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Blinkilde et al.

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[45] **Jan. 7, 1975**

[54] **OCCUPANT SENSOR SEAT SWITCH**

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[73] Assignee: **Essex International, Inc.**, Fort Wayne, Ind.

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[52] **U.S. Cl.** .... **200/85 A**, 340/278

[51] **Int. Cl.** **H01h 3/14**

[58] **Field of Search** .... 200/85 A, 86 R, 166 C; 338/114, 100; 340/278

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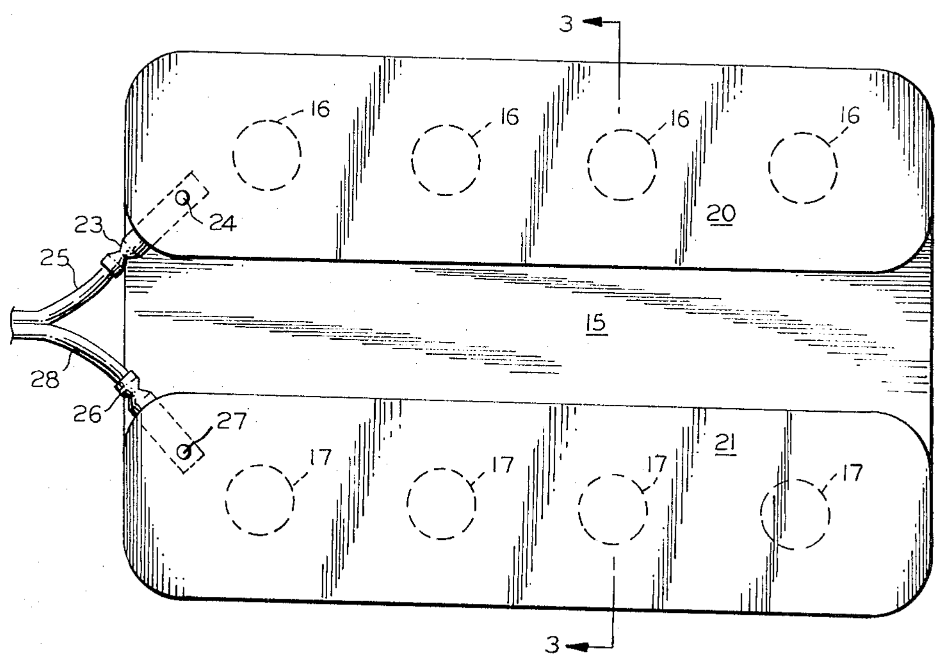
Attorney, Agent, or Firm—Robert D. Sommer

[57] **ABSTRACT**

A pressure sensitive occupant sensor seat switch to detect the presence of an occupant in an automobile seat. A flat body formed of electrically insulating, resilient compressible material has one or more openings extending therethrough. A pad formed of electrically nonconductive compressible, resilient, inorganic or semiorganic material having discrete electrically conductive particles dispersed throughout occupies each opening. When the pad is uncompressed, the electrically conductive particles do not engage one another. When the pad is compressed, however, the electrically conductive particles engage one another and the pad becomes conductive. Electrical conductors on both sides of the insulating body make electrical contact to the pads so that the switch assembly controls a device connected to it when pressure is applied.

