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(71) Applicant: **TRAFFIC MANAGEMENT PRODUCTS LIMITED** [GB/GB]; Unit 7, Gatwick Distribution Point, Church Road, Lowfield Heath, Crawley Sussex RH11 0PJ (GB).

(72) Inventors; and

(71) Applicants *(for US only)*: **MEEK, Darryl** [GB/GB]; Unit 7, Gatwick Distribution Point, Church Road, Lowfield Heath, Crawley Sussex RH11 0PJ (GB). **BAILEY, John** [GB/GB]; Unit 7, Gatwick Distribution Point, Church Road, Lowfield Heath, Crawley Sussex RH11 0PJ (GB).

(74) Agent: **BRIDLE INTELLECTUAL PROPERTY LIMITED**; 6F Thomas Way, Lakesview Business Park, Canterbury Kent CT3 4JZ (GB).

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(54) Title: FLEXIBLE BASE ASSEMBLY

(57) Abstract: A flexible base assembly including a base element comprising a resiliently deformable body and an insert element, wherein a portion of the insert element is located within the body of the base element, the insert element includes one or more apertures therein and portions of the base element body are located within the apertures.

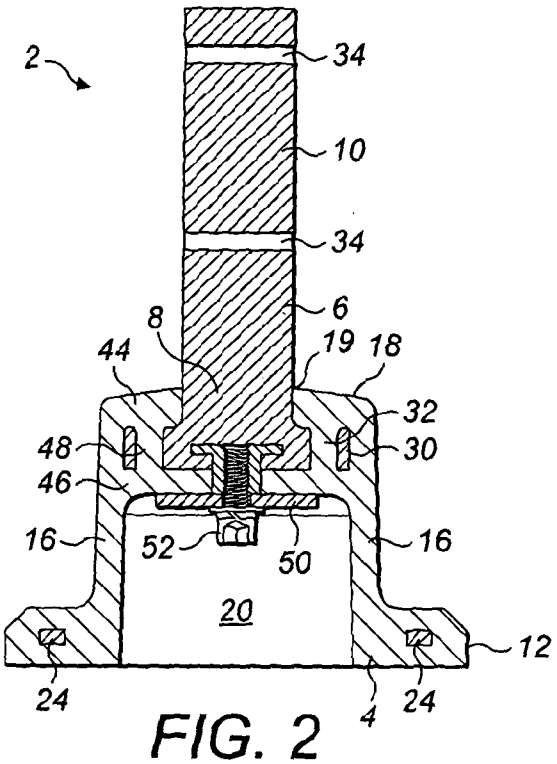

FIG. 2

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Flexible Base Assembly

The present invention relates to a flexible base assembly and in particular to a two-part base assembly comprising a flexible base element and an insert element, wherein the insert element is partially located within the base element.

Flexible base assemblies have been known for some time. They are typically used to support street furniture, such as road signs and traffic delineators and are designed to deform and then recover if impacted by a vehicle or other moving object.

Early flexible bases were only able to deform and recover when a body carried by the base assembly was impacted from a specific direction. These were then improved to allow for recovery from impacts in any direction. Recently, further improvements have been made such that the flexible bases are self-fronting. That is to say, they are biased to a specific orientation.

However, as these developments to the bases have been made, they have become increasingly more complicated and now often include spring arrangements, pulley arrangements and/or various cam arrangements in order to provide all of the featured restorative forces. This greater complexity has resulted in increased manufacturing costs and has also increased the likelihood of failure of the base as a whole.

Accordingly, there exists a need for a flexible base assembly which is able to recover from an impact from any direction, which is self-fronting, which contains relatively few parts and which is cost-effective to manufacture.

According to a first aspect of the present invention, there is provided a flexible base assembly including a base element comprising a resiliently deformable body and an insert element, wherein a portion of the insert element is located within the body of the base element, the insert element includes one or more apertures therein and portions of the base element body are located within the apertures.

As will be noted, the flexible base assembly of the present invention requires only two components, wherein the required features of the base assembly are provided by the interengagement of these components. The resiliently deformable base is adapted to permit deflection of the insert element (in any direction) as a result of an impact, typically an impact to a body carried by the insert element. Thus, the base element is adapted to deform in response to a force applied to the insert element and to return to a rest configuration when the force is removed. It thereby urges the insert element back to its rest configuration when the force of the impact is removed. Therefore, for an upstanding insert element (e.g. an insert element which is arranged substantially vertically in its rest configuration), a force can be applied from any direction and the base element is adapted to deform

to permit deflection of the insert element away from the force and then to cause the insert element to return to a substantially vertical orientation. Accordingly, the base assembly of the present invention permits deflection of the insert element via resilient deformation of the base element.

