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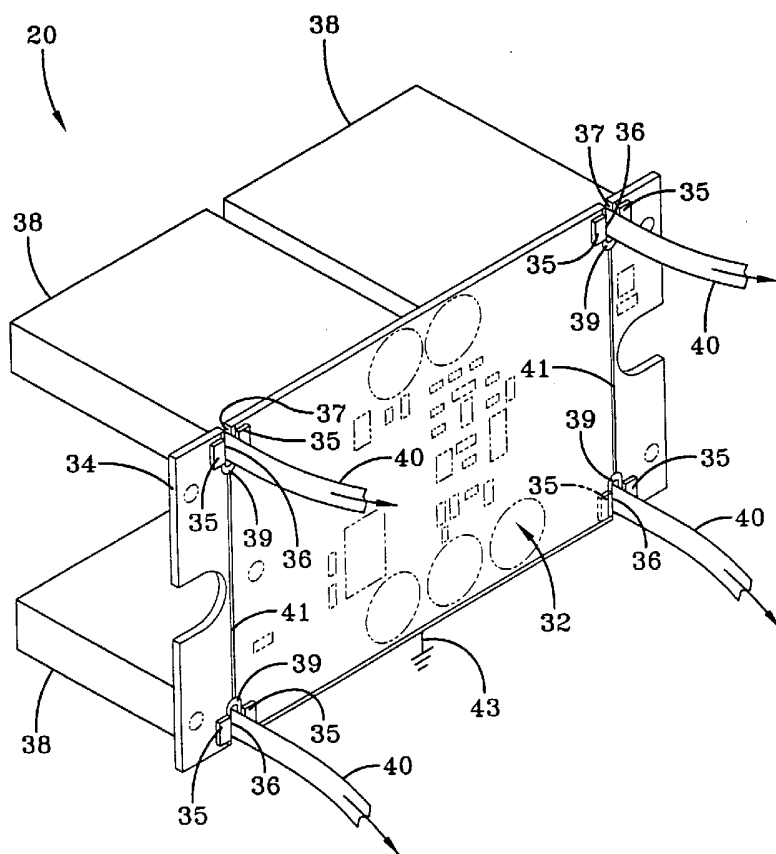
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[Continued on next page]

(54) Title: AIRBAG DEPLOYMENT RATE SENSOR WITH ELECTROSTATIC DISSIPATIVE GUIDE SLOTS



(57) Abstract: An airbag deployment rate sensor assembly (20) has a printed circuit board (32) with a substrate (34) that has guide slots (36) for the withdrawal of deployable tapes (40). Each tape (40) is fastened to the interior of the airbag. When the airbag is deployed, the tapes (40) are withdrawn from tape cartridges (38) mounted with respect to the substrate (34). The surfaces of the guide slot (36) are coated with an electrically conductive coating (35). Static charges on the tapes (40) are dissipated as they pass through the guide slots (36).



SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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AIRBAG DEPLOYMENT RATE SENSOR WITH ELECTROSTATIC DISSIPATIVE GUIDE SLOTS

The present invention relates to static electricity dissipation structures and methods that are employed with airbag deployment sensors that utilize a substantially nonconductive tape or string.

Although airbags are generally mounted to deploy toward the expected position of a vehicle occupant, at times the vehicle occupant may be out of position, e.g., too close to the airbag, such that activation of the safety system, particularly an airbag may be harmful. However, systems which attempt to predict where the vehicle occupant will be during the time the airbag is deploying are limited by the necessity of predicting the future with all the uncertainty that entails. A recently developed approach is to monitor the deployment of the airbag itself and to open a vent to stop airbag deployment if the airbag prematurely impacts a vehicle occupant. In this way the necessity of predicting the future is avoided and action by the vehicle safety system is taken based on the actual interaction between the vehicle occupant and a deploying airbag. One effective way to obtain this information is to mount one or more tape dispensing cartridges within the airbag with the ends of the tapes fixed to the interior of the airbag as taught, for example in US 6 129 379. As the airbag is deployed, the rate of tape extraction is monitored. A sudden reduction in the tape extraction rate indicates that the airbag has encountered a vehicle occupant. Static charges present on the dispensing tapes, however, can cause an electrostatic discharge to the tape sensors which interferes with the accurate collection of sensor data, or can even damage electronic components.

What is needed is a means for dissipating static charge on the tape that lessens the possibility of electrostatic discharge related interference with the collection of sensor data.

