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(54) **SENSOR PAD FOR CONTROLLING AIRBAG DEPLOYMENT AND ASSOCIATED SUPPORT**

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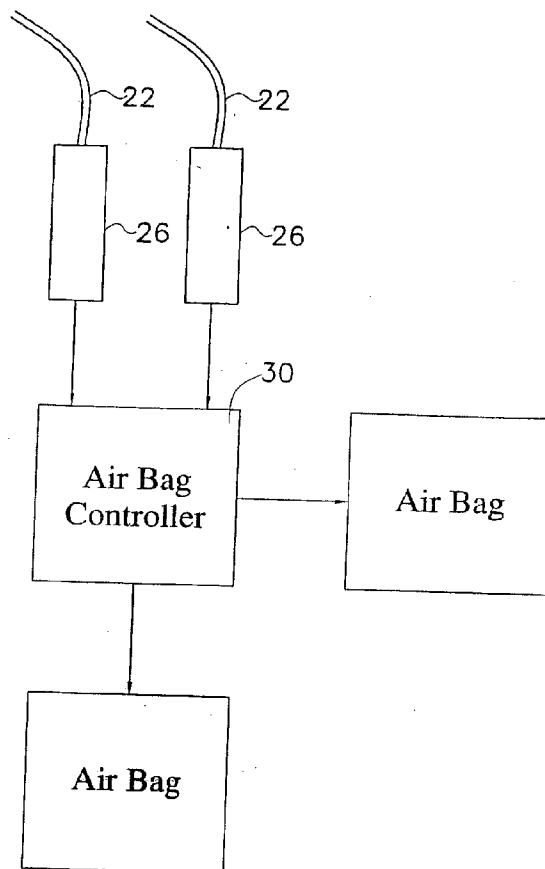
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(57) **ABSTRACT**

A weight sensing pad for controlling activation of an automobile airbag, the weight sensing pad comprising a bladder member having an interior volume defined by first and second sheets perimetrically bonded together, wherein the interior volume of the bladder member is subdivided into a plurality of cells by a plurality of small, substantially circular welds between the first and second sheets, the plurality of cells being in fluid communication with each other; and a fluid contained within the interior volume of the bladder member, whereby the automobile airbag is activated upon a change in pressure caused by displacement of a volume of the fluid in the interior volume of the bladder.

Related U.S. Application Data

(63) Continuation of application No. 11/541,670, filed on Oct. 3, 2006, now Pat. No. 8,151,654, which is a continuation of application No. 11/362,745, filed on Feb. 28, 2006, now Pat. No. 7,237,443, which is a continuation of application No. 11/110,718, filed on Apr. 21, 2005, now abandoned, which is a continuation of application No. 10/677,360, filed on Oct. 3, 2003, now abandoned, which is a continuation of application No. 09/988,206, filed on Nov. 19, 2001, now abandoned, which is a continuation of application No. 09/368,113, filed on Aug. 4, 1999, now abandoned, which is a



