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(56) Documents Cited:
GB 2481202 A **US 20120098174 A1**

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Other: **WPI; EPODOC; KNOVEL; SPRINGER**

(54) Title of the Invention: **A shock attenuating mounting**
Abstract Title: **A shock attenuating mounting for a vehicle seat**

(57) A shock attenuating mounting 1 for a vehicle seat 2 is provided. The shock attenuating mounting comprises: an attenuating element 3, 30 composed of resilient material, the element 3, 30 securable on a first side 4 to a vehicle seat 2 and securable on a second side 5 to a vehicle 6. The element 3, 30 is configured to attenuate shock experienced by the vehicle 6 along more than one axis.

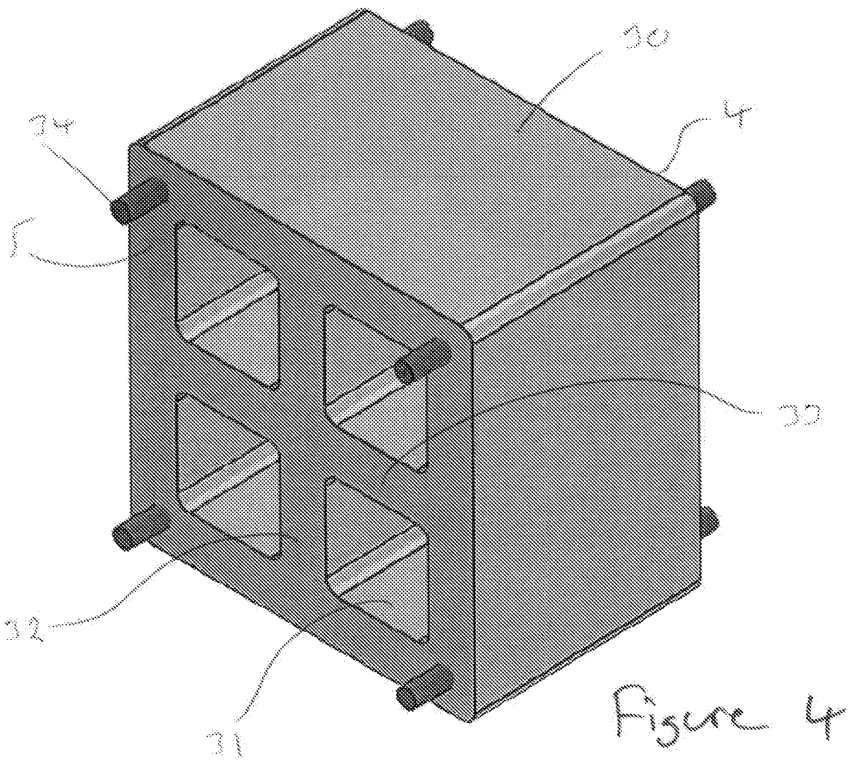

Figure 4

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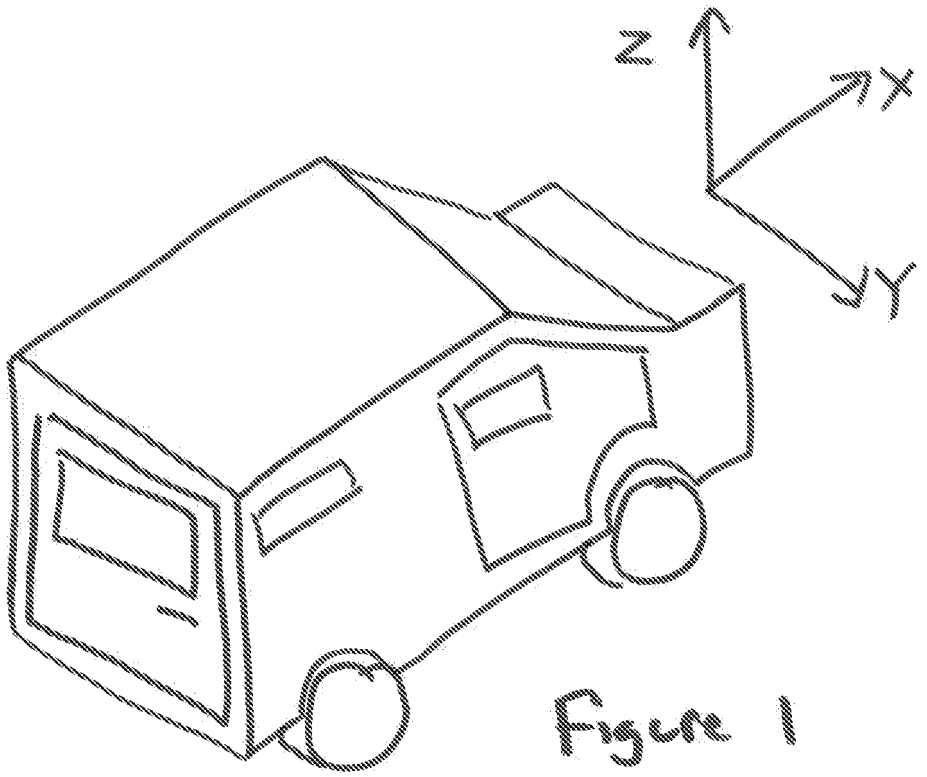

