ELECTRICAL SURFACE SWITCH HAVING IMPROVED BIASING MEANS

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Fig. 1

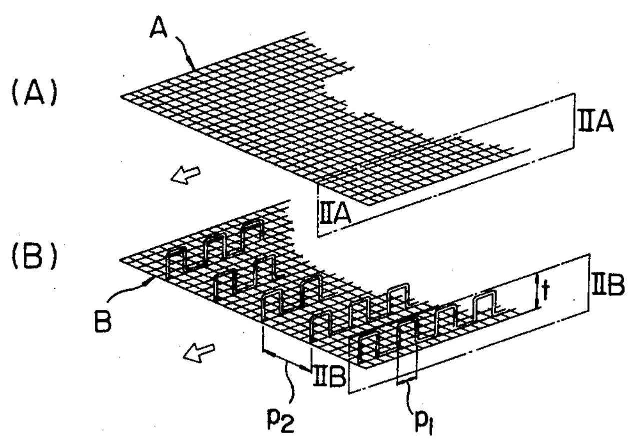
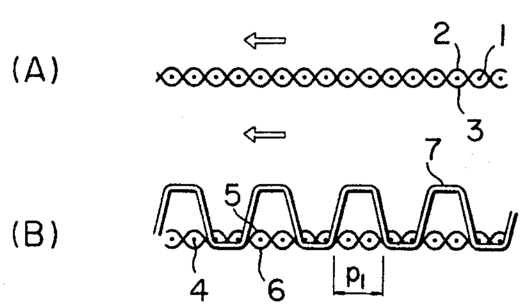


Fig. 2



INVENTORS
RYUNOSUKE SERIZAWA
KIICHI TANAKA
OSAMU TAKAMATU
by: Wolfe, Hubbard, Voit & Osann
ATTYS.

Aug. 6, 1968 RYUNOSUKE SERIZAWA ET AL 3,396,252

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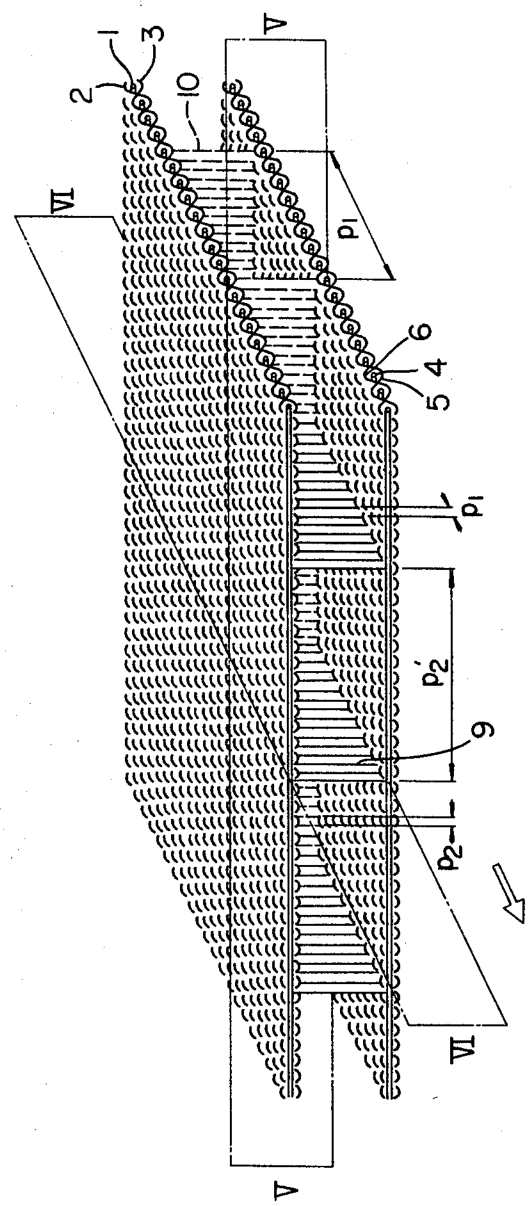

Fig. 3

INVENTORS
RYUNOSUKE SERIZAWA
KIICHI TANAKA
OSAMU TAKAMATU
by: Wolfe, Hubbard, Voit & Osann
ATTYS.

