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(56) Documents Cited
GB 2278580 A **GB 1279881 A**
WO 2001/014077 A1 **WO 1997/039254 A1**
US 6293587 B1 **US 5476284 A**

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(54) Abstract Title
A collapsible support

(57) A collapsible support (1) for absorbing energy during an impact, particularly to a support for an automobile knee bolster, has the form of a tubular body with closed ends. The body extends along a longitudinal axis (3) along which it will collapse during an impact. The support (1) has two opposing end walls (4,10) substantially perpendicular to the axis (3). The two end walls (4,10) are connected by four similar stepped side walls (8) of rectangular plan form that substantially enclose the longitudinal axis (3) such that the side and end walls (8,4,10) of the collapsible support (1) substantially enclose an internal volume. The tubular body is adapted to deform so that sections (31-35) of side walls 8 collapse with one section moving inside another adjacent section upon the application of a compressive force applied to said body along said axis 3.

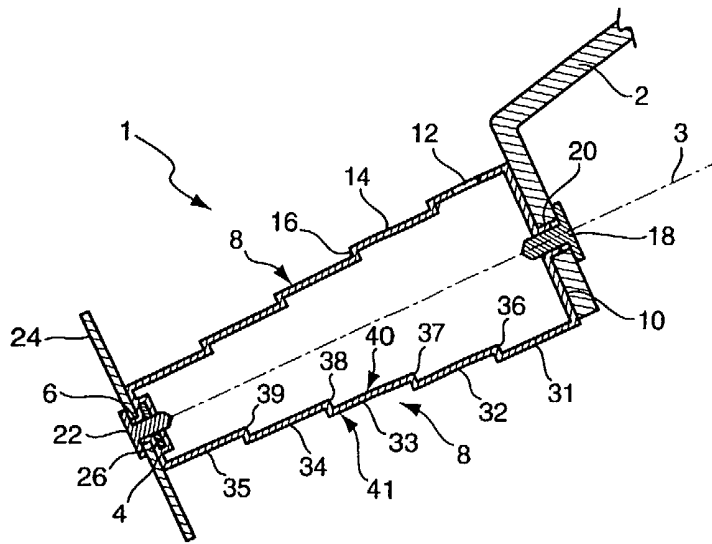


Fig. 3

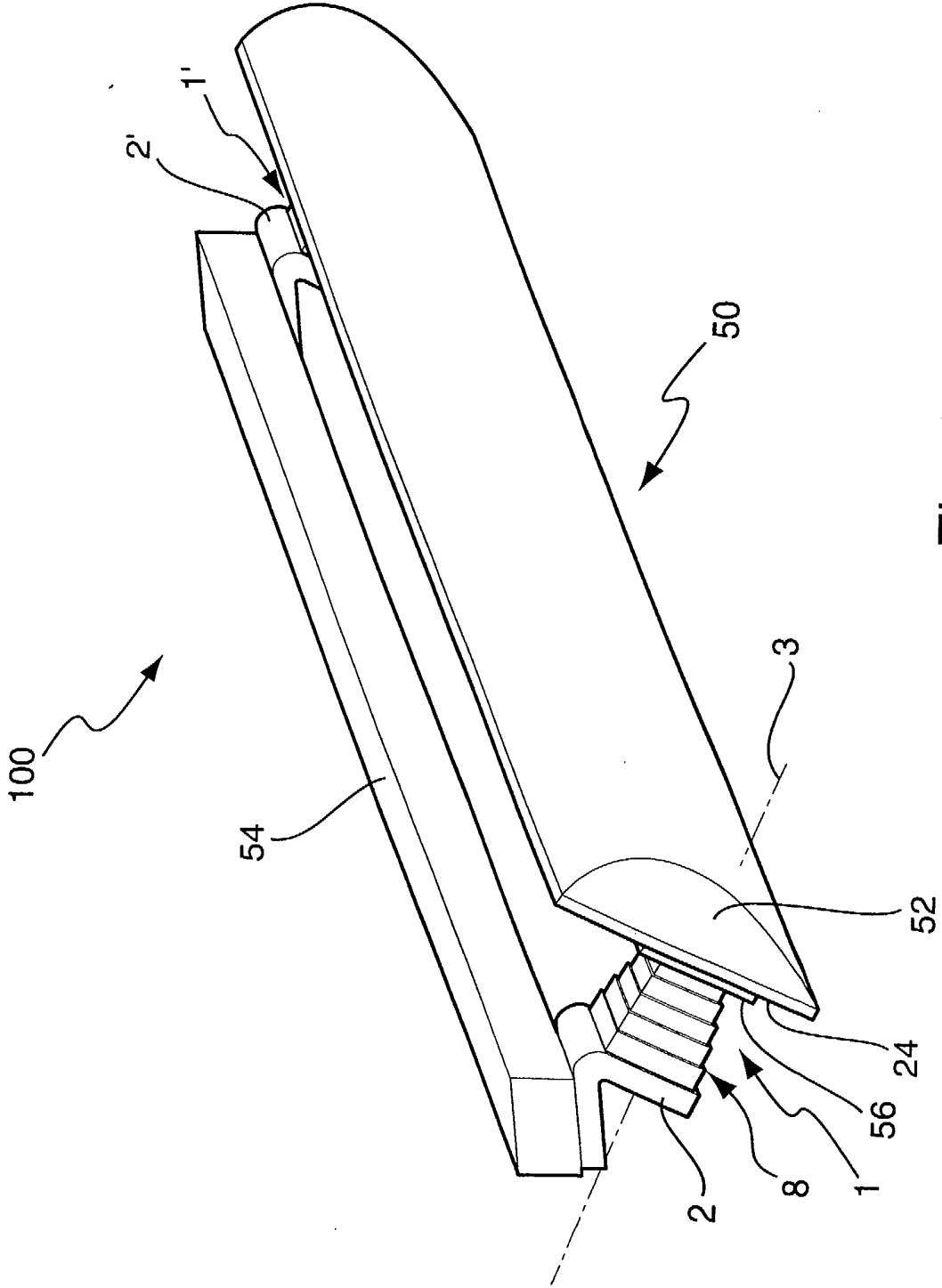


Fig. 1

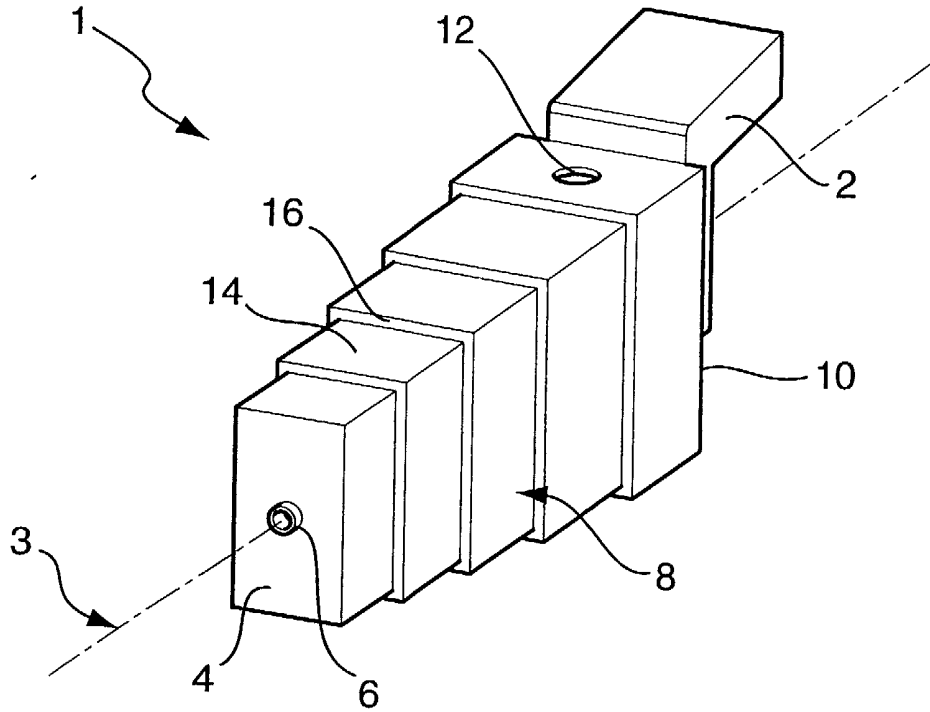


Fig. 2

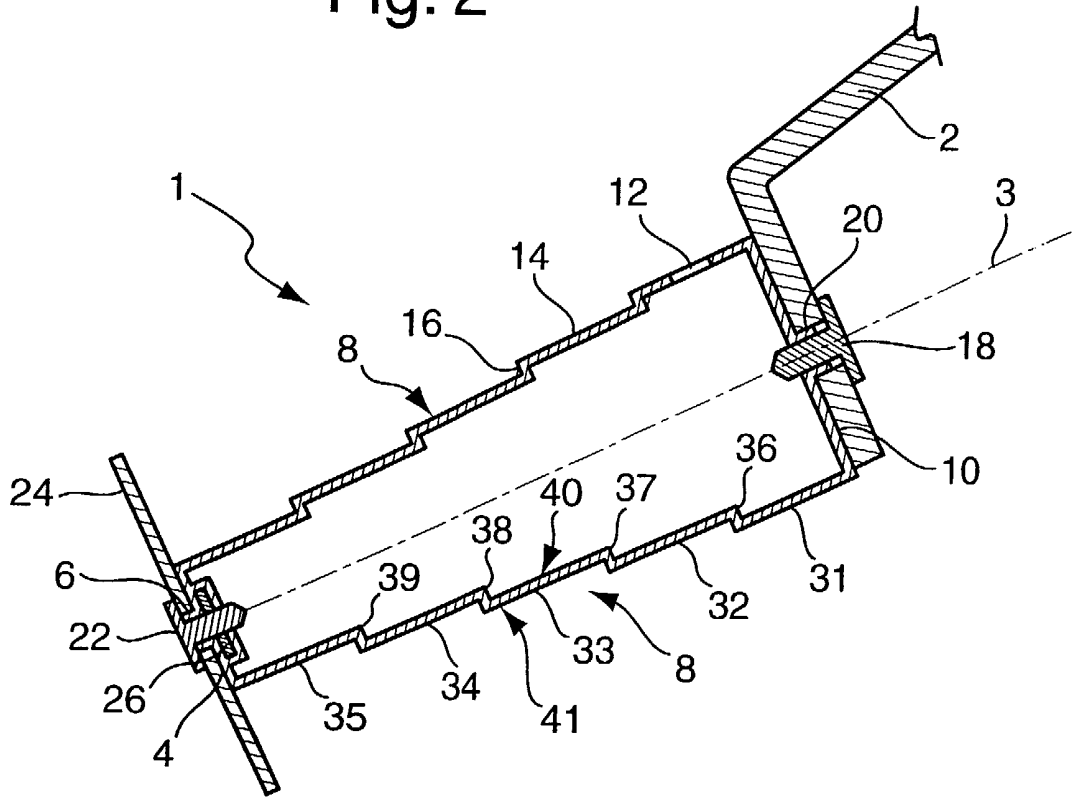


Fig. 3

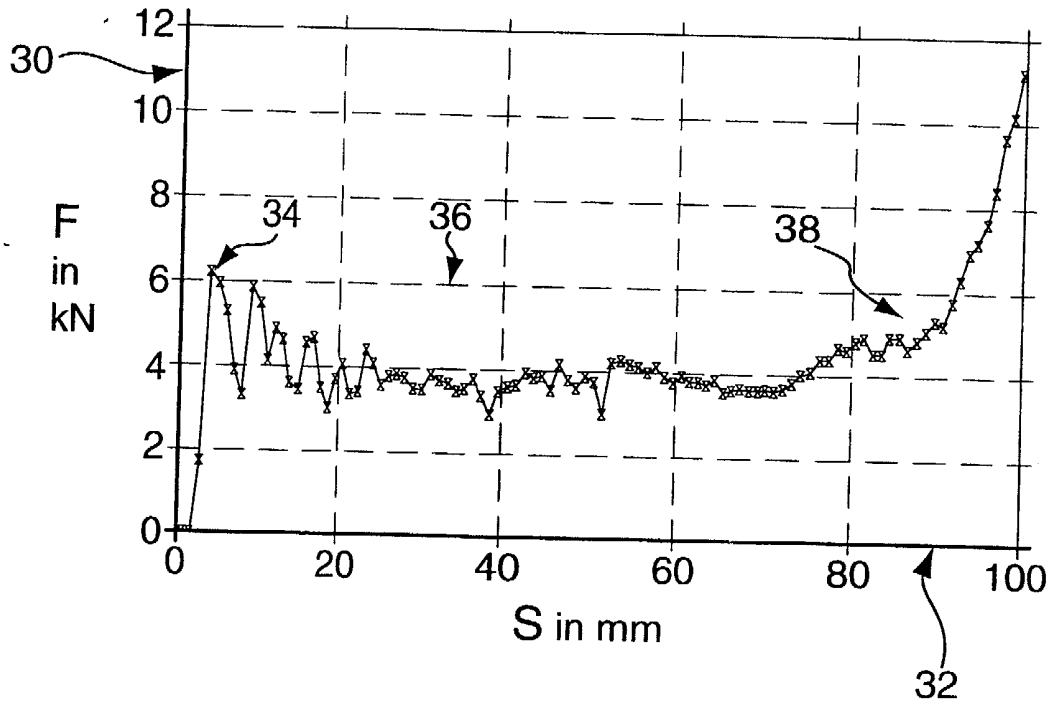


Fig. 4

A Collapsible Support

The present invention relates to a collapsible support for absorbing energy during an impact. The invention is of particular relevance to energy absorbing apparatus for an automobile knee bolster.

Energy absorption within the instrument panel assembly of an automobile is desirable during a frontal automobile crash to control the loads transmitted to an occupant and thereby reduce the likelihood of injury if an occupant makes contact with a front portion of the cabin.

During a frontal crash of an automobile, an occupant will tend to slide forward in their seat. As a result, it is possible that the knees of the occupant may strike a lower portion of an instrument panel at the front of the cabin. If the knees strike the instrument panel or other surface at the front of the cabin with sufficient force, the femur or other bones may be broken, or other injuries sustained. An energy absorbing knee bolster, often a padded portion of the instrument console, may be provided in a location where an occupant's knees are likely to strike. As the knees of the occupant strike the knee bolster, it cushions the knees and absorbs at least some of the energy of the impact, thereby reducing the maximum load transmitted to the occupant.

It is known to provide deformable supports for knee bolsters in automobiles. These supports are located between the knee bolster and a bracket that fixes the knee bolster to the automobile. The support will deform or

collapse and absorb some of the energy of the impact if an occupant's knees should strike the knee bolster. This will further reduce the maximum load transmitted to an occupant during an impact.

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Conventional deformable supports are curved metallic sections that roll-up or flex during an impact, or are made from extruded metallic sections that are crushed during an impact. Such metal sections are both relatively
10 costly and inconvenient components to include in a collapsible support for absorbing energy during an impact.

It is an object of the present invention to provide a collapsible support that addresses some of these issues.