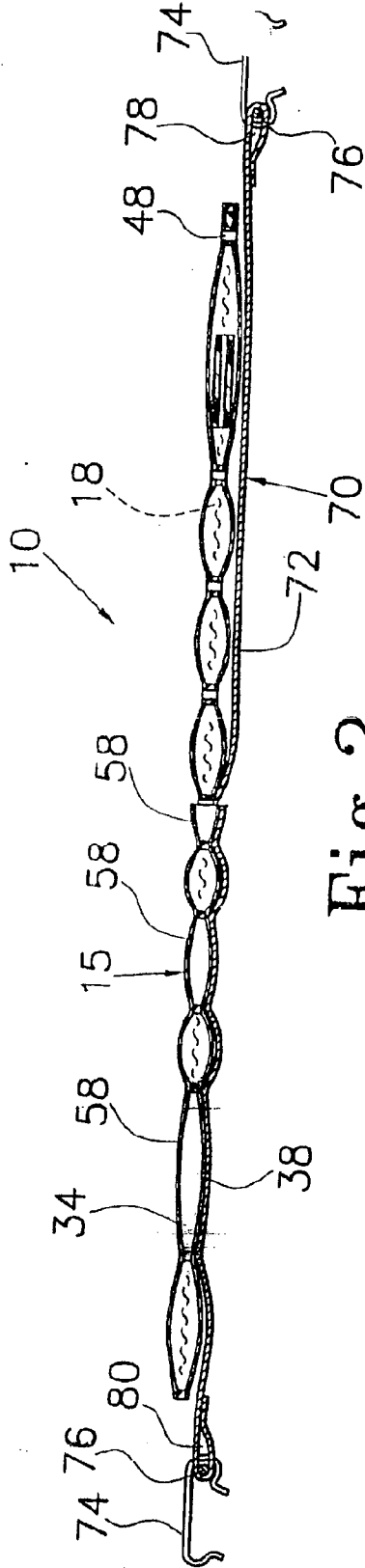


Fig. 2

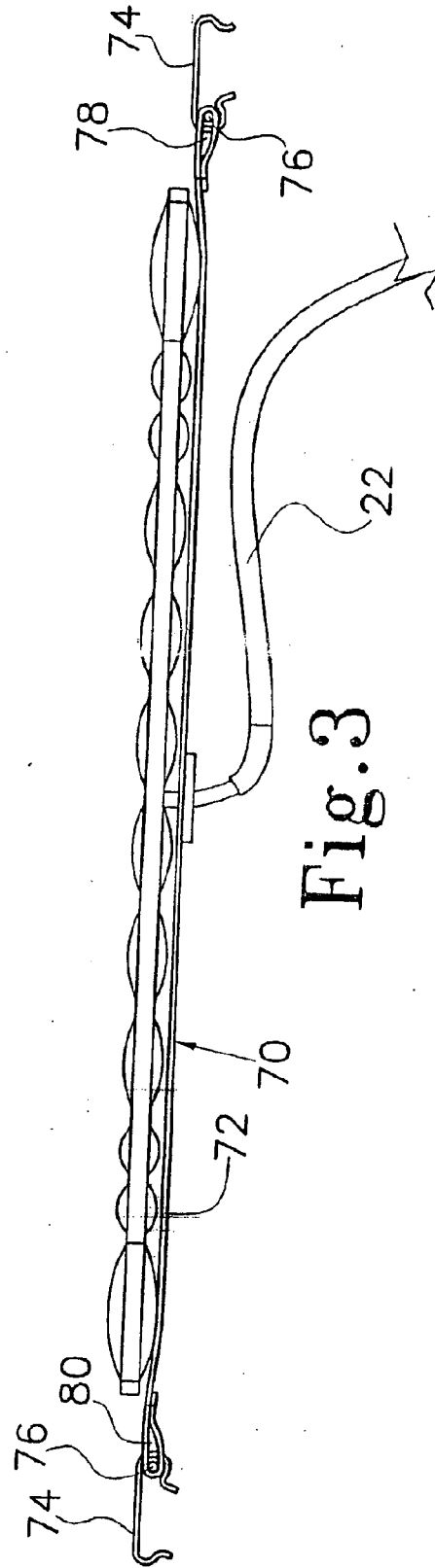


Fig. 3

