Title: IMPACT ABSORBING UNIT

Abstract: A unit for absorbing the impact of a falling person comprises a puncture-resistant outer bag (2) and an inflatable inner air cushion (4) that deflates immediately upon impact by a falling person, either by rupturing or by the opening of a relief valve. The inner air cushion (4) may be formed from a plurality of layers (18, 19) of a thin, flexible material such as polyethylene, at least one of which is not permeable to air. The unit can be deflated for ease of transport and storage but does not require the permanent operation of an air pump to maintain pressure during use. Preferably, the unit comprises means (24, 25) for fastening the unit to other similar units as part of a modular system.
IMPACT ABSORBING UNIT

Technical Field
The present invention relates generally to a unit for absorbing the impact of a falling person thus intended to reduce injury.

Although it can also be used in other applications, the present invention is particularly useful on building construction sites. Health and safety legislation for the construction industry states that an individual must not be allowed to fall more than two metres onto a hard surface. Scaffolding can be used to meet the requirement on the exterior of a building by provide platforms at intervals of less than two metres but there is also a requirement for preventing injury in the interior of the building. For example, there may exist a fall of more than two metres from the interior of the roof to the floor below. It would be impractical or expensive to erect scaffolding inside the building so there is a need for another method of preventing injuries from such a fall, and indeed in any situation, indoors or outdoors, where it is likely that an individual may fall from a distance greater than two metres onto a hard surface.

Background
There are systems currently available on the market, designed to provide protection for falling persons or objects. Some of these systems comprise a filling of impact absorbing material, whilst others comprise an air cushion inflated by an air-pump continuously inflating the system. These systems both have significant disadvantages.

The air-pump type system generally comprises a single inflatable cushion large enough to substantially cover the floor of a room. It is difficult to install due to the weight of the system and is only suitable for certain types of construction sites and only lends itself to certain floor-plan designs. It requires continuous operation of the air-pump while in use, with associated noise and running costs. If inflated to too high a pressure, the system could cause a falling person to bounce, with a further risk of injury.
The absorbent material filled product is generally a modular system comprising smaller units. However, the units cannot be compressed so they are bulky and expensive to transport, as well as difficult to store on construction sites. Once the system reaches its disposal date, the only method for disposal is to landfill it and the typical filling material – expanded polystyrene – is environmentally unfriendly.

This invention offers a superior level of protection than offered by the other two types of systems. It is light-weight and packs flat for storage and transportation from site to site. Its specific dimensions and design enable it to lend itself to any floor-plan design. It is constructed from fully recyclable materials making disposal easy.

**Summary of Invention**

The present invention defines a unit for absorbing the impact of a falling person, as defined in claim 1. Further, preferred aspects of the invention are defined in the subclaims.

When a person falls from a height of approximately two metres above the unit, the air cushion will absorb the initial impact and then rapidly deflate to dissipate the impact energy. Because the units contain no packing material, they are lightweight and are easily disposed of at the end of their lives. The units may be stored and transported in a compact, deflated condition.

For simplicity of manufacture and on-site assembly, a generally cuboid shape for the units is preferred, but any one or more tessellating shapes such as hexagonal or triangular prisms could be used, provided that the interconnected units form a generally flat upper surface.

It would be possible for a single outer bag to contain more than one air cushion.

**Description of Drawings**

Figure 1 is a perspective view of the outer bag of an impact absorbing unit according to an embodiment of the present invention.
Figure 2 is a perspective view of the inner air cushion of an impact absorbing unit for use with the bag of Figure 1.

Figure 3 is a schematic view a seam of the outer bag shown in Figure 1.

Figure 4 is a schematic view a seam of the inner air cushion shown in Figure 2.

A unit for absorbing impacts in accordance with the present invention comprises an outer bag 2, for example as shown in Figure 1, containing an inner inflatable air cushion 4, for example as shown in Figure 2.

The outer bag 2 is in the form of a cuboid, made up of two square end panels 6 and four rectangular side panels 8. It is preferred that each of the six panels 6, 8 is a separate piece, the pieces being joined along their edges by stitched seams 9. The two edges 10 are turned outwards and bound by an overlocking stitch 12, as shown schematically in Figure 3. For this purpose a high strength thread is used, such as 5000 denier (555 tex) polypropylene, in order to resist wear when the unit is handled on a construction site. The out-turned seams 9 stiffen and clearly define the edges of the outer bag 2 so that the bag 2 substantially retains its cuboidal form when the inner air cushion 4 is inflated and the bag 2 can be placed adjacent to other similar bags without leaving large gaps between the adjacent upper surfaces. Instead of forming the panels 6, 8 from six separate pieces, two or more adjacent panels 6, 8 may be folded formed from a single a piece, with a fold between the panels 6, 8 to define an edge of the bag 2. However, in that case it is still preferred that an overlock stitch 12 should be provided along the fold in order to stiffen and define it, as previously described. The panels 6, 8 of the outer bag 2 must be made of a material that is sufficiently wear-resistant and puncture-resistant to prevent damage to the inner air cushion 4 in the environment of a construction site. One suitable material is woven polypropylene.
The units may be made in any size. Smaller units are easier to handle and may permit the replacement of burst air cushions over a smaller area in the event of an impact (as discussed below). Larger units require less work to inflate the air cushions and connect the units together. A suitable compromise for most applications has been found to be a length of approximately 2 metres and a width and height of approximately 0.5 metres. Clearly, the width and height do not have to be equal.

The inner inflatable air cushion 4 is formed from one or more layers of a thin, flexible material that is impermeable to air. As shown schematically in Figure 4, panels 14 of the material are welded together at their periphery to form a projecting edge 16 and create a cuboid form that matches the form of the outer bag 2.

