(12) UK Patent Application (19) GB (11) 2 287 116 (13) A

(43) Date of A Publication 06.09.1995

(21) Application No 9503309.8

(22) Date of Filing 21.02.1995

(30) Priority Data
(31) 4406897 (32) 03.03.1994 (33) DE

(71) Applicant(s)
Mercedes-Benz Aktiengesellschaft

(Incorporated in the Federal Republic of Germany)

Mercedesstrasse 136, D-70327 Stuttgart,
Federal Republic of Germany

(72) Inventor(s)
Falk Zeidler
Volker Petri
Reinhold Mickeler
Michael Meyer

(74) Agent and/or Address for Service
Jensen & Son
70 Paul Street, LONDON, EC2A 4NA, United Kingdom

(51) INT CL^6
G08B 21/00 , B60N 2/44 , B60R 21/00

(52) UK CL (Edition N)
G4N NPPXP N6V1
U1S S1820

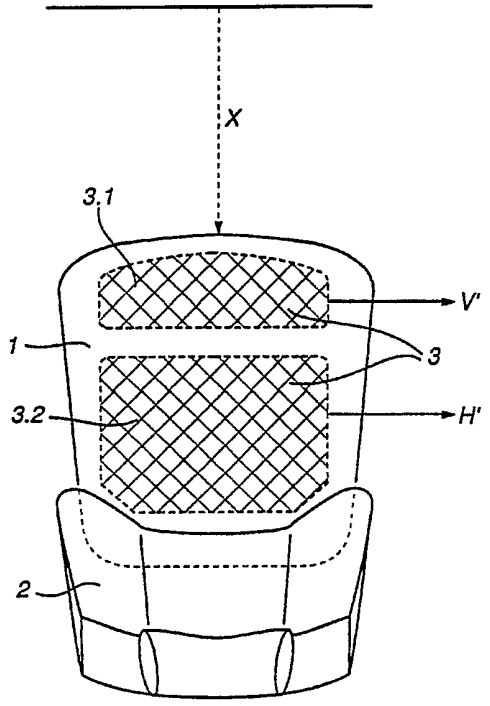
(56) Documents Cited
EP 0357225 A1

(58) Field of Search
UK CL (Edition N) G4N NHVSA NHVSC NHVSX NPPXAX NPPXP
INT CL^6 B60N 2/00 2/44 , B60R 21/00 , G08B 21/00
Online : WPI

(54) Device for seat occupancy detection for a motor vehicle

(57) A device for seat occupancy detection for a motor vehicle, especially for inhibiting airbag release when a seat is unoccupied, has a seat occupancy sensor 3 which has a front sensing region 3.1 and a rear sensing region 3.2, which can be evaluated separately. In this way, it is possible to indicate whether the front-seat passenger is in a sitting position close to the front seat edge of the seat cushion 1. As a further measure, the inhibiting of airbag release can be provided in the case of an incorrect sitting position.