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According to the invention there is provided collapsible support for absorbing energy during an impact, the collapsible support comprising a hollow tubular body that extends along a longitudinal axis, the tubular body having
20 one or more side walls that extend around said axis, the or each side wall having at least two sections, adjacent sections of a side wall being separated by a step in the cross-section of said side wall when viewed in a plane parallel to said axis, wherein the tubular body is adapted
25 to deform so that sections of wall collapse with one section moving inside another section upon the application of a compressive force applied to said body along said axis.

30 Also according to the invention, there is provided apparatus for absorbing the energy of an impact of a moving body, comprising an impact pad for receiving

contact of said moving body, a rigid support structure,
and at least one collapsible support between the impact
pad and the support structure arranged to collapse and
absorb energy upon contact of said moving body on the
5 impact pad, wherein said collapsible support(s) is/are as
claimed in any preceding claim, the or each collapsible
support extending along the longitudinal axis between the
support structure and the impact pad.

10 The tubular body may be generally circular or oval as
viewed in a cross-section transverse to the longitudinal
axis. In a preferred embodiment of the invention, however,
the tubular body is generally square or rectangular as
viewed in a cross-section transverse to the longitudinal
15 axis, and the side walls forms a stepped pyramid.

In order to help sections move inside adjacent sections as
the spurt collapses, the step in the or each wall is
preferably a step in both an outer surface of said wall,
20 and an inner surface of said wall.

In a preferred embodiment of the invention, the tubular
body has a first end wall and a second end wall, the side
wall(s) then extending between the said end walls. The
25 side wall(s) and the end walls may then substantially
enclose a hollow internal volume.

In use, the collapsible support is preferably arranged
between a mounting bracket and a movable member with which
30 an impact may occur. The longitudinal axis of the support
is preferably substantially aligned with the expected
direction of an impact force such that the collapse of the

support will tend to occur in the direction of the impact. This will allow the collapse of the support to control the load deflection characteristics of the system experienced during an impact between an object and the movable member.

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In automobile knee bolster energy absorbing apparatus, there is preferably a collapsible support at each end of a knee bolster to allow either end of the knee bolster to move during an impact. The two collapsible supports may be
10 connected by a single steel cross brace upon which the knee bolster is also supported. The cross brace allows an impact load to be distributed between the supports.

Since a collapsible support according to the invention is
15 of particular relevance to an automobile knee bolster energy absorption apparatus, another aspect of the invention provides a knee bolster energy absorbing apparatus in which the knee bolster is supported by at least one collapsible support according to the invention.
20 It should be understood that the present invention may be of wider general applicability than this, for example collapsible supports may support a panel with which a person's head, or a fragile object, may make contact. The collapsible supports collapsing to reduce damage in the
25 event of an impact.

The steps in the stepped side wall provide several locations along the side wall at which the collapse of the support may be initiated due to stress concentration at
30 the steps. During collapse of the collapsible support along the longitudinal axis, the stepped side wall will buckle and absorb at least some of the energy of the

impact. The thickness of the side walls can be varied to alter the characteristics of the collapse of the support. Thinner walls would permit collapse with lower applied forces and with less energy absorbed, while thicker walls
5 would result in more energy absorbed, but with higher forces required.

Substantially enclosing an internal volume can substantially trap air, another gas, or even a liquid
10 within the support. During collapse of the support the gas may be compressed within the support or the gas or liquid may be expelled from the support, thereby increasing the energy dissipation of the support as it collapses. It is presently preferred that air is substantially trapped
15 within the support and the invention will be described hereafter with reference to this preferred embodiment although it should be understood that the invention is not so limited.

20 The escape of the trapped air preferably occurs through vent apertures located through the end and or side walls. The size and shape of the vent apertures may be varied to permit different flow rates or flow patterns of air from the support and thereby control the deformation of the
25 support. Some or all of the vent apertures may also include a membrane covering the aperture that prevents gas flow initially, but breaks if the gas pressure within the support increases above a predetermined limit. This allows a further degree of control over the characteristics of
30 the collapse of the support.