The arrangement of a resiliently deformable base element with a relatively rigid insert element provides the base assembly with an ability to withstand impacts from any direction.

More specifically, the resiliently deformable body of the base element permits the base assembly to recover its original configuration following an impact, typically to a body carried by the insert element e.g. by a vehicle, from any direction. Additionally, the location of portions of the base element body in the aperture(s) formed in the insert element effectively “locks” together the insert element and the base element and resists rotational forces applied to the insert element about its longitudinal (e.g.vertical) axis. This provides a self-fronting arrangement.

It will be appreciated from the foregoing that all or part of the apertures defined by the insert element are in the portion of the insert element which is located within the body of the base element.

The skilled person will further appreciate that discussions relating to the various axes of the base assembly and to parts of a body carried by the base assembly described as “top”, “bottom”, etc., refer to the base assembly when in use, for example when fixed to a substrate with the insert element upstanding or projecting away from the substrate.

It will further be appreciated that the term “aperture” includes a through-hole formed through a portion of the insert element, a cavity formed in a portion of the insert element and a notch formed in a peripheral edge portion of the insert element.

In an embodiment of the invention, the or each aperture is in the form of a through-hole or a bore extending through a portion of the insert element, and the respective portion of the base element body extends the entire length of the through-hole. Such an arrangement provides for a desirable interengagement between the base element and the insert element.

Suitably, there is a first portion of the base element body located at one end of the through-hole, a second portion of the base element body located at the other end of the through-hole and the portion of the base element body within the through-hole forms a bridge between (i.e. it links or joins) the first and second portions of the base element body. In this embodiment, each end of the portion of the base element body within the through-hole is connected to a respective portion of the base element body, which results in the base element body within the through-hole acting similarly to a spring which is anchored at both ends. The portion of the base element body located within the through-hole resists movement of the insert element relative to the base element, particularly rotation of the insert element about its longitudinal axis relative to the base element. A resistance to

rotation of the insert element relative to the base element provides a self-fronting property of the base assembly.

In an embodiment of the invention, the insert element includes a flange located in use within the body of the base element. The flange being located within the body of the base element helps to resist the unwanted removal of the insert element from the base element. It also provides a greater surface area of the insert element, thus increasing the area of contact between the insert element and the base element.

Suitably, one or more of the insert element apertures are formed in the flange. Each of such apertures may be in the form of a through-hole through a portion of the flange. Additionally or alternatively, the flange may include one or more apertures in the form of cavities defined by the flange and/or notches defined in a peripheral edge portion of the flange.

In an embodiment of the invention, the body of the base element is formed from an elastomeric material. Such an arrangement allows for the flexible base assembly to be deformed and recover without the need for any additional components.

The base element body may be selected from any known elastomer possessing the desired properties. Examples of elastomers that could be used to form the base element body include rubber materials such as unsaturated rubbers (i.e. rubbers that can be cured by a vulcanisation process) or saturated rubbers that are not able to undergo vulcanisation. In an embodiment, the elastomer is selected from polyisoprene, polybutadiene, chloroprene, isobutylene/isoprene copolymer (butyl rubber), halogenated butyl rubber, styrene/butadiene copolymer, nitrile rubber (including halogenated nitrile rubbers), ethylene/propylene copolymer (EPM rubber), ethylene/propylene/diene copolymer (EPDM rubber), epichlorohydrin rubber, silicone rubber (including halogenated silicone rubber), fluoroelastomers, perfluoroelastomers, ethylene vinyl acetate, elastomeric polyurethane and combinations thereof.

The elastomer may include one or more filler materials conventionally associated with the relevant elastomer. Such fillers may include carbon black and silica. Additionally or alternatively, the elastomer may include one or more reinforcing materials, such as glass fibres, carbon fibres or the like. Further components may also be present to modify the properties of the elastomer.

The base element body is suitably formed from an elastomeric polyurethane material, which provides desirable physical properties and demonstrates acceptable resistance to damage from environmental factors, such as liquids (organic and aqueous), light, weather, etc.