An airbag deployment rate sensor incorporates a printed circuit board having a substrate with guide slots that extend through the substrate. A deployable tape is withdrawn through each slot. Sensors for monitoring the

rate at which tape is withdrawn are mounted about the guide slots on the circuit board. Each tape extends through a slot and extends to, and is fastened to, the interior of an airbag. When the airbag is deployed, the tapes are withdrawn from tape cartridges mounted behind the substrate so the tapes are drawn through the slots in the circuit board. The edges or sides of the slots and a portion of the board around the slots are coated with an electrically conductive coating, e. g. copper, rendering the slots smooth and conductive. Static charges on the tapes are dissipated as they pass through and brush against the sides or edges of the guide slots.

FIG. 1 is a schematic view, not to scale, showing an airbag deployment rate sensor of this invention within an airbag in relation to a vehicle occupant.

FIG. 2 is a fragmentary view of the apparatus of FIG. 1, showing tapes being extracted through the slots in the circuit board substrate.

As anyone who lives in a northern climate know, fabrics that are rubbed together or against a non-conducting surface can develop a static charge. A static charge requires a nonconductive substrate from which electrons are removed by engagement with another nonconductive substrate. For examples leather or plastic soles of shoes may pick up a static charge when walking over a carpet. Recently, a new type of airbag has been developed which incorporates active components that measure the rate of airbag deployment and, in the event the airbag stops deploying too soon, indicating the airbag has prematurely impacted a vehicle occupant, a vent is opened, collapsing the airbag or preventing further deployment. A mechanism for monitoring airbag deployment has a plurality of strings or tapes that are sewn on the inside of the airbag. As the airbag inflates, string or tape is drawn from a tape cassette, spool or bobbin, and the rate of tape withdrawal is monitored. The string or tape must be made of lightweight material that is not stiff, so that the string or tape does not pose a hazard by penetrating the airbag itself.

It has been found that the tape or string can develop a static charge of sufficient magnitude to prevent proper operation of the sensors that monitor the rate at which tape is being withdrawn from the tape cassettes. Airbag

deployment is very rapid, requiring only perhaps 10 to 25 milliseconds, which means that the tape leaving the tape dispenser may reach a velocity of over 3,000 centimeters per second. These high velocities, combined with the nonconductive nature of the tape 40, which is typically cloth, can produce electrostatic discharge.

The solution developed is to pull the tape or string through a grounded metal slot. The grounded metal slot is formed with little or no additional cost by integrating the grounding function into the circuit board on which the tape deployment monitoring electronics are mounted. The circuit board incorporates a ground. A trace on the circuit board brings the ground over to a slot formed in the board, the edges of the slot are plated using the standard technique for plating holes formed in the circuit board. Because the formation of copper traces around the slots and leading to the board ground and the edge plating, occur as part of the normal processing, the only change required to the circuit board is to design and etch masks which are used to form areas of resist and areas where the board is etched. Plating the slots not only makes the slots conductive, but also the plating can reduce the roughness of the slot edges which can lower the friction of drawing the tape through the slots.

As shown in the FIG. 1, an airbag deployment rate sensor assembly 20 is part of an airbag assembly 22 that is mounted within a vehicle 24. The airbag assembly 22 can be mounted to a steering wheel or instrument panel of a vehicle or in another position within the vehicle. Airbags may be positioned in doors, seats, and other locations within a vehicle. The monitoring of airbag deployment is particularly advantageous for airbags placed directly in front of the vehicle occupants where the vehicle occupant may be too close to the deploying airbag. The airbag assembly 22 is shown deploying an inflatable airbag 26 into the path of a vehicle occupant 28 during a crash event.

The airbag assembly 22 includes an inflator that rapidly discharges a quantity of pressurized gas into the interior of the airbag 26 when instructed to do so by a control unit. The control unit typically is separate from the airbag

assembly and controls a number of airbags or other safety systems. As shown in the figure, a printed circuit board 32 is constructed of a stiff electrically insulating substrate 34 for example fiber glass 0.8 to 3.2 millimeters thick, on which conductive traces are formed and electrical components are mounted. As shown in FIG. 2, the substrate 34 forms a structural part of an airbag deployment sensor assembly 20 on which tape deployment sensors 35 are mounted. As shown, the circuit board substrate 34 has four inwardly extending slots 36 formed in two opposed edges of the substrate 34. Each slot 36 is perpendicular to the edge of the substrate, and extends inwardly about 7.5 mm. The slots have through board extending edges 37 that are plated with about 0.25 millimeter of copper. A land 39 about the same width as the board thickness surrounds the slot 36. Copper traces 41 extend from each slot to a board ground 43. It is understood that the slots do not have to be adjacent to edges of the printed circuit board.

