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(54) Title: BELT FORCE SENSOR

(57) Abstract: An occupant restraint assembly and for a motor vehicle operates to sense the tension forces on a seat belt to detect the presence of a human occupant or a child restraint seat. A sensor attached to the seat belt measures tension forces. The sensor is mounted in line with the seat belt. A strain gauge senses tension on the seat belt. An additional embodiment of the sensor includes three prongs attached to a common beam that allow the sensor to be slipped onto the seat belt without modification to the seat belt. A middle prong includes the strain gauge to sense movement relative to outside prongs. The seat belt threads over the outside prongs and under the middle prong such that tension on the seat belt forces the middle prong transversely to tension exerted on the seat belt.

BELT FORCE SENSOR

BACKGROUND OF THE INVENTION

This invention relates to a passenger restraint assembly having a sensor for detecting seat belt tension to indicate the presence of a child restraint seat.

Typically, a motor vehicle will include an air bag system to deploy an air bag cushion to protect passengers in the event of a collision. Air bag cushion deployment must necessarily by quick in order to prevent injury caused by the collision. The speed of deployment of the air bag cushion and the accompanying force of the inflating air bag cushion makes deployment of the air bag cushion to protect small children undesirable. Further, the use of a child restraint seat is not compatible with the intended operation of the air bag system. Although warnings of and prohibitions against the seating of children or the use of child restraint seats where an air bag may deploy are now standard in vehicles equipped with an air bag system, such warning may be ignored, causing undesirable results.

Passive warnings and notices may be supplemented with an active system that senses the type of occupant utilizing the seat and disables air bag deployment based on predetermined criteria. One such system known in the art is a weight based occupant detection system. A weight-based system includes sensors placed in the seat that allow a determination of the weight of the occupant in that seat. Such systems are set to disable the air bag upon a determination that an occupant is below a certain predetermined weight. Such systems work well, however, such a system can be fooled by the placement of child restraint seat over the weight sensors. Typically, the child restraint seat is secured to a seat of a motor vehicle by threading the seat belt around or through the child restraint seat. The seat belt of the motor vehicle does not actually secure the child as is normal when used to secure and adult. Instead the seat belt is used to secure the seat, and then the seat secures the child. Because the seat belt is securing the child restraint seat, it will be pulled tighter than when normally used to secure a human occupant. Pulling of the seat belt tightly around the child restraint seat will provide a large force on the seat, and thereby the weight sensors. Such a force can fool the weight sensor system into believing that a large adult is seated in the passenger seat

rather than the child restraint seat and therefore not disable deployment of the air bag cushion.

For these reasons it is desirable and necessary to develop a method and device that can detect and differentiate between the presence of an adult occupant and a child restraint seat such that deployment of the air bag cushion can be disabled when the seat is occupied by a child restraint seat.

SUMMARY OF THE INVENTION

The invention is an assembly and method for sensing the tension forces on a seat belt such that a determination can be made as to the presence of a human occupant or a child restraint seat.

The assembly includes a seat belt attached to an interior support of the motor vehicle. Attached to the seat belt is a sensor that measures the tension forces exerted on the seat belt. Forces above a predetermined magnitude not tolerable by the human occupant indicates the presence of a child restraint seat and thereby provides the information needed to signal disable deployment of the air bag cushion. The sensor of a first embodiment is mounted in line with the seat belt by looping ends of the seat belt through the sensor. A center section of the sensor connects a strain gauge to detect tensile forces exerted on the seat belt. The strain gauge is electrically connected to a controller mounted within the motor vehicle for use in determining if deactivation of the air bag is necessary.

Another embodiment of the invention includes three prongs attached to a common beam. A middle prong includes the strain gauge that operates to sense movement relative to at least two outside prongs. The seat belt is threaded over the outside prongs and under the middle prong. This configuration provides for the installation of the sensor without modification to the seat belt. Tension on the seat belt operates to force the middle prong to move substantially perpendicular to the tension of the belt. The strain gauge mounted on the middle prong senses the amount of movement and signals the controller. The amount of movement of the middle prong is proportional to the tension force placed on the belt, which is used to determine the presence of an adult occupant or a child restraint seat.