Figure 1

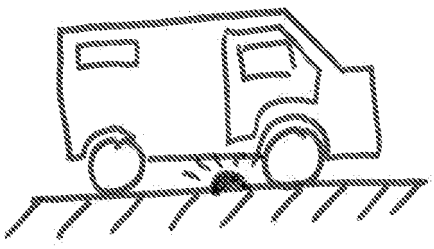

Figure 2a)

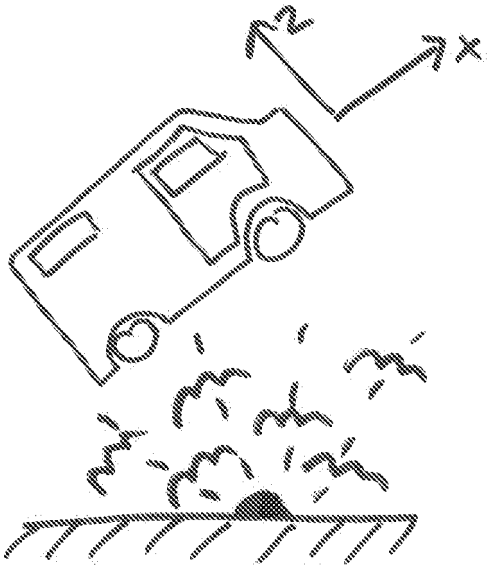

Figure 2b)

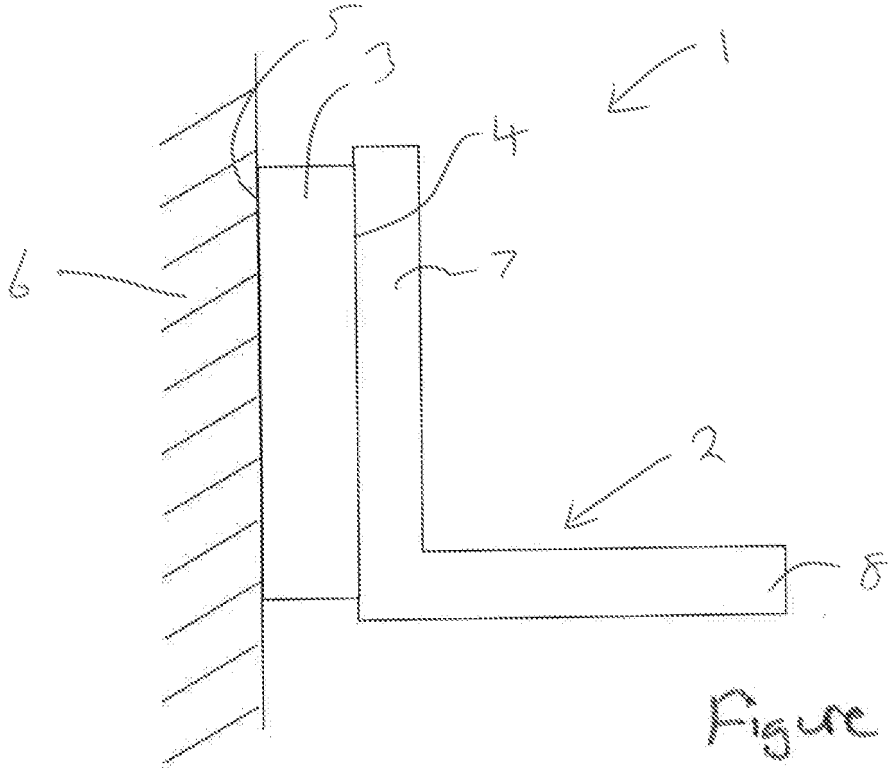

Figure 3a)

