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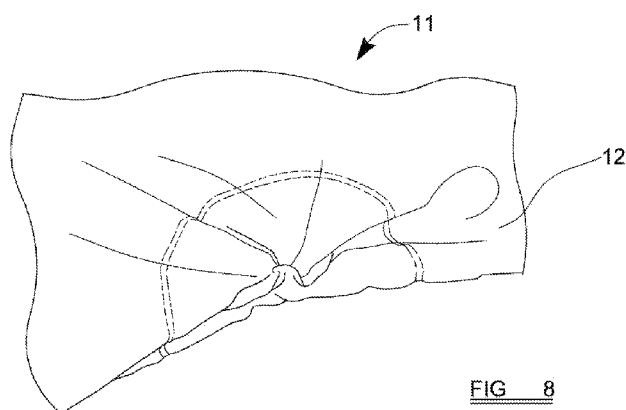


FIG. 8

(57) Abstract: An airbag of a type suitable for use as a safety device in a motor vehicle is disclosed. The airbag has an inflatable volume which is at least partially defined by a pair of superimposed layers (11, 12) of flexible material (1) which are interconnected to one another by either a fold (10), a seam, or a combination of both. The airbag comprises an adaptive vent configured to permit the venting of inflating gas from within the inflatable volume upon inflation of the airbag. The vent comprises an opening (9) formed through a resiliently deformable ring (3) having a relaxed condition in which the opening (9) has an initial cross-sectional area, and which is configured to deform in response to an increase in pressure within the inflatable volume so as to adopt a stretched configuration in which the opening (9) has a larger cross-sectional area. The ring (3), which may conveniently take the form of an elastomeric O-ring, is located between said layers (11, 12) of flexible material such that said opening (9) is formed through said interconnecting fold (10) or seam.



AN AIRBAG

The present invention relates to an airbag, and more particularly relates to an airbag suitable for use as a safety device in a motor vehicle in order to provide protection for an occupant of the vehicle in the event that an accident should occur.

It has been proposed previously to provide inflatable airbags in order to provide protection to the occupants of a vehicle in the event that an accident involving the vehicle should occur. More particularly, it has been proposed to provide airbag arrangements in which an airbag is arranged for rapid inflation at a position generally adjacent an occupant of a motor vehicle and towards which the occupant is likely to be thrown as a result of the crash. In order to inflate an airbag sufficiently quickly in order to provide adequate crash-protection, gas must be injected into the airbag at a very high pressure from a source such as a gas generator. In the case of a side-impact airbag, the gas must be injected into the bag at a particularly high pressure due to the very short time available to ensure adequate deployment of the bag.

Once the airbag has been inflated, it must provide a sufficient cushioning effect in order to gently decelerate the moving occupant, thereby preventing significant injury. During an accident, the occupant initially comes into contact with the inflated airbag and the occupant will therefore begin to compress the airbag, thereby increasing the internal pressure of gas within the airbag. It is therefore important to insure that the gas pressure within the airbag does not reach an excessively high level such that the occupant's head or torso is caused to bounce off the inflated airbag.

In order to provide an airbag with a desirable inflation characteristic, it has therefore been proposed previously to incorporate one or more vents into the structure of the airbag in order to release gas from within the airbag as the occupant's head or torso begins to impact with the airbag. Previously proposed conventional airbag vents typically have a fixed size in order to allow an airbag to deflate gently as a person of average size and weight moves against it. However, more recently it has been recognised that the volume of gas which must be vented from the airbag, and the speed with which it must be vented from the airbag can vary in dependence on the size and weight of the occupant moving against the airbag, but also according to circumstances particular to the individual crash situation. It has therefore been proposed to provide adaptive vent arrangements of a type configured to adjust in effective size in response to the internal pressure of the inflating gas within the airbag. For example,

such an arrangement is typically arranged to present a vent hole of an initial, relatively small, size for initial or normal inflation of the airbag, but which is configured to become enlarged in response to internal pressure within the airbag rising above a predetermined threshold value.

However, it has been found that most previously proposed adaptive airbag vents of the
5 general type mentioned above are rather complicated in construction.

It is therefore an object of the present invention to provide an improved airbag of a type suitable for use as a safety device in a motor vehicle.

According to the present invention, there is provided an airbag having an inflatable volume at least partially defined by a pair of superimposed layers of flexible material which are
10 interconnected to one another by a fold or a seam, the airbag comprising a vent configured to permit the venting of inflating gas from within the inflatable volume upon inflation of the airbag, wherein the vent comprises an opening formed through a resiliently deformable ring having a relaxed condition in which the opening has an initial cross-sectional area and which is configured to deform in response to an increase in pressure within the inflatable volume so
15 as to adopt a stretched configuration in which the opening has a larger cross-sectional area, said ring being located between said layers of flexible material such that said opening is formed through said interconnecting fold or seam.

Preferably, the two superimposed layers are formed from a single sheet of said flexible material, the sheet being folded about a fold line to superimpose the layers, said fold line
20 forming an edge of the airbag. In such an arrangement, it is envisaged that the opening formed through the deformable ring will be provided through the resulting fold formed between the layers.

Alternatively, however, each said layer may be formed from a separate sheet of flexible material, in which case the layers will be interconnected by a seam defining an edge of the
25 airbag. In such an arrangement, it is envisaged that the opening formed through the deformable ring will be provided through said edge-seam.