Suitably, the base element body includes one or more side walls and a top wall, which together define a cavity within the body of the base element. In this arrangement, the or each side wall is able

to act like a spring in the sense that it is able to deform when the base assembly is impacted and then recovers when the cause of the impact is removed. Upon an impact, one side of the base element is typically compressed and the opposite side is typically stretched. The cavity allows for easier deformation of the body of the base element and reduces or minimises the risk of failure of the base element body.

When the body of the base element is formed from an elastomeric material, the elastomer suitably has a hardness measured on the Shore A scale of 40 to 85, more suitably 50 to 75. An elastomeric material having a hardness within the specified ranges provides desirable properties for a flexible post assembly in terms of its ability to deform in the event of an impact and then recover to its original or rest configuration. A further suitable range of Shore A hardness values is 65 to 75.

In an embodiment of the invention, the insert element is formed from a form-sustaining material. The skilled person will appreciate that a form-sustaining material is a material which is able to maintain its original configuration. Such materials include rigid materials, such as metals, thermoplastic polymers and reinforced materials, such as carbon reinforced plastic (carbon fibre reinforced polymers) and glass reinforced plastic; and resiliently deformable (semi-rigid) materials, such as elastomers as discussed above. Thus, the insert element may be formed from a metal, such as steel or aluminium; from a polymer, such as nylon or acrylonitrile/butadiene/styrene copolymer (ABS); a reinforced material, such as a fibre glass material or a carbon fibre material; or an elastomer such as elastomeric polyurethane.

Suitably, the insert element is formed from a polymeric material (the insert element material) which has a Shore A hardness in the range 70 to 100. In a further embodiment of the invention, the insert element material has a greater Shore A hardness value than the base element material. Thus, the insert element may be harder and/or more rigid than the base element.

An elastomeric polyurethane material having a Shore A hardness value of 75 to 95 may be used to form the insert element.

In an embodiment of the invention, the insert element includes a projecting portion which extends beyond the body of the base element. In this embodiment, the projecting portion may define a substrate to which a supported body to be carried by the flexible base assembly may be attached.

Many such supported bodies are adapted to be secured to cylindrical posts. Accordingly, the projecting portion of the insert element may be substantially cylindrical. However, other shapes of the projecting portion are possible within the scope of the invention, including portions having triangular, rectangular, hexagonal, etc. cross sectional shapes.

The projecting portion may include one or more fixing elements adapted to secure a supported body to the insert element. The or each fixing element may be relatively simple, such as a bore or through-hole which is adapted to receive therethrough a respective fixing (e.g. a bolt or screw) for securing the supported body to the insert element. Alternatively, the or each fixing element may be in the form of a first component of a two component fixing element, wherein the first component is adapted to mate or interengage with a corresponding second component carried by the supported body.

According to a second aspect of the invention, there is provided a combination of a supported body and a flexible base assembly as defined or described anywhere herein. In this aspect of the invention, the supported body may be any supported body adapted to be carried by a flexible base assembly. Examples of such supported bodies include street furniture and barrier panels. The supported body may be secured or fixed to the flexible base assembly or it may be releasably coupled to the base assembly.

The skilled person will appreciate that the term “street furniture” is intended to cover items such as traffic signs, traffic bollards, lane delineators, lights and so forth. However, it is not limited to roads and is also intended to cover signs, bollards, delineators, barriers, lights, etc. when used in alternative environments, such as railways and airports. Thus, street furniture in the context of the present invention includes any supported body adapted to be carried by a base assembly, which is typically upstanding, and which is at risk of being hit by a moving vehicle.

With regard to barriers, it is often desired to provide barriers to prevent access to certain restricted areas, where the barriers are designed to fail or collapse in certain situations, such as emergency situations. An example of such a situation is crowd control barriers used for example at sports stadia and the like. In normal use, the barriers are used to prevent access, e.g. to the sports pitch or arena. However, in the event of an emergency situation, such as a fire, the barriers may be deformed or deflected to allow passage to an area of safety. Thus, the supported body may be a barrier panel or part of a barrier panel.

According to a third aspect of the invention, there is provided a method of producing a flexible base assembly as defined or described anywhere herein, the method comprising:

providing an insert element comprising one or more apertures;

locating a portion of the insert element within a mould for a base element body; and

moulding the base element body around the insert element such that portions of the base element body are located within the insert element apertures.

In embodiments where the base element body is formed from an elastomer, the step of moulding the base element body around a portion of the insert element may comprise pouring a base element

precursor material into the base element mould and allowing or causing the precursor material to cure *in-situ*.