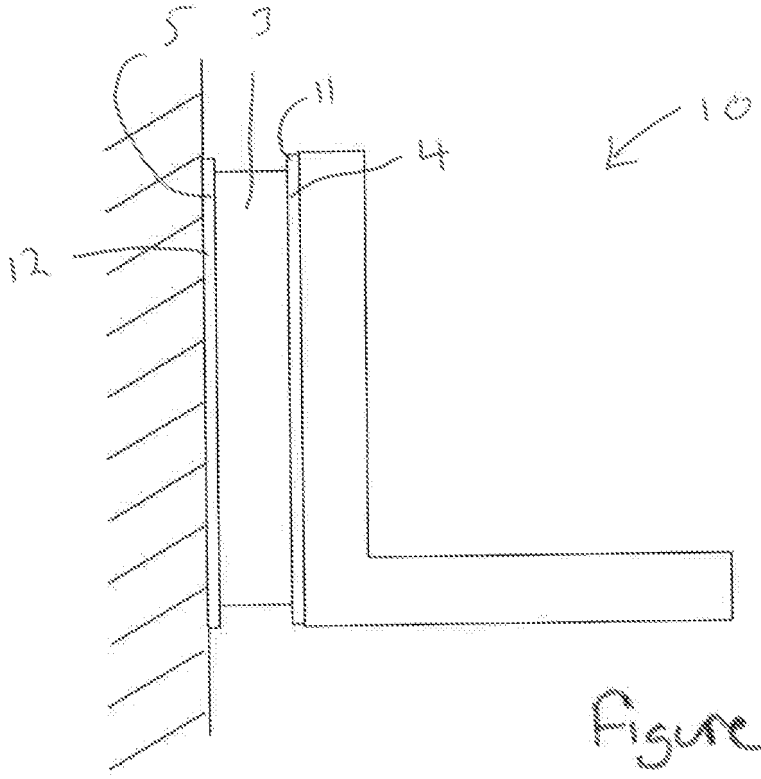

Figure 3b)