The invention also includes a method of differentiating between the presence of a human occupant and a child restraint seat in a motor vehicle. The method includes the steps of sensing tension exerted on a seat belt, communicating the magnitude of the sensed tension to a controller, comparing the magnitude of tension to a predetermined tension, and determining that a child restraint seat is present if the sensed tension is greater than the predetermined tension.

The method and assembly of the subject invention provides the necessary information to detect and differentiate between the presence of an adult occupant and a child restraint seat such that deployment of a vehicle air bag can be prevented when a child restraint seat occupies the seat

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

Figure 1 is perspective view of a seat and the occupant restraint assembly positioned within a motor vehicle;

Figure 2 is a perspective view of the first embodiment of the force sensor;

Figure 3 is an exploded view of the first embodiment of the force sensor;

Figure 4 is a view of the first embodiment enclosed in the housing; and

Figure 5 is a perspective view of a second embodiment of the force sensor with the seat belt attached.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, the subject invention is an occupant restraint assembly generally shown at 10 in Figure 1. The assembly 10 includes a seat belt 12 having two sections 14, 16 and a sensor 18. The assembly 10 is disposed within the interior of a motor vehicle 20 having an air bag system 22. A controller 24 is disposed within the motor vehicle 20 and communicates with the sensor 18 by electrical leads

26. The controller 24 also is in communication with the air bag system 22. Typically the air bag system 22 is disposed within a dashboard 28 and positioned to provide protection to a passenger seated in a passenger seat 30. It will be appreciated to those knowledgeable in the art that the subject invention may be placed anywhere and integrated into any seat belt restraint system positioned anywhere within the motor vehicle 20 and coupled with the air bag system 22. The sensor 18, is preferably located on the static or non-retracting section of the seat belt 12.

Referring to Figure 2, the sensor 16 includes prongs 32 that extend from a common beam 34. The prongs 32 include a middle prong 36 disposed between two outside prongs 38. A strain gauge 40 is disposed on the middle prong 36 for sensing movement of the middle prong 36. The strain gauge 40 may be of any type known by a worker knowledgeable in the art. The strain gauge 40 is electrically attached to the controller 24 of the motor vehicle 20 by way of the leads 26.

The sensor 18 is attached by threading the seat belt 12 over the outside prongs and under the middle prong 36 creating a loop 42 in the seat belt 12. Tension on the seat belt 12, in the direction indicated by arrows A, force the loop 42 to straighten, thereby exerting a force on the middle prong 36 in a direction transverse to the tension on the seat belt as indicated by arrow B. The movement of the middle prong 36 caused by the straightening of the seat belt 12 is sensed by the strain gauge 40. Movement of the middle prong 36 is proportional to the tension exerted on the seat belt 12 and therefore provides for a measurement of the forces exerted on the seat belt 12 and that measurement is communicated to the controller 24.

Referring to Figure 3 and 4, a housing 44 and cover 46 encloses the sensor 18 to protect against errant contact. The housing 44 and cover 46 also conceals the sensor 18 and accompanying leads 26 to provide a more pleasing appearance. The housing 44 and cover 46 are preferably fabricated from plastic and are assembled by a simple snap fit configuration 48. As appreciated, the housing 44 and cover 46 arrangement may be of any type known in the art.

An additional embodiment discloses an inline sensor 60 and is shown in Figure 5. The inline sensor 60 of the additional embodiment includes a tensile section 50 disposed between belt ring sections 52. The inline sensor 60 is attached in line with the

seat belt 12 by splicing the sensor 60 into the seat belt 12. Splicing is accomplished by looping ends 54 of the seat belt 12 through the belt ring sections 52 and securing the seat belt 12 back onto itself. A strain gauge 56 is disposed on the tensile section 50 and is electrically connected to the controller by leads 26. The strain gauge 26 measures tension on the seat belt 12, (shown by arrows C). Measurement of tension exerted on the seat belt 12 is directly measured because the inline sensor 60, being in line with the seat belt 12 encounters the tension in the same direction and magnitude as the seat belt 12.