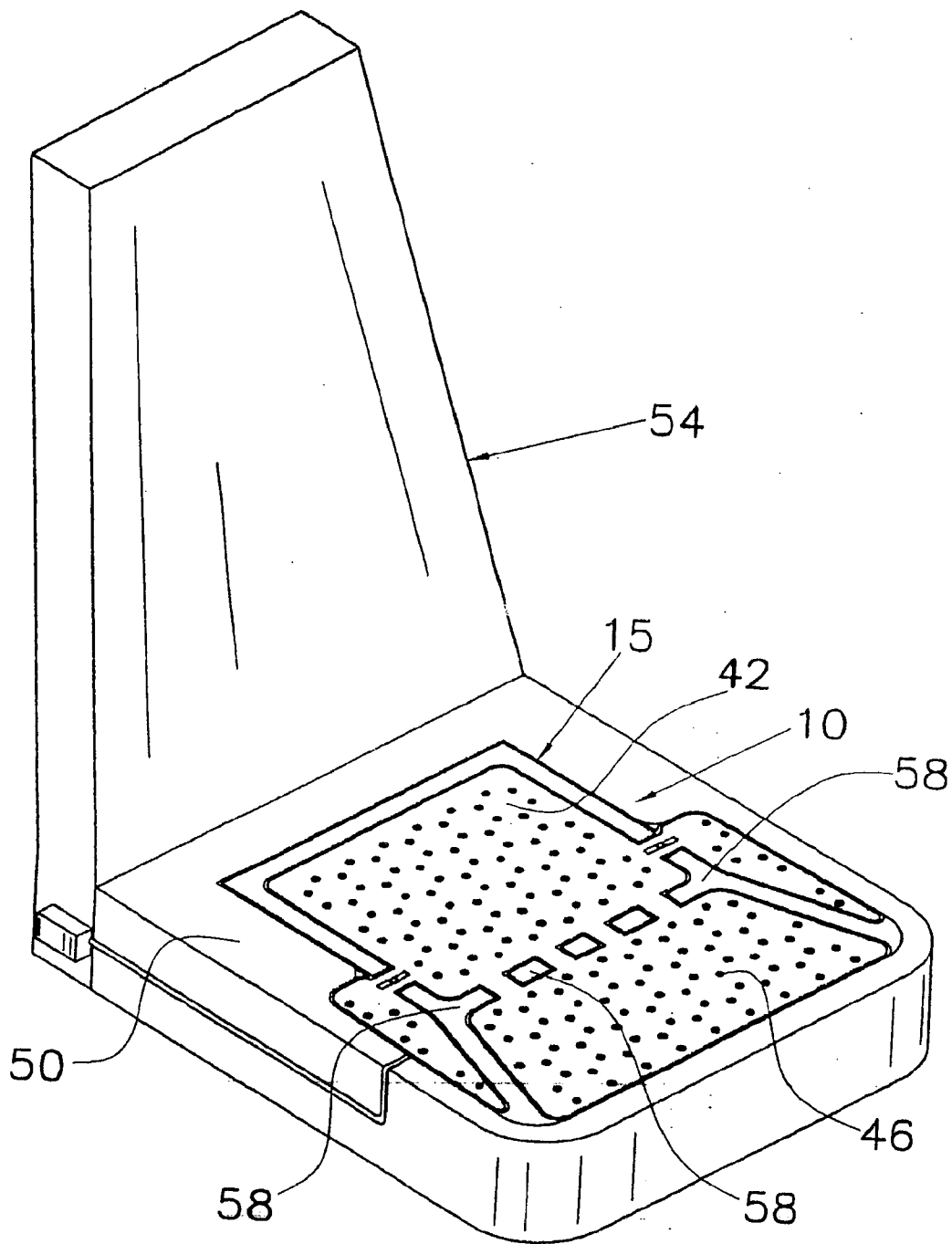


Fig.4

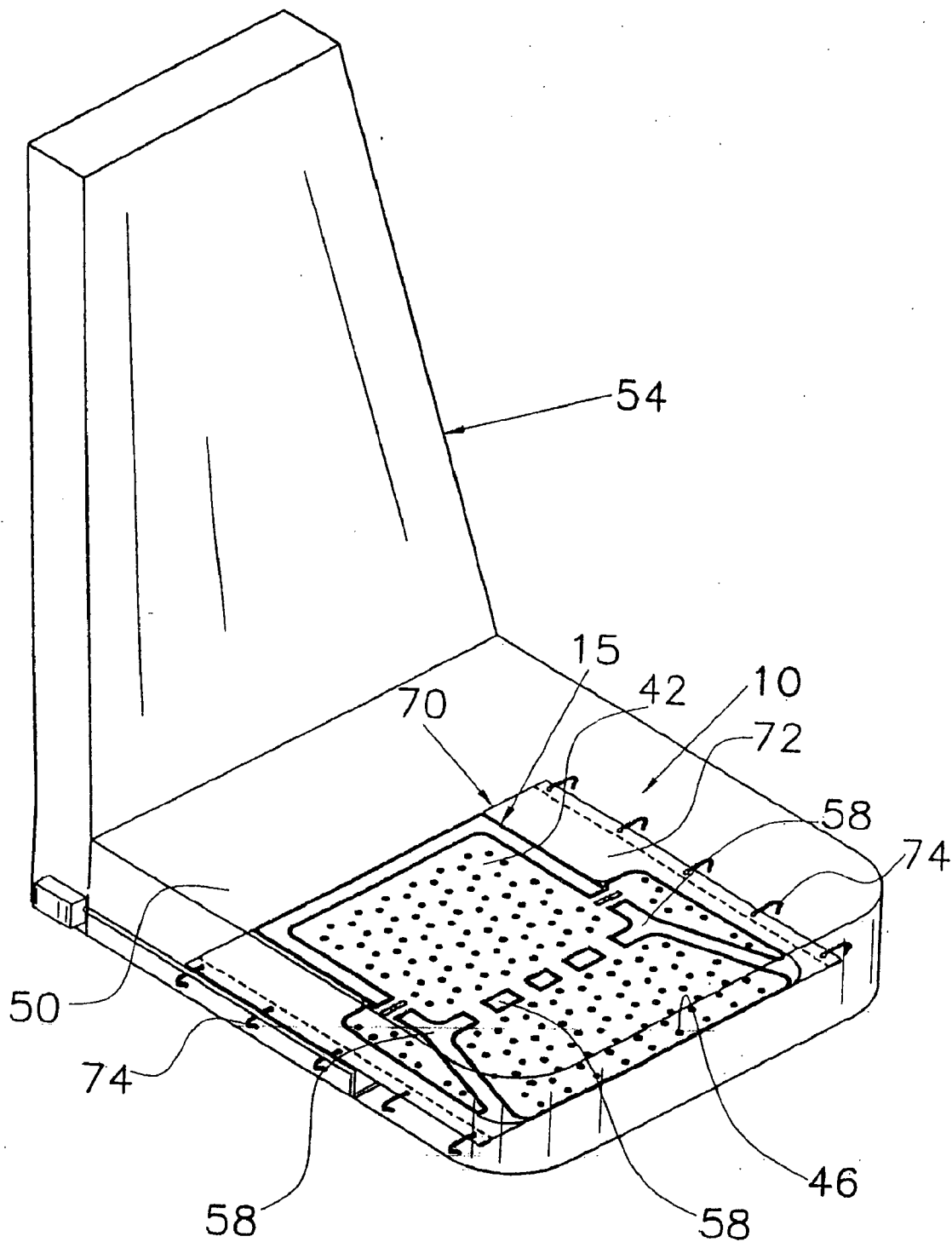


Fig.5

