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(54) SEAT SUSPENSION MAT, ESPECIALLY FOR VEHICLE SEAT

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pour : «Seat Suspension mat, especially for vehicle seat»,
DESCRIPTION

SEAT SUSPENSION MAT, ESPECIALLY FOR VEHICLE SEAT

Technical field

[0001] The present invention generally relates to a suspension mat for a seat, in particular for a vehicle seat. In particular, the seat suspension mat according to the invention is configured for detecting a seat occupancy state.

Background Art

[0002] Seat occupancy sensors are nowadays widely used in automotive vehicles to provide a seat occupancy signal for various appliances, such as, e.g. a seat belt reminder, an auxiliary restraint system (airbag), etc. Seat occupancy sensors exist in a number of variants, e.g. based on capacitive sensing, deformation sensing or pressure (force) sensing.

[0003] The possibility of customization and personalization of the vehicle by the customer is a key selling factor of modern cars. This leads to many different variants of car interiors being offered for one car model. With the increasing number of available options, severe constraints arise concerning the implementation of technical equipment in the vehicle. With seat occupancy sensors arranged between the foam body of the seat cushion and the seat cover, every seat design (leather, cloth, sport, comfort, ...) requires specific development effort for the occupant detection system. That induces high development costs and therefore is an unattractive solution for the automotive industry. A problem to be solved is, therefore, to find a sensor solution, which is less influenced by seat design and thus can be used for a greater variety of car seats or even car platforms.

[0004] Vehicle seats typically comprise a structural frame and a suspension mat supporting a cushion. Such suspension mat typically comprises a plurality of springs taut between fixation sites on the structural frame and interlinked by a plurality of cross-ties. The cushion-supporting springs usually comprise of specially
formed metal wires, which provide a suspension or cushioning effect. An example for a vehicle seat of this type is disclosed in the document WO2005/108160.

[0005] Document DE 20 2010 003 563 U1 discloses a pressure-sensor unit, comprising a film-type pressure sensor. The pressure-sensor is arranged between the suspension mat and the seat cushion. The pressure sensor includes two films maintained at a distance by a spacer material arranged there between. The pressure sensor is disposed on a compressible intermediate layer, which is, in turn arranged on a base plate. In document FR 2 844 592 A1, the cushion-supporting suspension mats of the seat base and the seat back are used as the electrodes of a capacitive occupancy detection system. The electrodes are arranged below the cushion at the so-called "B-side" of the seat. In documents LU 91701 and US 7 523 803, a tension sensor is arranged between the cushion-supporting spring and the structural frame to measure a mechanical tension between them or an elongation of the spring.

Technical problem

[0006] It is an object of the present invention to enable more cost-efficient and easier integration of an occupancy sensor into a seat, especially a vehicle seat. This object is achieved by the invention as claimed in claim 1.

General Description of the Invention

[0007] The invention proposes a seat suspension mat of innovative configuration. The seat suspension mat, which is especially suitable for use in a vehicle seat, comprises a plurality of spring members for being taut between respective fixations sites of a structural seat frame. The plurality of spring members includes at least one central spring member and at least two outer spring members arranged alongside of the at least one central spring member (i.e. the at least one central spring member is arranged between the outer spring members). A cross-tie (hereinafter referred to as "underpassing cross-tie") attached to the at least two outer spring members passes underneath the at least one central spring member. The underpassing cross-tie carries an electric contact element arranged under the at least one central spring member so as to be able to be pressed on by the at
least one central spring member when the at least one central spring member bends down under load.

[0008] As those skilled will appreciate, the pressure exerted by the at least one central spring on the electric contact element may be detected using a suitable detection circuit and may serve to deduce the occupancy state ("empty" or "occupied") of the seat. The invention exploits the fact that in the assembled seat, the outer spring members experience a lesser load than the at least one central spring in typical occupancy situations. This means that the outer spring members are subjected to less important bending than the at least one central spring; as a result, the underpassing cross-tie is displaced downward less than the part of the at least one central spring member that faces it. If the load exerted on the seat is high enough, the at least one central spring member presses on the electric contact element on the underpassing cross-tie. The force threshold, i.e. the force above which the electric contact element and the at least one central spring member are in contact, may be adjusted by choosing an appropriate distance between the underpassing cross-tie and the at least one central spring, and by appropriately selecting the modulus of elasticity of the spring members.