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Fig. 4

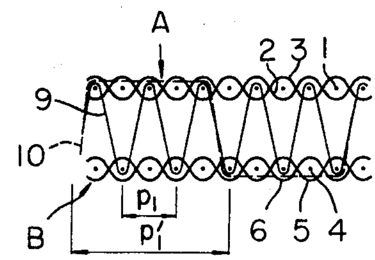


Fig. 5

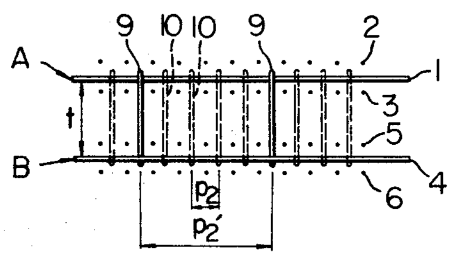
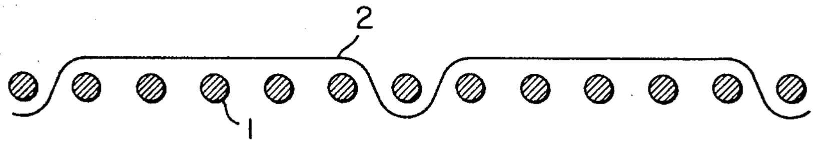


Fig. 6



INVENTORS
RYUNOSUKE SERIZAWA
KIICHI TANAKA
OSAMU TAKAMATU

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

ELECTRICAL SURFACE SWITCH HAVING IMPROVED BIASING MEANS

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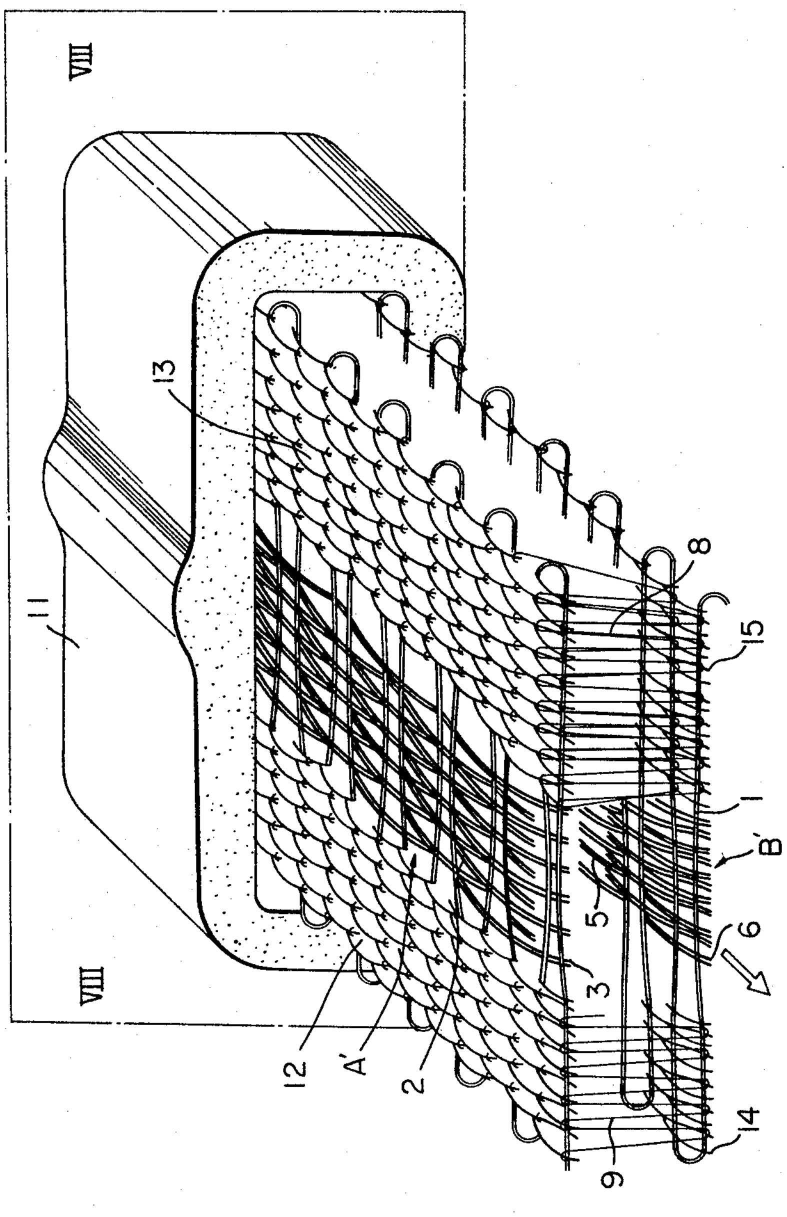
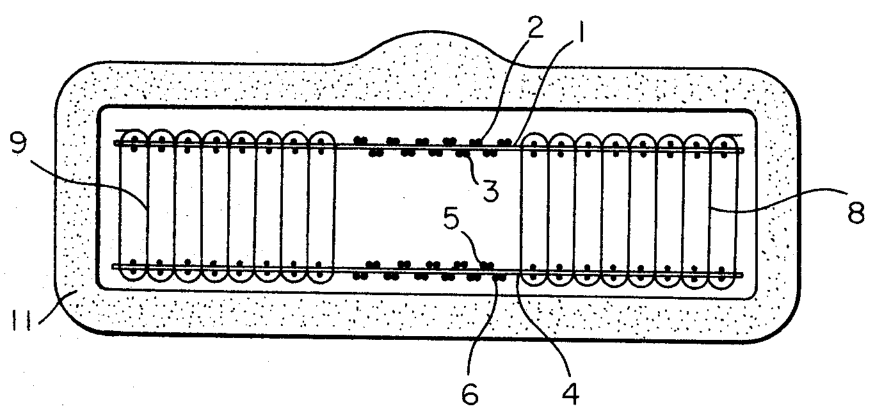
Fig. 7