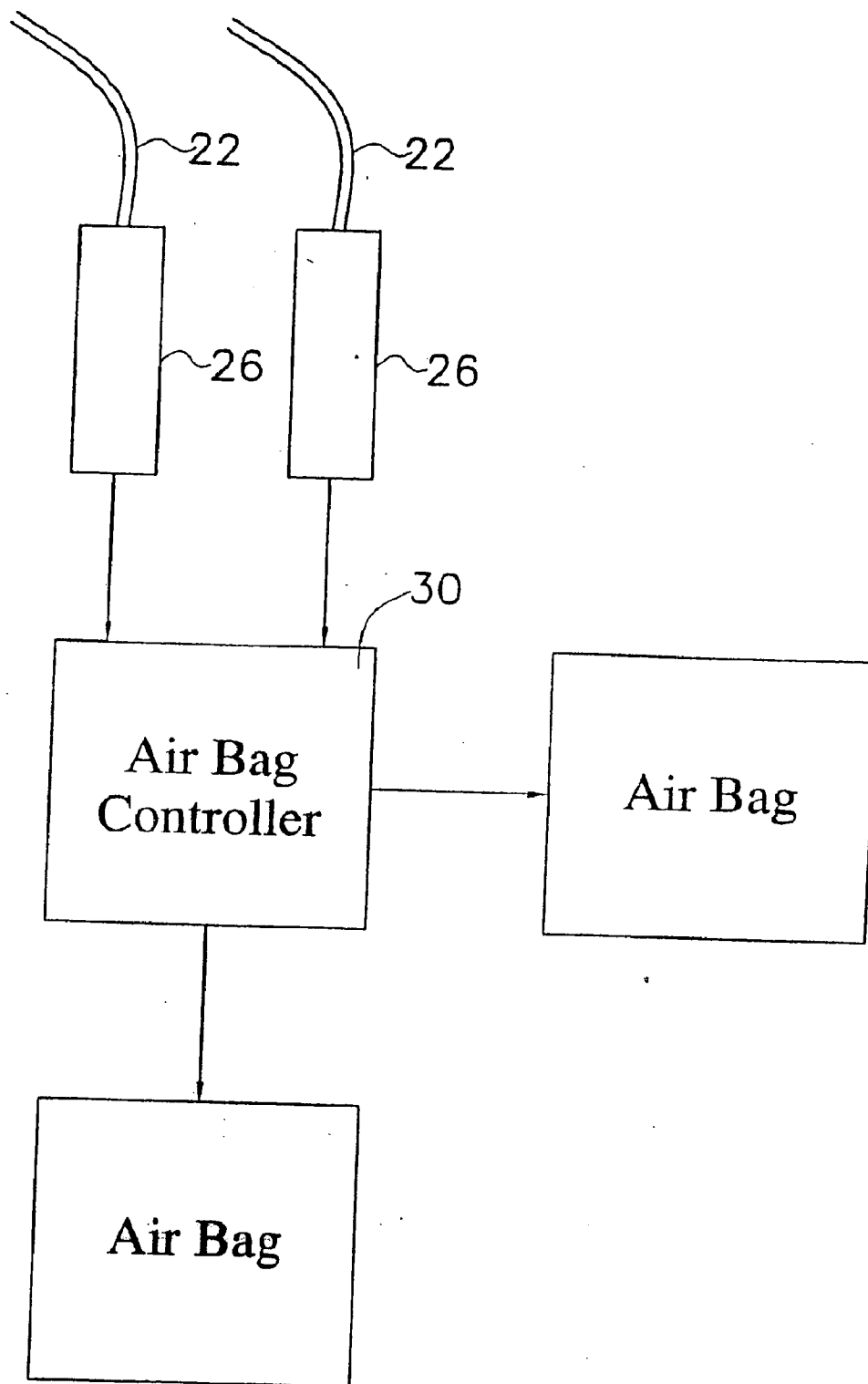
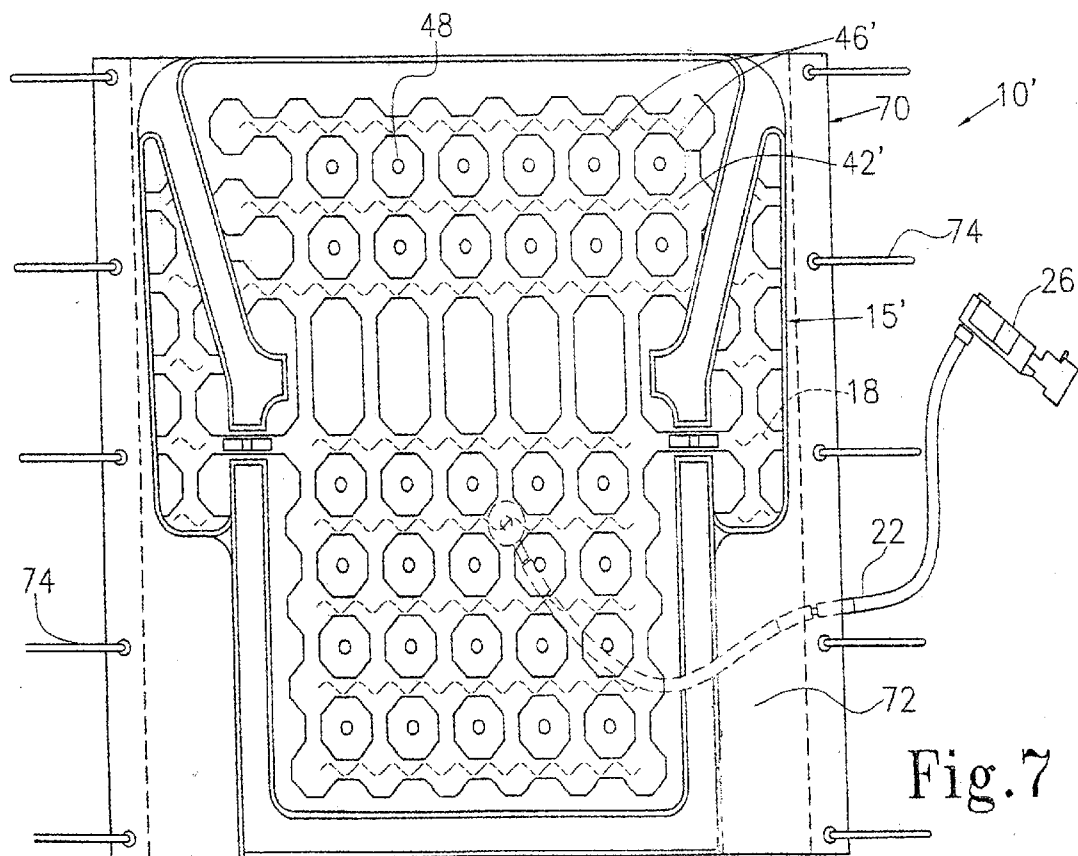
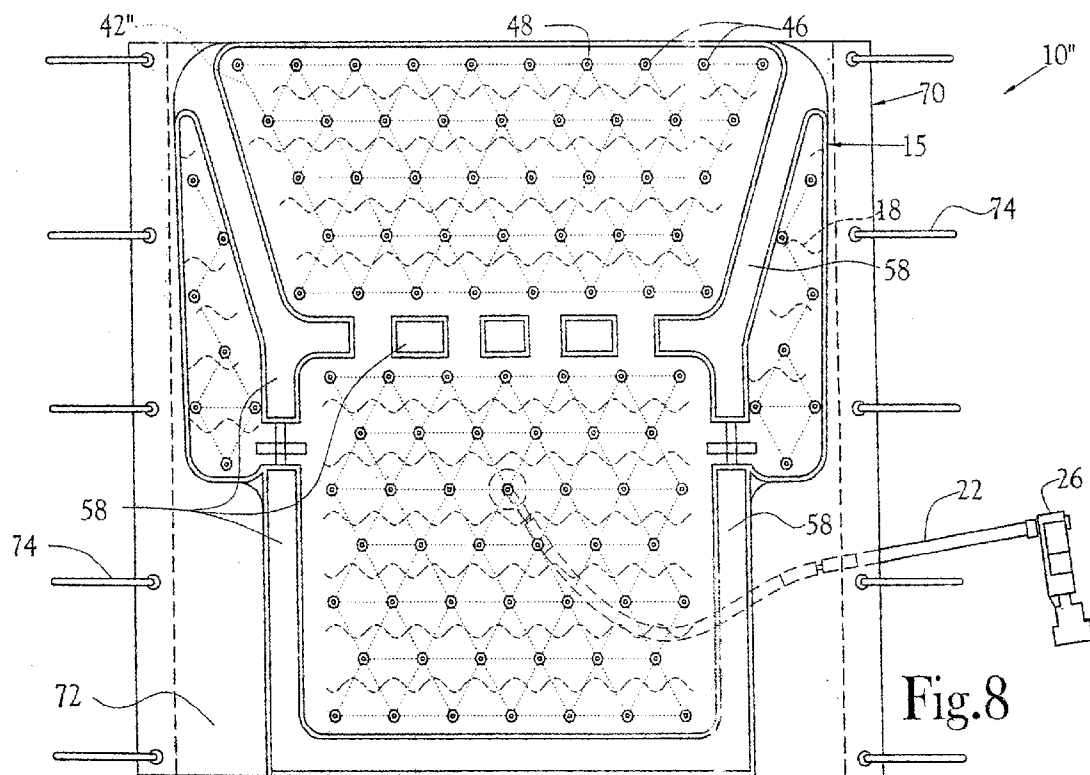