4 Claims, 11 Drawing Figures



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3 Sheets-Sheet 1

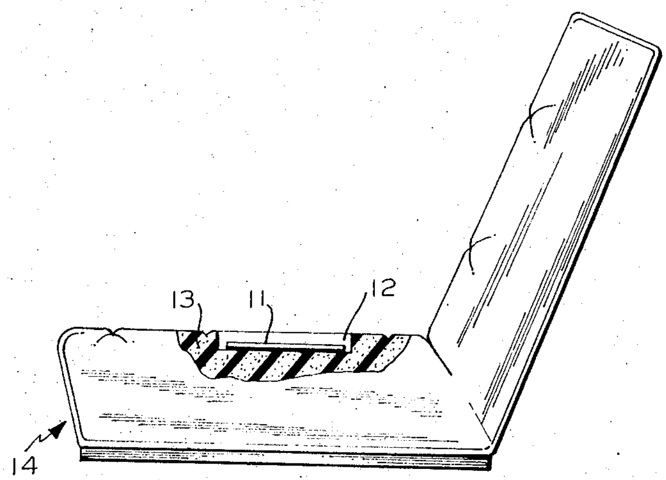

FIG.1

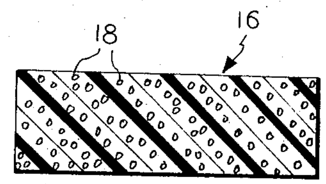

FIG.4

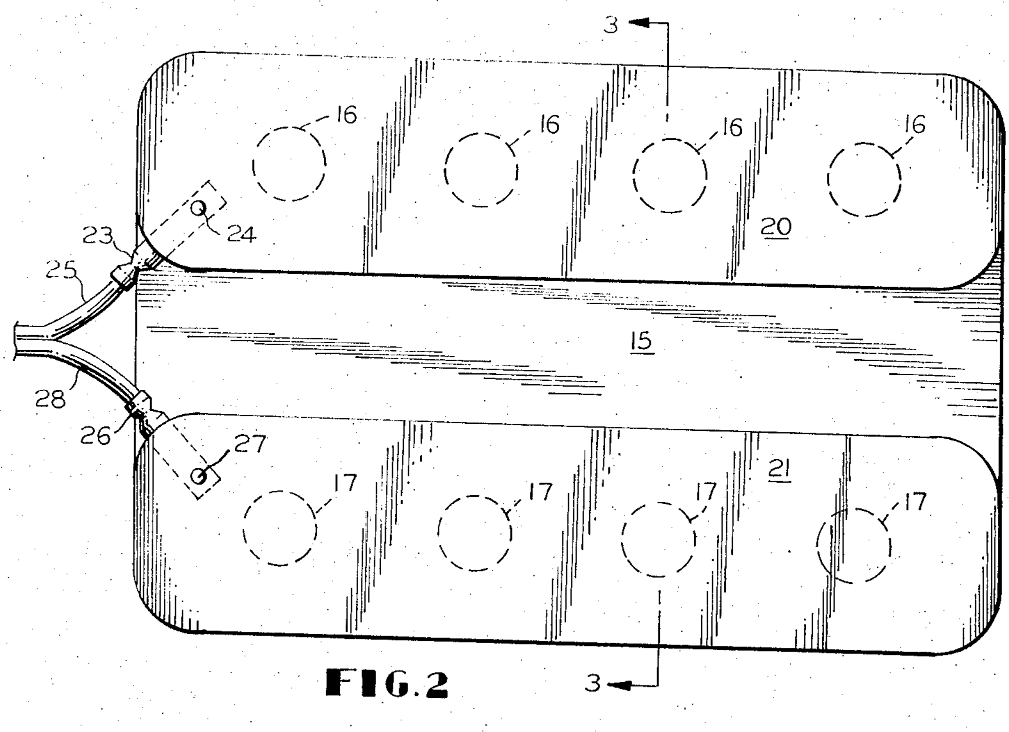

FIG.2

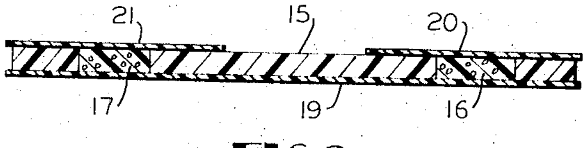

FIG.3

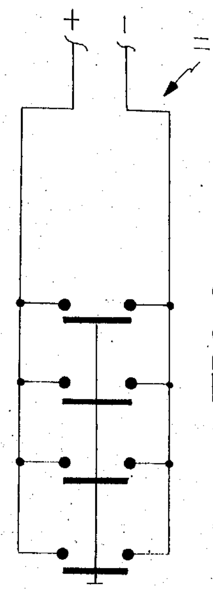

FIG. 6

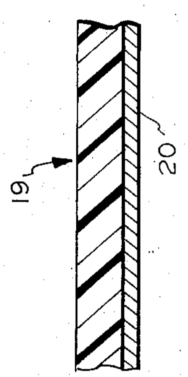

FIG. 5

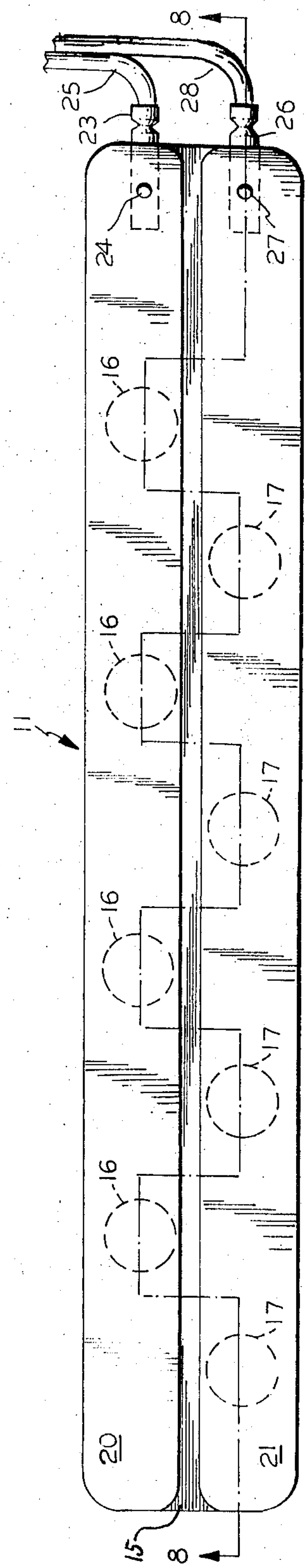

FIG. 7

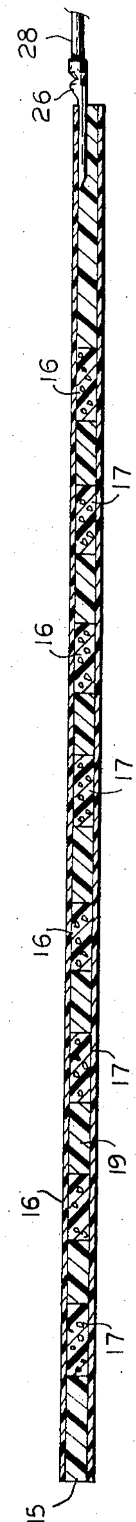

FIG. 8

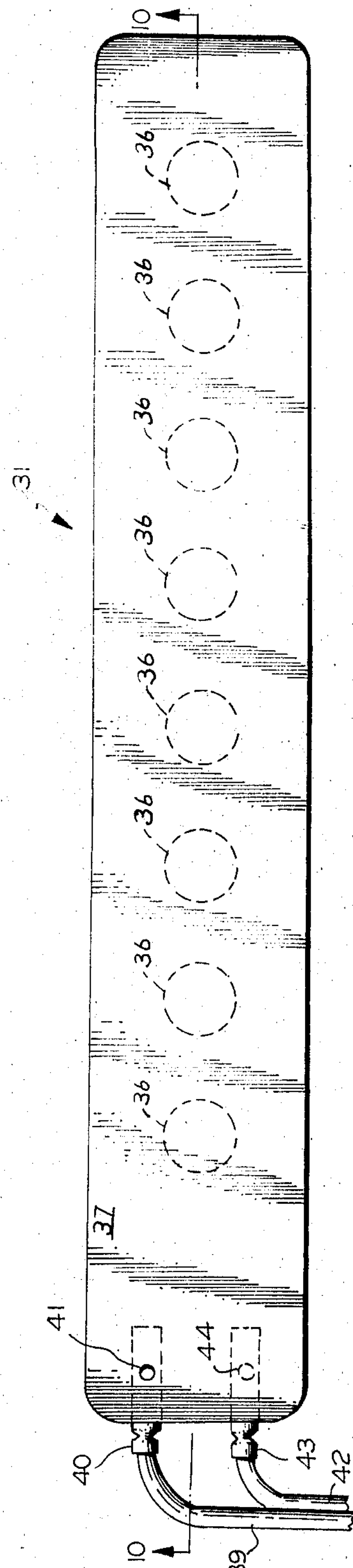

FIG. 9

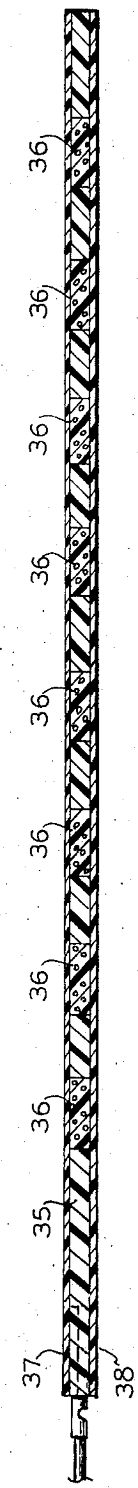

FIG. 10

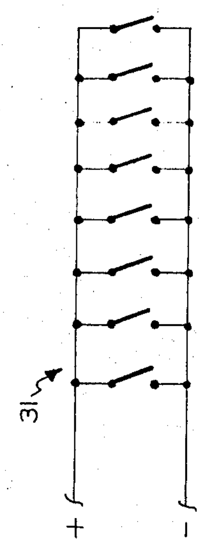

FIG. 11

OCCUPANT SENSOR SEAT SWITCH

BACKGROUND OF THE INVENTION

This invention relates to pressure sensitive switches and, in particular, to switches used in automobile seats to detect the presence of an occupant.

With the advent of certain Federal requirements for safety systems in automobiles it has been necessary to provide automobile seats with pressure sensitive switches to detect the presence of an occupant. The requirements for models prior to 1974 dictate the need for a driver and a passenger seat switch. However, an additional switch is required on 1974 models to detect the presence of an occupant in the middle of the front seat. Seat switches presently used do not function properly in the center front seat because they are influenced by the weight of the driver and/or right front passenger.