INVENTORS
RYUNOSUKE SERIZAWA
KIICHI TANAKA
OSAMU TAKAMATU
by: Wolfe, Hubbard, Voit + Osann
ATTYS.

Fig. 8



INVENTORS
RYUNOSUKE SERIZAWA
KIICHI TANAKA
OSAMU TAKAMATU
by: Wolfe, Hubbard, Voit + Osann
ATTYS

United States Patent Office

3,396,252

Patented Aug. 6, 1968

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3,396,252

ELECTRICAL SURFACE SWITCH HAVING IMPROVED BIASING MEANS

Ryunosuke Serizawa, 3—26, Shimouma-cho, Setagaya-ku, Tokyo, Japan; Kiichi Tanaka, Tsu-20, Aza Ryoke, Tsuhata-cho, Kahoku-gun, Ishikawa-ken, Japan; and Osamu Takamatu, 1—23—10 Fukazawa-cho, Setagaya-ku, Tokyo, Japan

Filed Dec. 2, 1966, Ser. No. 598,844

Claims priority, application Japan, Dec. 6, 1965, 40/74,948

5 Claims. (Cl. 200—86)

ABSTRACT OF THE DISCLOSURE

An electrical surface switch comprising two flexible contact sheets made of electrically conductive fabrics adapted to make electrical connection when the opposed surfaces thereof are brought into contact with each other. The two contact sheets are normally biased away from each other to normally open positions by means of a multiplicity of resilient fibers which are interwoven with at least one of the contact sheets and extend between the two sheets. When the two contact sheets are moved to the closed position, the resilient fibers flex so as to permit the opposed surfaces of the sheets to contact each other.

This invention relates to a surface switch for which are used fabrics intertwined with elastic and insulative threads.

