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STEERING WHEEL HAVING ELECTRODES FOR DETECTING STEERING WHEEL CONTACT

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Detecting steering wheel contact using self-capacitance sensing systems is known. Self-capacitance sensing systems can include an electrode arranged in a steering wheel and an evaluation device that measures changes in capacitance at the electrode with respect to ground. When an occupant contacts the steering wheel, the capacitance at the electrode increases. However, liquids and moisture on the steering wheel can also increase the capacitance at the electrode. Therefore, most self-capacitance sensing systems cannot easily differentiate between occupant contact and liquid/moisture on the steering wheel. This inability to differentiate can lead to false or inaccurate steering wheel contact detections. The steering wheel described below is designed to overcome the problems found in the previously known self-capacitance sensing systems that detect steering wheel contact.

A steering wheel designed in accordance with the present disclosure is shown in the below drawings. A steering wheel rim of the steering wheel includes a first foam layer surrounding a steering wheel rim armature. A heating electrode surrounds the first foam layer. The heating electrode can be one or more wires or a combination of one or more wires and fabric. A shielding electrode, which can be formed from a conductive fabric, surrounds the heating electrode. A second foam layer surrounds the shielding electrode. A sensing layer surrounds the second foam layer. The sensing layer includes interdigitated first and second electrodes, which can be formed from conductive fabric and/or one or more wires, for detecting steering wheel contact. A third foam layer surrounds the sensing layer. A wrapping, which can be formed from a dielectric material, surrounds the third foam layer.

An evaluation and control device (“EVCD”) is connected to the first and second electrodes. The EVCD is switchable between a self-capacitance sensing mode (“SC mode”) and a mutual capacitance sensing mode (“MC mode”). The switch between the two modes can be time based and/or event based. In the SC mode, the EVCD can drive a current into at least one of the first and second electrodes and sense a change in capacitance at each driven electrode with respect to ground to detect occupant contact on the steering wheel rim and/or liquid/moisture on the steering wheel rim. In the MC mode, the EVCD drives a current through one of the first and second electrodes that passes into the other of the first and second electrodes, and senses changes in capacitance between the first and second electrodes to detect occupant contact on the steering wheel rim and/or liquid/moisture on the steering wheel rim. The EVCD is able to store sensed capacitance values in order to make comparisons with subsequently sensed capacitance values.

The EVCD can also be connected to the heating electrode and the shielding electrode. The EVCD can selectively apply a current to the heating electrode to heat the steering wheel rim. The EVCD can drive a current through the shielding electrode that maintains the shielding electrode’s voltage at a constant potential or ground to help shield the first and second electrodes from the EMI caused by the heating electrode and/or the armature.

Advantages of the steering wheel of the present disclosure:

- The ability of the EVCD to switch between the two sensing modes and compare stored values with subsequent values allows the EVCD to determine when an occupant is contacting the steering wheel rim, when liquid/moisture is on the steering wheel rim, and the presence of both the occupant and liquid/moisture on the steering wheel rim.

- Interdigitating the first and second electrodes allows clearances between the electrodes and edges of the second foam layer to be smaller than what they would be if the electrodes were arranged in a different manner. Shrinking the clearances can decrease detection dead zones and increases detection coverage on the steering wheel rim.
- The first and second electrodes can be included in a single electrode mat that also includes the second foam layer, the shielding electrode and the heating electrode. The electrode mat permits a manufacturer to wrap the all of the electrodes and the second foam layer about the first foam layer as a single unit to save manufacturing time.
- The electrode mat can be made about 2 mm or less.
- The shielding electrode, being radially between the heating electrode/armature and the first and second electrodes, helps shield the first and second electrodes from the EMI caused by the heating electrode and/or the armature.
- The EVCD can utilize one of the first and second electrodes as a shielding electrode when the EVCD is in the SC mode. For example, the EVCD can drive a current through the second electrode that maintains the second electrode’s voltage at a constant potential or ground while using the first electrode to detect steering wheel contact. The driven second electrode’s close proximity to the first electrode helps shield the first electrode from incoming EMI.
- Any of the foam layers can be formed from ethylene propylene diene monomer or polyurethane.