The measured tension is communicated to the controller 24 and compared to a predetermined tension. The predetermined tension is of a magnitude greater than that normally exerted on a human occupant that would not be tolerable to the human occupant, but would by indicative of the magnitude of force exerted on the seat belt 12 to hold a child restraint seat 58 (shown in Figure 1) in place.

The subject invention also includes a method of differentiating between a human occupant and the child restraint seat 58 such that the air bag system 22 can be disabled if the child restraint seat 58 is detected. The method includes the sensing of the tension exerted on the seat belt 12 by providing a sensor 18, 60, on the seat belt 12 to communicate the magnitude of tension on the seat belt 12 to the controller 24. As described above, tension is sensed by the use of strain gauge 40, 56 disposed on the sensor 18,60. The strain gauge 40,56 senses the amount of strain placed on the sensor 18, 40 by the seat belt 12. The sensed tension is compared to the predetermined tension. As described above, the predetermined tension is a tension determined to be intolerable to a human occupant and indicative of the magnitude of tension commonly used to secure the child restraint seat 58 within the motor vehicle 20. If the magnitude of tension on the seat belt 12 is below the predetermined magnitude, the air bag system 22 will remain enabled. However, if the measured magnitude of tension is above the predetermined magnitude, the air bag system 22 will be disabled due to the indication of the presence of the child restraint seat 58.

The foregoing description is exemplary and not just a material specification. The invention has been described in an illustrative manner, and should be understood that the terminology used is intended to be in the nature of words of description rather

than of limitation. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, one of ordinary skill in the art would recognize that certain modifications are within the scope of this invention. It is understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.

CLAIMS

1. An occupant restraint assembly for a motor vehicle having an air bag system, said assembly comprising;

a seat belt assembly having at least two sections lockable to each other;

a sensor assembly attached to at least one of said belt sections that operates to sense tension on said belt;

a controller electrically connected to said sensor and the air bag system such that a magnitude of tension on said belt above a predetermined magnitude indicates the presence of a child restraint seat.

2. The assembly of claim 1, wherein the motor vehicle includes an air bag system, and said controller communicates with said air bag system and disables deployment of said air bag system upon the indication of the presence of the child restraint seat.

3. The assembly of claim 1, wherein said sensor assembly includes a strain gauge that operates to sense strain on said sensor and thereby tension on said belt.

4. The assembly of claim 1, wherein said sensor is attached in line with one of said belt sections.

5. The assembly of claim 3 wherein said sensor includes a carrier having a tensile section and said strain gauge is disposed within said tensile section.

6. The assembly of claim 5, wherein said carrier includes two belt loops disposed on opposite ends of said tensile section, and said sensor is attached in line with one on of said belt sections at said belt loops.

7. The assembly of claim 1, wherein said sensor includes three prongs extending from a common beam that can be attached to said belt sections without modification of said belt.

8. The assembly of claim 7, wherein a middle prong is disposed between outside prongs and includes a strain gauge that operates to measure movement of said middle prong.

9. The assembly of claim 7, wherein, said belt is threaded through said prongs such that tension on said belt operates to force said middle prong in a direction transverse to the tension on said belt and tension on said belt is proportional to the movement of said middle prong such that tension forces on said belt can be determined.

10. The assembly of claim 1, wherein said sensor includes three prongs extending from a common beam and said belt is threaded over said outside prongs and under said middle prong such that tension on said belt will force movement of said middle prong in a direction transverse to said tension forces on said belt.

11. The assembly of claim 1, wherein said sensor is disposed in a housing having a cover.

12. The assembly of claim 11, wherein said housing is fabricated from plastic and said cover snaps onto said housing.

13. An occupant restraint assembly for a motor vehicle having an air bag system, said assembly comprising;

a belt assembly having at least two sections for locking engagement;

a sensor assembly having a tensile section and belt loop sections disposed on opposite sides of said tensile section, said sensor attached to said belt loop sections such that said sensor is in line with said belt;

a strain gauge disposed on said tensile section that operates to sense strain on said sensor and thereby tension on said belt.

a controller electrically connected to said sensor and the air bag system such that a magnitude of tension on said belt above a predetermined magnitude operates to disable deployment of the air bag system.