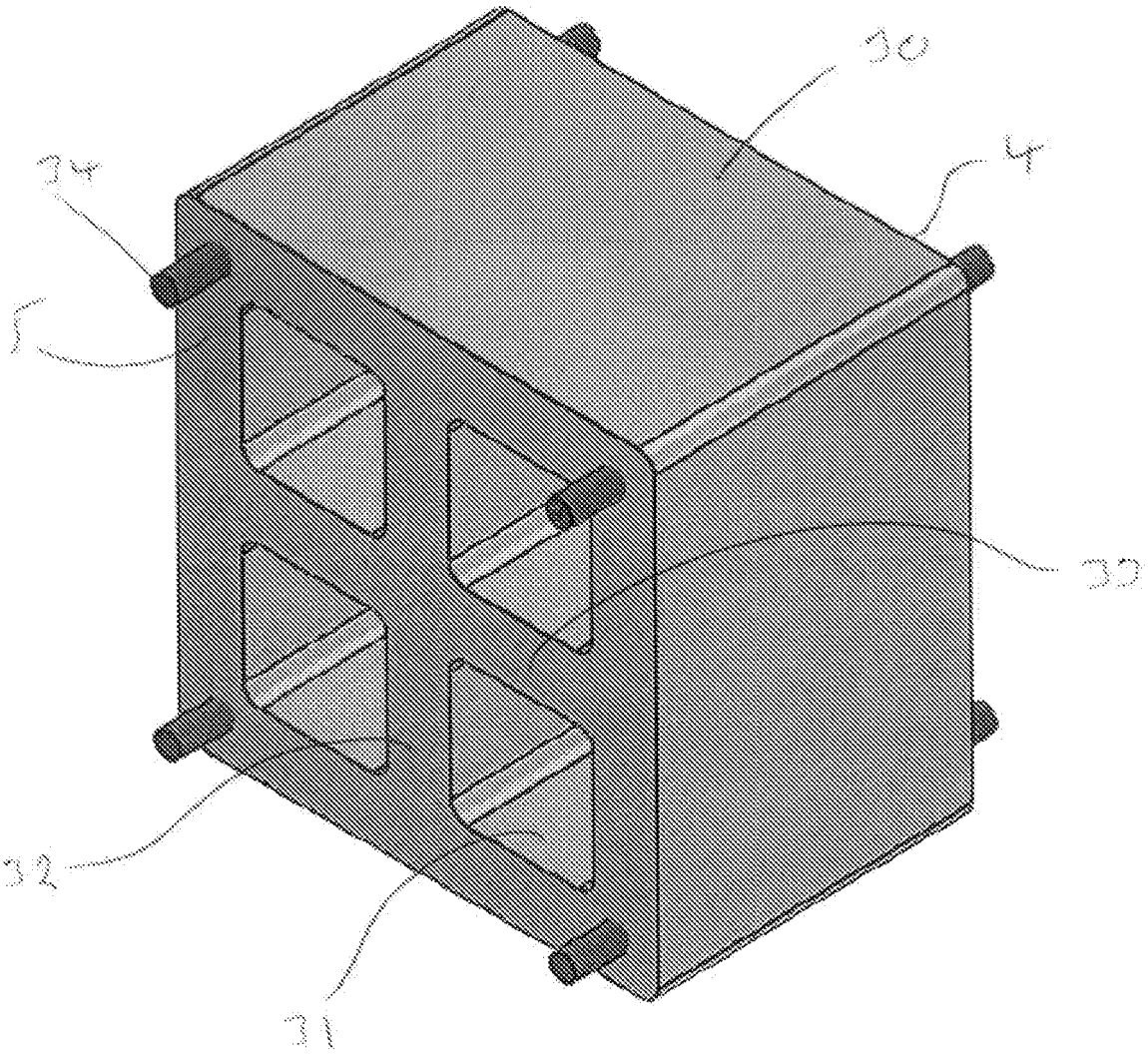

Figure 4

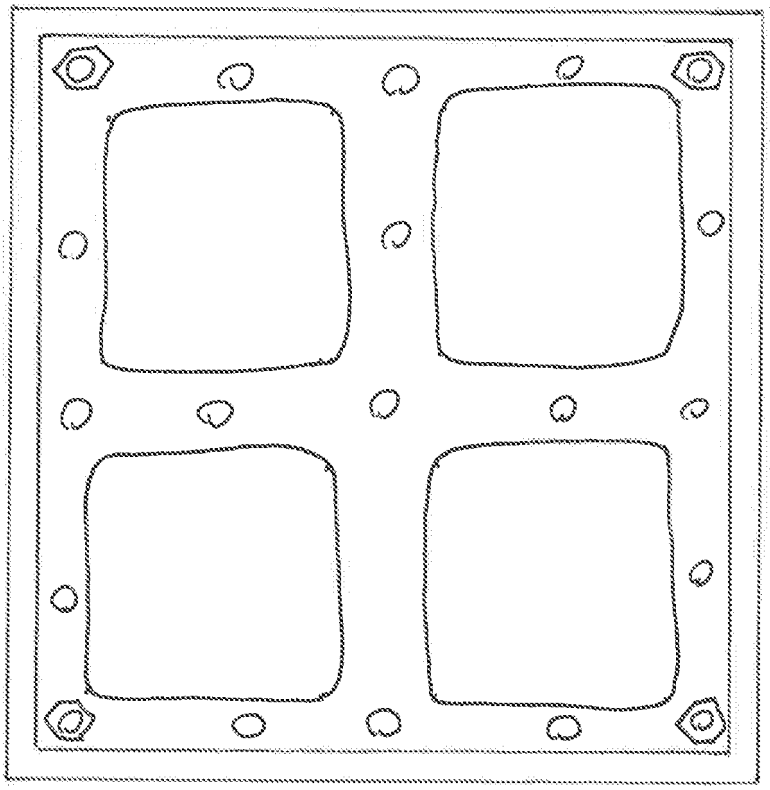

Figure 5b)

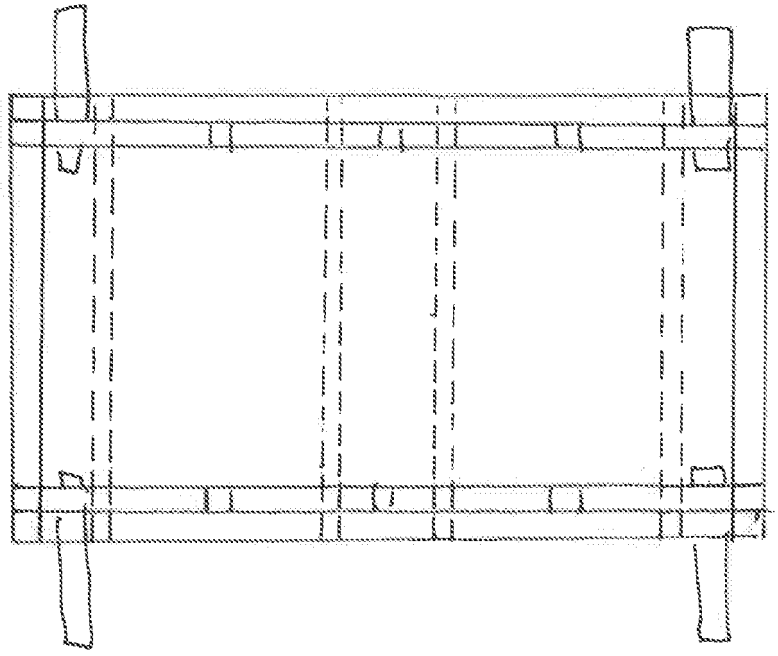

Figure 5a)