Preferably, said vent further comprises a hole formed through the flexible material of the airbag in the region of said interconnecting fold or seam, said deformable ring being secured to the flexible material of the airbag around said hole.

Advantageously, the diameter of said deformable ring in its relaxed condition is smaller than the diameter of said hole formed through the flexible material, the vent being such that said flexible material is puckered in the region of said vent when the ring adopts its relaxed condition.

5 Conveniently, said deformable ring is provided within an annular pocket formed around said hole.

Preferably, said pocket is formed inside the airbag.

Advantageously, said deformable ring is formed of elastomeric material.

Conveniently, said deformable ring is an O-ring.

10 Alternatively, said deformable ring is provided in the form of a spring.

Preferably, said deformable ring lies in a plane which is substantially orthogonal to each said layer when the airbag is laid out substantially flat in an uninflated condition.

The airbag may be provided in the form of a side airbag for inflation between a seat and a side panel of a motor vehicle.

15 Preferably, said flexible material is woven fabric.

So that the invention may be more readily understood, and so that further features thereof may be appreciated, an embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

20 Figure 1 is a schematic illustration of a vent hole formed through a sheet of fabric used to form an airbag in accordance with the present invention;

Figure 2 illustrates a resiliently deformable ring which is used to form part of the vent arrangement of the present invention;

25 Figure 3 illustrates a stage in the construction of the airbag of the present invention, showing the resilient ring of figure 2 in a stretched condition in which it extends around the vent hole illustrated in figure 1;

Figure 4 is a schematic illustration showing a subsequent stage in the manufacture of the airbag;

Figure 5 is a transverse cross-sectional view of the arrangement illustrated in figure 4, taken along line A-A;

5 Figure 6 is a schematic illustration showing the resulting vent arrangement, with the resilient ring shown in its normal, relaxed condition;

Figure 7 shows an airbag in accordance with the present invention, incorporating the vent arrangements, the airbag taking the form of a side airbag;

10 Figure 8 is an enlarged perspective view of the vent arrangement of the airbag illustrated in figure 7;

Figure 9 is another enlarged illustration showing the vent arrangement of the completed airbag;

Figure 10 is a schematic illustration showing the vent arrangements in an alternate, substantially open configuration.

15 Turning now to consider the drawings in more detail, figure 1 illustrates a localised region of a sheet 1 of flexible material from which an airbag in accordance with the present invention is produced. In preferred arrangements, the sheet 1 is a sheet of woven fabric material, but in other variants of the invention it is envisaged that the sheet 1 could be provided in the form of a thin film of polymer material or the like. A circular vent hole 2 having a diameter D is cut
20 from the sheet 1.

Figure 2 illustrates a resiliently deformable ring 3 which is used to form part of the vent arrangement of the present invention. The deformable ring 3 is shown in its normal, relaxed condition in which it has an inner diameter d_1 . In a preferred embodiment of the present invention, the deformable ring 3 is formed from elastomeric material and has a substantially
25 circular transverse cross-section; thus taking the form of a generally conventional O-ring. However, it is envisaged that in variants of the invention, the deformable ring 3 could take other convenient forms such as, for example, a ring formed from a helically wound compression spring.

Turning now to consider figure 3, there is illustrated a stage in the manufacture of an airbag in accordance with the present invention. In particular, figure 3 shows the deformable ring 3 having been stretched against its inherent resilience under the action of radially outwardly directed forces F illustrated schematically on figure 3. The deformable ring 3 is stretched in this manner so that it adopts a stretched configuration in which it has an enlarged inner diameter d_2 which is larger than the diameter D of the vent hole 2 provided through the fabric sheet 1. The deformable ring 3, whilst held in this stretched configuration is positioned adjacent the fabric sheet 1 so as to lie substantially concentric with the vent hole 2 and thus extends around the vent hole 2 in the manner illustrated in figure 3.

The stretched ring 3 is then secured to the fabric sheet 1, in the manner illustrated in figures 4 and 5, by securing an annulus 4 of similar flexible material (i.e. preferably woven fabric) to the sheet 1 so as to trap the stretched ring 3 therebetween. Having particular regard to figure 5, it will be noted that the annulus 4 has an inner diameter which is substantially equal to the diameter D of the vent hole 2 formed through the sheet 1, and has an outer diameter which is somewhat greater than the outer diameter of the ring 3 in its stretched configuration. The annulus 4 is secured to the sheet 1 via inner and outer circular seams 5, 6, each of which is formed as a line of circular stitching. The inner seam 4 serves to interconnect the annulus 4 and the sheet 1 around the inside of the stretched ring 3, whilst the outer seam 6 serves to interconnect the annulus 4 and the sheet 1 around the outside of the stretched ring 3. The annulus 4 thus effectively defines an annular pocket 7 formed around the vent hole 2.

Following completion of the annular pocket 7 in the manner described above, the radial stretching forces F are removed from the ring 3 such that it is allowed to revert from the stretched configuration illustrated in figures 3-5, back to its normal relaxed condition illustrated in figure 6, (i.e. with inner diameter d_1). As will be appreciated, because the deformable ring 3 is secured to the fabric sheet 1 whilst both the fabric sheet 1 and the annulus 4 are laid substantially flat, subsequent relaxation of the deformable ring 3 back to its normal condition illustrated in figure 6 causes the fabric of the sheet 1, and also the fabric of the reinforcing annulus 4, to become puckered into a series of folds or pleats 8 as illustrated schematically in figure 6. Nevertheless, a small opening 9 is defined through the deformable ring 3 and the regions of puckered fabric extending through the ring 3, the opening 9 having an initial relatively small cross-sectional area in the relaxed configuration illustrated in figure 6.

