for foam:

polyether, polystyrene, polypropylene, polyurethane (preferably having some plasticity), silicone, natural or synthetic rubber.

Whichever material is used for the element, it is preferably available in a form having relatively large interstices (e.g. 50–500 microns) and capable of collapse by compression by a factor of 2 to 8 leaving further compressibility.

Typically the element has 2 dimensions substantially greater than the third. Thus it is of a sheet-like configuration, for example the thickness 0.1 to 5, especially 0.5 to 2.0 mm. Its other dimensions are chosen to suit convenience in manufacture and user requirements, for example to permit contacting with a test specimen in a sensor according to the third aspect of the invention. If the element is to be stressed electrically, its cross-sectional area should be subdivided into electrically separate sub-regions, to permit the required partial activation. Preferably the element is anisotropic, that is, compressible perpendicularly to its plane but resistant to compression or stretching in its plane.

The content of strongly conductive material in the element is typically 500–5000 mg/cm^3. The size of the variable resistor can be chosen from an extremely wide range. It could be as small as a few granules of encapsulated metal; it could be part of a human movement area. In a useful example, since it can be made of flexible material, it may incorporated into a garment.

If the layer is to be weakly conductive, this may be due to containing 'semi' conductive materials, including carbon and organic polymers such as, polyaniline, polyacetylene and polypyrrole. The invention can be used to change the physical and electrical properties of these conductive materials. The weak conductance of the layer may, alternatively or additionally be due to a strong conductor, typically as present in the element, but at a lower content, for example 0.1 to 10% of the level in the element.

The element may contain weakly ('semi') conductive material as listed above. If the element has interstices, these may contain such a weak conductor, for example open-cell foam pre-loaded during manufacture with a semi-conductive filler to give a start resistance to a switch or variable resistor or to prevent the build up of static electricity on or within such a device.

The element and the layer, that is, the conductive and non-conductive strata, can be manufactured separately and placed over each other or held together using an adhesive—see FIG. 2*c* below. In an alternative—see FIG. 2*b* below—the layer may be integral with the element, the concentration of the strongly conductive material being graded. Thus an example of element and layer is a thin foam sheet which if stressed is capable of strong electrical conductance on one side whilst the opposite side remains electrically insulating or weakly conductive. The sheet can be produced by loading the interstices of a non-conductive open-cell foam sheet part of the way through its thickness with a strongly conductive powder or granule. This produces a conductive stratum of foam overlying a non-conductive stratum of foam. The conductive material can be kept in place within the foam sheet by an adhesive or by cross-linking the foam after loading.

In the variable resistor the strongly conductive material may be present in one or more of the following states:

a constituent of the base structure of the element;

(b) particles trapped in interstices and/or adhering to surfaces accessible to the mobile fluid;

(c) a surface phase formed by interaction of strongly conductive filler particles (i or ii below) with the base structure of the element or a coating thereon.

Whichever state the conductive material is present in, it may be introduced:

(i) 'naked'; that is, without pre-coat but possibly carrying on its surface the residue of a surface phase in equilibrium with its storage atmosphere or formed during incorporation with the element. This is clearly practicable for states (a) and (c), but possibly leads to a less physically stable element in state (b);

(ii) lightly coated, that is, carrying a thin coating of a passivating or water-displacing material or the residue of such coating formed during incorporation with the element. This is similar to (i) but may afford better controllability in manufacture;

(iii) polymer-coated but conductive when quiescent. This is exemplified by granular nickel/polymer compositions of so high nickel content that the physical properties of the polymer are weakly if at all discernible. As an example, for nickel starting particles of bulk density 0.85 to 0.95 this corresponds to a nickel/silicone volume ratio (tapped bulk:voidless solid) typically over about 100. Material of form (iii) can be applied in aqueous suspension. The polymer may or may not be an elastomer. Form (iii) also affords better controllability in manufacture than (i);

(iv) polymer coated but conductive only when stressed. This is exemplified by nickel/polymer compositions of nickel content lower than for (iii), low enough for physical properties of the polymer to be discernible, and high enough that during mixing the nickel particles and liquid form polymer become resolved into granules rather than forming a bulk phase. This is preferred for (b) and may be unnecessary for (a) and (c). An alternative would be to use particles made by comminuting material as in (v) below. Unlike (i) to

(iii), material (iv) can afford a response to stress within each individual granule as well as between granules, but ground material (v) is less sensitive. In making the element, material (iv) can be applied in aqueous suspension;

(v) embedded in bulk phase polymer. This relates to (a) and (c) only. There is response to stress within the bulk phase as well as between interstice walls if present.

The strongly conductive material may be for example one or more of titanium, tantalum, zirconium, vanadium, niobium, hafnium, aluminium, silicone, tin, chromium, molybdenum, tungsten, lead, manganese, beryllium, iron, cobalt, nickel, platinum, palladium, osmium, iridium, rhenium, technetium, rhodium, ruthenium, gold, silver, cadmium, copper, zinc, germanium, arsenic, antimony, bismuth, boron, scandium and metals of the lanthanide and actinide series and if appropriate, at least one electroconductive agent. It can be on a carrier core of powder, grains, fibres or other shaped forms. The oxides can be mixtures comprising sintered powders of an oxycompound. The alloy may be conventional or for example titanium boride.

For (a) or (c) co-pending application A discloses and claims a composition which is elastically deformable from a quiescent state and comprises at least one electrically conductive filler mixed with a non-conductive elastomer, characterised in that the volumetric ratio of filler to elastomer is at least 1:1, the filler being mixed with the elastomer in a controlled manner, in a mixing regime avoiding destructive shear forces, whereby the filler is dispersed within and encapsulated by the elastomer and may remain structurally intact, the nature and concentration of the filler being such that the electrical resistivity of the composition is variable in