



(51) International Patent Classification:

B60R 21/015 (2006.01) **B60N 2/00** (2006.01)
B62D 1/06 (2006.01) **G01G 7/06** (2006.01)
H03K 17/96 (2006.01) **G01G 19/414** (2006.01)

(21) International Application Number:

PCT/EP2016/062460

(22) International Filing Date:

2 June 2016 (02.06.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

92 732 5 June 2015 (05.06.2015) LU

(71) Applicant: **IEE INTERNATIONAL ELECTRONICS & ENGINEERING S.A.** [LU/LU]; Zone Industrielle, 6468 Echternach (LU).

(72) Inventor: **ALTHAUS, Frank**; Kolbenhofstr. 1, 66113 Saarbrücken (DE).

(74) Agents: **BEISSEL, Jean** et al.; Office Freylinger S.A., 234, Route d'Arlon, BP 48, 8001 Strassen (LU).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LI, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: CAPACITIVE DETECTION DEVICE AND SYSTEM FOR USE IN VEHICLE INTERIOR

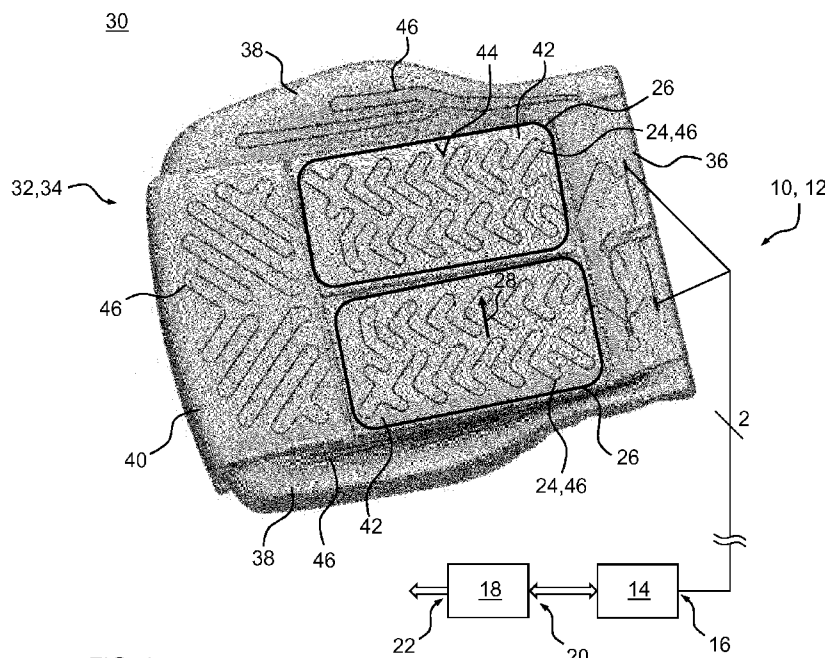


FIG. 1

(57) Abstract: A capacitive detection device (12) and capacitive detection system (10) for use in a vehicle interior comprises at least one electrically conductive wire (24), at least partially attached to a component of the vehicle interior, and at least one electrically conductive layer (26) that is arranged in close proximity to the at least one electrically conductive wire (24), compared to a potential minimum distance to a vehicle occupant, wherein a galvanic connection between the at least one electrically conductive layer (26) and the at least one electrically conductive wire (24) is avoided.

Capacitive Detection Device and System for Use in Vehicle Interior

Technical field

[0001] The invention relates to a capacitive detection device and a capacitive detection system for use in a vehicle interior, and a vehicle seat and a vehicle steering wheel with an installed such capacitive detection system.

Background Art

[0002] Vehicle seat occupancy detection systems are nowadays widely used in vehicles, in particular in passenger cars, for providing a seat occupancy signal for various appliances, for instance for the purpose of a seat belt reminder (SBR) system or an activation control for an auxiliary restraint system (ARS). Seat occupancy detection systems include seat occupancy sensors that are known to exist in a number of variants, e.g. based on capacitive sensing, on deformation sensing or on sensing of pressure/force. In order to meet requirements regarding easy integration and feared robustness, weight-sensitive seat occupancy sensors have typically been arranged on the B-surface of a vehicle seat, i.e. between a foam body of a seat cushion and a seat pan or cushion-supporting springs of the vehicle seat.

[0003] Further, vehicle seat occupancy detection systems are known to be employed as a means of assessing a potential activation of an installed vehicle passenger restraint system, such as an airbag.