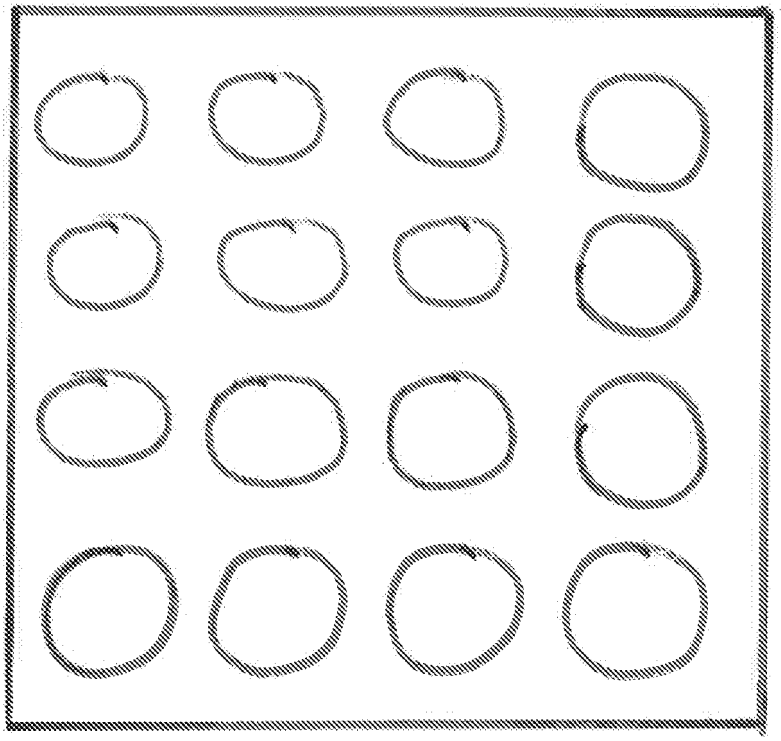

Fig 6a

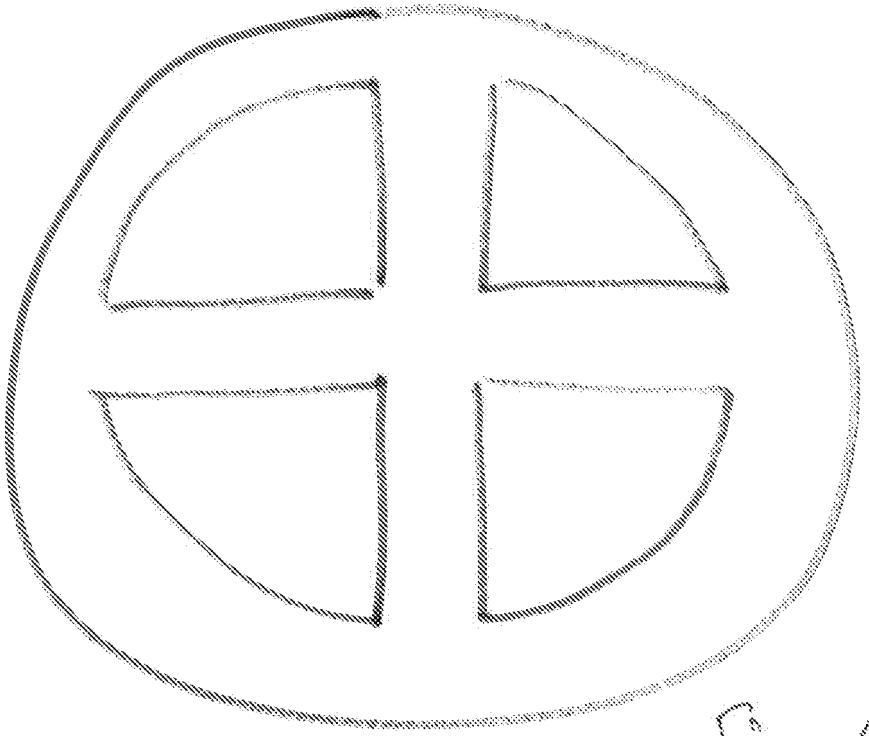

Fig 6b

A Shock Attenuating Mounting

In military vehicles, such as personnel carriers, it is known to provide occupant (crew) seating with a mechanical shock attenuating mounting between the seat and the vehicle. The mounting is provided to attenuate severe shocks, such as those caused by a blast under the vehicle. It is neither intended nor suitable to dampen high frequency vibrations caused by travelling over rough ground.