Following the creation of the vent arrangement in the manner described above, the sheet 1 may then be formed into a completed airbag by folding the sheet 1 about a fold line 10 running substantially through the centre of the deformable ring 3 and the opening 9 defined therethrough. A completed airbag 11 formed in this manner is illustrated in an uninflated condition in figure 7. As will be seen, the airbag 11 is formed by folding the sheet 1 about the fold line 10 so as to form a pair of superimposed fabric layers 12, 13. The overlying peripheral edges of the superimposed layers 12, 13 may then be secured together by a peripheral seam 14 in the form of a line of stitching, so as to define an airbag having an inflatable volume defined between the superimposed and interconnected layers of fabric 12, 13.

In the particular airbag arrangement illustrated in figure 7, it will be noted that the fold line 10 has a "cranked" or angled configuration rather than being entirely linear. This can easily be achieved by the creation of a tapering tuck or dart in the fabric of the airbag, in the region of the puckered pleats 8.

The particular airbag 11 illustrated in figure 7 is provided in the form of a side-impact airbag of a type intended to be mounted to the outboard side of the back-rest of a vehicle seat in order to be inflated so as to adopt a position located generally between the seat occupant and the side panel of the motor vehicle in the event of a side impact accident.

The airbag 11 is also provided with a gas inlet aperture 15 provided through one of the two superimposed layers 12. The gas inlet aperture 15 is intended to be fitted over part of an inflator such as a gas generator in order to provide a supply of high pressure inflating gas to the interior volume of the airbag. As will thus be appreciated, the gas inlet aperture 15 is provided in the rear-most region of the airbag, at a position where the airbag is intended to be secured to the back-rest of the vehicle seat, whilst the vent arrangement provided by the opening 9 defined through the deformable ring 3 is provided in a front region of the airbag, generally opposite to the gas inlet aperture, at a position generally between the superimposed side panels 12, 13. Thus, as the airbag is inflated so as to adopt a deployed position generally between the seat occupant and the side panel of the motor vehicle, the vent opening 9 will be directed generally forwardly, away from the gas inlet aperture 15, and thus neither directly towards the seat occupant, nor directly towards the adjacent side panel of the motor vehicle.

Figures 8 and 9 illustrate the completed vent arrangement provided within the fold 10 in further detail. Having particular regard to figure 9, it will be noted that the deformable ring 3 (illustrated in dashed line in figure 9) lies in a plane which is generally orthogonal to each fabric layer 12, 13 of the airbag when the airbag adopts an uninflated condition in which the two panels lie generally flat and adjacent one another. This orientation of the deformable ring 3 ensures that the opening 9 which is defined through the ring 3, between the gathered folds and pleats of fabric material is directed generally away from the gas inlet aperture 15 in the rear part of the airbag.

As will be appreciated by those of skill in the art, the airbag 11 of the present invention is intended to be initially provided in a tightly packed condition in which it is rolled and/or folded. However, upon inflation via the injection of inflating gas into the interior volume of the airbag, the airbag will inflate and so unroll and/or unfold so as to adopt an inflated condition in which it lies generally between the seat occupant and the side panel of the motor vehicle. Initially, the deformable ring 3 adopts its normal relaxed configuration such that the vent opening 9 defined through the ring has a relatively small cross-sectional area. However, the deformable nature of the ring 3 allows the ring 3 to stretch under the action of significant internal gas pressure within the airbag, so as to move from its initial configuration illustrated in figure 6 towards a stretched configuration illustrated in figure 10 (or at least to an intermediate position between its initial condition and its fully stretched condition illustrated in figure 10) which is thus effective to enlarge the opening 9 formed through the ring 3, thereby increasing its cross-sectional area and permitting the venting of an increased flow of gas from the interior volume of the airbag.

As will therefore be appreciated, the vent arrangement described above has a relatively simple construction which provides an effective and reliable adaptive vent configured to adjust its size in dependence upon the interior pressure within the inflating airbag.

Whilst the invention has been described above with particular reference to an airbag provided in the form of a side impact airbag intended for deployment between a seat occupant and the side panel of a motor vehicle, it is to be appreciated that the above-described vent arrangement could be provided in alternative forms of airbag devices such as, for example, front-impact airbags or so-called inflatable curtain airbags.

Furthermore, it is to be appreciated that whilst the invention has been described above with reference to an airbag in which the vent arrangement is provided in the region of an

interconnecting fold between two layers formed from the same sheet of flexible material, the vent arrangement could instead be provided in an interconnecting seam formed between two discrete layers of flexible material. In such an arrangement, it is envisaged that the interconnecting seam will be created first, after which the vent hole may be cut through the seam and the deformable ring 3 secured in position in an otherwise similar manner to that proposed above.