[0004] It is further known to employ detection systems for detecting a presence or absence of a driver's hands on the steering wheel of a vehicle. Such detection systems provide input, for instance, to automatic driver assistance systems (ADAS).

[0005] By way of example, patent application US 2002/0038947 A1 describes an occupant detecting apparatus for detecting an occupant seated on a passenger seat of a vehicle with an airbag for the occupant. A load sensor is provided in a bottom part of the seat. A plurality of first electric field sensors are provided in the bottom part of the seat, and a plurality of second electric field sensors are provided in a rear part of the seat. An airbag inflation permission control unit permits

inflation of the airbag in accordance with output signals of the load sensor and the first and second electric field sensors.

[0006] Patent application US 20100228417 A1 describes a system and method for determining whether a vehicle driver is holding a steering wheel of the vehicle while the vehicle is in an autonomous driving mode. The vehicle will include an electric power steering (EPS) system and may include an active front steering (AFS) system, both of which include a motor that can apply a high frequency and low amplitude perturbation signal to the steering wheel of the vehicle that is not felt by the vehicle driver and does not cause the vehicle to turn, but is able to be detected by a steering angle sensor. The method subtracts a steering angle command signal from the steering angle signal and removes road disturbances, and then determines whether the induced perturbation signal is present in the steering angle sensor signal. If the perturbation signal is present, then the system knows that the vehicle driver is not holding the steering wheel.

Technical problem

[0007] It is an object of the invention to provide a capacitive detection device for use in a vehicle interior, in particular for detecting a proximal presence or an absence of a vehicle occupant to or from a component of the vehicle interior, with improved performance, high reliability and easy installation.

Summary of the Invention

[0008] In one aspect of the present invention, the object is achieved by a capacitive detection device comprising at least one electrically conductive wire that is at least partially attached to a component of the vehicle interior, and a signal generating unit provided for generating a time-varying output signal and for applying the time-varying output signal to each electrically conducting wire of the at least one electrically conductive wire. The capacitive detection device further includes at least one electrically conductive layer that is arranged to at least partially overlap the at least one electrically conductive wire in a direction perpendicular to a portion of an outer surface of the component that is closest to the at least one electrically conductive layer. A galvanic connection between the at

least one electrically conductive layer and the at least one electrically conductive wire is avoided.

[0009] The ratio of the lesser of a minimum distance between a portion of the outer surface of the component to the at least one electrically conductive wire and a minimum distance between the portion of the outer surface of the component to the at least one electrically conductive layer to the minimum distance between the at least one electrically conductive wire and the at least one electrically conductive layer at a location of the portion of the outer surface of the component is larger than or equal to 2.0 at least for a major portion of the part of the at least one electrically conductive wire that is attached to the component.

[0010] The term “vehicle”, as used in this application, shall particularly be understood to encompass passenger cars, trucks and buses.

[0011] The phrase “major portion”, as used in this application, shall in particular be understood as a portion of more than 30%, more preferable of more than 50%, and, most preferable, of more than 70%.

[0012] The performance of a capacitive detection device is directly linked to an areal density of a routing of an employed electrically conductive wire. The at least one electrically conductive layer of the capacitive detection device in accordance with the invention amplifies a change in capacitance of the at least one electrically conductive wire in a situation when a vehicle occupant approaches or moves away from the component of the vehicle interior, which can beneficially enable a higher sensitivity of the capacitive detection device, or can allow for easy installation requiring less material effort for achieving the same sensitivity.

[0013] The change of the capacitance of the at least one electrically conductive wire can be detected by any simple electronic circuit that appears to be suitable to those skilled in the art.

[0014] Preferably, the time-varying output signal is a periodic output signal. The periodic signal may be a sinusoidal signal or a square-wave signal. In one embodiment, the periodic output signal has a fundamental frequency selected from a range between 1 kHz and 1 MHz.

[0015] In another aspect of the present invention, a capacitive detection system is provided that comprises a capacitive detection device as disclosed above, and further includes a signal evaluation unit that is provided for sensing a change of an electrical quantity that is indicative of a change in capacitance of the at least one electrically conductive wire, and that is provided for generating an output signal that is representative of the sensed change of the electrical quantity. In this way, a detected absence or proximal presence of the vehicle occupant to the component of the car interior can readily be made available to other vehicle or auxiliary control units as an input for the purpose of a seat belt reminder (SBR) system, an activation control for an auxiliary restraint system (ARS) or an automatic driver assistance system (ADAS).