SUMMARY OF THE INVENTION

Briefly, an occupant sensor seat switch is provided which is placed in a pocket in the foam padding of a conventional automobile seat just below the seat covering. The switch is comprised of a body formed of an electrically nonconductive, compressible, resilient material such as polyurethane foam. One or more openings extend through the flat body and a pad formed of a resilient, compressible, nonconductive, organic or semiorganic material having discrete electrically conductive particles dispersed throughout occupies each such opening. The pads are conductive only when compressed and are nonconductive when in an uncompressed state. When a plurality of pads is employed, electrical connections are made to the pads such that it is necessary to compress at least two pads in order to complete a circuit. According to an alternate embodiment, the pads are connected in parallel such that it is necessary to compress only one pad to complete a circuit.

Accordingly, it is an object of this invention to provide a pressure sensitive switch that is substantially unaffected by a pressure unless that pressure is applied directly over the switch.

It is another object of the invention to provide a pressure sensitive occupant sensor seat switch to detect the presence of an occupant in an automobile seat.

Another object of the invention is to provide a pressure sensitive occupant sensor seat switch to detect the presence of an occupant in an automobile seat is unaffected by the presence of other occupants in the automobile.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will be made to the drawings, in which:

FIG. **1** is a side view, partly in cross section, of a conventional automobile seat incorporating the invention;

FIG. **2** is a top plan view of one embodiment of the invention;

FIG. **3** is a cross sectional view taken along lines **3—3** in FIG. **2**;

FIG. **4** is an enlarged sectional view of the resilient pad employed in the invention showing the electrically conductive particles dispersed throughout;

FIG. **5** is a cross sectional view of the copper coated film used to make contact to resilient pads;

FIG. **6** is an electrical schematic of the embodiment shown in FIG. **2**;

FIG. **7** is a top plan view of a second embodiment of the invention;

FIG. **8** is a cross sectional view taken along lines **8—8** of FIG. **7**;

FIG. **9** is a top plan view of a third embodiment of the invention;