Fig.6





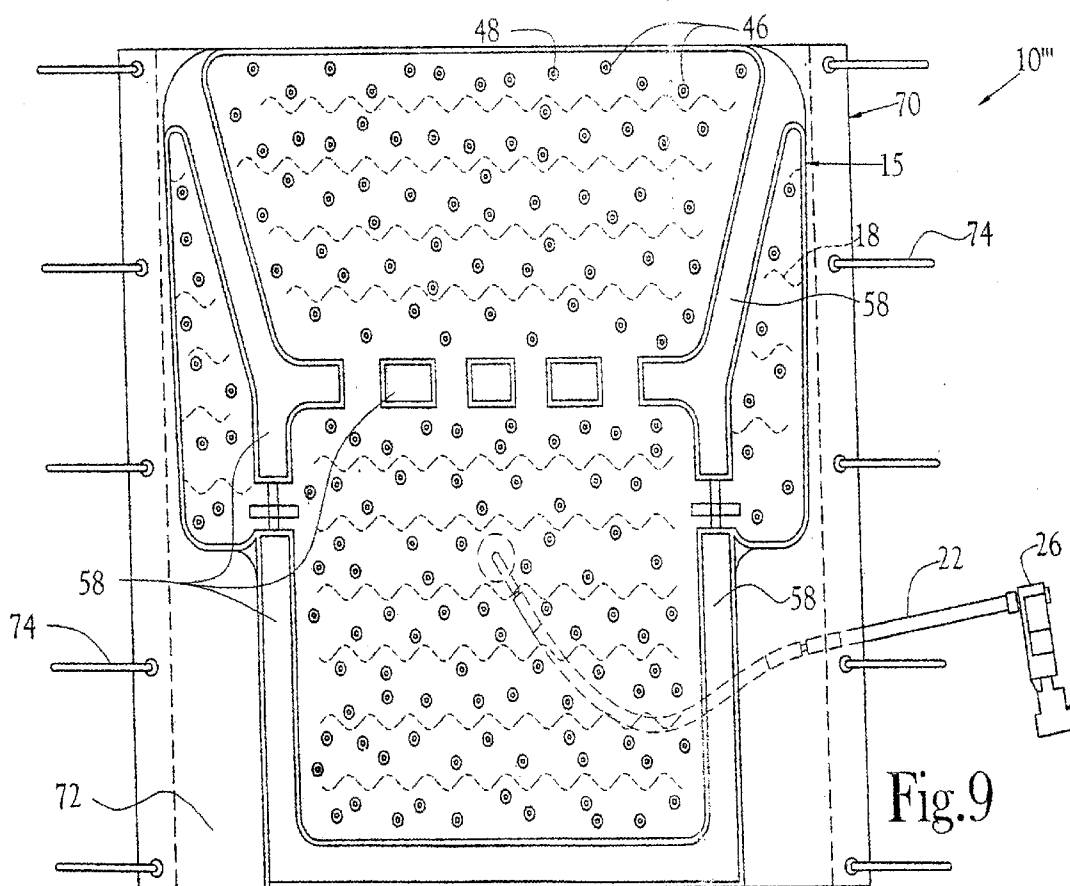


Fig.9

SENSOR PAD FOR CONTROLLING AIRBAG DEPLOYMENT AND ASSOCIATED SUPPORT

RELATED APPLICATIONS

[0001] This application is a continuation of Ser. No. 11/541,670, filed Oct. 3, 2006, which is a continuation of Ser. No. 11/362,745, filed Feb. 28, 2006 (now U.S. Pat. No. 7,237,443), which is a continuation of Ser. No. 11/110,718, filed Apr. 21, 2005 (now abandoned), which is a continuation of Ser. No. 10/677,360, filed Oct. 3, 2003 (now abandoned), which is a continuation of Ser. No. 09/988,206, filed Nov. 19, 2001 (now abandoned), which is a continuation of Ser. No. 09/368,113, filed Aug. 4, 1999 (now abandoned), which is a continuation-in-part of Ser. No. 09/146,677, filed Sep. 3, 1998 (now U.S. Pat. No. 5,975,568) which is a continuation-in-part of Ser. No. 09/072,833, filed on May 5, 1998 (now abandoned) which is a continuation-in-part of Ser. No. 29/085,897, filed on Apr. 1, 1998 (now U.S. Pat. No. D409,935) all of which are herein incorporated by reference.