[0016] It will be appreciated, that the signal generating unit and the signal evaluation unit may be provided as separate units. In a preferred embodiment, the signal generating unit and the signal evaluation unit are however integrated in a single electronics module or circuit, e.g. in an application-specific integrated circuit (ASIC).

[0017] The output provided by the signal evaluation unit may be an analog electric signal, a digital electric signal or a digital optical signal.

[0018] Preferably, the change in capacitance of the at least one electrically conductive wire is sensed with regard to a vehicle chassis.

[0019] In yet another aspect of the invention, a vehicle seat with an installed capacitive detection system as disclosed above is provided. The vehicle seat includes a seat base configured for taking up a seat base cushion. The seat base and the seat base cushion are provided for supporting a bottom of a seat occupant. The vehicle seat further comprises a backrest that is configured for taking up a backrest cushion provided for supporting a lumbar and back region of the seat occupant. At least one electrically conductive wire of the at least one electric conductive wire of the capacitive detection system is at least partially attached to at least one out of the seat base cushion and the backrest cushion.

[0020] In this way, a presence of a seat occupant can readily and reliably be detected. In a suitable embodiment the detected seat occupant can even be categorized, for instance into at least two categories given as "adult" and "child".

[0021] If, in another preferred embodiment, the vehicle seat includes a seat heater device with at least one seat heater wire, at least one seat heater wire of the at least one seat heater wire serves as the at least one electrically conductive wire to which the time-varying output signal of the signal generating unit is applied. By that, the hardware effort related to the capacitive detection device can beneficially be reduced. The at least one seat heater wire may be installed at the seat base cushion or at the backrest cushion.

[0022] In a possible embodiment of the vehicle seat with an installed capacitive detection system, the capacitive detection system comprises two electrically conductive wires and two electrically conductive layers. Each electrically conductive wire is at least partially overlapped by one of the two electrically conductive layers in a direction that is perpendicular to a portion of one out of a surface of the seat base cushion and a surface of the backrest cushion that is closest to the electrically conductive layer. The two electrically conductive wires are attached to one out of a seat base cushion and a backrest cushion of the vehicle seat, preferably close to a surface. In this way, redundancy is created and reliability for detecting the presence of a seat occupant can be ensured even in case of a single failure of one of the two electrically conductive wires.

[0023] In yet another preferred embodiment of the vehicle seat with an installed capacitive detection system, each electrically conductive wire of the at least one electrically conductive wire forms a meandering pattern. The meandering patterns cover a major portion of a surface of the seat base cushion or the backrest cushion. In this way, a seat occupancy can also be detected in cases in which a seat occupant is occupying the seat in a lounged, non-standard manner.

[0024] In another aspect of the invention, a vehicle steering wheel with an installed capacitive detection system as disclosed herein is provided. The at least one electrically conductive wire is at least partially attached to the steering wheel in a portion of a circumference of the steering wheel. In this way, a presence of a vehicle driver's hands can readily and reliably be detected and the output signal of the signal evaluation unit can be used in support of an activation control for an automatic driver assistance systems (ADAS).

[0025] If the at least one electrical conductive layer is arranged to cover a portion of an outer surface of the steering wheel, such that a high coupling between the wire and the conductive layer is achieved, presence of the vehicle driver's hands can beneficially be detected in a reliable way and for a large number of individual holding positions, including non-standard ones.

[0026] In a preferred embodiment of the vehicle steering wheel with an installed capacitive detection system, an areal density of the at least one electrically conductive wire is higher in regions of azimuthal positions with regard to an axis of rotation of the steering wheel that correspond to regular holding positions used by a vehicle driver when driving in a straight forward direction. In this way, a sensitivity for detecting presence of the vehicle driver's hands can be enhanced, in particular in the critical situation of high-speed cruising on a highway.

[0027] If the vehicle steering wheel includes a heater device with at least one heater wire, at least one heater wire of the at least one heater wire serves as the at least one electrically conductive wire to which the time-varying output signal of the signal generating unit is applied, beneficially saving hardware and installing effort.

Brief Description of the Drawings

[0028] 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 schematic illustration of a vehicle seat with an installed capacitive detection system in accordance with the invention; and

Fig. 2 schematically shows a configuration of a capacitive detection device in accordance with the invention and a vehicle occupant.

Description of Preferred Embodiments

[0029] Fig. 1 is a schematic illustration of a vehicle seat 30 with an installed capacitive detection system 10 in accordance with the invention. The vehicle seat 30 comprises a seat base 32 configured for taking up a seat base cushion 34. The seat base 32 and the seat base cushion 34 are provided for supporting a bottom of a seat occupant 50. The vehicle seat 30 further includes a backrest

configured for taking up a backrest cushion provided for supporting a lumbar and back region of the seat occupant 50. The backrest, which is not shown in Fig. 1 for reasons of clarity, is arranged at a rear edge 36 of the seat base 32 shown on the right-hand side of Fig. 1.