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 in the following claims, or in 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 obtaining the disclosed results, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

CLAIMS

1. An airbag having an inflatable volume at least partially defined by a pair of superimposed layers (11, 12) of flexible material (1) which are interconnected to one another by a fold (10) or a seam, the airbag comprising a vent configured to permit the venting of inflating gas from within the inflatable volume upon inflation of the airbag, characterised in that the vent comprises an opening (9) formed through a resiliently deformable ring (3) having a relaxed condition in which the opening (9) has an initial cross-sectional area and which is configured to deform in response to an increase in pressure within the inflatable volume so as to adopt a stretched configuration in which the opening (9) has a larger cross-sectional area, said ring (3) being located between said layers (11, 12) of flexible material such that said opening (9) is formed through said interconnecting fold (10) or seam.
2. An airbag according to claim 1, wherein said vent further comprises a hole (2) formed through the flexible material (1) of the airbag in the region of said interconnecting fold (10) or seam, said deformable ring (3) being secured to the flexible material (1) of the airbag around said hole (2).
3. An airbag according to claim 2, wherein the diameter d_1 of said deformable ring (3) in its relaxed condition is smaller than the diameter D of said hole (2) formed through the flexible material (1), the vent being such that said flexible material (1) is puckered (8) in the region of said vent when the ring (3) adopts its relaxed condition.
4. An airbag according to claim 2 or claim 3, wherein said deformable ring (3) is provided within an annular pocket (7) formed around said hole (2).
5. An airbag according to claim 4, wherein said pocket (7) is formed inside the airbag.
6. An airbag according to any preceding claim, wherein said deformable ring (3) is formed of elastomeric material.
7. An airbag according to any preceding claim, wherein said deformable ring (3) is an O-ring.

8. An airbag according to any one of claims 1 to 5, wherein said deformable ring (3) is provided in the form of a spring.
9. An airbag according to any preceding claim, wherein said deformable ring (3) lies in a plane which is substantially orthogonal to each said layer (11, 12) when the
5 airbag is laid out substantially flat in an uninflated condition.
10. An airbag according to any preceding claim, provided in the form of a side airbag for inflation between a seat and a side panel of a motor vehicle.
11. An airbag according any preceding claim, wherein said flexible material (1) is woven fabric.