A known shock attenuating mounting comprises a sacrificial mechanical element. In one known arrangement, the seat base is pivotably mounted at one end to the side wall of the vehicle structure. Additionally, a sacrificial fracture elbow is secured between the seat base and the side wall of the vehicle, away from the pivoting mounting, maintaining the seat base in a substantially horizontal plane. In normal use, the seat base provides a sturdy support for an occupant.

When a shock above a predetermined threshold acting upwards through the vehicle is experienced, the reactionary force exerted on the seat by the occupant causes the fracture elbow to deform, thereby lessening (attenuating) some of the shock imparted on the occupant. Such an arrangement helps to reduce the chance of injury to the occupant of the seat.

An alternative sacrificial attenuating mounting comprises an inner tube received in an outer tube with an interference fit. The tube assembly is provided substantially vertically between the seat and the vehicle base. When a force above a predetermined threshold is imparted on the mounting, the inner tube is forced into the outer tube. The

force causes either or both of the inner and outer tubes to deform and/or shear, thereby attenuating energy. A still further arrangement may use a mechanical arm and spring arrangement or conventional hydraulic or pneumatic piston arrangement.

Known shock attenuating mountings are designed to attenuate the shock caused by an improvised explosive device (IED) being detonated directly beneath the vehicle. When used in helicopter crew seating, the shock attenuating mountings may alternatively be provided to reduce injury to crew in the event of an emergency landing where the fuselage impacts the grounds with significant velocity.

Regardless of the intended use, the sacrificial nature of known mechanical shock attenuating mountings means that they are 'single use' items. Even if the sacrificial element has only partially deformed after being subjected to a first shock, it will likely not be in an optimal condition to sufficiently attenuate a subsequent shock. The sacrificial element therefore needs to be replaced when subjected to a shock/force over a predetermined level.

The force created by an IED exploding beneath a vehicle is often sufficient to cause the vehicle to leave the ground, particularly in the case of lightweight vehicles. When a vehicle is caused to leave the ground, the subsequent 'slam down' – as the vehicle contacts the ground again - creates an additional shock of a level which may cause (further) injury to occupants. Therefore, both the initial blast shock and slam down can cause injury to occupants.

Furthermore, depending on factors such as the location and/or characteristics of the IED and/or the velocity of the vehicle at the time of detonation, the vehicle may not remain in a vertical orientation following the initial blast. The shock created by the slam down may therefore be imparted on the seating in a different direction to the initial shock caused by the blast.

Known mechanical sacrificial shock attenuating mountings, such as those described above, are not suitable to effectively attenuate multiple shocks, such as those caused by an initial blast and the subsequent slam down. Moreover, known mountings are only designed and suitable to attenuate shocks acting in a vertical direction.

Accordingly, the present invention provides a shock attenuating mounting for a seat, comprising an attenuating element composed of resilient material, the element securable on a first side to a seat and securable on a second side to a vehicle, the element configured to attenuate shock experienced by the vehicle along more than one axis.

The present invention further provides a vehicle, shock attenuating mounting or seating arrangement according to the appended claims.

Embodiments of the present invention will now be described, by way of non-limiting examples, with reference to the figures, in which:

Figure 1 shows a perspective view of a vehicle with which the invention may be used;

Figure 2a illustrates a vehicle travelling over an IED;

Figure 2b illustrates the vehicle leaving the ground following the detonation of the IED;

Figure 3a schematically illustrates a shock attenuating mounting according to one embodiment of the present invention;

Figure 3b schematically illustrates a shock attenuating mounting according to another embodiment of the present invention;

Figure 4 is a perspective view of an attenuating element of an embodiment of the present invention;

Figure 5a is a side view of the element of figure 4;

Figure 5b is a front view of the element of figure 4.

Figure 6a shows an alternative attenuating element; and

Figure 6b shows a further alternative attenuating element.

A vehicle with which the present invention may be used is shown in figure 1. A set of co-ordinate axes is shown, wherein the X axis is oriented with the longitudinal axis of the vehicle. This may be referred to as the "crash plane", since it is the direction

along which a force will act should the vehicle collide with an object in its path. The Y axis is horizontal and perpendicular to the X axis. Finally, the Z axis is the vertical axis. Known shock attenuating mountings are designed to attenuate shocks occurring along the Z axis.