[0030] The vehicle seat 30 includes a seat heater device including a one or more seat heater wires 46 made e.g. from Constantan[®] wire having an outer electrical insulation layer 52. The seat heater wire or wires 46 is/are arranged in the vehicle seat 30 so as to extend through the various locations of the seat. One part of the heater wire 46 each is attached to each one of two seat base cushion side members 38 that are provided for supporting the seat occupant's thighs. Another portion of the heater wire 46 is attached to a seat base cushion front member 40, and two more portions of the heater wire are attached to a two-part seat base cushion center member 42, close to the A surface 44 of the seat base cushion 34. It will be noted that the different heater wires of the different portions of the heater wire may be independent from each other or may be interconnected so as to form a single heater loop. As will be explained in the following, this heater wire or heater wires 46 serve as electrically conductive wire 24 to which a time-varying output signal of a signal generating unit 14 of the capacitive detection system 10 will be applied.

[0031] The capacitive detection system 10 comprises the electrically conductive wire 24 formed by the heater wire 46 that is attached to the seat base cushion center member 42. The conductive wire 24 forms a meandering pattern that is arranged in parallel to the A surface 44 of the seat base cushion center member 42. The capacitive detection system 10 further includes two electrically conductive layers 26. Each electrically conductive layer 26 is arranged to overlap the meandering pattern formed by two heater wire 24, 46 attached to the two parts of the seat base cushion center member 42 in a direction 28 that is perpendicular to a portion of a surface of the seat base cushion center member 42 that is closest to the electrically conductive layer 26. The conductive layer 26 is arranged to overlap the meandering pattern at least in the area where a person/hand is expected to be in proximity. It will be appreciated that instead of two separate

electrically conductive layers 26, a single electrically conductive layer may be arranged overlapping both parts of the seat base cushion center member 42.

[0032] Due to the outer electrical insulation 52 of the electrically conductive wire 24/heater wire 46 and an optional electrical insulating layer, which may be positioned between the electrically conductive layer 26 and the electrically conductive wire 24, a galvanic connection between the electrically conductive layers 26 and the electrically conductive wire 24 is avoided. The meandering patterns formed by the electrically conductive wire 24/heater wire 46 covers a major portion of the surface of the seat base cushion center member 42.

[0033] Moreover, the capacitive detection system 10 includes a signal generating unit 14 and a signal evaluation unit 18, which are installed remotely from the vehicle seat 30. The signal generating unit 14 is electrically connected with its output port(s) 16 to the electrically conductive wire(s) 24 formed by the heater wire(s) that is/are attached to the seat base cushion center member 42. The signal generating unit 14 is provided for generating a sine-wave output signal and for applying the output signal to the electrically conducting wire 24 or the electrically conductive wires 24.

[0034] The electrically conductive wire 24 is connected via the signal generating unit 14 to an input port 20 of the signal evaluation unit 18. The signal evaluation unit 18 is provided for sensing a change of an electrical quantity that is indicative of a change in capacitance of the electrically conductive wire 24, and is provided for generating an output signal at its output port 22 that is representative of the sensed change of the electrical quantity.

[0035] It will be appreciated, that the signal generating unit 18 and the signal evaluation unit 18 are preferably integrated in a single electronics module or circuit, e.g. in an application-specific integrated circuit (ASIC).

[0036] A configuration of the capacitive detection device 12 and the seat occupant 50 is schematically shown in Fig. 2. The configuration as well applies to a vehicle steering wheel with an installed capacitive detection system 10 in accordance with the invention and a vehicle occupant holding the steering wheel as a driver of the vehicle, which therefore will not be described to avoid repetition.

[0037] In Fig. 2, which expressly is not meant to scale, the electrically conductive wire 24 to which the square-wave output signal is applied is shown in the bottom part, being arranged close to the A surface 44 of the seat base cushion center member 42 (not shown in Fig. 2). Above the electrically conductive wire 24, the electrically conductive layer 26 is positioned in a minimum distance d_1 . In principle, the sequence of the electrically conductive wire 24 and the electrically conductive layer 26 may be reversed, such that the electrically conductive wire 24 is positioned above the electrically conductive layer 26. Above the electrically conductive layer 26, a trim layer 48 of a vehicle interior component is shown, which in case of the vehicle seat 30 shown in Fig. 1 may be a cover layer of the seat base cushion 34 or the backrest cushion, and in case of a vehicle steering wheel may be the trim layer of the steering wheel. The closest position to the capacitive detection device 12 that the seat occupant 50 can take is to be in contact with the cover layer of the seat base cushion 34 (or the backrest cushion), or the steering wheel trim layer, respectively.