Fig. 1



GB 2 287 116 A

Fig. 1

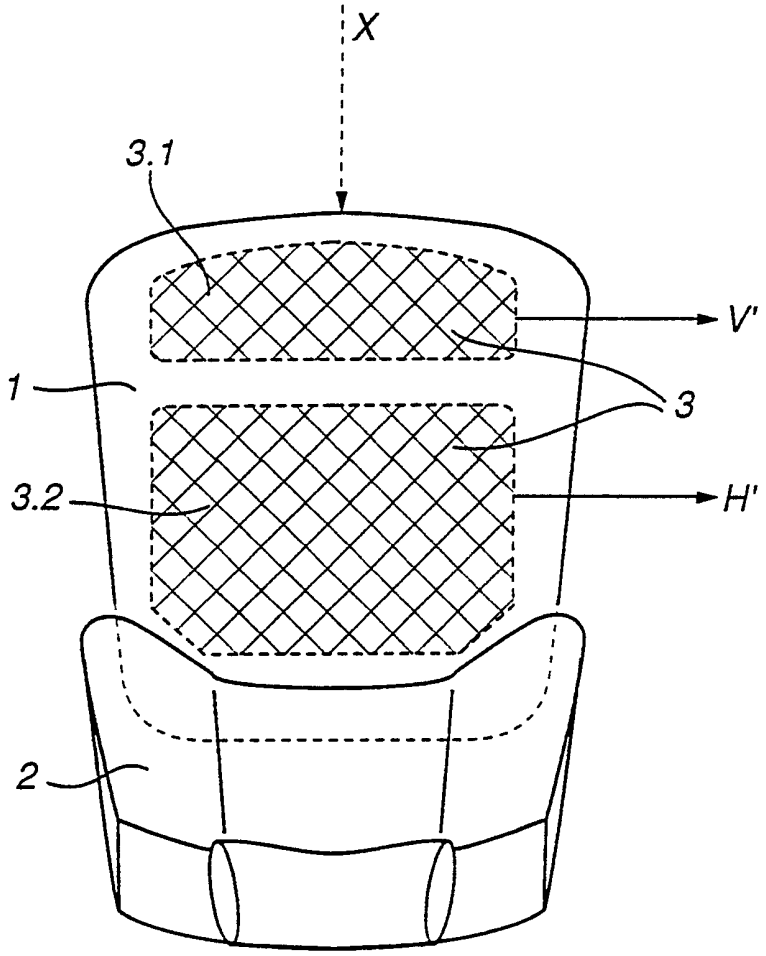


Fig. 2

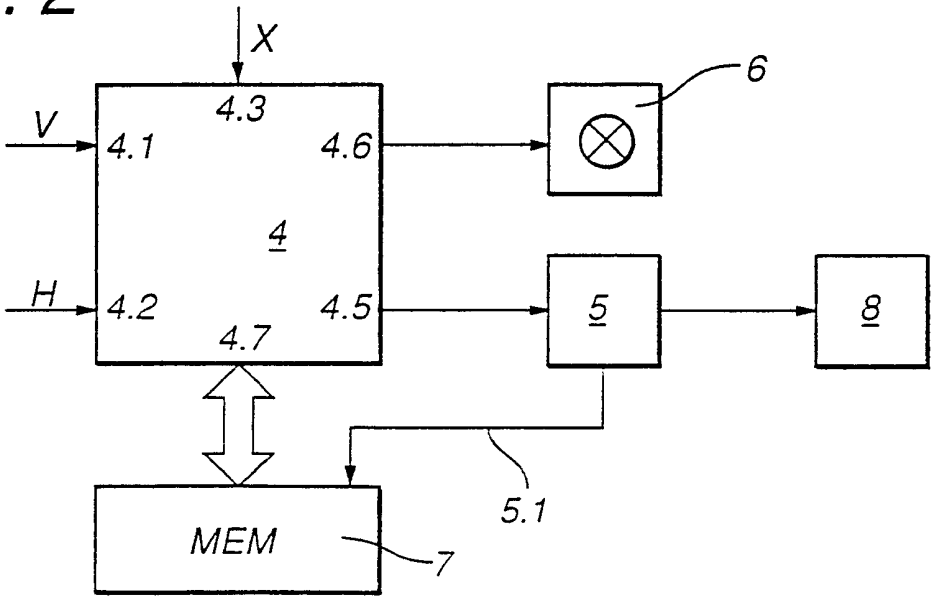
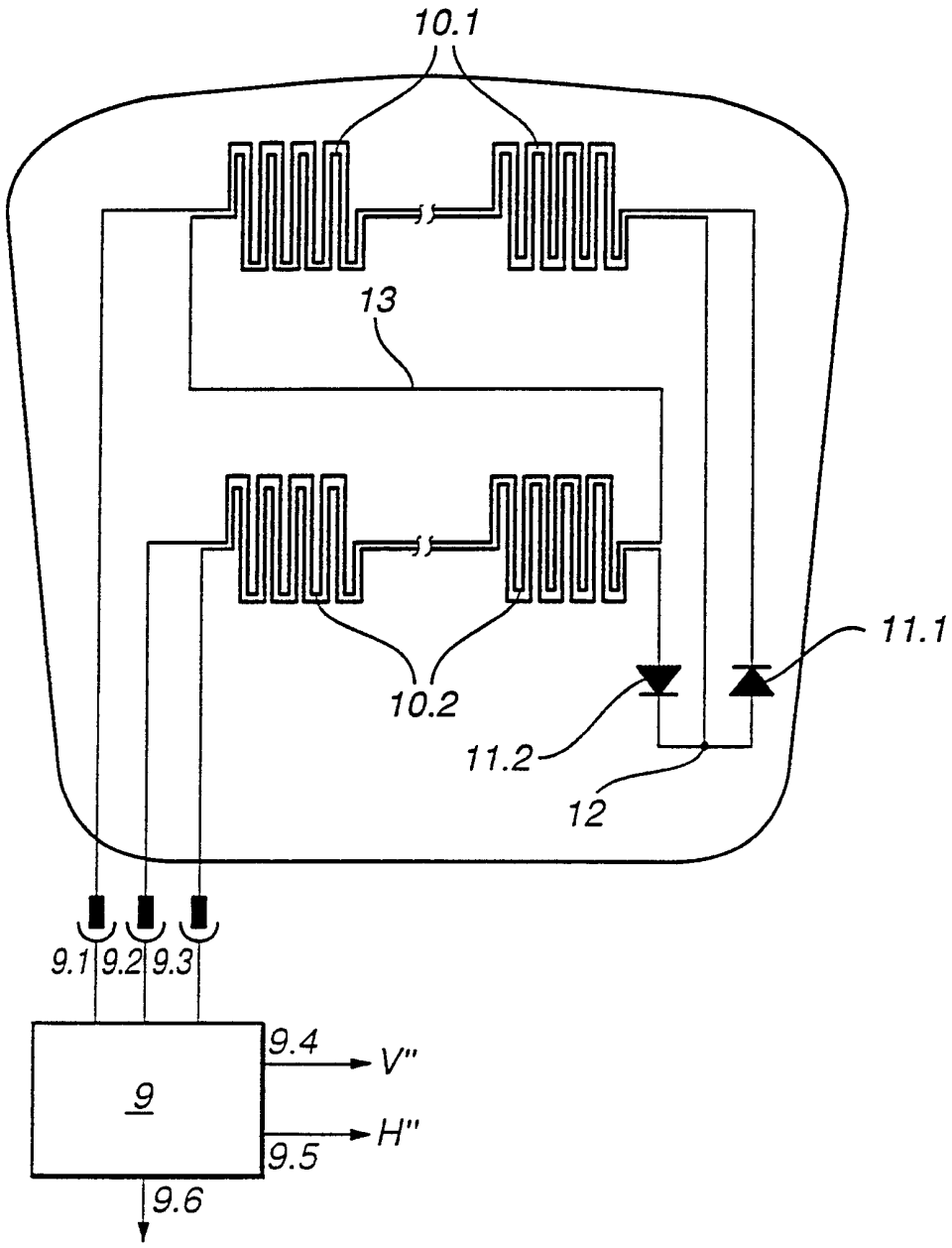


Fig. 3



Device for seat occupancy detection for a motor vehicle

The invention relates to a device for seat occupancy detection for a motor vehicle, having a seat occupancy sensor, which is integrated in a seat cushion, and an associated evaluation circuit which is adapted to generate a signal indicative of whether or not the seat is occupied.

In order to protect the occupants of vehicles more effectively, motor vehicles, inter alia, are being equipped to an increasing extent with a front seat passenger's airbag. In doing so, no unnecessary damage occurs provided it is possible to release the front seat passenger's airbag in the case of an accident only when the front seat passenger's seat is occupied.