[0009] Preferably, the seat suspension mat comprises further cross-ties (preferably made of plastic) flexibly interlinking the spring members.

[0010] The contact element may comprises an electric switch including at least a first and a second conductor, which are brought into electrical contact when the electric switch is pressed on. The electric switch may e.g. comprise a membrane switch.

[0011] Alternatively, the electric contact element may comprise an electrode and the central spring carried out electrically conductive, whereby the contact element and the central spring form together an electric switch.

[0012] According to a preferred embodiment of the invention, the seat suspension mat comprises a detection circuit configured for detecting whether the central spring member presses on the electric contact element. The detection circuit preferably comprises an output for issuing a signal indicative of the result of the detection (and thus of the seat occupancy state). The detection circuit may be an
application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), a microcontroller or the like.

[0013] The spring members may be individual (i.e. separate) suspension springs. Alternatively, the spring members may comprise sections of one or more springs bent over at the fixation sites, these sections being arranged so as to extend alongside each other. For instance, instead of separate suspension springs, a single suspension spring could be used that is folded (bent over) at the fixations sites so as to provide the different spring members.

[0014] The underpassing cross-tie (and any other cross-tie) is preferably made of injection-moulded plastic.

[0015] Advantageously, the underpassing cross-tie is configured for being clipped on the at least two outer spring members. As will be appreciated, this greatly facilitates the manufacturing of the seat suspension mat in accordance with this invention.

[0016] An aspect of the present invention concerns a seat, in particular a vehicle seat, that comprises a structural frame having a plurality of fixation sites for a seat suspension mat, a seat suspension mat as described hereinabove and a seat cushion supported by the seat suspension mat.

**Brief Description of the Drawings**

[0017]Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a seat according to a first embodiment of the invention;

Fig. 2 is a schematic detail of a seat according to the first embodiment of the invention;

Fig. 3 is a schematic detail of the seat according to the first embodiment of the invention when a force is applied on the cushion;

Fig. 4 is a schematic detail of a seat according to a second embodiment of the invention.
Description of Preferred Embodiments

[0018] A vehicle seat 10 according to a preferred embodiment of the invention is generally shown in Fig. 1. The vehicle seat 10 comprises a backrest (not shown) and a seating portion 12. The seating portion 12 comprises a structural frame 14, a suspension mat 16 and a cushion 18, e.g. made of foam, which rests on the suspension mat 16. The seat suspension mat 16 comprises a plurality of steel wire springs 20a, 20b, 20c, 20d (commonly referred to by reference number 20, where appropriate), each taut between respective fixation sites 22 provided on the structural frame 14.

[0019] The springs 20 extend alongside one another in the longitudinal direction of the seating portion. The springs 20 comprise steel wire bent into an essentially planar wavy shape. Each of the springs 20 has two hook-shaped end portions 24, 26, which engage with the respective fixation sites. The hook-shaped end portions 24, 26 are preferably covered with plastic coatings 28, in order to avoid undesired squeak noises due to friction between the structural frame 14 and the springs 20.

[0020] The springs 20, are interconnected by cross-links 30, e.g. made of plastic. The cross-links 30 transmit pulling forces between the springs 20, and participate in the elastic suspension of the cushion 18.

[0021] The springs 20 of the seat suspension mat 16 comprise outer springs 20a, 20d and central springs 20b, 20c disposed between the outer springs 20a, 20d. The outer springs 20a, 20d are linked to each other by a cross-tie 32 (underpassing cross-tie), which passes underneath the central springs 20b, 20c. The underpassing cross-tie 32 carries a contact element 34 in the region which faces the central springs 20b, 20c. In the embodiment of the invention shown in Figs. 1-3, the contact element 34 comprises an electrode applied (e.g. by printing) on the underpassing cross-tie 32 or applied (e.g. by printing) on a carrier film itself arranged on the underpassing cross-tie 32.