FIELD OF THE INVENTION

[0002] This invention relates to the field of weight sensing pads. More particularly, it relates to a sensor pad, and associated sensor pad support, for detecting both the presence and weight of a passenger for controlling deployment of an automobile airbag.

BACKGROUND OF THE INVENTION

[0003] In recent years, airbags or self-inflating restraints, have proven to be effective in preventing injury resulting from head-on and near head-on collisions, when used correctly in conjunction with the shoulder-lap restraints. However, a small number of highly publicized incidents have highlighted a serious risk of potentially catastrophic injury to small adults, children or infants in rear-facing child-safety seats. While it is certainly advisable to place small children or infants in rear-facing child-safety seats in a rear seat, in certain types of vehicles, namely pick-up trucks, this is simply not an option. As a result, a demand has arisen for selective deployment of the automobile's self-inflating restraint. In response, certain automobile manufacturers now provide a key-switch to allow the owner/operator to choose whether or not the self-inflating restraint should be "armed" that is to say, whether the self-inflating restraint should be active and deployable in the event of a collision. However, these types of manual controls, or overrides, also carry an inherent risk. Namely the inadvertent failure to re-arm the restraint for an adult passenger, or the failure to deactivate the restraint in the event that the passenger seat is occupied by a child or safety seat. Further, the state of the art airbag deployment system does not detect whether the passenger seat is unoccupied and in the event of a collision fires the airbag, needlessly resulting in the unnecessary expense of replacing the dash and airbag mechanism.

[0004] What is missing in the art is a sensor pad that would detect the presence or absence of a person sitting in the seat and that could distinguish between an average size adult and a diminutive adult or child safety seat so as to control the deployment of an automobile self-inflating restraint, such as an airbag.

[0005] Accordingly, it is an object of the present invention to provide a sensor pad for controlling the deployment of a self-inflating restraint.

[0006] Another object of the present invention is to provide a sensor pad that is weight sensitive and that detects the presence of a person sitting in seat associated with the sensor pad and that upon detection of a person occupying the seat directs the airbag to deploy in the event of a collision.

[0007] Yet another object of the present invention is to provide a sensor pad for controlling the deployment of an automobile airbag without significantly increasing the vehicle weight or cost of manufacture.

[0008] Other objects and advantages over the prior art will become apparent to those skilled in the art upon reading the detailed description together with the drawings as described as follows.

SUMMARY OF THE INVENTION

[0009] In accordance with the various features of this invention, a sensor pad for controlling the deployment of an automobile airbag is provided. In the preferred embodiment, the weight sensing pad is used in the seat of an automobile to sense the detect the presence of the seat's occupant. The volumetric displacement of the fluid within the weight sensing pad produces a pressure change and is measured with an electronic pressure transducer and is used to determine if an airbag should be deployed upon impact in a collision. In this regard, the transducer is in electronic communication with the vehicle's airbag control module. The weight sensing pad is defined by a thin, fluid-filled bladder. The bladder is preferably constructed of two identical sheets of urethane. The urethane sheets are spot welded together at a plurality of points or areas in order to form cells, in a selected geometric configuration, in fluid communication with one another. The size, geometric configuration and cross-sectional area of the spots are selected so as to maximize performance while minimizing weight. In this regard, in order to minimize the weight of the bladder, internal volume must be small in relation to the external surface area of the weight sensing pad. The bladder in the preferred embodiment is filled with a non-compressible fluid having a very low freezing point, such that there are a minimum of air, or gas, pockets within the bladder. A silicone, such as silica gel, of medium viscosity is a suitable fluid. In a preferred embodiment, the cells may be randomly spaced.

[0010] Volumetric displacement, under pressure, of the fluid within the bladder is dependent on a number of factors such as bladder stiffness, i.e. the ability of the urethane material to resist stretching, the zero pressure volume of the bladder, the seated area of the passenger or child safety seat, and the weight of the seated passenger or car safety seat. Bladder stiffness can be measured in units of lb/in.sup.5 and can be defined to be the slope of the curve of volume change vs. pressure increase. In other words bladder stiffness=pressure change/volume change=lb/in.sup.2/in.sup.3. Bladder stiffness is a function of the physical size and shape of the individual cells as well as the thickness of the bladder material. The preferred bladder will have a high bladder stiffness. The slope of the curve is not expected to be constant. As the bladder volume increases, the slope of the curve is expected to increase.

[0011] Zero pressure volume is defined as the volume of fluid that will first cause the pressure in the bladder to increase. In order to have minimum bladder weight, the zero pressure volume should be as small as possible. Thus, the preferred bladder has a relatively small zero pressure volume and a high degree of bladder stiffness. A bladder having a

large number of relatively small internal cells in fluid communication with one another and a thin-wall bladder material meets these two criteria.

[0012] In one embodiment, the bladder is configured to be placed within the seat portion of a state of the art automobile seat. While, the bladder can be supported by a seat cushion, the bladder is preferably secured to a support member that is suspended on the seat frame. The bladder includes a pressure tube connected to a pressure activated electronic transducer that is in electronic communication with the air bag control module. As will be described in more detail below, the preferred transducer is digital and sends an arming signal to the airbag control module upon detection of a preselected pressure. The bladder further includes a plurality of securement regions for securing the bladder to the seat cushion or the support member. The bladder is formed by two urethane panels that are perimetrically sealed to each other. In the preferred embodiment, the two panels are additionally secured to one another by a plurality of relatively small, preferably circular spot welds configured to form, preferably, hexagonal-like cells that are in fluid communication with each other. Alternatively, the spot welds can be configured to form substantially triangle-like cells, that are in fluid communication with each other or can be placed randomly. In an alternate embodiment, relatively large approximately octagonal spot welds are used to form small fluid cell areas, (about thirty-three percent cell area to about sixty-seven percent weld area), thus reducing the overall weight of the liquid in the bladder.