A number of systems for seat occupancy detection having the features set out in the first paragraph are known. Thus, in DE-AS 21 25 198, a contact band is integrated into the seat cushion of the motor vehicle seat, the two contact strips of which contact band come into contact when loaded. This contact making is evaluated as a signal for the loading of the seat cushion. The seat occupancy detection can be carried out using contact bands of various patterns, as a result of which locally different sensitivities are achieved.

An embodiment for seat occupancy detection, which furthermore allows locally resolved evaluation of the load, is known from US 50 10 774. In this document, a matrix of pressure-sensitive contact points is evaluated in order to detect the load on the backrest of a seat by a trials person as a function of different designs of the seat. Furthermore a trials shoe is known from the document, having a pressure-sensitive bottom, in the case of which the pressure load on the running sole and the step can be evaluated separately.

In DE 42 37 072 C1, a sensor mat is described for installation in the seat cushion of a motor vehicle seat, which is constructed as a resistive membrane pressure sensor and, in addition to interrogation of the seat occupancy

status, also allows simple interrogation of the functional status (self check).

The known systems for seat occupancy detection signal seat occupancy independently of the sitting position of the occupant. In consequence, airbag release is also allowed independently of the sitting position. However, it is advantageous for an optimum impact-damping effect of the airbag if a minimum distance is ensured between the occupant and the airbag at the start of release, in order that there is sufficient time for the airbag to unfold in the case of an accident.

The present invention seeks to develop a system for seat occupancy detection such that an incorrect sitting position (out of position) close to the front seat edge, in the case of which the minimum distance mentioned above is not maintained, can be detected and the occupant warned.

According to present invention there is provided a seat occupancy detection device for a motor vehicle, having a seat occupancy sensor, which is integrated in a seat cushion, and an associated evaluation circuit, wherein the seat occupancy sensor is divided into a front sensing region responding to seat occupancy in the front region of the seat cushion and the rear sensing region responding to seat occupancy in the rear region of the seat cushion, and the evaluation circuit including means to evaluate the occupancy state of both sensing regions separately.

By splitting the sensitive region of the seat occupancy sensor into a front sensing region and a rear sensing region, a sitting position close to the front seat edge can be detected and an appropriate warning signal emitted.

This measure makes particular sense if, despite the warnings in the operating instructions from the vehicle manufacturer, children are seated on the front seat without there being a suitable child restraint system. Because of their shorter thighs, small children prefer to sit on the front seat surface, for comfort. Using the device according

to the invention for seat occupancy detection, in conjunction with an audible or visual warning device, the driver can be emphatically advised to ensure that the front seat passenger is in a correct sitting position.

An embodiment of the invention is now described in more detail in the following text, with reference to the drawings, in which:

Fig. 1 shows the seat occupancy sensor according to the invention,

Fig. 2 shows the evaluation circuit according to the invention,

Fig. 3 shows an exemplary embodiment of the seat occupancy sensor as a resistive membrane pressure sensor.

Fig. 1 shows a plan view of a driver's seat having a seat cushion 1 and a backrest 2. Furthermore, the seat occupancy sensor 3 and the arrangement of the two sensing regions 3.1, 3.2 over the seat cushion 1 are illustrated, it being possible to combine the two sensing regions 3.1, 3.2 in one mechanical structural unit (sensor mat). The front sensing region 3.1 detects seat occupancy on the front region of the seat, close to the seat edge, and emits a corresponding signal V'. In an analogous manner, the rear sensing region 3.2 detects seat occupancy in the rear region, close to the backrest 2, and emits a corresponding signal H'. It is, of course, easily possible also to provide a further sensing region in the backrest 2, which would be included for evaluation.

