of the load is obtained by the two torsion bars 14*c* and 14*d*.

In all constructions according to this invention the torsion bar may be a solid or tubular metal bar and absorbs the energy of the load and gives a restoring moment varying directly with the angle through which the bar is twisted and with the polar moment of inertia of the section, and varies inversely with the length of torsion bar.

The advantages of the improved device are as follows:

(1) Simplicity;

(2) Low cost;

(3) Easily installed;

(4) Adaptable to existing sites;

(5) Stroke, load and energy absorbing capacity can be varied to suit specific requirements;

(6) Can be used singly or in groups to give a very wide range of loadings and also types of loading;

(7) No maintenance required.

It is to be understood that although the invention has been described mainly in its application to docks and the like, there is not intended to be limitation of the invention to such use but that it may be used for any shock absorbing device to which it is capable of being adapted.

What I claim and desire to secure by Letters Patent is:

1. An energy absorbing device for a dock comprising, at least one pile-like member fixedly mounted at its lower end with its upstanding yieldable free end in spaced relation to the dock face, a torsion bar and means mounting said bar on the dock face substantially parallel therewith between it and said pile-like member and fixedly holding a length of the torsion bar with at least one end free for rotational movement, a lever carried by said free end of the torsion bar constituting a buffer element operatively connected with the free end of the pile-like member and on a load being applied to said lever by flexion of the pile-like member towards the dock face, imparting twisting moment to the torsion bar against the resistance of the fixedly held length thereof thereby to cause the torsion bar to absorb the energy of the applied load.

2. An energy absorbing device for a dock comprising, at least one pile-like member fixedly mounted at its lower end with its upstanding yieldable free end in spaced relation to the dock face, a torsion bar and means mounting said bar on the dock face substantially parallel therewith between it and said pile-like member said means fixedly holding one end of the torsion bar and rotatably accommodating and exposing the other end thereof, a lever carried by said exposed rotatable end of the torsion bar constituting a buffer element operatively connected with the free end of the pile-like members and adapted, on a load being applied to said lever by flexion of the pile-like member towards the dock face, to apply twisting moment to the torsion bar against the resistance of the fixedly held end thereof thereby to cause said torsion bar to absorb the energy of the applied load.

3. An energy absorbing device for a dock comprising, at least one pile-like member fixedly mounted at its lower end with its upstanding yieldable free end in spaced relation to the dock face, a torsion bar and means mounting said bar on the dock face substantially parallel therewith between it and said pile-like member said means rotatably accommodating the torsion bar and exposing the ends thereof, a lever carried by each end of the torsion bar and constituting separate buffer elements operatively connected one each with the free end of separate pile-like members and adapted, on a load being applied to at least one of said levers by flexion of the pile-like member towards the dock face, to apply opposing twisting moment to the opposite ends of the torsion bar thereby to cause said torsion bar to absorb the energy of the applied load.

4. An energy absorbing device as claimed in claim 1 characterized in that the lever of the torsion bar is provided at its outer end with means for making rolling contact with the free end of the pile-like member.

5. An energy absorbing device as claimed in claim 1 characterized by this that a plurality of torsion bars is arranged one above another to come into operation at a predetermined interval of movement one after another of the levers thereof and thereby obtain a progressive increase in absorption of the energy of the load.

6. An energy absorbing device as claimed in claim 1 characterized by this that a plurality of torsion bars is arranged side by side to come into operation at a predetermined interval of movement one after another of the levers thereof and thereby obtain a progressive or cumulative increase in absorption of the load.

7. An energy absorbing device for a dock comprising, at least one pile-like member fixedly mounted at its lower end with its upstanding yieldable free end in spaced relation to the dock face, a torsion bar and means mounting said bar on the dock face substantially parallel therewith between it and said pile-like member and fixedly holding a length of the torsion bar with at least one end free for rotational movement, a lever carried by said free end of the torsion bar constituting a buffer element operatively connected with the free end of the pile-like member and, on a load being applied to said lever by flexion of the pile-like member towards the dock face, imparting twisting moment to the torsion bar, against the resistance of the fixedly held length thereof thereby to cause the torsion bar to absorb the energy of the applied load, a guide on the free end of the pile-like member and the free end of the lever of the torsion bar operating in said guide.

8. An energy absorbing device for a dock comprising, at least one pile-like member fixedly mounted at its lower end with its upstanding yieldable free end in spaced relation to the dock face, a torsion bar and means mounting said bar on the dock face substantially parallel therewith between it and said pile-like member said means rotatably accommodating the torsion bar and exposing the ends thereof, a lever carried by each end of the torsion bar and constituting separate buffer elements operatively connected one each with the free end of separate pile-like members and adapted, on a load being applied to at least one of said levers by flexion of the pile-like member towards the dock face, to apply opposing twisting moment to the opposite ends of the torsion bar thereby to cause said torsion bar to absorb the energy of the applied load, and means on the torsion bar mounting means contacting with and supporting the levers of the torsion bar.

9. An energy absorbing device for a dock comprising, at least one pile-like member fixedly mounted at its lower end with its upstanding yieldable free end in spaced relation to the dock face, a torsion bar and means mounting said bar on the dock face substantially parallel therewith between it and said pile-like member and fixedly holding a length of the torsion bar with at least one end free for rotational movement, a lever carried by said free end of the torsion bar constituting a buffer element bearing against and being pre-loaded by the free end of the pile-like member and, on a load being applied to said lever by flexion of the pile-like member towards the dock face, imparting twisting moment to the

torsion bar against the resistance of the fixedly held length thereof thereby to cause said torsion bar to absorb the energy of the applied load.

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