FIG. **10** is a cross sectional view taken along lines **10—10** of FIG. **9**;

and

FIG. **11** is an electrical schematic of the embodiment shown in FIGS. **9** and **10**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An occupant sensor seat switch constructed in accordance with the invention comprises essentially a unitary body formed of a synthetic, resilient nonconductive substance such as silicone rubber or polyurethane, body having at least one inlay or portion thereof constituted by nonconductive material such as silicone rubber or polyurethane throughout which is dispersed a quantity of discrete, electrically conductive particles. According to the invention the pad containing the conductive particles and the dispersion of the particles are such that, when the pad is in its normal, unstressed condition the electrical resistance of the pad is infinite and the pad is nonconductive. When the pad is subjected to compressive force of sufficient magnitude, however, the particles are forced to move relatively to one another into particle to particle engagement. The resistance of the pad thereupon changes to that of the metal particles and the pad becomes electrically conductive. Upon release of the compressive force, the inherent resilience of pad restores it to its normal, unstressed condition whereupon the particles again move relatively to one another, but in this instance in such manner as to disengage one another and render the pad nonconductive. The change from conductive to nonconductive condition, and vice versa, occurs rapidly, as is the case with a conventional switch of the snap-action type.

The number of particles which move into particle-to-particle engagement may vary according to the force applied to the body or to the compressive force under which it is formed, and it is not essential that all of the particles engage one another. It is only necessary that a train of particles be in engagement between the other current conductors of a circuit so as to establish a conductive path through the body. In fact, it is preferred that not all of the particles in the body engage one another. In such a case, one train of engaged particles may be consumed by an overload current, thereby rendering the body nonconductive. Other particles, however, will be unaffected thereby making it possible for such other particles to form additional trains for current conduction.

An advantage of devices of the kind herein disclosed is the ease with which they may be varied to conform to differing operating requirements. In general, the compressive force required to render a pad conductive will be directly proportional to the thickness of the pad. A given sample of the composite body or pad, therefore, can be made responsive to extremely light pressures or responsive to relatively heavy pressures, depending on the thickness of the pad. The sensitivity of the device also is related to the quantity and size of the conductive particles. The force required to render a pad conductive varies, in general, inversely according to the quantity of particles contained within the pad and varies directly according to the size of such particles. It is possible, therefore, to manufacture devices having greatly differing operating characteristics.

The force required to render a composite body conductive and the amount of travel necessary to effect compression of the pad to a state of conductivity also is related to the density of the body. Thus, a relatively dense body requires the application of a greater compressive force than does a less dense or foamed body, whereas the foamed body requires a greater compressive movement than does the more dense body. Consequently, the force and stroke of an operating mechanism can vary within wide limits.

The material from which the device is made should be resilient at both low and high temperatures, readily moldable, stable at high temperatures, porous or nonporous, resistant to ozone, oil and arcing, in-organic, semiinorganic durable, low in carbon content, and have high dielectric strength. Certain kinds of polyurethanes and silicone rubbers possess all of these properties. Silicone rubbers are prepared by milling together a dimethyl silicone polymer, an inorganic filler, and a vulcanizer or catalyst. Many different fillers may be used, such as titania, zinc oxide, iron oxide, silica, and the like. The type and amount of filler used alters the chemical, physical, and electrical properties. It is possible, therefore, to produce many different kinds of silicone rubbers which have the properties referred to above.

Many varieties of silicone rubbers exist which perform satisfactorily. For example, good results have been obtained with silicone rubbers formed by combining resins 850 or 3120 (Dow Corning Corporation, Midland, Michigan) with the manufacturer's recommended S. For H Catalyst or vulcanizer which includes as its active ingredients such compounds as dibutyl tin dilorate or stanis octoate. Satisfactory results also have been obtained with silicone rubbers formed by combining RTV-7 resin (General Electric Company, Schenectady, New York) with the manufacturer's Nuocure **28** vulcanizer. Metallic particles are stirred into the resin-catalyst substances in sufficient quantity to be dispersed substantially uniformly throughout the mass. The mixture then is poured into a mold and cured in the manner prescribed for the particular resin. Polyurethane devices are made in the same way, but utilizing the appropriate resins and catalysts. The mold may be any desired shape to produce a composite solid or foamed body composed of the elastomeric material and the metal particles, the latter being dispersed throughout the body, including its outer surfaces.