14. A seat belt tension sensor assembly for a motor vehicle having a seat belt assembly and an air bag system, said assembly comprising;

at least three prongs extending from a common beam, said prongs attached to said seat belt without modification of the seat belt;

a strain gauge disposed on one of said prongs to generate a force signal representative of a force exerted on the seat belt.

15. The assembly of claim 14, wherein said force signal is received by a controller disposed within the motor vehicle, said controller signals the air bag system to disable deployment of the air bag system if the force signal exceeds a predetermined magnitude that indicates the presence of a child restraint seat.

16. The assembly of claim 14, wherein said prongs are further defined as a middle prong disposed between outside prongs and said strain gauge is disposed on said middle prong to measure movement of said middle prong.

17. The assembly of claim 14, wherein the seat belt is threaded through said prongs such that tension on the seat belt operates to move said middle prong in a direction transverse to tension on the seat belt, movement of said middle prong being proportional to tension on the belt such that tension forces on the seat belt are measured.

18. The assembly of claim 14, wherein said prongs are further defined as a middle prong and outside prongs and the seat belt is threaded over said outside prongs and under said middle prong such that tension on the seat belt forces movement of said middle prong in a direction transverse to said tension forces on the seat belt.

19. The assembly of claim 14, wherein said sensor is disposed in a housing having a cover.

20. The assembly of claim 14, wherein said housing is fabricated from plastic and said cover snaps onto said housing.

21. A method of differentiating between the presence of a human occupant and a child restraint seat in a motor vehicle, said method comprising the steps of;

sensing tension exerted on a seat belt;

communicating the magnitude of the sensed tension to a controller;

comparing the magnitude of tension to a predetermined tension; and

determining that a child restraint seat is present if the sensed tension is greater than the predetermined tension.

22. The method of claim 21, wherein the motor vehicle includes an air bag system, and further includes the step of disabling deployment of the air bag system upon determining the presence of the child restraint seat.

23. The method of claim 22, wherein the predetermined tension is further defined as the tension that is normally not tolerable for human occupants and that which is normally exerted to secure a child restraint seat in place.

24. The method of claim 23, wherein the sensing step further includes the step of providing a sensor disposed on the seat belt having a strain gauge to sense tension forces exerted on the seat belt.