The precise geometry of the sensing regions 3.1, 3.2 and their delineation from one another must be optimized individually in a trial for each vehicle type and seat type, it also being necessary to detect seat occupancy by a child reliably. The seat occupancy sensor 3 can be implemented as a resistive membrane pressure sensor, or can be based on the principles on which other known seat occupancy sensors are based.

In a development, it is possible to provide that the adjustable longitudinal sitting position x of a seat is also

detected and interrogated, for absolute determination of the centre of gravity position of the occupant with respect to the vehicle and thus with respect to the airbag. The longitudinal sitting position x can be detected by a position sensor or switch as is known, for example, from seat memory circuits.

Fig. 2 shows the evaluation circuit 4 according to the invention, having an input 4.1 for a first seat occupancy signal V which is assigned to the front sensing region, and an input 4.2 for a second seat occupancy signal H which is assigned to the rear sensing region. The seat occupancy signals V and H are provided, for example, by the signals V' and H' respectively from Fig. 1. In a development, an input 4.3 for the longitudinal sitting position x can also be provided. The evaluation circuit determines from the input signals a control signal 4.5 by means of which a release controller 5 for an airbag 8 is driven in such a manner that release is allowed when the sitting position is correct. Furthermore, the evaluation circuit 4 determines from the input signals a warning signal 4.6 which drives a warning device 6 and is emitted when an incorrect sitting position (out of position) has been assumed. The warning device 6 may comprise an audible or visual indication.

In a development, it can be provided that the evaluation circuit 4 enters data via an interface 4.7 into a non-volatile memory 7 (MEM). These data can be, for example, the input signals 4.1-4.3 or the output signals 4.5, 4.6. In this way, it is intended to make it possible to reconstruct the sitting position of the occupant and the measures derived from the evaluation circuit 4 therefrom, for example the emission of a warning signal 4.6, after an accident has occurred. It is thus sufficient to use a stacking memory (stack) for the memory 7, in the case of which relatively old data are cyclically overwritten by relatively new data, so that less memory space is required overall. An inhibiting signal 5.1, which is passed to the

memory from the release controller 5 at the time of airbag release, ensures that the memory 7 can no longer be overwritten after a crash and that therefore the data can still be read out only by a suitable person. Further overwriting of the data is thus impossible after airbag release.

The evaluation which is carried out in the evaluation circuit 4 is described in the following text with reference to a simple algorithm. For simplicity, it is assumed that the seat occupancy signals V and H are logic signals having the occupancy status "1" for an occupied sensing region and "0" for an unoccupied sensing region. A total of four occupancy combinations are thus possible for the front sensing region and the rear sensing region overall, which combinations are illustrated in the following table:

V	H	Occupancy situation	Measure
0	0	Seat unoccupied	A
0	1	Seat correctly occupied	B
1	0	Seat incorrectly occupied (out of position)	C
1	1	Seat correctly occupied	B

The first column always shows the occupancy status of the seat occupancy signal V for the front sensing region, and the second column the seat occupancy signal H for the rear sensing region. The third column explains the corresponding occupancy situation, and the fourth column shows the measures derived therefrom.

Measure A accordingly occurs when the seat is unoccupied. In this measure, the control signal 4.5 inhibits the release controller 5, so that it is not possible for the airbag 8 to be released.

Measure B occurs when the seat is correctly occupied. In this measure, the control signal 4.5 causes the

release controller 5 to be ready to release.

Measure C occurs in the case in which a seat is incorrectly occupied and includes at least the emission of a warning signal 4.6 to an audible or visual warning device 6. In addition, inhibition of airbag release can be provided in accordance with measure A, it then being possible to provide explicit advice by means of a display or warning symbol that the airbag is not ready to release.

This supplementary measure can be provided as an alerting measure if a differentiated evaluation of the sitting position is possible and it is clearly evident that an infringement of the minimum distance between the airbag and the occupant has been recorded.