[0013] In use, an electronic transducer is selected to generate a signal upon detection of pressure resultant from the volumetric displacement of fluid inside the bladder expected from the average size adult of approximately one hundred pounds or heavier. In an alternate embodiment, an analog transducer could be utilized to generate a signal as a function of the passenger's weight. With this information the control module would fire the airbag in accordance with a preselected set of conditions. Further information regarding passenger weight could be used to determine the force at which a variable force airbag would deploy as airbag technology advances.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 illustrates a plan view of the weight sensing pad and support member of the present invention.

[0015] FIG. 2 illustrates a cross sectional view of the weight sensing pad and support member of the present invention taken along line 2-2 in FIG. 1.

[0016] FIG. 3 illustrates and end view of the embodiment illustrated in FIG. 1.

[0017] FIG. 4 illustrates a perspective view showing the weight sensing pad positioned above the cushioning in an exemplary automotive seat.

[0018] FIG. 5 illustrates a perspective view showing the weight sensing pad positioned below the cushioning in an exemplary automotive seat.

[0019] FIG. 6 illustrates a schematic view of the control of air bag deployment by the present weight sensing pad.

[0020] FIG. 7 illustrates an alternate embodiment weight sensing pad.

[0021] FIG. 8 illustrates a further alternate embodiment weight sensing pad.

[0022] FIG. 9 illustrates still another alternate embodiment weight sensing pad.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0023] A sensor pad for controlling the deployment of an automobile airbag, constructed in accordance with the present invention, is illustrated generally as **10** in the figures. As seen in FIGS. 4 and 5, in the preferred embodiment, weight sensing pad **10** is used in the seat **54** of an automobile, (not illustrated), to detect the presence of an occupant on the seat. Weight sensing pad **10** is used in conjunction with the vehicle's airbag control module in order to allow deployment of the airbag, in the event of a collision, only if the seat is occupied by a person of above a preselected weight. Weight sensing pad **10** is defined by a bladder member **15** having an interior volume subdivided into a plurality of individual cells **42** in fluid communication with each other and that is filled with a non-compressible fluid **18**, such as silicone or a silica gel of medium viscosity. In the preferred embodiment, fluid **18** should have a very low freezing point, preferably below the temperature of reasonably anticipated atmospheric conditions to which the typical automobile is exposed. A pressure tube **22** is in fluid communication with bladder **15** and is in further fluid communication with a pressure activated electronic transducer **26** which in turn is in electronic communication with the airbag controller **30**. When a person sits upon a seat **54** in which a weight sensing pad **10** is mounted, there is a volumetric displacement of fluid **18** inside the bladder **15** causing the bladder **15** to change shape and consequently causes the pressure to increase which is measured by transducer **26**. If there is a sufficient volumetric displacement of fluid to cause sufficient pressure change to activate transducer **26**, transducer **26** sends a signal to air bag controller **30**. In other words, if a passenger that weighs in excess of a preselected weight is seated on a seat **54** in which a weight sensing pad **10** is mounted, a sufficient volumetric displacement will occur to activate transducer **26**.

[0024] In the preferred embodiment, bladder **15** is constructed of two preferably substantially identical sheets of urethane **34** and **38**. Volumetric displacement, under pressure, of fluid **18** within bladder **15** is dependent on a number of factors such as bladder stiffness, i.e. the ability of the urethane material to resist stretching, the zero pressure volume of bladder **15**, the seated area of the passenger and the weight of the seated passenger. Bladder stiffness can be measured in units of lb/in.sup.5 and can be defined to be the slope of the curve of volume change vs. pressure increase. In other words, bladder stiffness=pressure change/volume change=lb/in.sup.2/in.sup.3. Bladder stiffness is a function of the physical size and shape of the individual cells **42** as well as the thickness of urethane sheets **34** and **38**. In general, the bladder stiffness increases when the bladder pressure increases. The preferred bladder **15** will have a high bladder stiffness. The slope of the curve is not expected to be constant. As the bladder volume increases, the slope of the curve is expected to increase.

[0025] Zero pressure volume is defined as the volume of fluid **18** that will first cause the pressure in bladder **15** to increase. In order to have minimum bladder weight, the zero pressure volume should be as small as possible. Thus, the preferred bladder **15** has a relatively small zero pressure volume and a high degree of bladder stiffness. A bladder **15** having a large number of relatively small internal cells **42** in fluid communication with one another and thin-wall urethane

sheets **34** and **38** meets these two criteria. The urethane sheets **34** and **38** are spot welded together by a plurality of spot welds **46** in order to form cells **42**, which are defined by the regions between spot welds **46**, in, preferably, a selected geometric configuration, in fluid communication with one another. In the preferred embodiment, a bore hole **48** is provided through each spot weld **46** in order to provide ventilation between the passenger and the seat. The size, geometric configuration and cross-sectional area of cells **42** are selected so as to maximize performance while minimizing weight. In this regard, in order to minimize the weight of the bladder **15**, internal volume must be small in relation to the external surface area of the weight sensing pad **10**.

