insulating yarns, the conductive yarns at a crossover point are separated by a greater distance. The conductive yarns must be deflected further in order to make contact, thus requiring a greater actuation pressure.

[0063] b) Propensity of Conductive Yarn to Make Electrical Contact

[0064] A number of variables contribute to the propensity of a conductive yarn to make mechanical electrical contact. Conductive yarns with very smooth and/or hard surfaces tend to smaller areas of contact than fibrous and/or compressible yarns when contacted together under similar pressures. Mono-filament conductors of circular cross-section similarly offer less contact area than prism shaped or multi-filament yarns. Specifics of the composite yarns are described above.

[0065] c) Fabric Stiffness

[0066] The actuation pressure required to deflect the conductors at a crossover and make electrical contact is directly governed by the stiffness of the conductive and surrounding insulating yarns, and the general stiffness of the fabric, which in turn is governed by the weave structures used, the yarn spacing and the level of weft compacting, or beat, used. Stiffer fabric requires a greater force for a given deflection and will therefore result in crossovers of greater actuation pressure.

[0067] d) Number of Adjacent Conductive Yarns

[0068] If multiple adjacent conductive yarns are used instead of a single warp or weft conductive yarn, as in **FIG. 9**(*a*), the actuation pressure is reduced. Wider conductors with a greater number of adjacent yarns, as shown in **FIG. 9**(*b*), both offer a larger contact area at a crossover point and require less angular deflection of the yarns, and thus less pressure, to make contact.

[0069] e) Number of Yarns Floated

[0070] If a conductive weft yarn is floated over a minimum number of warp yarns to ensure separation at a crossover point, as shown in **FIG. 9**(*a*), the actuation pressure is correspondingly lesser than if the conductive weft is floated over a larger number of adjacent warp yarns, as shown in **FIG. 9**(*c*).

[0071] Implications to Note on Actuation Pressures

[0072] Controlling the aforementioned manufacturing parameters allows crossover points with predetermined actuation pressures to be woven into a piece of fabric. The threshold pressures for both electrical contact to be made and maximal contact to be achieved can be determined independently. Crossover points with different pressure thresholds may be incorporated into a single piece of fabric. This enables the construction of, for instance, a group of neighbouring crossover points that make contact consecutively with increasing pressure and together constitute a quantised pressure sensor.

[0073] Another implication of controlling the parameters at a crossover point is that the two conductive yarns may be woven to be in permanent electrical contact, regardless of applied pressure. Principally, this may be achieved through the use of a plain weave structure at the crossover point, where the conductive weft is not floated over any additional warps, but instead shares a large, permanent contact area with the conductive warp yarn. This allows, for instance, the woven construction of bus-bars, discussed herein.

[0074] Conversely, if the actuation pressure threshold of a crossover point is made very large, the two conductive yarns may be woven such that they never make electrical contact under typical operating conditions. This allows two conductors to pass over one another and remain electrically independent. This facility to design crossover points that make or fail to make contact within a grid of conductors allows the routing of current throughout the piece of fabric akin to the tracks of a printed circuit board.

[0075] Addressing the Matrix of Crossovers

[0076] Each crossover point between two conductors may be treated as an independent switch, with the array of crossovers constituting a row-column addressed matrix, similar to the majority of existing keyboards. In order to achieve this, each conductive yarn must be individually connected to a suitable circuit for scanning the matrix. Making this number of connections to the piece of fabric can prove inconvenient.

[0077] Alternatively, a scheme which requires far fewer connections to the piece of fabric is to address the matrix of crossovers through electrical bus-bars, as shown in **FIG. 10**. These bus-bars each serve to interconnect the conductors of one set. The number of connections to the piece of fabric does not scale with the number of crossovers.

[0078] The bus-bars may be sewn, embroidered, printed, adhered, mechanically clamped or crimped to the piece of fabric in order to make electrical contact with the matrix of conductors. Most attractively, they can also be of woven construction, integral to the piece of fabric in a similar manner to the matrix. A typical arrangement is also shown in **FIG. 10**.

[0079] Some reproducible electrical characteristic, for example resistivity, can be measured to ascertain the length of a conductor and/or bus-bar. The position of a "closed switch" at a crossover in the matrix can be deduced from these measurements.

[0080] For example, first assume that the conductive yarns of the matrix exhibit a linear resistivity, and that connections are made to three perfectly conductive bus-bars as shown in **FIG. 10**. If the switch at crossover point D is closed, the resistance RAB measured from bus-bar A to bus-bar B is given by:

$$RAB=K(X+Y)$$

[0081] where K is a constant determined by the absolute lengths, cross-sectional areas and resistivities of the conductive yarns, and distances X and Y are the orthogonal vector components of point D, where

$$0<=(X,Y)<=1.$$

[0082] Similarly, the resistance measured from bus-bar B to bus-bar C is given by:

$$RBC=K(Y+1-X).$$

[0083] Substituting gives:

$$X=[((RAB)/K)-((RBC)/K)+1]/2$$

[0084] and:

$$Y=[((RAB)/K)+((RBC)/K)-1]/2.$$