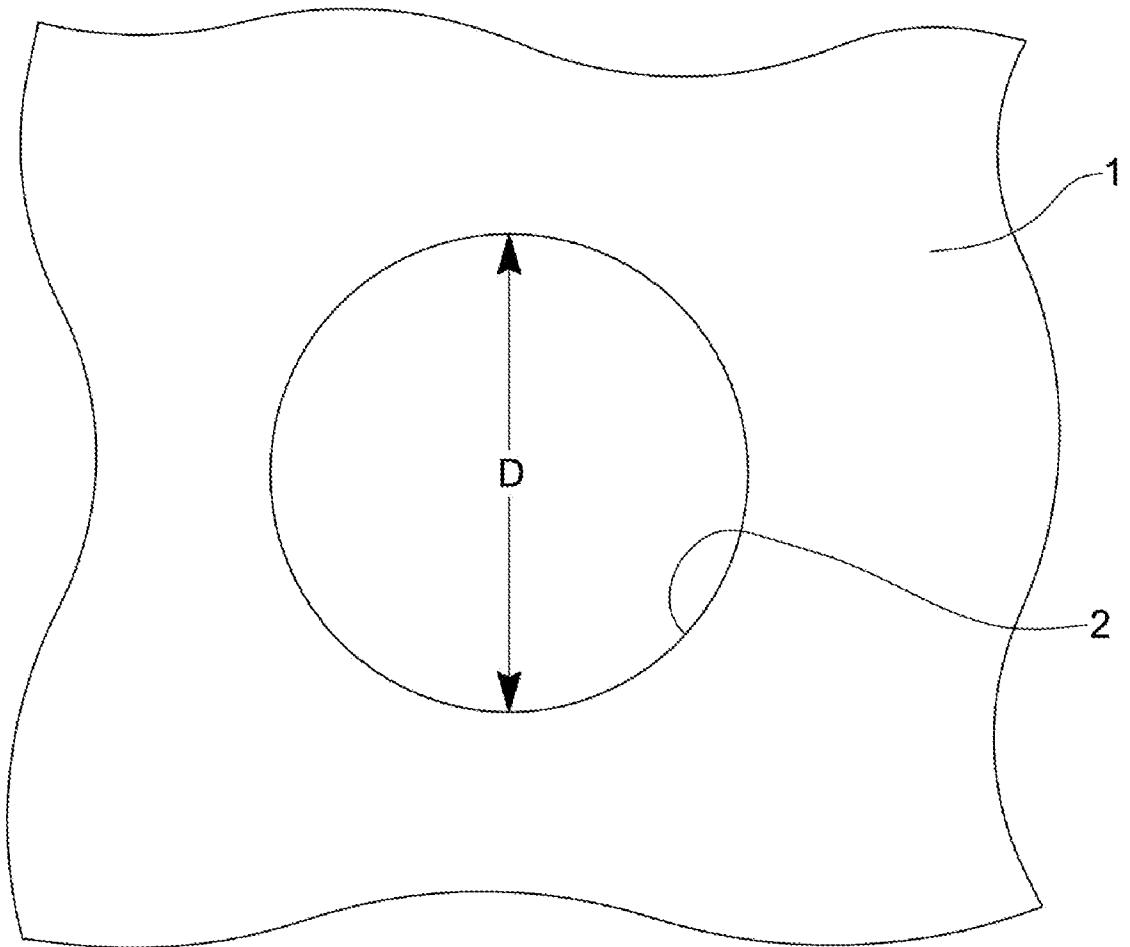


FIG 1

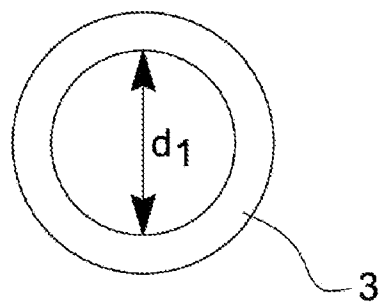


FIG 2

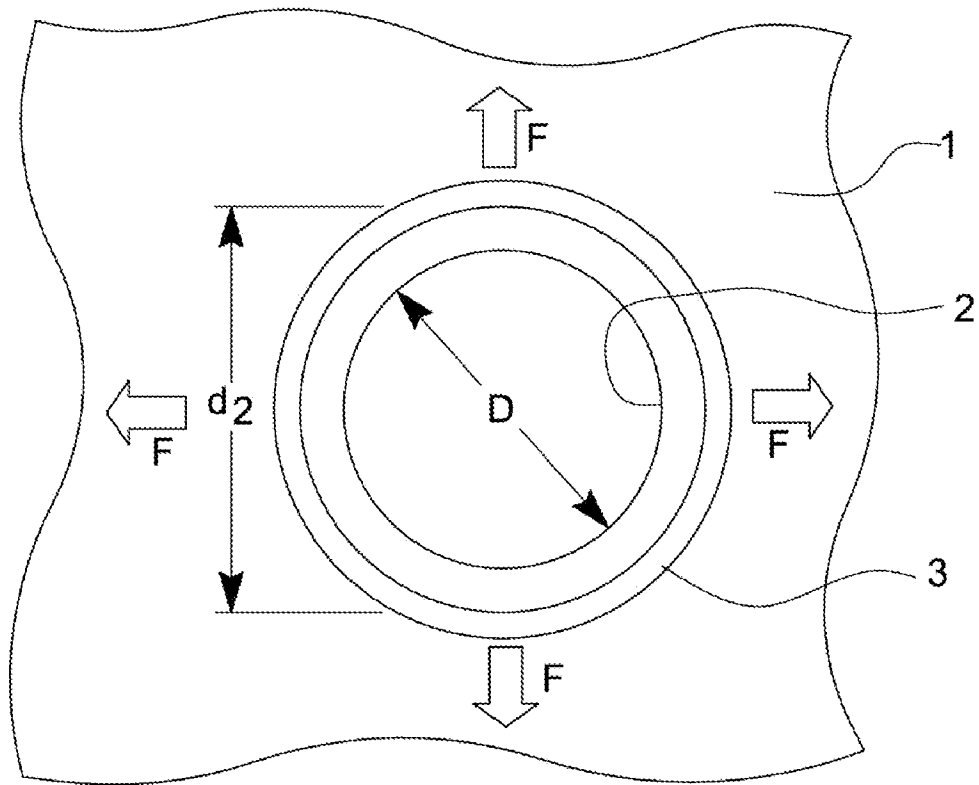