As illustrated in figures 2a and 2b, when the vehicle travels over an explosive device (IED), the shockwave created by the explosive device may cause the vehicle to lift off the ground., particularly in the case of lightweight vehicles. As the vehicle lifts from the ground, the orientation of the vehicle with respect to the ground will likely change. It will be appreciated from figure 2c that, as the vehicle contacts the ground, ("slam down"), the force of the impact will have an element along the X axis as well as an element along the Z axis. If the vehicle has rotated about its longitudinal (X) axis, there will also be an element of force along the Y axis.

Figure 3a shows a shock attenuating mounting 1 for a seat 2 comprising an attenuating element 3 composed of resilient material. The element 3 is secured on a first side 4 to a seat 2 and secured on a second side 5 to a vehicle 6. The seat 2 comprises a seat back 7 and seat base 8. The element 3 is configured to attenuate shock experienced by the vehicle 6 along more than one axis and is multidirectional.. Preferably, the element is configured to attenuate shock experienced by the vehicle 6 along at least the Z axis.

In known crew seating, the backs 7 of the seats 2 are secured to the side walls of the vehicle 6, such that an occupant sitting in the seat will generally be facing a direction along the Y axis. Accordingly, should the vehicle 6 be involved in a collision, the

force of the impact will generally be directed along the X axis (crash plane). Preferably, an attenuating element 3 of a shock attenuating mounting; according to the present invention is also configured to attenuate shock experienced in the X axis; in addition to the Z axis.

Preferably, the element 3 of the present invention is also configured to attenuate shock in the Y axis, such that the element 3 effectively attenuates shock in all directions. The resilient material has multidimensional shock attenuation, such that it can simultaneously attenuate shocks occurring along all axis.

In one embodiment, the extent of attenuation along a first axis is different to the extent of attenuation along a second axis. For example, with reference to figure 3a, in which the seat back 7 is secured to the side wall of the vehicle 6, the element 3 may be configured to attenuate shock along both the X and Z axes more than a shock along the Y axis. The different levels of attenuation may depend on factors such as the dimensions of the attenuating element 3 and/or the mechanical properties of the attenuating element 3.

The element 3 may be a unitary item of substantially uniform density. The attenuating characteristics along a particular axis may depend on the dimensions of the attenuating element 3 along that axis.

In the embodiment shown in figure 3a, the element 3 is adhered to the vehicle 6 and the seat back 7 on both sides. In the embodiment shown, the interface between the element 3 and vehicle 6 / seat back 7 is planar. It will be appreciated that forces along

the X and Z axes create shear forces along this interface. To prevent or reduce undesired separation of the element 3 from the vehicle 6 / seat back 7, the interface may be non-planar. For example, the interface may be curved or undulating, or may be provided with multiple protrusions across the interface. In one embodiment, the element 3 is physically keyed to at least one of the vehicle 6 and seat back 7, so as to be less affected by any shear forces acting along the plane of the interface.

Figure 3b illustrates another shock attenuating mounting 10 embodying the present invention, comprising a first mounting plate 11 secured to the first side 4 of the element 3 and a second mounting plate 12 secured to the second side 5 of the element 3. Preferably, the element 3 is permanently secured to both the first 11 and second 12 plates. The first plate 11 may be secured to the seat 2 by mechanical fixing means through apertures in the plate; for example bolts or rivets. The second plate 12 may be secured to the vehicle 6 by similar means. Alternatively, the resilient element 3 may be secured directly to the seat back 7, with only a single mounting plate 12 secured to the second side 5 of the element 3, for removably fixing the shock attenuating mounting to the vehicle 6.

The shock attenuating mounting 1, 10 may be provided with a flexible cover (not shown) to prevent the ingress of foreign particles and/or liquid.

An exemplary attenuating element 30 of resilient material is shown in figure 4. The element comprises four apertures 31 passing there-through, from the first surface 4 to a second surface 5. The plurality of apertures 31 create vertical 32 and horizontal 33 ribs, which serve to affect the attenuating behaviour of the attenuating element 30.

The element 30 shown in figure 4 further comprises protrusions 34 which are received in corresponding apertures of the seat back (or first mounting plate) and the vehicle (or second mounting plate) respectively, so as to mechanically key the element to the surrounding structure.

Preferably, the material of the element is EPDM (ethylene propylene diene monomer (M-class)) rubber.

The dimensions and structure of the attenuating element may be different to that shown in figure 4. For example, a different number of apertures may be adopted, thus affecting the number of ribs created within the element. In another embodiment, the element may be composed of a single, uniform density, piece of resilient material, without any apertures. In a still further embodiment, the resilient element may comprise a honeycomb type structure.