[0038] The minimum distance between a portion of the outer surface of the vehicle interior component to the electrically conductive wire 24 is given by $d_1 + d_2$. The minimum distance between the portion of the outer surface of the component to the electrically conductive layer 26 is given by d_2 . The lesser of these two minimum distances is therefore given by d_2 in the shown embodiment.

[0039] A ratio of the lesser of the two minimum distances to the minimum distance d_1 , between the electrically conductive wire 24 and the electrically conductive layer 26 at a location of the portion of the outer surface of the component is thus given by d_2/d_1 and is larger than or equal to 2.0 (in the embodiment shown in Fig. 2 about 2.6) for a major portion of the part of the electrically conductive wire 24 that is attached to the component, i.e. the seat base cushion center member 42.

[0040] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments.

[0041] Other variations to be disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting scope.

List of Reference signs

- 10 capacitive detection system
- 12 capacitive detection device
- 14 signal generating unit
- 16 output port
- 18 signal evaluation unit
- 20 input port
- 22 output port
- 24 electrically conductive wire
- 26 electrically conductive layer
- 28 direction
- 30 vehicle seat
- 32 seat base
- 34 seat base cushion
- 36 rear edge
- 38 seat base cushion side member
- 40 seat base cushion front member
- 42 seat base cushion center member
- 44 A surface
- 46 seat heater wire
- 48 trim layer
- 50 seat occupant
- 52 electrical insulation
- d₁ minimum distance
- d₂ minimum distance

Claims:

1. A capacitive detection device (12) for use in a vehicle interior, comprising
at least one electrically conductive wire (24), at least partially attached to a component of the vehicle interior,
a signal generating unit (14) provided for generating a time-varying output signal and for applying the time-varying output signal to each electrically conducting wire (24) of the at least one electrically conductive wire (24),
at least one electrically conductive layer (26) that is arranged to at least partially overlap the at least one electrically conductive wire (24) in a direction (28) perpendicular to a portion of an outer surface of the component that is closest to the at least one electrically conductive layer (26), wherein a galvanic connection between the at least one electrically conductive layer (26) and the at least one electrically conductive wire (24) is avoided,
wherein the ratio of the lesser of
 - a minimum distance between a portion of the outer surface of the component to the at least one electrically conductive wire (24) and
 - a minimum distance (d2) between the portion of the outer surface of the component to the at least one electrically conductive layer (26)to the minimum distance (d1) between the at least one electrically conductive wire (24) and the at least one electrically conductive layer (26) at a location of the portion of the outer surface of the component is larger than or equal to 2.0 at least for a major portion of the part of the at least one electrically conductive wire (24) that is attached to the component.
2. A capacitive detection system (10) comprising a capacitive detection device (12) as claimed in claim 1, and further including a signal evaluation unit (18) that is provided for sensing a change of an electrical quantity that is indicative of a change in capacitance of the at least one electrically conductive wire (24), and that is provided for generating an output signal that is representative of the sensed change of the electrical quantity.

3. A vehicle seat (30) with an installed capacitive detection system (10) as claimed in claim 2, the vehicle seat (30) comprising

a seat base (32) configured for taking up a seat base cushion (34), the seat base (32) and the seat base cushion (34) being provided for supporting a bottom of a seat occupant (50), and

a backrest configured for taking up a backrest cushion provided for supporting a lumbar and back region of the seat occupant (50),

wherein at least one electrically conductive wire (24) of the at least one electrically conductive wire (24) is at least partially attached to at least one out of the seat base cushion (34) and the backrest cushion.
4. The vehicle seat (30) as claimed in claim 3, further comprising a seat heater device including at least one seat heater wire (46), wherein at least one seat heater wire (46) of the at least one seat heater wire (46) serves as the at least one electrically conductive wire (24) to which the time-varying output signal of the signal generating unit (14) is applied.
5. The vehicle seat (30) as claimed in any one of claims 3 to 4, wherein each electrically conductive wire (24) of the at least one electrically conductive wire (24) forms a meandering pattern, and wherein the meandering pattern covers a major portion of a surface of the seat base cushion (34) or the backrest cushion.
6. A vehicle steering wheel with an installed capacitive detection system (10) as claimed in claim 2, wherein the at least one electrically conductive wire (24) is at least partially attached to the steering wheel in a portion of a circumference of the steering wheel.
7. The vehicle steering wheel as claimed in claim 6, wherein the at least one electrically conductive layer (26) is arranged to cover a portion of a surface of the steering wheel.
8. The vehicle steering wheel as claimed in claim 6 or 7, wherein an areal density of the at least one electrically conductive wire (24) is higher in regions of azimuthal positions with regard to an axis of rotation of the steering wheel that

correspond to regular holding positions used by a vehicle driver when driving in a straight forward direction.