The rate of collapse and energy absorption of the support

can be readily controlled using at least two variables, the side wall thickness and the size of the vent apertures, without altering the external shape of the support. The size and profile of each step, the number of
5 steps and the separation of the steps in the side wall or the size and shape of the end walls could also be varied to alter the collapse of the support in the event of an impact.

10 The end walls of the support may be adapted to facilitate attachment to another surface. The attachment may be made using separate fixings such as screws or fir-tree connectors, or fixings that are formed integrally with the surfaces or support, for instance on an end wall of the
15 support. For example, the end walls may include projections that aid the correct location of the support in a corresponding recess or hole in the surface. Preferably the projections are cylindrical, and they preferably have a threaded inner bore to accept a threaded
20 fixing such as a screw so that the support can be securely attached to the surface.

The end walls may additionally/alternatively include a metal insert to which a fixing may be secured. The metal
25 insert may be within the end wall or attached to it either internally or externally. The metal insert may include an aperture to accept a fixing, and preferably includes a threaded bore to accept a threaded fixing.

30 Preferably the force required to cause collapse of the knee bolster system along the longitudinal axis is less than about 10 kN. It is preferred that the force required

to cause collapse is less than about 7 kN, as fracture of the femur is likely to occur if the peak load applied to the knee along the femur is above about 10 kN. Once collapse of the support has been initiated a force is preferably required to continue the collapse, as this will increase energy dissipation during collapse. The force to continue the collapse is preferably between about 3-7 kN and preferably between 4-6 kN as such forces resist the collapse of the support to dissipate energy.

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Preferably the support is made of a plastics material. A plastics material may be lighter than a metal alternative and may also be cheaper and/or easier to form into the desired hollow shape of the support.

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It is preferred that the side and end walls of the support are formed by blow moulding, and preferably in a single stage of blow moulding. Blow moulding can be used to create three-dimensional hollow plastic articles quickly and cheaply. Once the walls have been formed, vent apertures or metal inserts may be added, or these may be included during the moulding stage. The thickness of the walls of the support can be varied during the moulding stage to provide supports with different collapse characteristics, this allows supports for applications requiring different characteristics to be moulded using a single tool.

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Preferably, the cross section of the support tapers along the longitudinal axis such that the cross section of the support reduces along the longitudinal axis. Deformation of the support is most likely to be initiated at a step at

or near the narrower end of the support, as any force will be concentrated in a narrower perimeter. The tapering allows greater control of the deformation of the support and may allow the steps of the side walls to collapse inside one another telescopically.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

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Figure 1 shows a perspective view of a knee bolster energy absorbing apparatus for an automobile;

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Figure 2 is a perspective view of a collapsible support according to the invention;

Figure 3 is a cross section view of the collapsible support of Figure 2; and

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Figure 4 is a graph showing the force applied to the support of Figure 2 versus the displacement of one end wall relative to the other end wall.

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Figure 1 shows a perspective view of a knee bolster energy absorbing apparatus 100. A knee bolster 50 comprising a back plate 24 and a front panel 52 is attached to brackets 2,2' on an automobile beam 54 by collapsible supports 1,1' of hollow tubular form. A cross beam 56 is located on the back plate 24 of the knee bolster 50. The back plate 24 connects the two collapsible supports 1,1'. It should be understood that a cross beam is not essential to the working of the present invention. The knee bolster could

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alternatively be a one-piece design.

During a crash the knees of an occupant in the automobile may impact with the knee bolster 50. The front 52 may
5 absorb some of the energy, but if the force of the impact is large enough, the collapsible supports 1,1' will collapse and absorb more of the energy of the impact. The energy absorption controls the load and forward movement experienced by the occupant and thereby reduces the
10 likelihood of injury to an occupant during a crash. Without the knee bolster energy absorbing apparatus, the knees of an occupant could make contact with alternative hard components which could be more likely to cause injury.