Elastomers typically comprise a precursor material, such as monomers or non-vulcanised unsaturated rubber components, which is then reacted or vulcanised to achieve the final elastomeric product. This reaction to convert the precursor material into the final form of the elastomer is referred to herein as "curing". The curing step may include the addition of heat, pressure, a catalyst and/or a reactive component.

Where the insert element is formed from metal, the step of providing the insert element may include casting the insert element, extruding the insert element, or it may include machining the insert element from a metal blank.

Where the insert element is formed from a thermoplastic polymer, the step of providing the insert element may include injection moulding or extruding the insert element.

Where the insert element is formed from an elastomeric material, the step of providing the insert element may include pouring an insert element precursor material into an insert element mould and allowing or causing the precursor material to cure *in-situ*.

According to a fourth aspect of the invention, there is provided a base element which is suitable for use in a flexible base assembly as defined or described anywhere herein, wherein the base element comprises a body formed from a resiliently deformable polymer, and a reinforcing element, and wherein the reinforcing element is embedded in the polymer body.

When a base element is secured to a substrate (such as a road) and is subject to an impact force (e.g. a shear force, a tensile force and/or a compression force), the impact force typically acts in such a way that the base element is urged away from the substrate to which it is secured. It has been observed that an impact force can cause relatively extreme deformation of the base element and can, in certain cases, result in the base element being ripped from the substrate. The location of a reinforcing element in the polymer body of the base element resists deformation of the base element and helps to prevent or resist the base element being forcibly removed from the substrate to which it is anchored.

As used herein, the term "embedded in" is intended to mean that at least a portion of the reinforcing element is located within the polymer matrix of the base element body. Thus, the reinforcing element may be wholly located within the polymer matrix of the base element body, such that the reinforcing element is entirely surrounded by the polymer material. Alternatively, the reinforcing element may be partially located within the polymer, such that a portion of the reinforcing element is located within the polymer and a potion of the reinforcing element extends beyond the polymer body.

In an embodiment of the invention, the polymer body of the base element includes one or more anchor elements. Suitably, the anchor elements each comprise a through-hole or bore defined by the base element body and through which an anchor bolt or similar may be located. The reinforcing element may include anchor elements corresponding to the anchor elements carried by the polymer body.

The polymer body may include a post member engaging portion adapted to have secured thereto an upstanding post member. The upstanding post member may be an insert element as defined and described herein.

The reinforcing material may be metal or it may be in the form of a thermoplastic polymer (suitably a rigid thermoplastic polymer), optionally itself reinforced with carbon fibres or glass fibres or the like. Suitably the reinforcing material is metal. Where the reinforcing material is metal, it may be selected from steel and aluminium.

The reinforcing material may be dispersed throughout the polymer body or it may be in the form of one or more sheets or layers of reinforcing material. In other words, the reinforcing material may be in the form of a laminate, wherein the layers of the laminate may be the same or different.

Suitably, the reinforcing element comprises a single sheet of reinforcing material. The single sheet may include voids in which areas of the reinforcing material have been removed from the sheet. Such voids may be useful to achieve the desired reinforcing properties without unduly impacting on the physical properties of the base element.

In an embodiment of the fourth aspect of the invention, there is provided a flexible base assembly as defined anywhere herein in connection with the first aspect of the invention, wherein the base element includes a metal reinforcing element embedded therein.

In a further embodiment of the invention, there is provided a flexible base assembly including a base element comprising a resiliently deformable body and an insert element, wherein a portion of the insert element is located within the body of the base element, the insert element includes one or more apertures therein and portions of the base element body are located within the apertures and wherein the base element includes a metal reinforcing element wholly embedded therein, the reinforcing element being in the form of a single sheet.

The skilled person will appreciate that the features described and defined in connection with the aspects of the invention and the embodiments thereof may be combined in any combination, regardless of whether the specific combination is expressly mentioned herein. Thus, all such combinations are considered to be made available to the skilled person.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a flexible base assembly according to the invention;
Figure 2 is a cross-sectional view of the assembly shown in Figure 1;
Figure 3 is a perspective view of an insert element forming part of the assembly;
Figure 4 is a cross-sectional view of the insert element shown in Figure 3;
Figure 5 is a plan view of a reinforcing plate located within the base element of the assembly; and
Figure 6 is a perspective view of the reinforcing plate shown in Figure 5.