At least one tape cartridge 38 is mounted to the substrate 34. A cartridge 36 is adjacent each slot 36, and each cartridge holds a length of tape 40. The tape is made of cloth or of a similar material of organic or inorganic material. An outside end 42 of the length of tape 40 is fixed to the interior 44 of the airbag, while the remainder of the tape is retained within the cartridge. The tape may be coiled on a spool, or preferably is retained in a fanfold arrangement within the cartridge 38 to facilitate rapid deployment with minimal build-up of momentum. When a crash event is detected that calls for deployment of the airbag 26, an ignitor or other activating device is actuated, causing pressurized gas to fill the interior of the airbag, thereby rapidly inflating it. As the airbag inflates, the tapes 40 are drawn from the cartridges. The speed at which the tapes are withdrawn through the slots is measured by sensors 35 that respond to attributes of the tape, such as optical magnetic or electrical markings that pass by the sensors.

To prevent any static electrical charges on the lengths of tape from interfering with the electronics of the assembly 22, it is important to prevent uncontrolled static discharge. To this end, the substrate 34 and more

particularly the edges 37 and the lands 39 around each of the slots 36 on the top and bottom of the board are formed by an electrically conductive coating. Copper traces 41 leading to a ground 43 and the lands 39 are formed as part of the etching of traces for mounting and connecting other electrical components on the board. Plating of the edges 37 is applied simultaneously with the formation of plating of the holes through the board. Thus conductive coating around the slots 36 and the traces 41 which lead to ground are created without adding any additional process steps. The plating also serves to provide a smooth surface to the edges 37 of the slots 36, which facilitates the unimpeded paying out of the tapes 40.

The conductive lands on the top and the bottom of the board are connected by the edge plating, and are further connected by the conductive lead 41 to the board ground 43. The lead 41 thus provides electrical connection between the electrically conductive coating overlying the guide slot surfaces and ground. Static charges on the tapes 40 are discharged by rubbing lightly past the conductive and grounded edges 37 of the slots 36, and any charge buildup which might impede operation of the airbag deployment sensor assembly 20 is avoided.

The static dissipating approach of this invention offers the advantage of having substantially no additional production cost, as the actual amount of coating material is extremely small, and the application of the coating is preferably carried out in steps which are required to be applied to the circuit board 32 in any event.

It should be noted that the term "tape" as used herein includes flat strip-like elongated members, as well as more uniform cylindrical members such as a string. It should also be understood that the printed circuit board 32 will preferably be the same board on which the electronics necessary to monitor the airbag deployment by means of the tapes 40 are mounted. Other circuits to control the venting of the airbag and even the airbag deployment and activation circuits might be mounted on the same board.

It should be understood that any conventional circuit board material including fiberglass, and various other ceramic or composite board structures

may be used to form the slots 36 through which the tape 40 is drawn and which are plated or otherwise rendered conductive to prevent a buildup static charge due to the rapid movement of the tape during airbag activation.

CLAIMS

1. An airbag deployment rate sensor assembly (20) comprising:
a substrate (34) having portions defining a guide slot (36) therein, the guide slot (36) having conducting portions connected to a ground (43);
a tape cartridge (38) assembled with the substrate (34); and
a length of tape (40) extending from the tape cartridge (38) through the guide slot (36) closely spaced from the conducting portions, such that the tape (40) passing through the guide slot (36) dissipates static charges on the length of tape (40).
2. An airbag deployment rate sensor assembly (20) according to claim 1 wherein the substrate (34) is a printed circuit board (32) and wherein the conducting portions are copper plating of edges (37) defined by the guide slot (36).
3. An airbag deployment rate sensor assembly (20) according to claim 2 further comprising at least one copper trace (41) extending from the copper plating of the edges (37) defined by the guide slot (36) to the ground (43).
4. An airbag deployment rate sensor assembly (20) according to claim 1 wherein tape dispensing rate sensors are mounted to the substrate (34) closely spaced from the guide slot (36) to measure an attribute of the tape (40) as it is drawn through the guide slot (36).
5. An airbag deployment rate sensor assembly (20) according to claim 1 wherein the tape cartridge (38) is mounted to a first side of the substrate (34), and the length of tape (40) extends from the first side through the guide slot (36) to a second side of the substrate (34).