Drawings

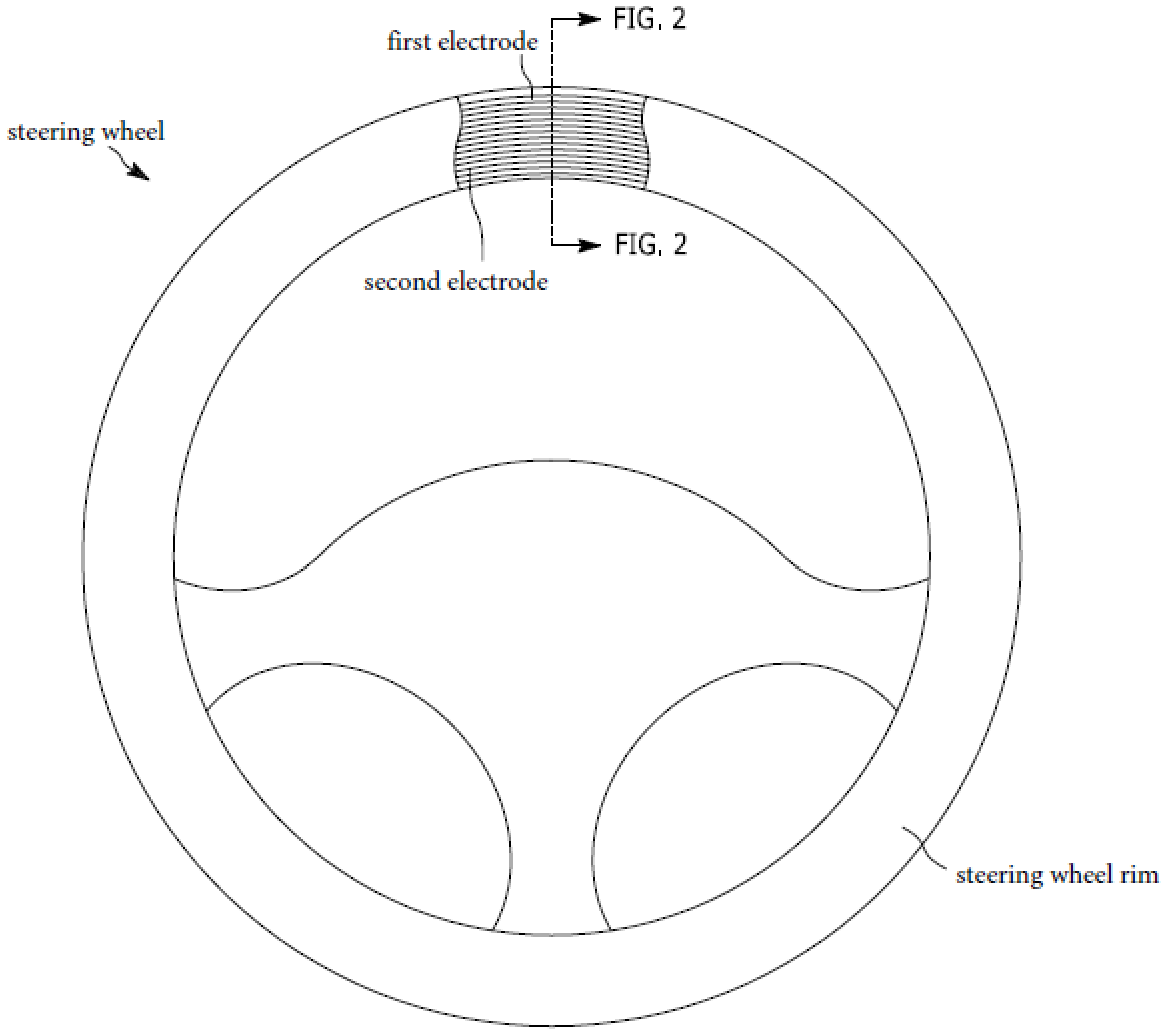

FIG. 1

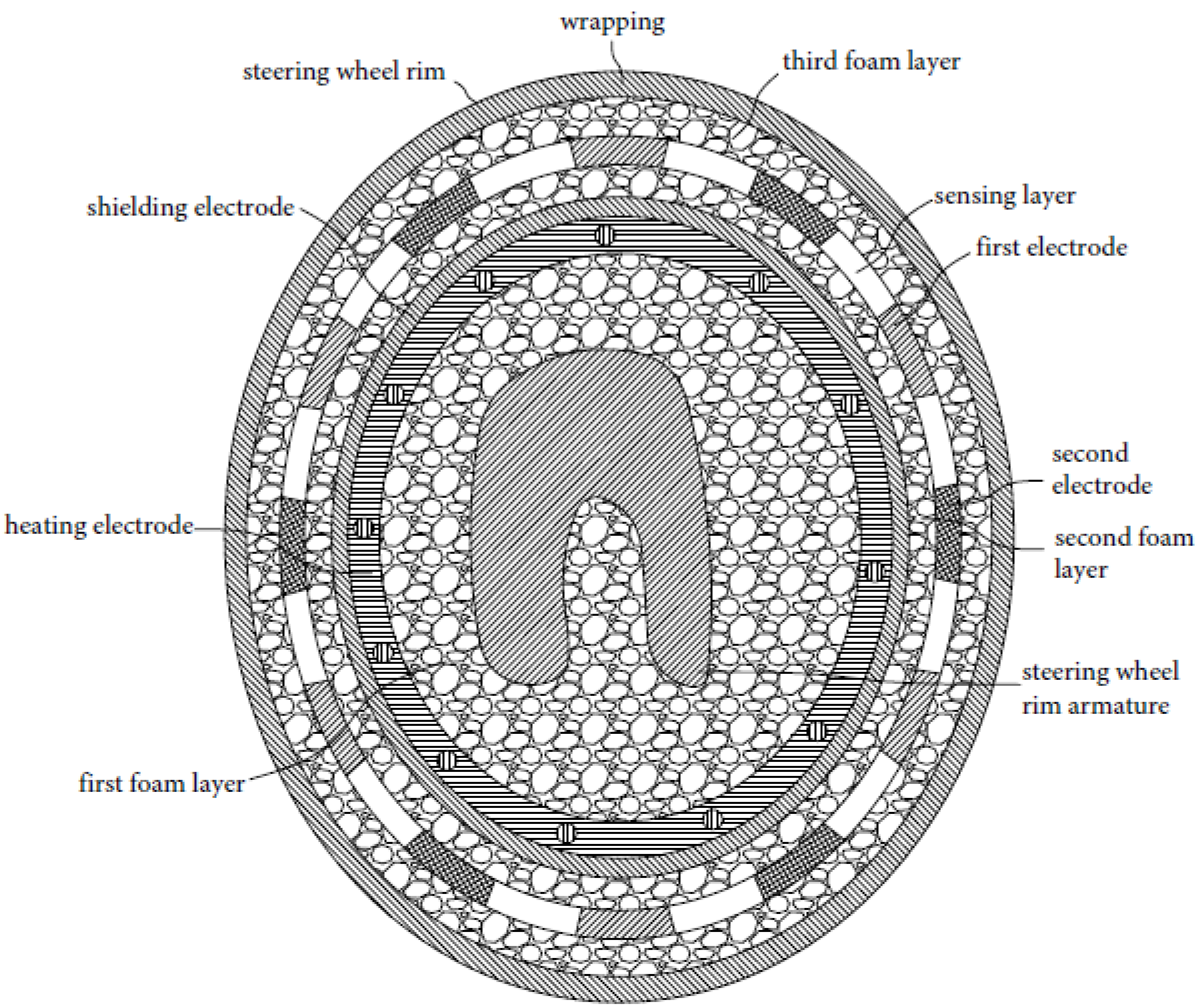
wrapping
steering wheel rim
third foam layer
shielding electrode
sensing layer
first electrode
second
electrode
heating electrode
second foam
layer
steering wheel
rim armature
first foam layer