[0022] Fig. 2 and 3 are schematic cross-sections of a part of the seat suspension mat 16 when the seat 10 is unoccupied and occupied, respectively.

[0023] When the seat 10 is unoccupied, the springs 20, of the seat suspension mat lie essentially in a common plane 36 and the central springs 20b, 20c and the
contact element 34 are mutually spaced. When the seat 10 is occupied, the cushion 18 transfers the occupant's weight to the seat suspension mat 16. As shown in Fig. 3, the springs 20b, 20c being displaced farther down than the outer springs 20a, 20d because the central springs 20b, 20c have to bear a greater load than the outer springs 20a, 20d. Since the vertical displacement of the underpassing cross-tie 32 corresponds to the displacement of the outer springs 20a, 20d, the central springs 20b, 20c move closer to the electric contact element 34 and ultimately touch it.

[0024] The contact between the central springs 20b, 20c and the contact element 34 is detected with a detection circuit 38. In the example illustrated in Figs. 1 to 3, the detection circuit 38 is connected to the central springs 20b, 20c and to the electric contact element 34 by respective leads. The detection circuit 38 detects a contact between the contact element 34 and one or both of the central springs 20b, 20c as a drop in resistance between the corresponding leads. The drop of resistance may be determined from an increase of current or a drop in voltage, depending on the configuration of the detection circuit 38. The detection circuit comprises an output 40 on which it outputs a signal indicative of whether none, one or both of the central springs 20b, 20c are in contact with the contact element 34 and thus of whether the seat 10 is occupied or empty.

[0025] Fig. 4 illustrates a seat suspension mat 116 according to another preferred embodiment of the invention. The seat suspension mat 116 comprises a central spring 120b extending between and alongside outer springs 120a, 120d. An underpassing cross-tie 132 links the outer springs 120a, 120d to each other. The underpassing cross-tie 132 carries an electrical contact element in the form of a film-type pressure sensitive switch (membrane switch 134) arranged in facing relationship with the central spring 120b disposed above it. The membrane switch comprises a first carrier film 142 and a second carrier film 144 spaced from each other by a spacer film 146, the spacer film 146 having therein an opening defining a cell. At least two electrodes 148a, 148b, 148c are arranged in facing relationship with each other in the cell on the first and the second carrier film, respectively, in such a way that they are brought into contact with each other when pressure is
applied on the membrane switch. The electrodes 148a, 148b, 148c are connected to a detection circuit 138, which monitors the electrical resistance between them.

[0026] When an occupant is seated on the seat, the cushion 118 transfers the occupant’s weight on the seat suspension mat 116 in the same manner as in the previously described embodiment (Figs. 1 to 3). In consequence, the central spring 120b presses on the membrane switch 134, which is thereby activated, in the sense that its electrodes 148a, 148b, 148c are brought into contact and the resistance between them drops significantly. This is detected by the detection circuit, which outputs a signal indicative of the activated state of the membrane switch 134 and thus of the fact that the seat is occupied. When no occupant is present on the seat, the central spring 120b and the membrane switch 134 are mutually spaced. In this case, the membrane switch 134 is in its inactivated state, which is also reflected in the signal output by the detection circuit 138 on the output 140.