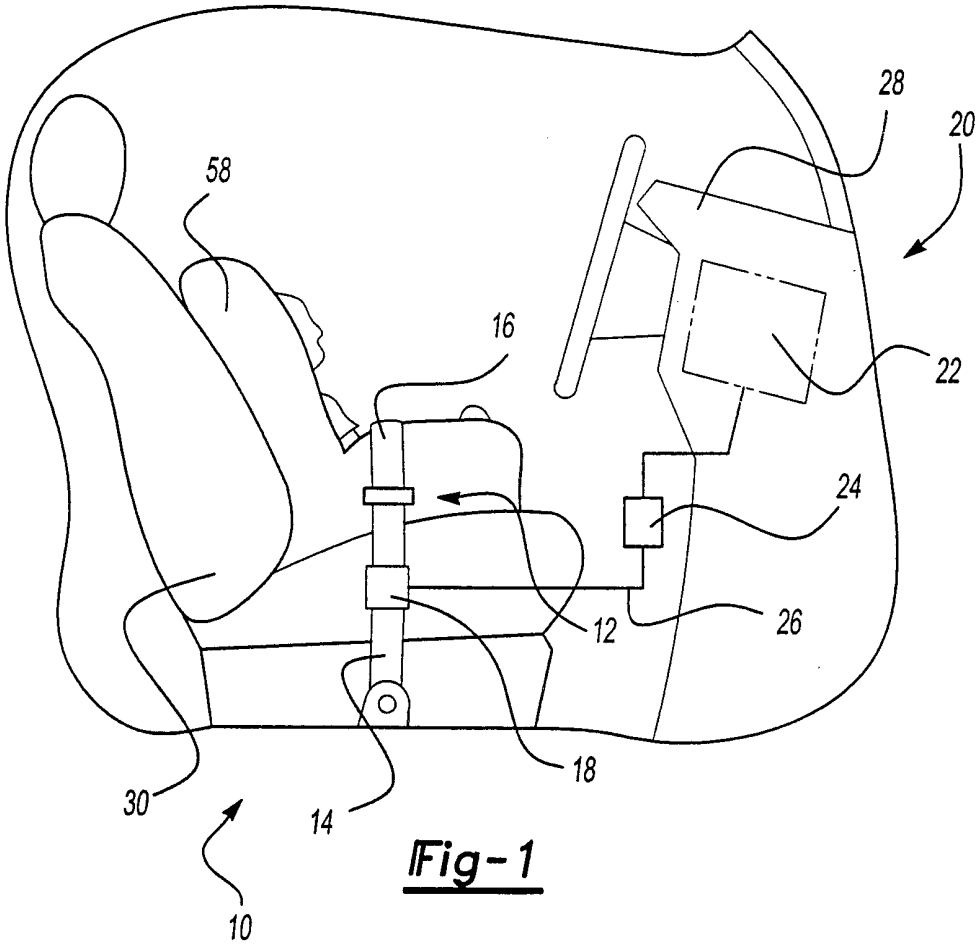

Fig-1

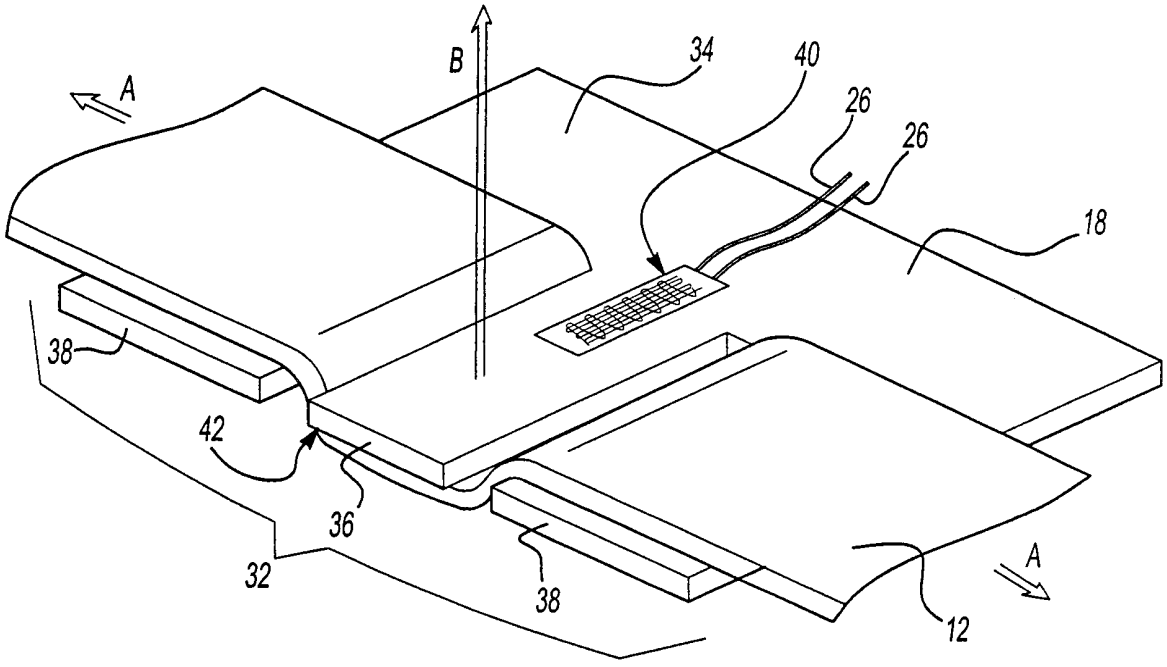

Fig-2

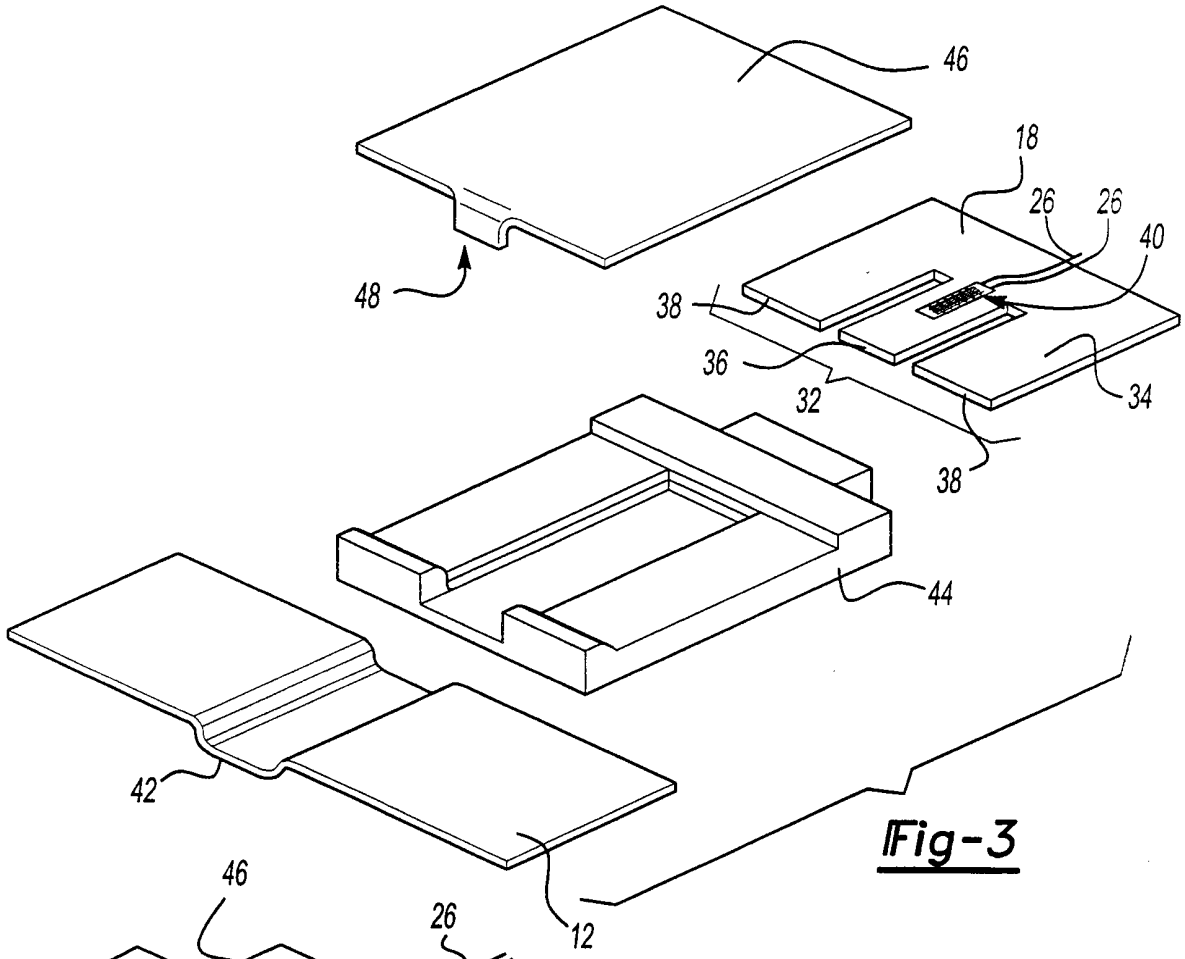

Fig-3

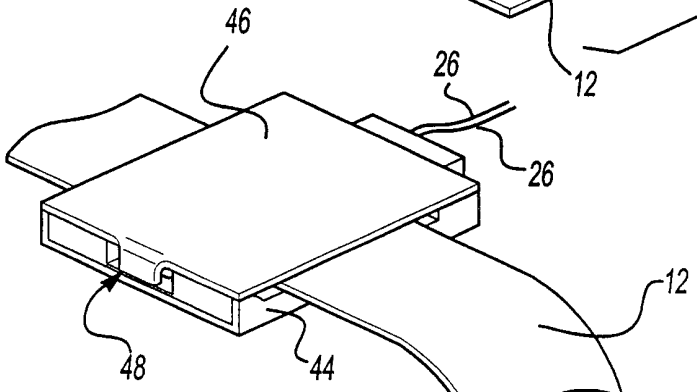

Fig-4

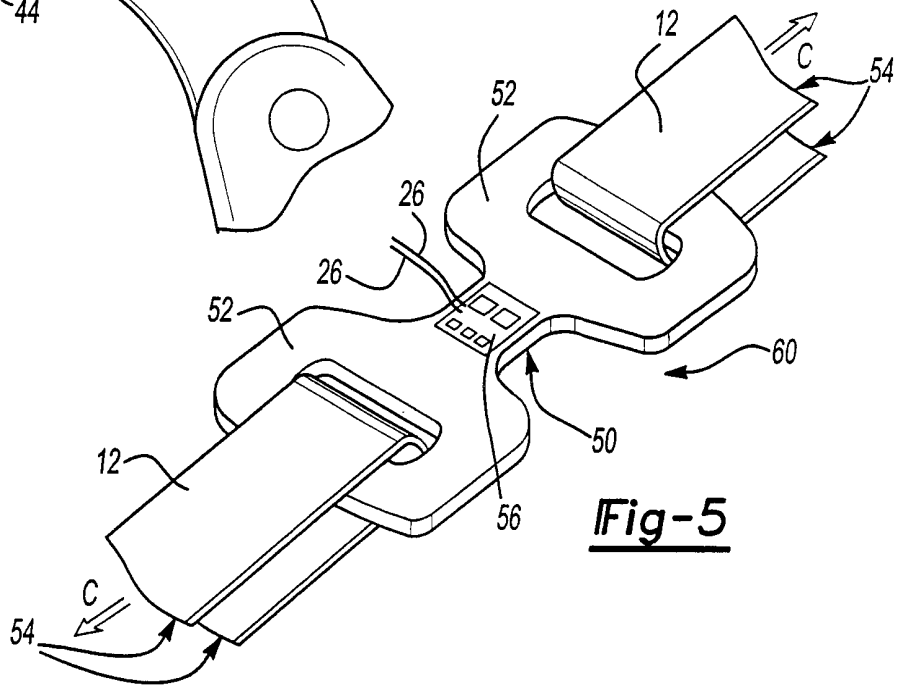

Fig-5

INTERNATIONAL SEARCH REPORT

Ir. .national Application No
PCT/US 01/02178

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R21/01 B60R22/00

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 7 B60R

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 996 421 A (HUSBY HARALD SNORRE) 7 December 1999 (1999-12-07) figures abstract	1-5, 21-24
A	column 2, line 39 -column 4, line 55	6,7,10, 11,13-15

X	WO 99 29538 A (AUTOMOTIVE SYSTEMS LAB) 17 June 1999 (1999-06-17) figures	1-4,11, 21-23
A	page 1, line 14 -page 9, line 27	5,7,10, 12-15, 19,20,24

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

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
29 June 2001	06/07/2001

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, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	D'sylva, C

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/02178

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X Y A	WO 99 12012 A (BREED AUTOMOTIVE TECH) 11 March 1999 (1999-03-11) figures 2-5 abstract page 5, line 20 -page 10, line 2 ---	1-4,21, 22 23,24 5,7, 10-15, 19,20
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P,X	WO 01 02219 A (SIEMENS AUTOMOTIVE CORP LP) 11 January 2001 (2001-01-11) figures abstract page 3, line 26 -page 6, line 9 ---	1-4, 21-23
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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