The inner air cushion 4 is designed to burst upon impact by a person falling from a height of 2 metres or more. Preferably this is achieved by choosing a material of suitable strength for the air cushion 4. The material should be strong enough not to rupture upon a minor impact (such as a falling tool) and not to rupture so easily that the cushion 4 fails adequately to resist the fall of a person. Specific areas of weakness could be provided in the air cushion 4 but care must be taken to design them such that the intended mode of rupturing occurs whether or not the point of impact coincides with an area of weakness. It is preferred that the strength of the material is uniform and is chosen such that the air cushion 4 bursts wherever a person falls on it.

The material from which the air cushion 4 is made preferably comprises three layers of polyethylene. In order to maintain pressure in the air cushion, it is not necessary that all of the layers should be impermeable to air. For example, two layers of 60 micron low density polyethylene 18, which is cheap but air-permeable, may sandwich between them one layer of 60 micron EVOH (ethylene vinyl alcohol copolymer) barrier field polyethylene 19, which is more expensive but impermeable to air.

The inflatable air cushion 4 comprises a valve 20, such as a butterfly valve, in one of its end panels, through which the cushion 4 may be inflated by the connection of a
high volume air blower to the valve 20. When the maximum level of inflation is reached, the valve 20 is closed and sealed. Preferably the valve 20 can be manually opened if it is desired to deflate the air cushion 4 in order to compress the unit for transport or storage. Alternatively, the air blower may be connected to the valve 20 and operated in reverse to deflate the air cushion 4.

The outer bag 2 has an access flap 22 to provide access to the inner air cushion 4 for inflating and deflating it. The flap 22 also provides access for the replacement of the air cushion 4 if damage to the air cushion 4 should occur as the result of a fall or otherwise. The access flap 22 is preferably positioned on an end panel 6 of the outer bag 2. It is required that the access flap 22 be secured on all four sides when not in use, for example by a hook and pile fastener (e.g. Velcro\textsuperscript{®}).

The outer bag 2 is provided with fastenings for interconnecting multiple units to form an extensive impact absorbing surface. A preferred form of the fastenings is quick-release clips. Figure 1 shows three transverse fastenings for connecting units side by side, comprising three male parts 24 of quick release clips arranged along one long edge of an upper panel 8 of the bag 2; and three female parts 25 of quick release clips correspondingly arranged along the opposite long edge of the upper panel 8. Each pair of transverse fastenings may conveniently be fixed at either end of a strap 26 that can act as a handle for lifting the unit. The straps 26 may alternatively pass partly or fully around the bag 2 for added strength. They may be made detachable from the bag 2, for example by using a hook and pile fastening, for ease of replacement or reconfiguration. Figure 1 also shows one longitudinal fastening for connecting units end to end, comprising a male part 24 of a quick release clip on one short edge of the upper panel 8; and one female part 25 of a quick release clip on the opposite short edge of the upper panel 8. Other types and arrangements of conventional fastenings may be provided to allow interconnection of similar units side by side, end to end, or one above another. Examples (not illustrated) include panels of hook and pile fastening; or sets of eyes through which cords can be passed to tie adjacent or distant panels together.
In an alternative embodiment of the invention, the inner air cushion 4 is not designed to burst upon impact by a falling person but instead it incorporates a relief valve (not illustrated). When a person falls onto the cushion 4, the sudden increase in pressure causes the relief valve to open, allowing deflation of the cushion. One advantage of using a relief valve over relying on bursting of the cushion is that it may be easier to control the magnitude of pressure increase required to trigger deflation. A relief valve can also reliably control the rate of deflation of the cushion 4. That may be important in the case of an especially deep impact absorbing unit, in which, if the inner cushion 4 were suddenly to burst, the person landing on it might then suffer an uncontrolled further fall through the depth of the unit. Finally, it may be possible for the relief valve to be re-usable so that the inner cushion does not have to be replaced following an impact.
CLAIMS

1. A unit for absorbing the impact of a falling person, comprising:
   a puncture-resistant outer bag (2); and
   an inflatable inner air cushion (4) which deflates immediately upon impact by a
   falling person.

2. A unit as claimed in claim 1, in which the inner air cushion (4) deflates by
   rupturing immediately upon impact by a falling person.

3. A unit as claimed in claim 1, in which the inner air cushion (4) deflates by the
   opening of a relief valve upon impact by a falling person.

4. A unit as claimed in any preceding claim, in which the inner air cushion (4) is
   formed from a plurality of layers (18,19) of a thin, flexible material.

5. A unit as claimed in claim 4, in which the thin, flexible material (18,19) is
   polyethylene.

6. A unit as claimed in claim 4 or claim 5, wherein at least one of the layers (18) is
   permeable to air and at least one of the layers (19) is not permeable to air.

7. A unit as claimed in claim 6, in which the impermeable material (19) is an
   EVOH barrier polyethylene.

8. A unit as claimed in any preceding claim, in which the inner air cushion (4)
   includes a valve (20) through which the air cushion may be inflated.

9. A unit as claimed in claim 8, in which the valve (20) may also be operated to
   deflate the air cushion (4).

10. A unit as claimed in any preceding claim, in which the outer bag (2) is formed
    from a plurality of panels (6,8) secured together to create a generally cuboid shape.
11. A unit as claimed in any preceding claim, in which the outer bag (2) includes an access flap (22) for accessing the inner air cushion (4).

12. A unit as claimed in any preceding claim, further comprising means (24,25) for fastening the unit to other similar units.
INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/001844

A. CLASSIFICATION OF SUBJECT MATTER

INV. E04G21/32 A62B1/22 A63B6/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04G A62B A63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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