The metal particles should be formed of a metal that has excellent conductive properties and also should be one which, if it oxidizes, has an electrically conductive oxide. Particles made from noble metals such as silver and gold have the desired inherent conductivity and normally form conductive oxides, but particles composed entirely of noble metal are quite expensive. It is preferred, therefore, to use discrete, spherical metal particles composed of base metals such as copper, iron and the like, coated with silver and which act very much like solid silver particles, but which are less expensive. The size of the particles may vary from 0.05 mil to 100 mils. Excellent results have been obtained utilizing particles in the 3–8 mils range. The size of the particles should vary according to the thickness of the body or pad, the amount of force desired to be exerted on the body, and the value of the current desired to be passed through the body. In general, the current which can be accommodated by a body is directly proportional to the size of the metal particles.

A typical molded body may have its nonconductive portion formed of silicone resin and catalyst in the ratio of 10 to 1 by weight and its conductive portion or portions formed of the same resin and catalyst, in the same weight ratio, but having a particle to silicone ratio of 6 to 1. The overall body may be of any desired area and of any desired thickness, such as 0.10 inch. It should be apparent, however, that the ratios and dimensions recited may be varied within rather wide limits depending on the particular characteristics the resulting body are to possess. When a sample of the conductive portion of a typical body is viewed under a microscope, the silicone rubber appears to encapsulate each metallic particle and isolate it from the others, but the rubber does not prevent relative movement of the particles. When the body is subjected to compressive forces and deformed or compressed, the metallic particles are forced to move relatively to one another and to the encapsulating rubber in such manner that a sufficient number of the particles move into engagement with one another to establish a conductive train or path through the body portion. Current then may flow through the conductive body portion. The low shear resistance of silicone rubber and the nonadherence of the rubber to the particles facilitate the movement of the particles. The resistance of the conductive body portion, when conductive, corresponds substantially to the resistance of the metal particles. Since the electrical resistance of noble metals, such as silver, is quite low, the resistance of the conductive portion also is quite low and, therefore, permits the latter to accommodate a high value current. For example, a conductive pad constructed of Dow Corning 3120 silicone rubber and containing 3 mil, silver coated copper particles in the ratio referred to above and having a thickness of 0.06 inch was sandwiched between conventional terminals and was capable of conducting a current of 50 amperes without impairment. Another similar pad was incorporated in a 115-volt AC circuit including a 25-watt electric lamp bulb and was cycled at the rate of 130 cycles per minute. After more than 7 million cycles of operation, the pad still functioned perfectly.

It is believed that when a conductive path is established through the pad the current density of such path between the other circuit components is much less than that of the point to point contact of conventional metal-to-metal connectors. The resistance of the body portion, when conductive, has been measured to be 0.0025 ohms which is equivalent to the resistance of 4.7 inches of 18 gauge wire or 3 inches of 20 gauge wire.

When the compressive force applied to the pad is released, the inherent resilience of the silicone rubber causes the latter to expand and assume its normal, unstressed condition, whereupon the engaged conductive particles are forced to move out of engagement, thereby dis-establishing or breaking the conductive path. If there should be any arcing between particles as they separate from one another, the arcing will be confined to the interior of the body. Even though the presence of an arc may destroy or impair the current conductive capacity of the particles between which current conductive capacity of the particles between which the arc forms, there are so many particles in the body and, consequently, so many possible current conductive paths that a potential path always exists through the body throughout its life expectancy. The presence of arcs within the body leaves a track, but because of the low carbon content of the silicone rubber the arcing track is composed of nonconductive inorganic matter, rather than a conductive carbon track such as would be left in organic materials.