For the avoidance of doubt, the skilled person will appreciate that in this specification, the terms "up", "down", "front", "rear", "upper", "lower", "width", etc. refer to the orientation of the components as found in the example when installed for normal use as shown in the Figures.

A flexible base assembly 2 according to the first aspect of the invention is shown in Figures 1 and 2. The base assembly 2 includes a base element 4 and an insert element 6. As can be seen from Figure 2, a portion 8 of the insert element 6 is located within the body of the base element 4 and a portion 10 of the insert element 6 projects upwardly from the base element 4.

The body of the base element 4 is formed from a 70 Shore A hardness elastomeric polyurethane polymer material (commercially available under the Vibrathane 8000 trade mark from Chemtura, USA) as a one-piece construction (i.e. a monolithic body). It includes a substantially square mounting portion 12 and an upstanding cylindrical portion 14, the cylindrical portion 14 being formed from a side wall 16 and a top wall 18. The top wall 18 defines a circular opening 19 through which the insert element 6 projects. As can be seen from Figure 2, the side wall 16 and the top wall 18 together define a cavity 20 within the cylindrical portion 14.

The measurement of the hardness of the polymer may be carried out according to any known method for measuring hardness based on the Shore A scale.

The mounting portion 12 of the body of the base element 4 defines therein four mounting holes 22 which are sized and configured to receive therein respective fixings, such as mounting bolts to secure the base element 4 to a substrate (not shown).

In order to strengthen and reinforce the mounting portion 12 of the body of the base element 4, a 6mm thick steel (hot rolled dry mild steel to BS EN 10111:2008 DD11) reinforcing plate 24 is located within the polymeric matrix of the mounting portion 12. As can be seen from Figure 2, the mounting

plate 24 is entirely surrounded by the polymer material. The steel reinforcing plate 24 is shown in more detail in Figures 5 and 6.

The reinforcing plate 24 defines a central void 26 which is shaped and sized so as not to interfere with movement of the base element 4 as a whole in the event of an impact. Thus the void 26 is defined such that the plate 24 does not extend into the cavity 20 defined by the body of the base element 4. The plate 24 also defines therein four holes 28 which correspond to the mounting holes 22 defined by the mounting portion 12. In this way, fixings such as bolts which pass though the holes 22 defined by the polymer body of the mounting portion 12 also pass through the corresponding holes 28 defined by the reinforcing plate 24.

The insert element 6 is shown in more detail in Figures 3 and 4. As shown in these figures, the insert element 6 has a flange 30 located at one end thereof. When forming part of the flexible base assembly 2 as a whole, the flange 30 is located within the body of the base element 4 as shown in Figure 2.

The flange 30 defines therein a number of circumferentially equally spaced bores 32 which extend through the flange 30. In this example, eight equally spaced bores 32 are defined within the flange, although any number of bores may be provided and the bores need not be equally spaced.

In addition, the upwardly projecting portion 10 of the insert element 6 defines therein two holes 34 which extend transversely through the projection portion 10 and which may be used to secure a supported body (not shown) to the flexible base assembly 2.

The insert element 6 is formed as a one-piece construction (i.e. it is a monolithic element) from an elastomeric polyurethane which has a Shore A hardness value of 90 (also formed from Vibrathane^{tm} 8000 polyurethane from Chemtura, USA).

As shown in Figure 4, a threaded cup 36 is provided in the base of the insert element 6. The threaded cup 36 is formed from steel and includes a generally cylindrical body 38 which is hollow and which defines therein a helical thread 40 on its inwardly facing surface. The cup 36 further includes a closed flange 42 at one end and is open at the opposite (downwardly facing) end.

The insert element 6 is formed by pouring a polyurethane precursor into a mould which contains therein the threaded cup 36. The polyurethane pre-curser is then caused to cure in the mould such that the threaded cup 36 is fixed within the polymer body of the insert element 6.

Once the polymer body of the insert element 6 is cured, the insert element 6 is removed from its mould and placed within a base element mould. Also located within the base element mould is the reinforcing plate 24. A polyurethane precursor for the body of the base element 4 is then poured into

the base element mould such that a portion 8 of the insert element 6 and the reinforcing plate 24 are located within the base element body. The polyurethane pre-curser is then caused to cure in the mould such that the base element is moulded around the reinforcing plate 24 and the portion 10 of the insert element 6.