[0027] While specific embodiments have been described in detail, those with ordinary skill in the art will appreciate that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention, which is to be given the full breadth of the appended claims and any and all equivalents thereof.
Legend:

10        Vehicle seat  
12        Seating portion  
14        Structural frame  
16        Seat suspension mat  
18        Cushion  
20        Cushion-supporting springs  
20a, 20d  Outer springs  
20b, 20c  Central springs  
22        Fixation sites  
24        First hook-shaped end portion  
26        Second hook-shaped end portion  
28        Plastic coating  
30        Cross-ties  
32        Underpassing cross-tie  
34        Contact element  
36        Plane  
38        Detection circuit  
40        Output  
116       Seat suspension mat  
118       Seat cushion  
120       Springs  
120a, 120d Outer springs  
120b      Central spring  
132       Underpassing cross-tie  
134       Membrane switch  
138       Detection circuit  
140       Output  
142       First carrier film  
144       Second carrier film  
146       Spacer film  
148a, 148b, electrodes  
148c
Claims

1. Seat suspension mat (16; 116), in particular for a vehicle seat (10), comprising a plurality of spring members (20, 120) for being taut between respective fixations sites of a structural seat frame; said plurality of spring members including:
   o at least one central spring member (20b, 20c; 120b); and
   o at least two outer spring members (20a, 20d; 120a, 120d) arranged alongside of said at least one central spring member;
said seat suspension mat (16; 116) being characterized by
an underpassing cross-tie (32; 132) attached to said at least two outer spring members (20a, 20d; 120a, 120d) and passing underneath said at least one central spring member (20b, 20c; 120b), said underpassing cross-tie (32; 132) carrying an electric contact element (34; 134) arranged under said at least one central spring member (20b, 20c; 120b) so as to be able to be pressed on by said at least one central spring member bends (20b, 20c; 120b) down under load.

2. Seat suspension mat (16, 116) as claimed in claim 1, comprising further cross-ties (30) flexibly interlinking said spring members (20; 120).

3. Seat suspension mat (16; 116) as claimed in claims 1 or 2, wherein said electric contact element comprises an electric switch (134) including at least a first and a second conductor (148a, 148b, 148c), which are brought into electrical contact when said electric switch (134) is pressed on.

4. Seat suspension mat as claimed in claim 3, wherein said electric switch comprises a membrane switch (134).

5. Seat suspension mat (16, 116) as claimed in claims 1 or 2, wherein said electric contact element (34) comprises an electrode and said central spring (20b, 20c) is electrically conductive, and wherein said contact element (34) and said central spring (20b, 20c) form together an electric switch.

6. Seat suspension mat (16, 116) as claimed in any one of claims 1 to 5, comprising a detection circuit (38; 138) configured for detecting whether said
at least one central spring member (20b, 20c; 120b) presses on said electric contact element (34; 134), said detection circuit (38; 138) comprising an output (40; 140) for issuing a signal indicative of said detection.

7. Seat suspension mat (16; 116) as claimed in claim 1 to 6, wherein said spring members (20; 120) are individual springs.

8. Seat suspension mat (16; 116) as claimed in claim 1 to 6, wherein said spring members comprise sections of one or more springs bent over at said fixation sites (22), said sections extending alongside each other.

9. Seat suspension mat (16; 116) as claimed in claim 1 to 8, wherein said underpassing cross-tie (32; 132) is made of injection-moulded plastic.

10. Seat (10), in particular vehicle seat, comprising
    o a structural frame (14) comprising a plurality of fixation sites (22) for a seat suspension mat (16, 116);
    o a seat suspension mat (16; 116) as claimed in any one of claims 1 to 9, and
    o a seat cushion (18; 118) supported by said seat suspension mat (16; 116).
Abstract

A seat suspension mat (16), e.g. for use in a vehicle seat (10), comprises a plurality of spring members (20) for being taut between respective fixations sites (22) of a structural seat frame (14). The plurality of spring members includes at least one central spring member (20b, 20c) and at least two outer spring members (20a, 20d) arranged alongside of the at least one central spring member. An underpassing cross-tie (32) attached to the at least two outer spring members passes underneath the at least one central spring member. The underpassing cross-tie carries an electric contact element (34) arranged under the at least one central spring member so as to be able to be pressed on by the at least one central spring member when the at least one central spring member bends down under load.

(Fig. 1)
## DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims.

1 February 2013

Lotz, Klaus-Dieter

### CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE SEARCH REPORT
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