9. The vehicle steering wheel as claimed in any one of claims 6 to 8, the vehicle steering wheel further including a heater device with at least one heater wire, wherein at least one heater wire of the at least one heater wire serves as the at least one electrically conductive wire (24) to which the time-varying output signal of the signal generating unit (14) is applied.

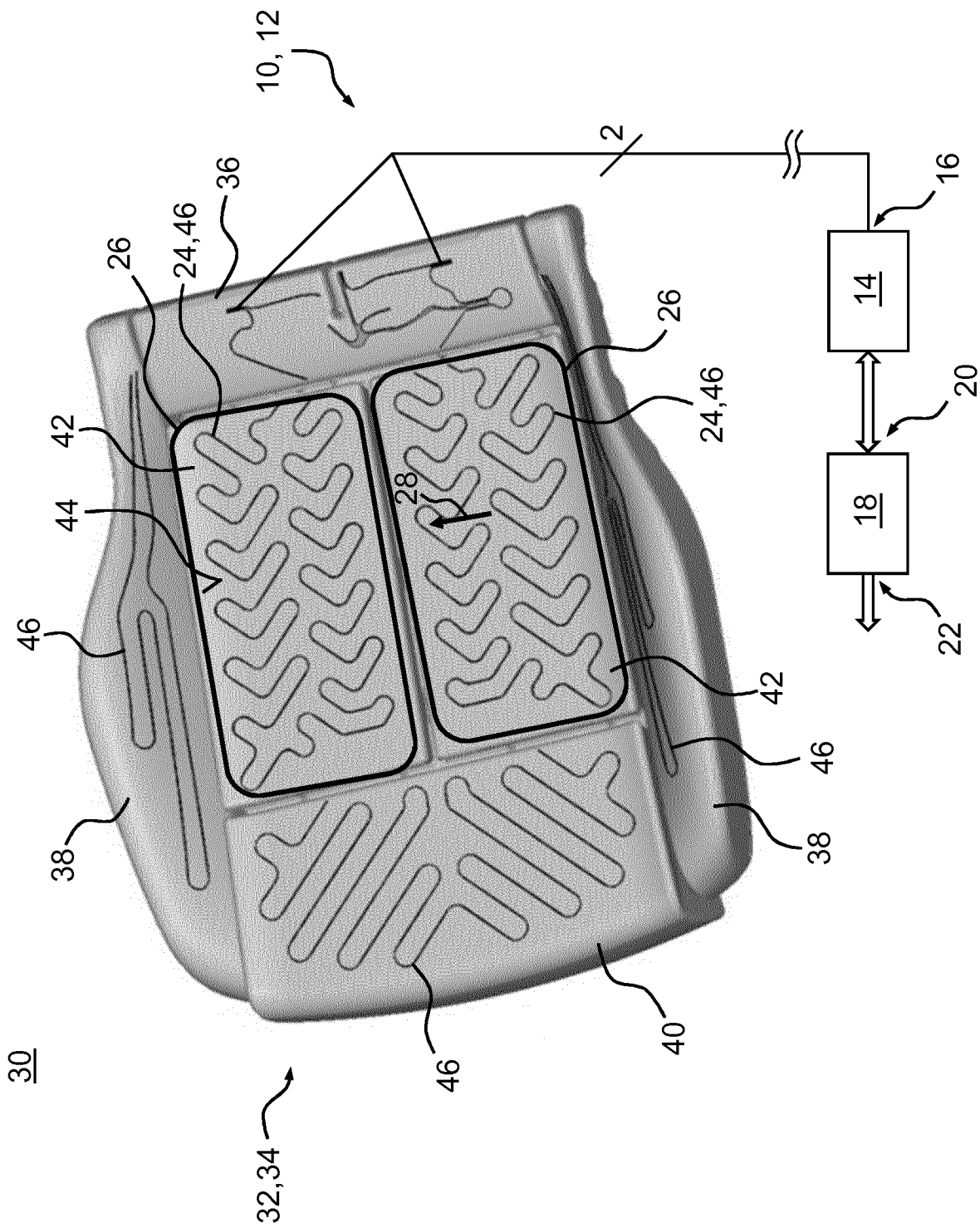


FIG. 1

2 / 2

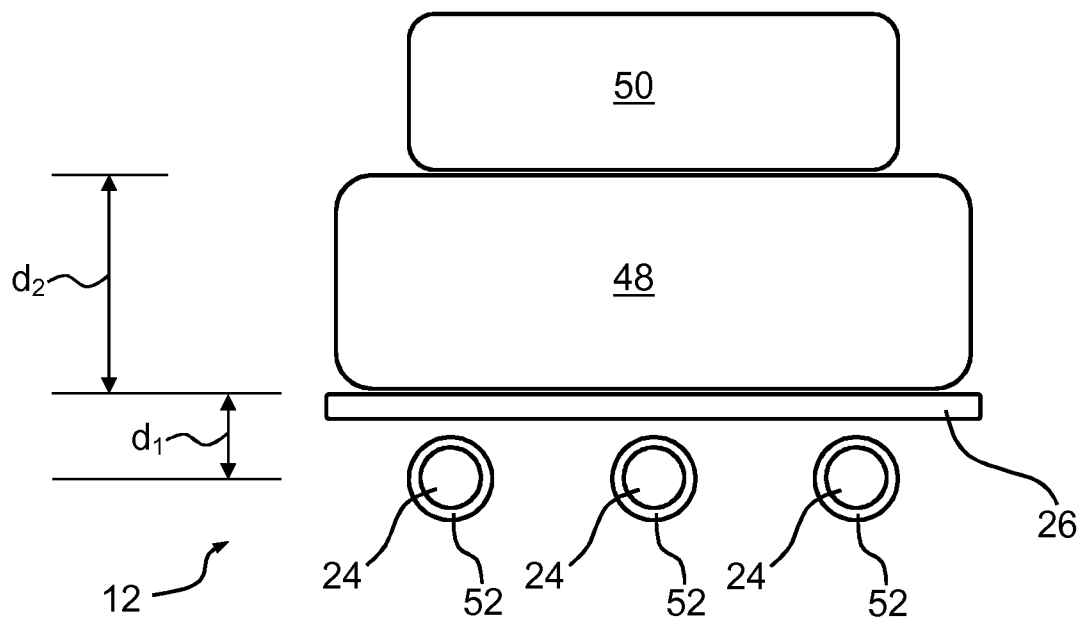


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/062460

A. CLASSIFICATION OF SUBJECT MATTER INV. B60R21/015 B62D1/06 H03K17/96 B60N2/00 G01G7/06 G01G19/414 ADD. 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) B60R B62D H03K B60N G01G 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) EPO-Internal, WPI Data											
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td> WO 03/007476 A2 (NARTRON CORP [US]) 23 January 2003 (2003-01-23) page 10, lines 11-17 page 12, line 13 - page 13, line 2 figures 6,8,9,10 page 9, lines 23-31 ----- </td> <td>1-9</td> </tr> <tr> <td>A</td> <td> WO 2004/069590 A2 (FAURECIA SIEGES AUTOMOBILE [FR]; HITACHI COMP PRODUCTS EUROP S [FR]; G) 19 August 2004 (2004-08-19) page 5, lines 23-32 page 6, line 27 - page 7, line 5 figures 1-7 ----- -/-- </td> <td>1-9</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	WO 03/007476 A2 (NARTRON CORP [US]) 23 January 2003 (2003-01-23) page 10, lines 11-17 page 12, line 13 - page 13, line 2 figures 6,8,9,10 page 9, lines 23-31 -----	1-9	A	WO 2004/069590 A2 (FAURECIA SIEGES AUTOMOBILE [FR]; HITACHI COMP PRODUCTS EUROP S [FR]; G) 19 August 2004 (2004-08-19) page 5, lines 23-32 page 6, line 27 - page 7, line 5 figures 1-7 ----- -/--	1-9
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.									
A	WO 03/007476 A2 (NARTRON CORP [US]) 23 January 2003 (2003-01-23) page 10, lines 11-17 page 12, line 13 - page 13, line 2 figures 6,8,9,10 page 9, lines 23-31 -----	1-9									
A	WO 2004/069590 A2 (FAURECIA SIEGES AUTOMOBILE [FR]; HITACHI COMP PRODUCTS EUROP S [FR]; G) 19 August 2004 (2004-08-19) page 5, lines 23-32 page 6, line 27 - page 7, line 5 figures 1-7 ----- -/--	1-9									
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.											
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "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) "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 "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 "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 "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 "&" document member of the same patent family											
Date of the actual completion of the international search 23 August 2016		Date of mailing of the international search report 30/08/2016									
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Sleightholme-Albanis									