In a development, a differentiated determination of the sitting position can be achieved in that the centre of gravity position of the occupant with respect to the seat is detected and evaluated more precisely and/ or the longitudinal sitting position x is also included, in order to determine the position of the occupant with respect to the airbag precisely. Subject to these preconditions, it can also be provided for measure C to be split into two levels, so that if the distance between the airbag and the occupant is slightly less than the minimum distance, only a warning signal 4.6 is emitted, and the inhibition of airbag release in addition does not take place until the minimum distance has been considerably infringed. Alternatively, the determined absolute sitting position can be passed as a control signal 4.5 to the release controller 5, in order to influence the switching threshold for airbag release. It can thus be provided that the switching threshold for airbag release is increased the shorter the determined distance between the occupant and the airbag is.

Fig. 3 illustrates a possible embodiment of the seat occupancy sensor according to the invention, as a resistive membrane pressure sensor. The design is based on a principle as disclosed in DE 42 37 072 C1: the membrane pressure sensor comprises two polymer layers which are laminated

together, one polymer layer being coated with a semiconductor material and the other with meandering double cables, which fill the pressure-sensitive region. When a pressure load is applied to the membrane pressure sensor, the semiconductor material connects closely adjacent conductor tracks of a double cable more or less in parallel, so that the electrical resistance between the conductor tracks reduces as the contact pressure increases. As a result of the conductor tracks being designed without branches, complete continuity testing of the conductor tracks is also possible, by which means it is possible to check the serviceability of the sensor in a simple manner. If the double cable is terminated by a diode at its end, it is possible to use the polarity of the measurement voltage to determine whether a pressure load measurement or a continuity test of the conductor tracks is carried out. For a continuity test, the measurement current flows in the forward direction through the diode, as a result of which a circuit composed of the conductor tracks forming the double cable is closed. In the event of an interruption in a conductor track, the circuit for the measurement current is thus also interrupted.

Fig. 3 shows a plan view of the membrane pressure sensor according to an embodiment of the invention, having a first pressure sensor 10.1 for the front sensing region and a second pressure sensor 10.2 for the rear sensing region. The two pressure sensors 10.1, 10.2 are each formed by a meandering double cable, each double cable having a first conductor track and a second conductor track which runs predominantly parallel thereto. The respectively first conductor tracks of the two double cables are each connected at one of their ends to a connecting contact 9.1 or 9.3 respectively, and at their other end, in each case via a diode 11.1 or 11.2 respectively, to a junction point 12, the two diodes 11.1, 11.2 having opposite polarity. The respective second conductor tracks of the two double cables are connected in series and form a common cable 13, which is

connected at one of its ends to a connecting contact 9.2 and at its other end to the junction point 12.

The interconnection according to the invention of the total of four conductor tracks of the two pressure sensors 10.1, 10.2 in the manner illustrated in Fig. 3 offers the advantage that, using only three connecting contacts 9.1-9.3, it is possible to carry out both an interrogation of the occupancy states and a functional test of the two pressure sensors 10.1, 10.2, separately. An initial evaluation circuit 9 is provided for this purpose, whose three inputs are connected to the connecting contacts 9.1-9.3 and which emits, via a first output 9.4, the seat occupancy signal V'' for the front sensing region and, via a second output, the seat occupancy signal H'' for the rear sensing region. Both seat occupancy signals V'' and H'' can drive, for example, the two inputs 4.1, 4.2 of the evaluation circuit 4 in Fig. 2. A third output 9.6 emits an error signal (ERROR), which emits the result of the continuity test. This error signal can be used, for example, to drive an indicating unit, which possibly advises the driver of a defect in the seat occupancy detection.

The following table illustrates how a pressure load measurement or a continuity test is in each case carried out as a function of the polarity of the measurement voltage on the connecting contacts 9.1-9.3, related to the front pressure sensor 10.1 (front) and the rear pressure sensor 10.2 (rear):

Polarity on 9.1	9.2	9.3	**Measurement carried out**
+	-		Front pressure load measurement
-	+		Front continuity test
	+	-	Rear pressure load measurement
	-	+	Rear continuity test

In this way, it is possible intrinsically to check each of the two pressure sensors 10.1, 10.2 with respect to pressure load and serviceability.