As can be seen from Figure 2, the result of pouring the base element precursor material around the insert element 6 is that the polyurethane polymer which forms the body of the base element 4 is located within each of the bores 32. Thus, a portion 44 of the base element polyurethane body is located above each bore 32, a portion 46 of the base element polyurethane body is located below each bore 32 and a portion 48 of the base element polyurethane body is located within each bore 32, such that the portion 48 of the polyurethane material within each respective bore 32 links the portions 44 and 46 above and below that bore 32.

This arrangement interlocks the insert element 6 with the body of the base element 4 and resists rotation of the insert element 6 about its longitudinal axis relative to the base element 4. This resistance to rotation provides a self-fronting effect. More specifically, if the insert element 6 is rotated relative to the base element 4, the portions 48 of the polyurethane base element material located within the bores 32 become stretched. When the rotational force is removed or released, the energy stored in the polyurethane material during the stretching process is then released, which urges the insert element 6 to return to its rest position.

In order to resist further the insert element 6 being urged out of engagement with the body of the base element 4, a relatively large surface area circular locking plate 50 is located within the cavity 20 and secured to the insert element 6 via a bolt 52 which screws into the threaded cup 36, the bolt 52 having a helical thread which is complementary to the thread 40 carried by the threaded cup 36.

The skilled person will appreciate that various routine modifications to the example described hereinabove can be made with little effort. For example, the mounting portion 12 of the base element 4 can be formed to have any desired shape, depending upon how it is intended to be fixed to the substrate.

Similarly, the fixing elements 34 of the insert element need not be holes; they may be any type of fixing element suitable for securing a body to an insert element.

Claims

1. A flexible base assembly including a base element comprising a resiliently deformable body and an insert element, wherein a portion of the insert element is located within the body of the base element, the insert element includes one or more apertures therein and portions of the base element body are located within the apertures.

2. A flexible base assembly according to Claim 1, wherein the or each aperture is in the form of a through-hole and a respective portion of the base element body extends the entire length of the through-hole.

3. A flexible base assembly according to Claim 2, wherein a first portion of the base element body is located at one end of the or each through-hole, a second portion of the base element body is located at the other end of the or each through-hole and the portion of the base element body within the or each through-hole forms a bridge between the first and second portions of the base element body.

4. A flexible base assembly according to any of Claims 1 to 3, wherein the insert element includes a flange located within the body of the base element and one or more of the apertures are formed in the flange.

5. A flexible base assembly according to any preceding claim, wherein the body of the base element is formed from an elastomeric material.

6. A flexible base assembly according to Claim 5, wherein the base element body is formed from an elastomer having a Shore A hardness of 50 to 85.

7. A flexible base assembly according to Claim 6, wherein the base element body is formed from a polyurethane elastomer.

8. A flexible base assembly according to any preceding claim, wherein the insert element is formed from a form-sustaining material.

9. A flexible base assembly according to Claim 8, wherein the insert element is formed from a material selected from a metal, a polymer and a co-polymer.

10. A flexible base assembly according to Claim 9, wherein the insert element is formed from a polymer or co-polymer and has a Shore A hardness of 70 to 100.

11. A flexible base assembly according to Claim 10, wherein the insert element is formed from a polyurethane polymer.

12. A flexible base assembly according to any preceding claim wherein the insert element includes a projecting portion which extends beyond the base element.

13. A flexible base assembly according to Claim 12, wherein the projecting portion of the insert element is substantially cylindrical.

14. A flexible base assembly according to Claim 12 or Claim 13, wherein the projecting portion includes one or more fixing elements adapted to secure a supported body to the flexible base assembly.

15. A flexible base assembly according to any preceding claim, wherein the base element includes a reinforcing element embedded within the base element body.

16. A flexible base assembly according to Claim 15, wherein the reinforcing element is in the form of a metal sheet.

17. A flexible base assembly according to Claim 16, wherein the metal sheet includes one or more voids.

18. A flexible base assembly according to any of Claims 15 to 17, wherein the reinforcing element is wholly embedded within the base element body.

19. A combination of a supported body and a flexible base assembly according to any of Claims 1 to 18, wherein the supported body is secured to the flexible base assembly.

20. A combination according to Claim 19, wherein the supported body is selected from an item of street furniture and a barrier panel.

21. A method of producing a flexible base assembly according to any of Claims 1 to 18, the method comprising:

providing an insert element comprising one or more apertures;

locating a portion of the insert element within a mould for a base element body; and

moulding the base element body around the insert element such that portions of the base element body are located within the insert element apertures.