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/062460

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2007/095068 A2 (TK HOLDINGS INC [US]; STANLEY JAMES GREGORY [US]; THEOS GEORGE [US]; M) 23 August 2007 (2007-08-23) abstract; figures 1-3 -----	4,5
A	US 2014/224040 A1 (VAN TZELFDE DWAYNE [US] ET AL) 14 August 2014 (2014-08-14) paragraphs [0070], [0073]; figure 8 -----	6-9
A	WO 2012/038326 A1 (IEE SARL [LU]; VIRNICH MICHAEL [DE]; HOYER DAVID [DE]; THINNES MARTIN) 29 March 2012 (2012-03-29) paragraph [0033]; figures 4,5 -----	1-5
A	WO 97/47976 A2 (SCANDMEC AB [SE]; BERGVALL BENGT ALLAN [SE]; FRISTEDT TOMMY [SE]) 18 December 1997 (1997-12-18) page 5, lines 8-30 page 6, lines 8-16 page 7, lines 7-14 figure 1 -----	1-5
A	US 2006/231320 A1 (KAMIZONO TSUTOMU [JP] ET AL) 19 October 2006 (2006-10-19) abstract; figures 1,4-8 -----	1-5
A	WO 2013/057263 A1 (TAKATA AG [DE]) 25 April 2013 (2013-04-25) page 9, line 17 - page 10, line 9 page 16, lines 16-33 figures 1,2,4 -----	6-9
A	JP S64 51564 U (NN) 30 March 1989 (1989-03-30) figures 1,2,5 -----	6-9
A	US 2002/038947 A1 (BABA SATOSHI [JP] ET AL) 4 April 2002 (2002-04-04) cited in the application abstract; figures 2,8,20,21 paragraphs [0045], [0046], [0138], [0139] -----	1
A	US 2010/228417 A1 (LEE JIN-WOO [US] ET AL) 9 September 2010 (2010-09-09) cited in the application abstract; figures 1,2 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/062460

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03007476	A2	23-01-2003	EP 1552613 A2 13-07-2005 EP 1933461 A1 18-06-2008 JP 4309259 B2 05-08-2009 JP 2005502859 A 27-01-2005 US 2003005775 A1 09-01-2003 WO 03007476 A2 23-01-2003
WO 2004069590	A2	19-08-2004	FR 2849918 A1 16-07-2004 JP 2006518033 A 03-08-2006 US 2006033507 A1 16-02-2006 WO 2004069590 A2 19-08-2004
WO 2007095068	A2	23-08-2007	US 2007200721 A1 30-08-2007 WO 2007095068 A2 23-08-2007
US 2014224040	A1	14-08-2014	CN 105143015 A 09-12-2015 DE 112014000795 T5 29-10-2015 JP 2016508917 A 24-03-2016 US 2014224040 A1 14-08-2014 WO 2014126999 A1 21-08-2014
WO 2012038326	A1	29-03-2012	LU 91738 A1 26-03-2012 WO 2012038326 A1 29-03-2012
WO 9747976	A2	18-12-1997	AU 3111797 A 07-01-1998 WO 9747976 A2 18-12-1997
US 2006231320	A1	19-10-2006	JP 4315388 B2 19-08-2009 JP 2006292631 A 26-10-2006 US 2006231320 A1 19-10-2006
WO 2013057263	A1	25-04-2013	CN 103874616 A 18-06-2014 DE 102011084903 A1 25-04-2013 EP 2768711 A1 27-08-2014 JP 2015502282 A 22-01-2015 US 2014253151 A1 11-09-2014 WO 2013057263 A1 25-04-2013
JP S6451564	U	30-03-1989	JP H0627494 Y2 27-07-1994 JP S6451564 U 30-03-1989
US 2002038947	A1	04-04-2002	JP 3879969 B2 14-02-2007 JP 2002104129 A 10-04-2002 US 2002038947 A1 04-04-2002 US 2004075259 A1 22-04-2004
US 2010228417	A1	09-09-2010	CN 101823487 A 08-09-2010 DE 102010010028 A1 04-11-2010 US 2010228417 A1 09-09-2010