FIG 3

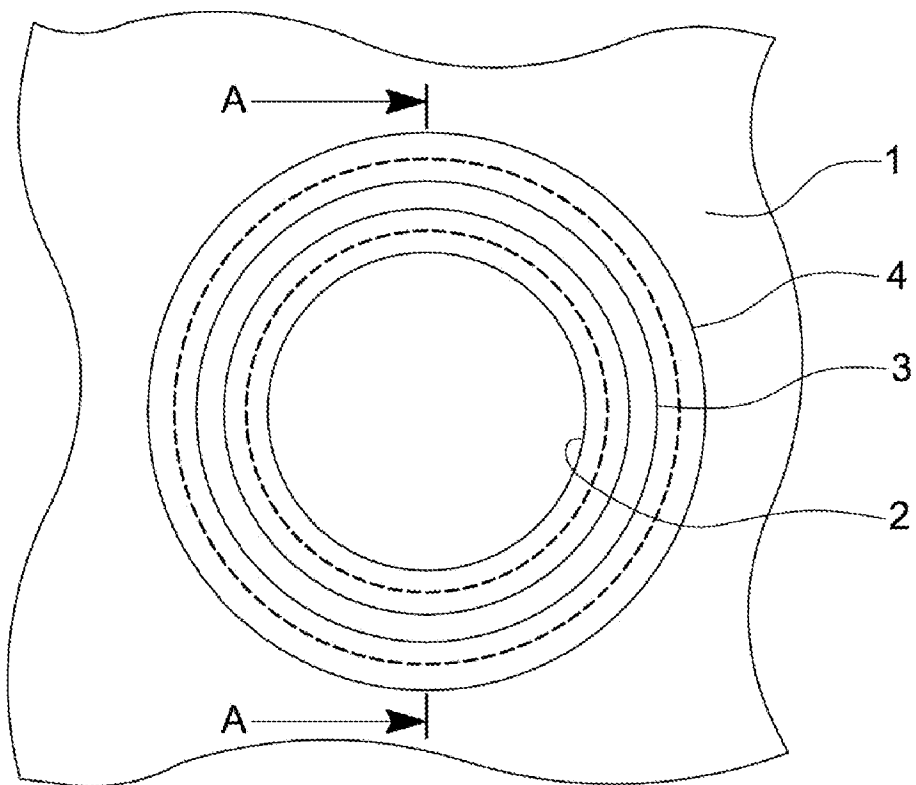


FIG 4

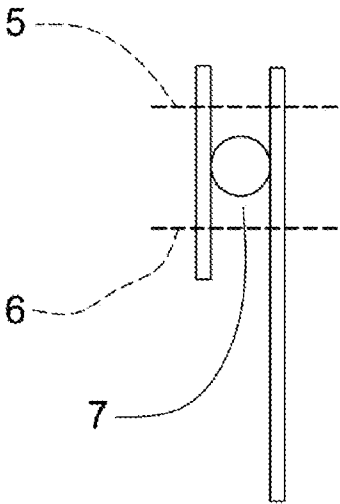