FIG. 2

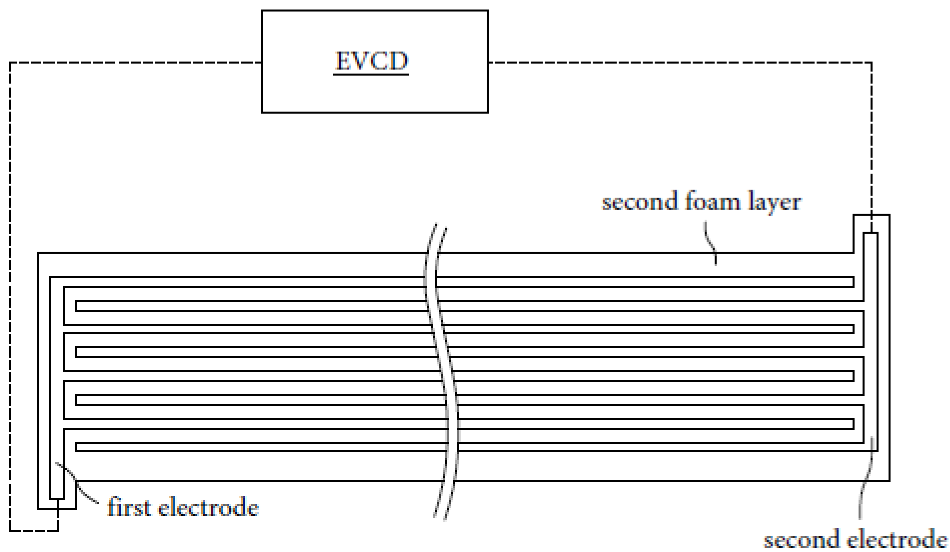
EVCD
second foam layer
first electrode
second electrode

FIG. 3

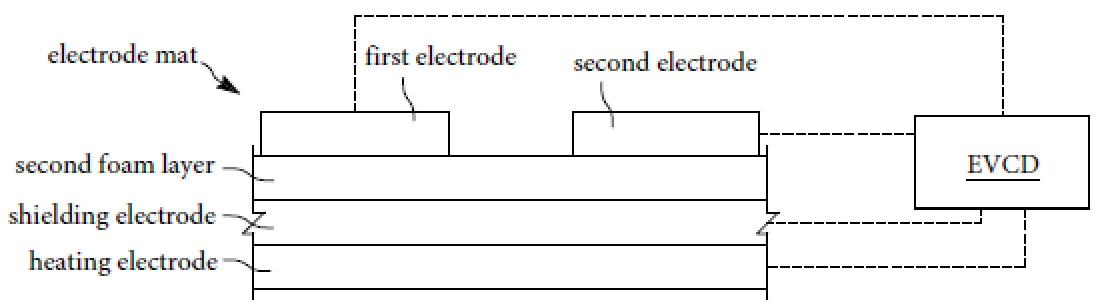
electrode mat
first electrode
second electrode
second foam layer
shielding electrode
heating electrode
EVCD

FIG. 4