An occupant sensor seat switch indicated generally by reference numeral **11** is adapted to sit in a pocket **12** in the seat foam **13** just below the seat covering of a conventional automobile seat **14.**

According to the first embodiment, an occupant sensor seat switch **11** comprises a body **15** formed of a resilient, electrically nonconductive, compressible material such as polyurethane foam. Resilient pads **16** and **17** having electrically conductive particles **18** dispersed throughout extend through the foam body **15.** The resilient pads **16** and **17** are provided so that they fit snugly in the holes of the foam body **15.** Adhesively bonded to the bottom side of the polyurethane foam body **15** is a copper coated polyester film **19.** The film **19** provides structural support for the switch **11** and the copper coating **20** makes electrical contact from pads **16** to pads **17.** Two copper coated polyester films **21** and **22** are adhesively bonded to the top of the polyurethane body **15.** Copper coated film **21** electrically connects pads **16** together and copper coated film **22** electrically connects pads **17** together. It is necessary that films **21** and **22** be electrically isolated. It is necessary, however, that the adhesive does not contact the resilient pads **16** and **17.** A terminal **23** is riveted to the polyester film **20** so that an electrical connection is made from wire **25** to the resilient pads **16** via the copper coating on the polyester film **20.** A similar connection is made to pads **17** from wire **28** by terminal **26.**

When the switch **11** is used in an automobile seat and an occupant sits in that seat, pads **16** and **17** will be compressed rendering them conductive. A circuit will be completed through wire **25,** terminal **23,** the copper coating on polyester film **20,** the compressed conductive pads **16,** copper coating **20** on polyester film **19,** compreessed conductive pads **17,** the copper coating on polyester film **21,** terminal **26** to wire **28.**

FIG. **6** represents an electrical schematic of the embodiment shown in FIGS. **2, 3, 7** and **8.** In order for the switch **11** to be closed, it is necessary that at least one of pads **16** and one of pads **17** be compressed.

Shown in FIGS. **9, 10 and 11** is a second embodiment. An occupant sensor seat switch **31** is comprised of a body **35** made from resilient nonconductive, compressible material such as polyurethane foam. Resilient pads **36** having electrically conductive particles dispersed throughout as previously described fit snugly and extend through the foam body. The foam body **35** is sandwiched between two copper coated polyester films **37** and **38** which are adhesively bonded to the foam body. A terminal **40** is riveted at **41** to the upper polyester film **37** such that electrical contact is made from wire **39** to the copper coating on the film **37.** A similar terminal **43** makes contact from the wire **42** to the copper coating on the bottom polyester film **38.** When any one of the resilient pads **36** is compressed a circuit will be completed from the wire **39** to the copper coating on the upper polyester film **37** through the compressed pad **36** to the copper coating on the bottom polyester film **38** to wire **42** as shown by the schematic in FIG. **11.**

In making the switches **11** and **31** the bottom polyester film can be made thicker than the upper film so that the switch has some structural rigidity. As a specific example in the embodiments shown in FIGS. **2, 3, 7** and **8** the bottom polyester film can be 0.014 copper coated mylar and the upper films **20** and **21** can be 0.005 copper coated mylar. In the embodiment shown in FIGS. **9** and **10** the bottom film **38** can be 0.014 copper coated mylar and the top film **37** can be 0.005 copper coated mylar.

Numerous changes and modifications can be made without departing from the true spirit of the invention. For example, the adhesive used to bond the copper coated polyester film to the foam body may be replaced by an electrically conductive adhesive. By doing this the copper coating on the polyester film may be eliminated. Materials other than polyurethane may be used to make the foam body. It is necessary, however, that these materials be compressible, resilient, and nonconductive. The number of resilient pads employed may be varied also. According to the electrical schematic desired, the pads may be connected in series, parallel, or series/parallel relationship or there may be just one pad.

We claim:

1. A flexible pressure sensitive switch for sensing the presence of an occupant in a vehicle seat, said switch comprising:

first and second flexible, sheet-like, relatively strong laminates each comprising a film of insulation material having a thin conductive coating on one side;

a flat electrically nonconductive body of resilient compressible foamed material interposed between said first and second laminates, the upper surface of said body being adhesively bonded to the conductive coating of said first laminate and the lower surface of said body being adhesively bonded to the conductive coating of said second laminate, said body having a set of at least two longitudinally spaced openings each extending from said upper surface to said lower surface, each of said openings being open to the respective portions of said conductive coatings overlying said openings;