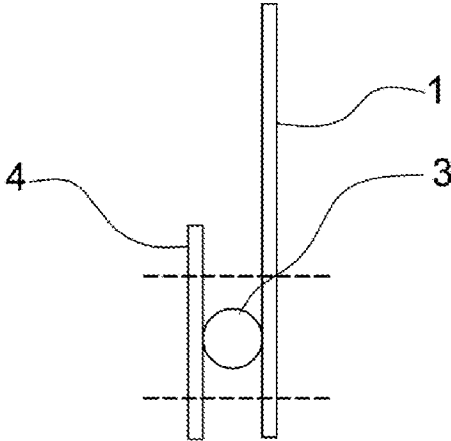
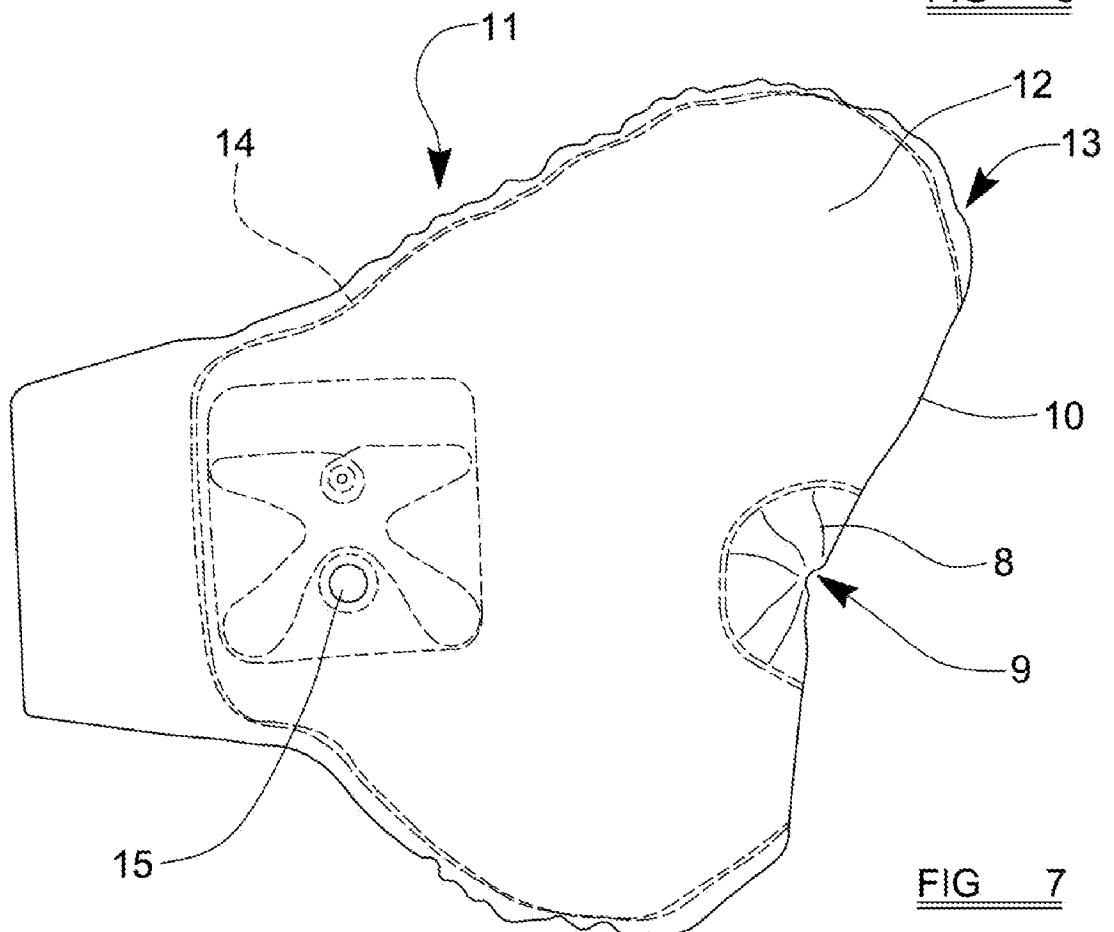
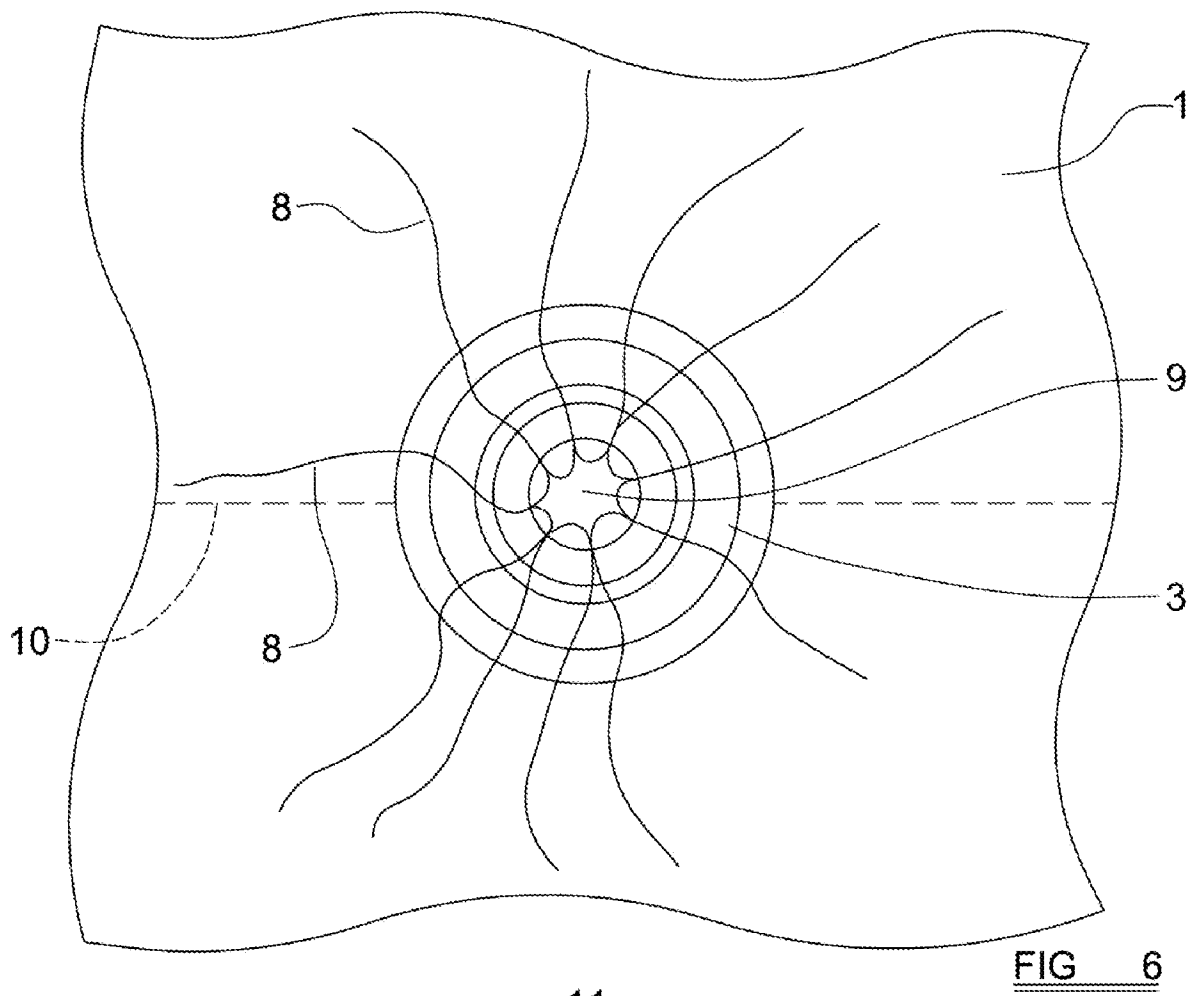