Figure 6a schematically illustrates an attenuating element according to one embodiment. As compared to the square apertures 31 of Figure 4, the attenuating element of Figure 6a comprises a plurality of circular apertures. Figure 6B schematically illustrates an attenuating element according to a further embodiment. The attenuating element is circular, and the apertures comprise sectors.

The attenuating element may be comprised of multiple materials, each having predetermined different mechanical properties. For example, a first material may have a first predetermined resiliency, a second material may have a second predetermined

resiliency , etc. The attenuating element may comprise discrete sections formed of a respective one of a first, second etc material.

In one embodiment, wherein the resilient material of the attenuating element comprises apertures, at least one element of a different material is inserted into at least one of the apertures. If the material of the element inserted in the aperture is different to the material of the main attenuating element, the behaviour and response of the attenuating unit will be different.

The shock attenuating mounting may comprise a single attenuating element or a plurality of attenuating elements mounted between the seat and vehicle.

Preferably, the resilient material is configured so as not to exhibit a truly elastic response but is configured to provide effective damping throughout multiple shock events. In one embodiment, the resilient material may provide an effective combination of memory and elasticity properties.

With prior art shock attenuating mountings, manufacturers and operators have been heavily focussed on the initial blast event, and not concerned with the subsequent slam down shock or associated crash event. Existing test acceptance criteria for shock attenuating seating is based only a static condition. The shock attenuating mounting of the present invention is not only operable to attenuate multiple shocks (initial blast and slam down) but is also able to attenuate non-vertical shocks, such as those experienced when the vehicle crashes whilst moving (a “dynamic” shock event)

Although a seat having a seat back and seat base has been described, this is not essential. The shock attenuating mounting may be mounted between a seat base and the vehicle only.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. A shock attenuating mounting for a seat, comprising an attenuating element composed of resilient material, the element securable on a first side to a seat and securable on a second side to a vehicle, the element configured to attenuate shock experienced by the vehicle along more than one axis.

2. A shock attenuating mounting according to claim 1, wherein the element is configured to attenuate shock along two axes.

3. A shock attenuating mounting according to claim 1, wherein the element is configured to attenuate shock in all directions.

4. A shock attenuating mounting according to any preceding claim, wherein the extent of attenuation along a first axis is different to the extent of attenuation along a second axis.

5. A shock attenuating mounting according to any preceding claim, wherein the resilient material is EPDM

6. A shock attenuating mounting according to any preceding claim, wherein the attenuating element is a unitary item.

7. A shock attenuating mounting according to any preceding claim, wherein the element has a substantially uniform density.

8. A shock attenuating mounting according to any preceding claim, wherein the element comprises at least one void.

9. A shock attenuating mounting according to any preceding claim, wherein the element has a honeycomb type structure.

10. A shock attenuating mounting according to any preceding claim, wherein the element comprises a unitary block having a plurality of parallel apertures extending therethrough, defining a plurality of ribs therebetween.

11. A shock attenuating mounting according to any preceding claim, comprising a first mounting plate secured to said first side of the element and a second mounting plate secured to said second side of the element.

12. A shock attenuating mounting according to claim 11, wherein the interface between at least one mounting plate and the respective side of the element is planar.

13. A shock attenuating mounting according to any of claims 11 and 12, wherein at least one mounting plate is adhered to the mounting plate.

14. A shock attenuating mounting according to any of claims 11 to 13, wherein the element is keyed to at least one of the mounting plates.

15. A shock attenuating mounting according to claim 14, wherein the element comprises at least one protrusion which is received in at least one of the mounting plates.

16. A seating arrangement for a vehicle, comprising a seat and at least one shock attenuating mounting according to any preceding claim, wherein the seat comprises a seat back and seat base.

17. A seating arrangement according to claim 16, wherein a shock attenuating mounting is secured between the seat back and the vehicle.

18. A seating arrangement according to claim 16 or 17, wherein a shock attenuating mounting is secured between the seat back and the vehicle

19. A vehicle having at least one shock attenuating mounting according to any preceding claim.

20. A shock attenuating mounting or seating arrangement substantially as herein described.

Application No:	GB1214633.8	**Examiner:**	Mr Kevin Hewitt
Claims searched:	1 to 20	**Date of search:**	15 November 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US 2012/098174 A1 (RUAN ET AL) See especially the Abstract and Figure 1.
A	-	GB 2481202 A (EXMOOR TRIM) See especially the Abstract and Figures 1 & 2.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F16F; F41H

The following online and other databases have been used in the preparation of this search report

WPI; EPODOC; KNOVEL; SPRINGER

International Classification:

Subclass	Subgroup	Valid From
F16F	0007/00	01/01/2006
F41H	0007/04	01/01/2006