22. A method according to Claim 21, wherein the step of moulding the base element body around a portion of the insert element comprises pouring a base element body precursor material into the base element body mould and allowing or causing the precursor material to cure in-situ.

23. A method according to Claim 21 or Claim 22, wherein the step of moulding the insert element includes pouring an insert element precursor material into an insert element mould and allowing or causing the pre-curser material to cure in-situ.

24. A base element for use in a flexible base assembly, the base element comprising a body formed from a resiliently deformable polymer and a reinforcing element, wherein the reinforcing element is embedded in the polymer body.

25. A base element according to Claim 24, wherein the reinforcing element comprises a single sheet of reinforcing material.

26. A base element according to Claim 25, wherein the reinforcing material comprises a metal.

27. A base element according to Claim 26, wherein the metal is selected from steel and aluminium.

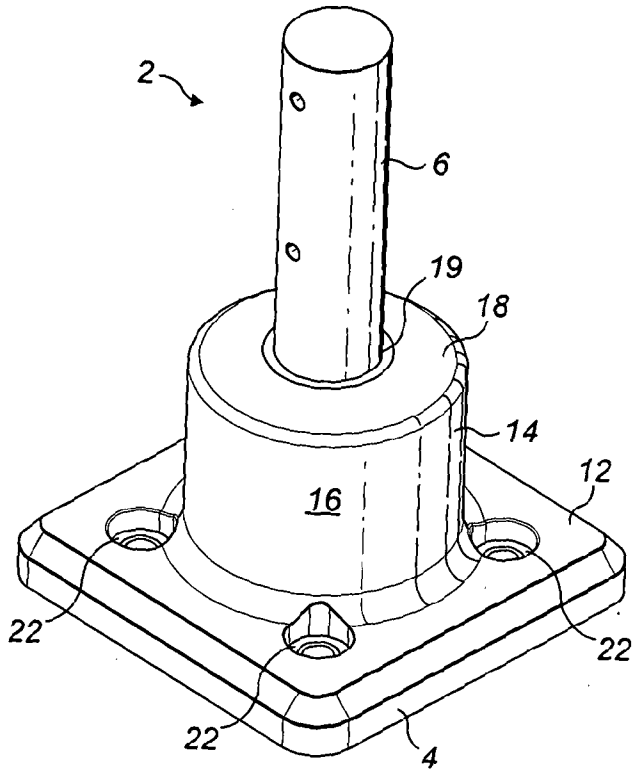
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FIG. 1

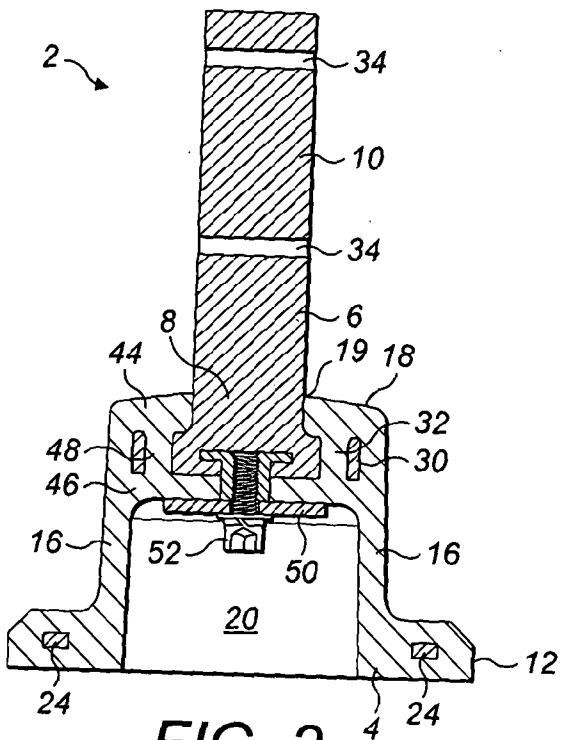
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FIG. 2