FIG 5

4 / 6



5 / 6

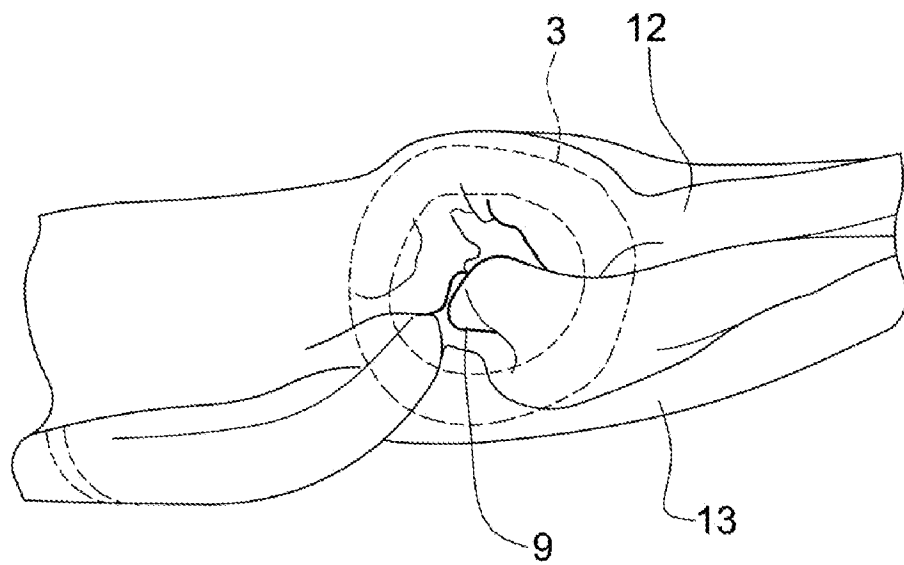
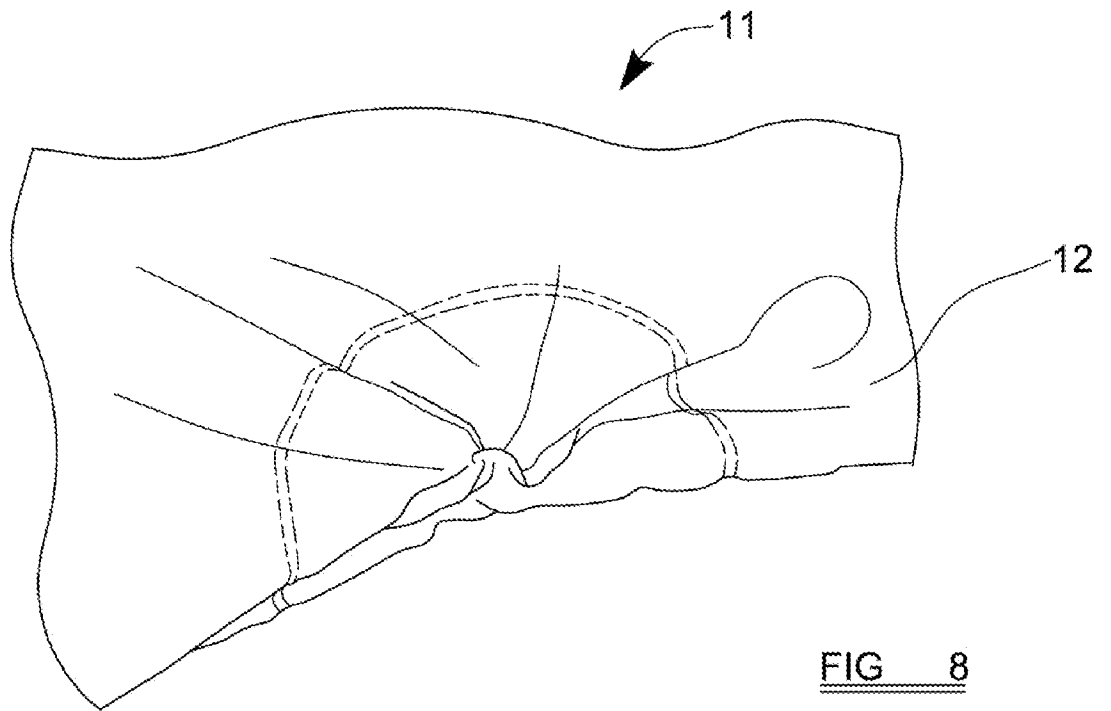
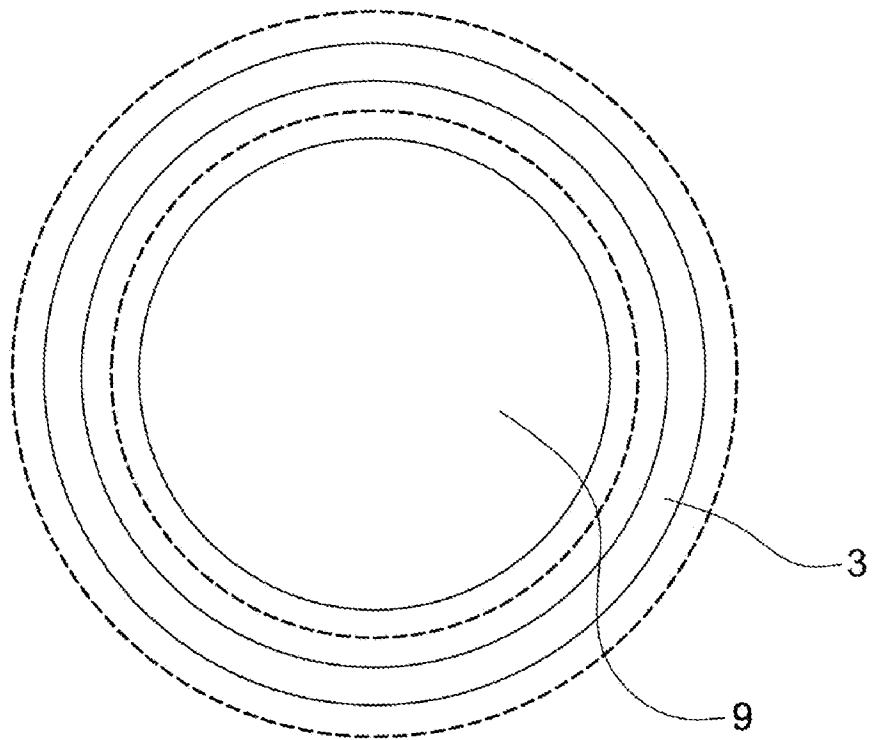


FIG 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2010/050935

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B60R

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11152008 A, NISSAN DIESEL MOTOR CO LTD, 1999-06-08: (abstract) Retrieved from: PAJ database; Original document: paragraphs (0010),(0013)-(0019); figure 1 --	1-11
X	DE 10059956 A1 (AUTOLIV DEVELOPMENT AB), 13 June 2002 (13.06.2002), figures 1-4, abstract, paragraphs (0018)-(0021) --	1-11
A	DE 102005028581 B3 (AUTOLIV DEVELOPMENT AB), 24 August 2006 (24.08.2006), whole document --	1-11

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2010/050935

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 20070187936 A1 (BRITZ), 16 August 2007 (16.08.2007), whole document --	1-11
A	US 5492363 A (HARTMEYER ET AL), 20 February 1996 (20.02.1996), whole document -- -----	1-11

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Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2010/050935

DE	10059956	A1	13/06/2002	NONE		

DE	102005028581	B3	24/08/2006	NONE		

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