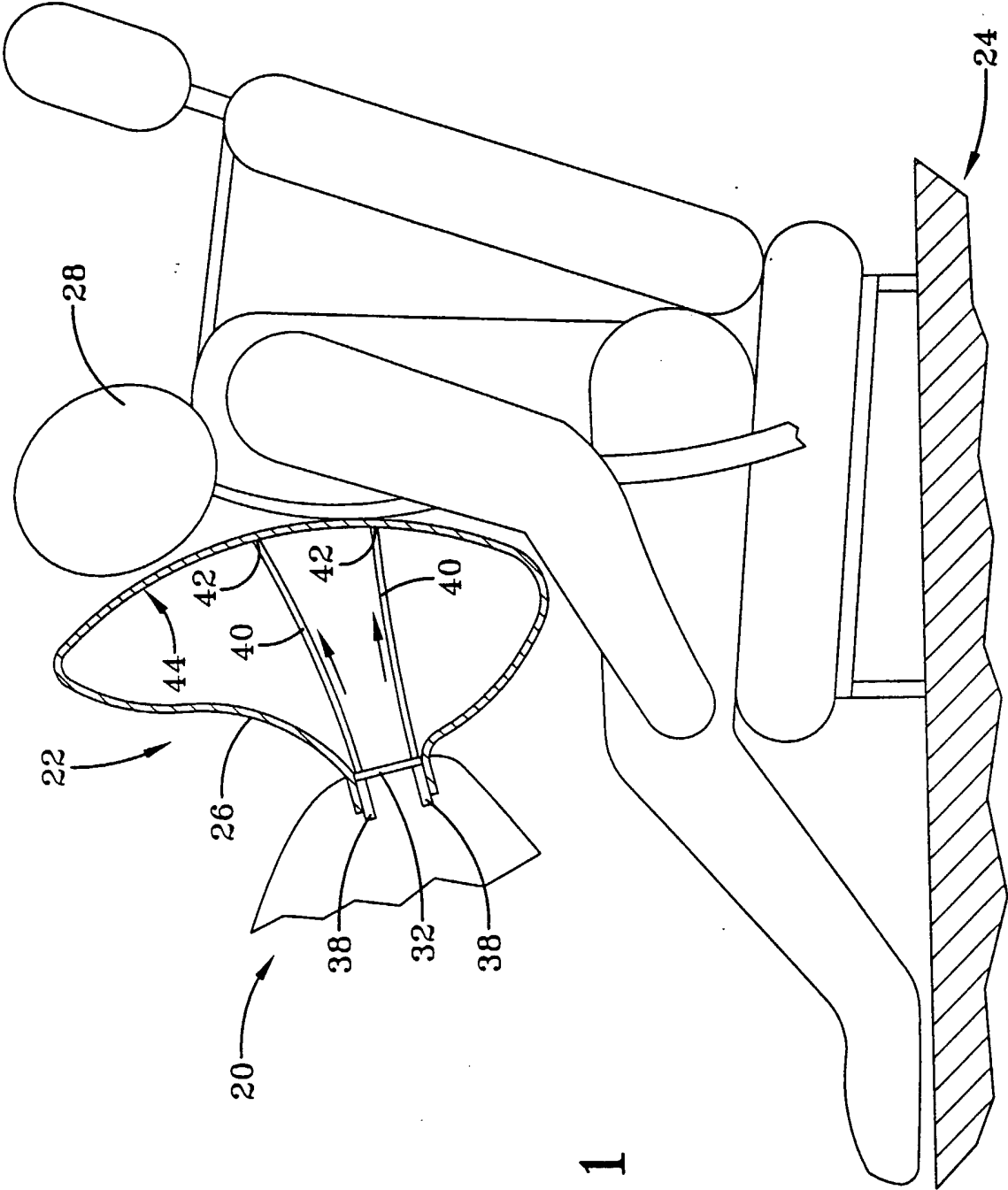


FIG-1

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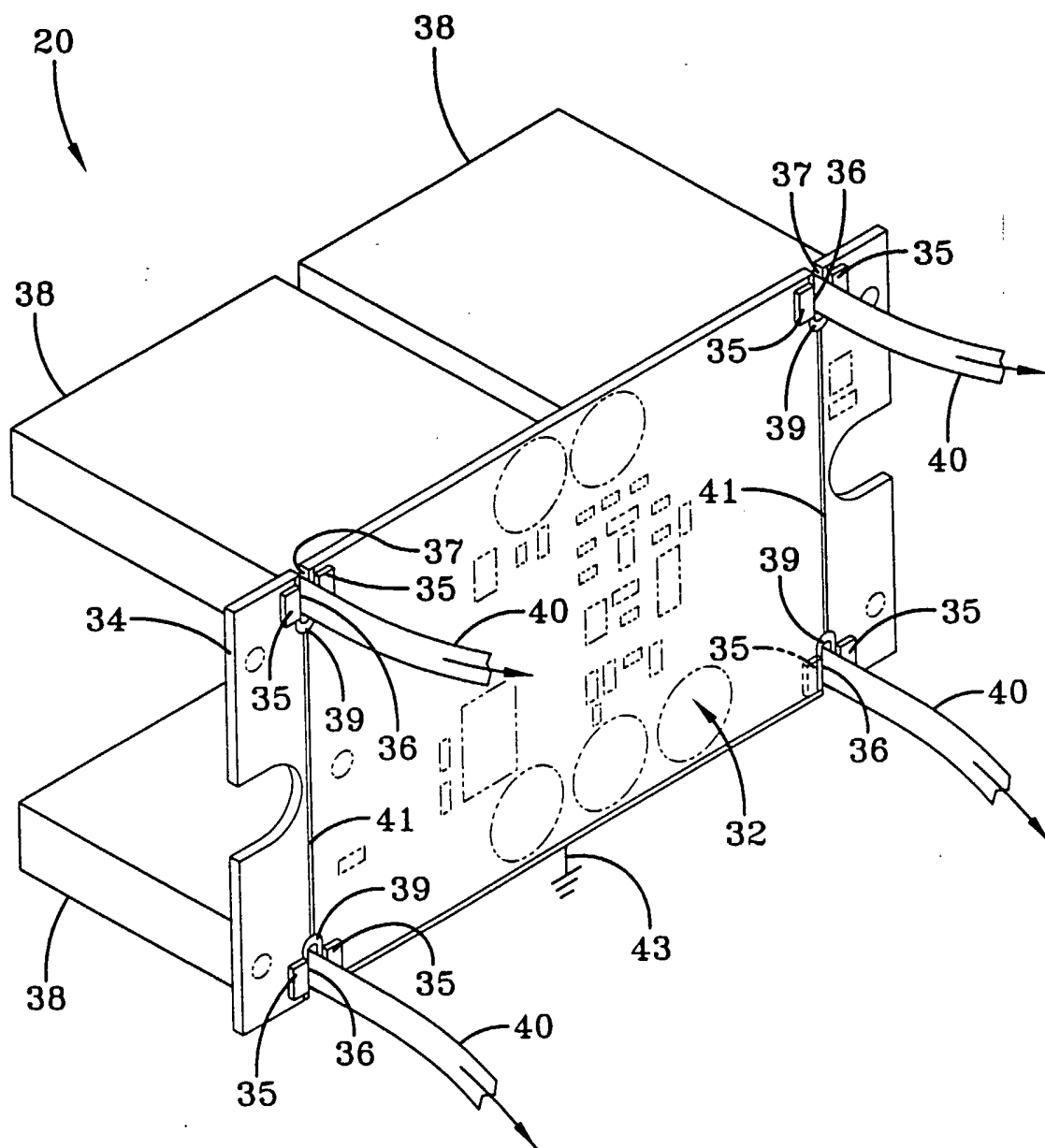


FIG-2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/41001

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B60R 21/32; G01P 3/50

US CL : 280/735; 324/166

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)

U.S. : 280/735, 743.2; 324/166, 173, 175

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6129379 A (Specht) 10 October 2000 (10.10.2000)	1
A	US 6308983 B1 (Sinnhuber) 30 October 2001 (30.10.2001)	1
A, P	US 6789818 B2 (Gioutsos et al.) 14 September 2004 (14.09.2004)	1
A, P	US 6825654 B2 (Pettypiece, Jr. et al.) 30 November 2004 (30.11.2004)	1

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:		"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier application or patent published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2005 (12.07.2005)	17 AUG 2005
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer: <i>P. C. English</i> Peter C. English Telephone No. 571-272-6640

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US04/41001

Continuation of B. FIELDS SEARCHED Item 3:

EAST

search terms: airbag, air bag, gas bag, sensor, detector, rate, velocity, speed, tape, string, strip, strap, static, electrostatic, charge, discharge, ground, circuit board