Claims

1. A seat occupancy detection device for a motor vehicle, having a seat occupancy sensor, which is integrated in a seat cushion, and an associated evaluation circuit, wherein the seat occupancy sensor is divided into a front sensing region responding to seat occupancy in the front region of the seat cushion and the rear sensing region responding to seat occupancy in the rear region of the seat cushion, and the evaluation circuit including means to evaluate the occupancy state of both sensing regions separately.

2. A device according to Claim 1, wherein, when seat occupancy is detected primarily in the front sensing region, the evaluation circuit emits a warning signal.

3. A device according to Claim 1 or 2, wherein, when seat occupancy is detected primarily in the front sensing region, the evaluation circuit emits a control signal adapted to be supplied to a release controller for an airbag by means of which release of the airbag is made more difficult or is inhibited.

4. A device according to Claim 1, wherein, when seat occupancy is detected primarily in the rear sensing region, the evaluation circuit emits a control signal is adapted to which make a release controller for an airbag ready to release.

5. A device according to any one of Claims 1 to 4, wherein the evaluation circuit uses the signals from the seat occupancy sensor to determine the absolute distance between the occupant and the airbag, it also includes means to take into account the longitudinal seat position of the vehicle seat, and emit a warning signal if said distance is less than a minimum distance.

6. A device according to any one of Claims 1 to 5, wherein input, output or internal signals of the evaluation circuit are stored in a non-volatile storage medium.

7. A device according to Claim 6, wherein the storage is carried out in accordance with the stacking principle (stack memory), in the case of which relatively old data are overwritten cyclically by relatively new data.

8. A device according to any one of Claims 1 to 7, wherein the seat occupancy sensor is constructed as a resistive membrane pressure sensor.

9. A device according to Claim 8, wherein the membrane pressure sensor is formed from a front pressure sensor and a rear pressure sensor each of which has a meandering double cable, each double cable being formed from a first conductor track and a second conductor track which runs predominantly parallel thereto.

10. A device according to Claim 9, wherein the respectively first conductor tracks of the double cables are each connected at one of their ends to in each case one connecting contact and at their other end via a diode in each case to a junction point, and the respectively second conductor tracks are connected to form a continuous common cable whose one end is connected to a connecting point, and whose other end is connected to the junction point.

11. A device according to any one of the preceding claims wherein, in addition to the interrogation of the occupancy state, a functional test for both sensing regions can also be carried out separately.

12. A device according to Claims 10 or 11, wherein an initial evaluation circuit is connected to three connecting contacts, and

- a measurement voltage having alternating polarity is in each case applied to two connecting contacts, and
- seat occupancy signals for the front sensing region and for the rear sensing region are determined from the respective measurement currents, and
- an error signal is determined from the respective measurement currents.

13. A device according to any one of the preceding claims adapted for inhibiting airbag release when the seat is unoccupied.

14. A device according to any one of claims 2 to 13, wherein said warning signal comprises an audible or visual warning device.

15. A seat occupancy detection device for a motor vehicle, substantially as described herein with reference to and as illustrated in the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(T[illegible] Search report) 13

Application number
GB 9503309.8

Relevant Technical Fields

(i) UK Cl (Ed.N) G4N (NPPXAX, NPPXP, NHVSA, NHVSC, NHVSX)

(ii) Int Cl (Ed.6) B60N 2/00, 2/44; B60R 21/00; G08B 21/00

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE: WPI

Search Examiner
D SUMMERHAYES

Date of completion of Search
10 MAY 1995

Documents considered relevant following a search in respect of Claims :-
1-15

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X	EP 0357225 A1 (MAZDA)	1 at least

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).