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Figure 2 shows a collapsible support 1 attached to a rigid mounting bracket 2. The support has an axis 3 along which it is adapted to collapse during an impact. The support 1 has a first end wall 4 substantially perpendicular to the
20 axis 3 with sides of about 55 mm by 20 mm.

The first end wall 4 includes a fixing boss in the form of a cylindrical projection 6. The support 1 has four similar stepped side walls 8, arranged in a rectangular plan about
25 the axis 3. Each side wall 8 connects the first end wall 4 to a second end wall 10 that has sides of about 75 mm by 40 mm. The first end wall 4 is separated from the second end wall 10 by about 115 mm. The side and end walls 4,8,10 are formed in blow moulded plastic about 2.5 mm thick.

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Each side wall 8 has five sections 31-35 separated by four steps 36-39. The sections 31-35 are each parallel with and

offset laterally from the axis 3. Each step 31-39 extends
perpendicularly from the axis 3. Each section has parallel
inner and outer wall surfaces 40,41, with the inner wall
surface of one section being latterly offset, either
5 inside or outside, from the outer wall surface 41 of the
adjacent section. This offset helps one section move
inside and adjacent section as the support 1 collapses.

The stepped side walls 8 form a truncated stepped pyramid
10 shaped shell with a rectangular cross section between the
first end wall 4 and second end wall 10. From the first
end wall 4 each step of the side wall 8 increases the
cross section of the support 1 until the side wall 8 joins
with the second end wall 10. The stepped side wall 8 has
15 flat sections 14 substantially parallel with the axis 3
and step sections 16 substantially perpendicular with the
axis 3. Each step 16 increases or decreases the plan area
of the support. The result is that one step may
substantially fit within an adjacent step to allow the
20 support 1 to collapse substantially telescopically upon
application of a sufficient force along the axis 3.

The side wall 8 includes a vent aperture 12 that allows
communication between the volume enclosed within the
25 support and the outside of the support. The vent aperture
12 is located in the flat section 14 adjacent the second
end wall 10 as this is likely to be the final step that
collapses.

30 Figure 3 shows a cross section through the collapsible
support 1 of Figure 2. The support 1 is attached to the
mounting bracket 2 by a screw 18. The second end wall 10

includes a hollow cylindrical projection 20 that is located in an aperture through the bracket 2. The screw 18 is then secured into the cylindrical projection 18 to secure the support 1 to bracket 2. Another screw 22
5 secures a back plate 24 of the knee bolster to the support 1 in a similar way, except that the screw 22 is also secured into a metal insert 26 moulded within the end wall 4.

10 Figure 4 is a typical graph of Force (kN) (F) 30 versus Displacement (mm) (S) 32 for a collapsible support 1. As can be seen from the graph, the peak force 34 required to initiate the collapse of the support 1 is about 6 kN. The force 36 required to continue the collapse is between 3 kN
15 and 5 kN until the support is substantially fully compressed 38 when the two end walls 4,10 have been moved together by about 90 mm.

It should be understood that the support could have a
20 variety of cross sections, such as circular, square or other polygon, but rectangular is currently preferred due to the ease of storage and manufacture.

The present invention has been described above purely by
25 way of example. It should be noted that modifications in detail may be made within the scope of the invention as defined in the claims.

Claims

1. A collapsible support for absorbing energy during an impact, the collapsible support comprising a hollow tubular body that extends along a longitudinal axis, the tubular body having one or more side walls that extend around said axis, the or each side wall having at least two sections, adjacent sections of a side wall being separated by a step in the cross-section of said side wall when viewed in a plane parallel to said axis, wherein the tubular body is adapted to deform so that sections of wall collapse with one section moving inside another section upon the application of a compressive force applied to said body along said axis.
2. A collapsible support as claimed in Claim 1, in which the tubular body is generally square or rectangular as viewed in a cross-section transverse to the longitudinal axis.
3. A support as claimed in Claim 2, in which the side wall forms a stepped pyramid.
4. A collapsible support as claimed in Claim 1, in which the tubular body is generally circular or oval as viewed in a cross-section transverse to the longitudinal axis.
5. A collapsible support as claimed in any preceding claim, in which the step in the or each wall is a step in both an outer surface of said wall, and an inner surface of said wall.