a resilient compressible contact pad occupying each of said openings in said body, each said contact pad being made of an elastomer with conductive particles dispersed therethrough such that said contact pad is electrically conductive when compressed above a predetermined value and electrically nonconductive when uncompressed, each said contact pad having end portions facing the respective conductive coatings on said laminates for conductive connection therewith so that pressure applied to a localized portion of said first laminate overlying said contact pad will result in compression of said contact pad between the respective conductive coatings of said laminates to provide a bridging conductive path therebetween, said body normally maintaining said laminates in a spaced relation such that each said contact pad is maintained in a substantially uncompressed condition in the absence of pressure applied directly against said localized portion of said first laminate overlying said contact pad;

and menas for making external electrical connection to said conductive coatings whereby the application of pressure against any of said localized portions of said first laminate overlying said contact pads completes a ciricuit to said external connection means.

2. The switch according to claim 1 wherein:

said body has two sets of said longitudinally spaced openings, one of said sets of openings being laterally spaced from the other of said sets of openings, one each of said openings being occupied by one of said contact pads;

the conductive coating of one of said laminates overlying the contact pads occupying all of said openings and providing a conductive path interconnecting all of said contact pads, the conductive coating of the other of said laminates being in the form of two electrically isolated portions, one of said isolated portions overlying the contact pads occupying said one set of openings and the other of said isolated portions overlying the contact pads occupying said other set of openings;

said external connection means comprising terminal means connected to said isolated portions of conductive coating of said other laminate whereby application of pressure against the localized portions of said first laminate overlying at least one of the contact pads occupying said second set of openings is required to complete a circuit to said external connection means.

3. In combination, a vehicle seat including a pad of foam material having a recessed pocket in one localized area thereof, and a flexible pressure sensitive switch disposed within said recessed pocket for sensing the presence of an occupant on said one localized area of said seat pad, said switch comprising:

first and second flexible, sheet-like, relatively strong laminates each comprising a film of insulation material having a thin conductive coating on one side;

a flat electrically nonconductive body of resilient compressible foamed material interposed between said first and second laminates, the upper surface of said body being adhesively bonded to the conductive coating of said first laminate and the lower surface of said body being adhesively bonded to the conductive coating of said second laminate, said body having a set of at least two longitudinally spaced openings each extending from said upper surface to said lower surface, each of said openings being open to the respective portions of said conductive coatings overlying said openings;

a resilient compressible contact pad occupying each of said openings in said body, each said contact pad being made of an elastomer with conductive particles dispersed therethrough such that said contact pad is electrically conductive when compressed above a predetermined value and electrically nonconductive when uncompressed, each said contact pad having end portions facing the respective conductive coatings on said laminates for conductive connection therewith so that during seat occupancy pressure applied to a localized portion of said first laminate overlying said contact pad will result in compression of said contact pad between the respective conductive coatings of said laminates to provide a bridging conductive path therebetween; said body normally maintaining said laminates in a spaced relation such that each said contact pad is maintained in a substantially uncompressed condition in the absence of pressure applied directly against said localized portion of said first laminate overlying said contact pad;

and means for making external electrical connections to said conductive coatings whereby during occupancy of said seat at said one localized area of said seat pad the application of pressure against any of said localized portions of said first laminate overlying said contact pads completes a circuit to said external connection means.

4. The combination of a vehicle seat and a switch assembly according to claim 3 wherein:

said body has two sets of said longitudinally spaced openings, one of said sets of openings being laterally spaced from the other of said sets of openings, one each of said openings being occupied by one of said contact pads;

the conductive coating of one of said laminates overlying the contact pads occupying all of said openings and providing a conductive path interconnecting all of said contact pads, the conductive coating of the other of said laminates being in the form of two electrically isolated portions, one of said isolated portions overlying the contact pads occupying said one set of openings and the other of said isolated portions overlying the contact pads occupying said other set of openings;

said external connection means comprising terminal means connected to said isolated portions of the conductive coating of said other laminate whereby application of pressure against the localized portions of said first laminate overlying at least one of the contact pads occupying said first set of openings and at least one of the contact pads occupying said second set of openings is required to complete a circuit to said external connection means.

* * * * *