[0026] The bladder further includes a plurality of securement regions **58** for securing bladder **15** in the seat area **50** either to the seat cushion directly or preferably to support member **70**. In this regard, in the preferred embodiment, securement regions **58** are defined by fluid-void regions not in fluid communication with the fluid filled interior volume of bladder **15**. Support member **70** is defined by a planar piece of fabric **72** and includes at least one hook member **74** which engages the seat frame (not shown). In this regard, in the preferred embodiment, at least one rigid rod member **76** is disposed in each of two loops **78** and **80** which are in spaced relation from each other. Hooks **74** are carried by rigid rod member **76**. A seat cushion overlies sensor pad **10** and is also supported by support member **70**.

[0027] In the preferred embodiment, spot welds **46** are relatively small, circular and are selectively positioned so as to form substantially hexagonal cells **42** that are in fluid communication with each other. While hexagonal cells are preferred, other geometrically shaped cells could be utilized. For example, FIG. **8** illustrates cells **42'** that are substantially triangular. And, while not as efficient, as the previously described geometrically shaped cells, the spot welds **46** could be randomly placed as illustrated in FIG. **9**. In an alternate embodiment, illustrated in FIG. **7**, relatively large octagonal spot welds **46'** are used to form small fluid cell areas **42'**, (about thirty-three percent cell area to about sixty-seven percent weld area), thus reducing the overall weight of the bladder **15'**. As above, a bore hole **48** is provided through each spot weld **46'** in order to provide ventilation between the passenger and the seat.

[0028] In use, electronic transducer **26** is selected to generate a signal upon detection of pressure resultant from the volumetric displacement of fluid **18** from bladder **15** expected from the average size adult of approximately one hundred pounds or heavier. Thus, for a small adult or child less than one hundred pounds, or if a child seat is positioned on the seat, there will be insufficient volumetric displacement to cause a pressure change to activate transducer **26** and the airbag controller will not arm the airbag to deploy in the event of a collision. In an alternate embodiment, an analog transducer could be utilized to generate a signal proportional to the passenger's weight. With this information the control module would fire the airbag in accordance with a preselected set of conditions. Further information regarding passenger weight could be used to determine the force at which a variable force airbag would deploy as airbag technology advances.

[0029] From the foregoing description, it will be recognized by those skilled in the art that a weight sensing pad for controlling deployment of an automobile airbag offering advantages over the prior art has been provided. Specifically, the sensor pad for controlling the deployment of a self-inflat-

ing restraint provides a sensor pad that is weight sensitive and that detects the presence of a person of a selected weight sitting in seat associated with the sensor pad and that upon detection of a person of a selected weight occupying the seat directs the airbag to deploy in the event of a collision without significantly increasing the vehicle weight or cost of manufacture.

[0030] While a preferred embodiment has been shown and described, it will be understood that it is not intended to limit the disclosure, but rather it is intended to cover all modifications and alternate methods falling within the spirit and the scope of the invention as defined in the appended claims.

What is claimed is:

1. A weight sensing pad for controlling activation of an automobile airbag, said weight sensing pad comprising:
 - a bladder member having an interior volume defined by first and second sheets perimetrically bonded together, wherein said interior volume of said bladder member is subdivided into a plurality of cells by a plurality of small, substantially circular welds between said first and second sheets, said plurality of cells being in fluid communication with each other, said plurality of cells having a substantially non-square shape, and said plurality of cells being randomly spaced; and
 - a fluid contained within said interior volume of said bladder member,
 whereby said automobile airbag is activated upon a change in pressure caused by displacement of a volume of said fluid in said interior volume of said bladder.
2. The weight sensing pad of claim **1**, wherein said plurality of cells are uniformly shaped.
3. The weight sensing pad of claim **1**, wherein said fluid is non-compressible and has a low freezing point.
4. The weight sensing pad of claim **1**, wherein said weight sensing pad further comprises a pressure activated electronic transducer in fluid communication with said bladder member and in electronic communication with an airbag control module, wherein said transducer is induced to emit a signal in response to the detected change in the pressure; and
- a pressure tube interconnected between and in fluid communication with said bladder member and said transducer.
5. The weight sensing pad of claim **1**, wherein said weight sensing pad further comprises at least one securement region for facilitating securement of said weight sensing pad to an automobile seat.
6. The weight sensing pad of claim **1** wherein said weight sensing pad further comprises at least one support member for engaging a seat frame, said support member being defined by a planar support panel that has engagement members that couple with said seat frame wherein said bladder member is secured to said support member.
7. The weight sensing pad of claim **1**, wherein a bore is provided in substantially each of said plurality of small, substantially circular welds.
8. The weight sensing pad of claim **1**, wherein said plurality of cells are substantially triangularly shaped.
9. A weight sensing pad for an automobile seat, said weight sensing pad comprising:
 - a bladder member having an interior volume defined by first and second sheets perimetrically bonded together, said interior volume of said bladder member being sub-

divided into a plurality of substantially hexagonal shaped cells in fluid communication with each other by a plurality of small, substantially circular welds between said first and second sheets, said plurality of substantially hexagonal shaped cells being randomly spaced; and

a fluid contained within said interior volume of said bladder member,

whereby said automobile airbag is activated upon a change in pressure caused by displacement of a volume of said fluid in said interior volume of said bladder.

10. The weight sensing pad of claim **9**, wherein a bore is provided in substantially each of said plurality of bonded regions.

11. The weight sensing pad of claim **9**, further comprising a pressure activated electronic transducer in fluid communication with said bladder member and in electronic

communication with an airbag control module, wherein said transducer is induced to emit a signal in response to the detected change in the pressure; and

a pressure tube interconnected between and in fluid communication with said bladder member and said transducer.

12. The weight sensing pad of claim **9**, wherein said fluid is non-compressible.

13. The weight sensing pad of claim **9**, wherein said weight sensing pad further comprises at least one support member for engaging a seat frame, said support member being defined by a planar support panel that has engagement members that couple with said seat frame wherein said bladder member is secured to said support member.

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