6. A collapsible support as claimed in any preceding claim, in which the tubular body has a first end wall and a second end wall, the side wall(s) then extending between said end walls.

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7. A collapsible support as claimed in any preceding claim, in which the side wall(s) and the end walls substantially enclose a hollow internal volume.

10 8. A collapsible support as claimed in Claim 7, in which at least one of the end walls or side wall(s) includes a vent aperture by which air inside the hollow volume may escape when the tubular body deforms.

15 9. A collapsible support as claimed in any preceding claim, in which the force required to collapse the support is less than 10 kN.

20 10. A collapsible support as claimed in Claim 9, in which the force required to collapse the support is less than 7 kN.

25 11. A collapsible support as claimed in any preceding claim, in which the support is made from a plastics material.

30 12. An apparatus for absorbing the energy of an impact of a moving body, comprising an impact pad for receiving contact of said moving body, a rigid support structure, and at least one collapsible support between the impact pad and the support structure arranged to collapse and absorb energy upon contact of said moving body on the

impact pad, wherein said collapsible support(s) is/are as claimed in any preceding claim, the or each collapsible support extending along the longitudinal axis between the support structure and the impact pad.

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13. An apparatus as claimed in Claim 12, in which the stepped form of the or each side wall tapers towards the longitudinal axis from the support structure to the impact pad.

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14. An apparatus as claimed in Claim 12 or Claim 13, when appendant from Claim 6, in which the collapsible support is joined to the impact pad by the first end wall.

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15. An apparatus as claimed in Claim 14, in which the second end wall includes a threaded metal insert for a screw by which the impact pad is joined to the collapsible support.

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16. An apparatus as claimed in any of Claims 12 to 15, in which the impact pad is joined to the support structure by at least two spaced-apart collapsible supports that are connected by a cross-brace that extends across the impact pad.

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17. An apparatus as claimed in any of Claims 12 to 16, when appendant from Claim 6, in which the collapsible support is joined to the support structure by the second end wall.

30

18. An apparatus as claimed in Claim 17, in which the first end wall has a fixing boss that engages with a

recess in the support structure when the collapsible support is joined to the support structure.

19. An apparatus as claimed in Claim 18, in which the
5 cylindrical protrusion has a threaded bore for a screw by
which the support structure is joined to the collapsible
support.

20. An apparatus as claimed in any of Claims 12 to 20, in
10 which the impact pad is a knee bolster.

21. A collapsible support for absorbing energy during an
impact, substantially as herein described, with reference
to or as shown in the accompanying drawings.

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22. A knee bolster energy absorbing apparatus,
substantially as herein described, with reference to or as
shown in the accompanying drawings.



INVESTOR IN PEOPLE

Application No: GB 0207277.5
Claims searched: 1 to 22

Examiner: Colin Thompson
Date of search: 21 August 2002

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.T): F2S (SCM); B7B (BSDB)

Int CI (Ed.7): F16F 7/12; B60R 19/26; B62D 1/19

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2278580 A (ACG France) See whole document	1,4,5
X	GB 1279881 A (Tokyo Sharyo Seizo KK) See Figs 4 & 5	1-7
X	WO 01/14077 A1 (Cosma International Inc) See Figs 3 & 4	1,4,5
X	WO 97/39254 A1 (CERA) See Fig 1	1,4,5,11
X	US 6293587 B1 (Lapic) See Figs 2 & 3	1-3,5
X	US 5476284 A (DuRocher) See Fig 5	1,4,5

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.