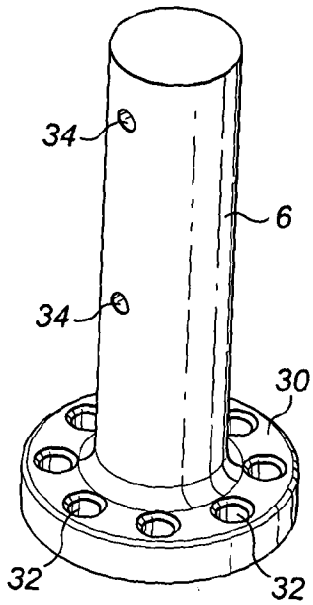

FIG. 3

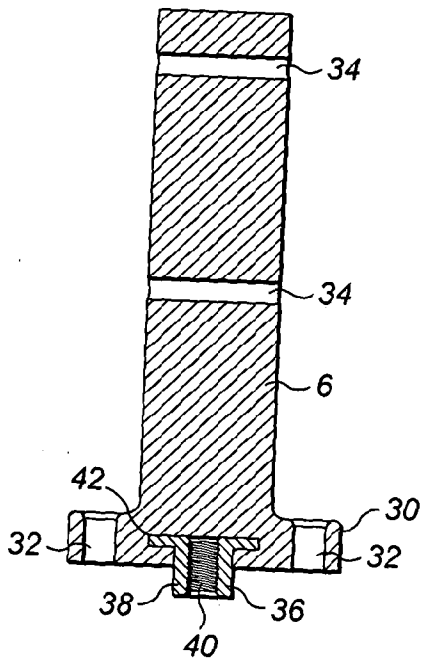

FIG. 4

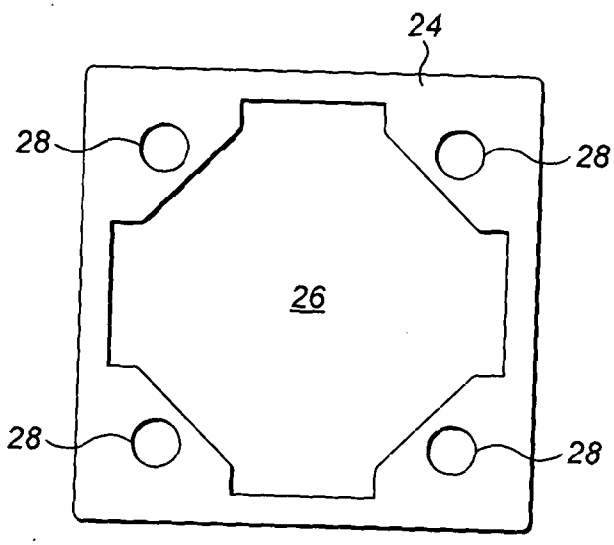

FIG. 5

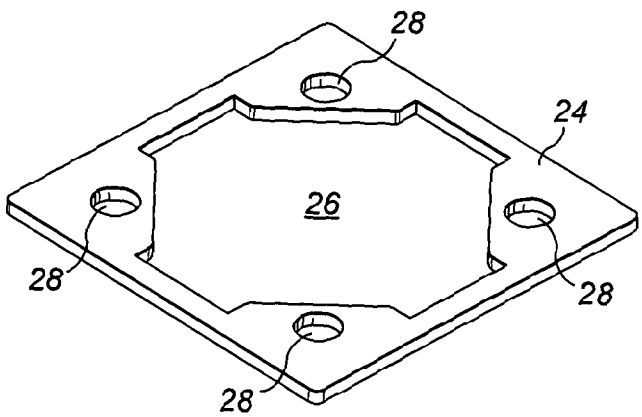

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/052592

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01F9/011 E01F9/17
ADD.

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)
E01F

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 practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 35 05 097 A1 (SCHAEFER HARTMUT; LINDER FRANZ) 14 August 1986 (1986-08-14) page 9, paragraphs before last, last page 10, last paragraph - page 11, paragraph first page 13, paragraph 3 - page 14, paragraph 1 page 16, paragraph 2; figures 3,5, -----	1,19,20, 24-27
A	US 4 269 534 A (RYAN JOHN E) 26 May 1981 (1981-05-26) column 3, lines 11-44; figures 1-7 -----	1
A	WO 2010/132264 A1 (ENERGY ABSORPTION SYSTEM [US]; INTAGLIATA JOHN D [US]; KEKEIS KENT A []) 18 November 2010 (2010-11-18) page 7, lines 2-4; figure 2 -----	1,24
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 February 2013	14/02/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Stern, Claudio

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/052592

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/279951 A1 (WHEELER JR DALE OWEN [US]) 12 November 2009 (2009-11-12) figures 1,2	24
A	US 3 091 997 A (BYRD RAY H) 4 June 1963 (1963-06-04) column 2, line 28 - column 3, line 4; figure 1 3 4	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2012/052592

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 4269534 A	26-05-1981	NONE	
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