The surface switches according to the present invention can be applied to many uses as switches not only for automatic doors but also for automobile doors, safety devices for elevators and others, thief alarms and measuring instruments. For the operation of an automatic door, a mat-shaped surface switch is generally used so that, when an external stress is applied on a part of the surface, two upper and lower electrode sheets may come into contact with each other to flow an electric current and a relay may be operated with this current to rotate an electric motor to open or close the door. The conditions required of this kind of surface switch are that (a) it should conduct electricity as soon as a required external stress is applied, (b) it should return to the original state as soon as the external stress is removed, (c) it should operate positively for a long time, (d) it should be easy to make, (e) it should be able to be rolled and (f) it should be cheap.

In a conventional surface switch, two upper and lower metal screens are made electrodes and such elastic insulator provided with many holes as a polyester sponge is inserted and bonded between them. However, there are defects that it is difficult to bond the metal screen and sponge with each other, that the bonding agent will penetrate the sponge to reduce its elasticity and that a part of the bonding agent will cover the electrode part to make the electric contact insufficient. Therefore, the holes made in the sponge are of a diameter of 30 mm. and the distance between the holes is about 40 mm. Thus, in fact, it is difficult to make the effective contact area of the electrodes more than ⅓ of the total area. Further, in order to prevent any accidental contact due to the flexing of the electrode surfaces in the position of the hole in the sponge, it is necessary to use thick metal screens and also

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to make the thickness of the sponge more than 10 mm. Further, it has been impossible to use this mat switch as rolled. Therefore, the conventional surface switch does not well meet any of the requirements (a) to (f) above.

Further, in the above example, it can be thought to use a conductive rubber for the electrode. But, in such case, it will be more difficult than in the case of metal screens to reduce the contact resistance and to improve the conductivity. The present invention has eliminated the above mentioned defects and has realized a surface switch meeting the requirements (a) to (f).

A principal object of the present invention is to provide a surface switch which has an excellent operation.

A further object of the present invention is to provide a surface switch which is high in the returning ability and durabilty.

Another object of the present nvention is to provide a surface switch which is very easy to mass-produce.

Still another object of the present invention is to provide a surface switch which can be used even as rolled.

The present invention shall now be explained with reference to the drawings in which:

FIGS. 1A and 1B are perspective views of fabrics forming a surface switch of the present invention;

FIGS. 2A and 2B are sectioned views on planes IIA—IIA and IIB—IIB in FIGS. 1A and 1B, respectively;

FIG. 3 is a perspective view of another embodiment;

FIG. 4 is a sectioned view on plane IV—IV in FIG. 3;

FIG. 5 is a sectioned view on plane V—V in FIG. 3;

FIG. 6 shows another embodiment of the fabric;

FIG. 7 is a perspective view of another embodiment;

FIG. 8 is a sectioned view on plane VII—VII in FIG. 7.

In FIG. 1, A is a conductive fabric whose structure is illustrated in detail in FIG. 2A. In the drawing, **1** is a weft made of metal wires or elastic synthetic fibers and **2** and **3** are warps of a cross-sectional area of less than 0.04 mm.^{2} woven with the above mentioned wefts and made of such conductive material as, for example, copper wires or metal foils or impregnated with a conductive paint.

In FIG. 1, B is a conductive fabric whose structure is illustrated in detail in FIG. 2B. In the drawing, **4** is a weft made of metal wires or elastic synthetic fibers and **5** and **6** are warps of a cross-sectional area of less than 0.04 mm.^{2} woven with the above mentioned wefts and made of such conductive material as, for example, copper wires or metal foils or impregnated with a conductive paint.

7 is a rather thick intertwining thread wiven, for example, in FIG. 2B, so as to be intertwined with two wefts **4**, pulled out above the conductive fabric, again intertwined with two wefts **4** and then pulled out. p_1 is a pitch in the longitudinal direction (indicated by the arrow in each of FIGS. 1 and 2) of said intertwining thread and p_2 is a pitch in the lateral direction of the interwining thread. t is a height of the intertwining thread. It is preferable that said intertwining thread is made of such synthetic fibers, for example, of 50 to 3000 deniers high in the elasticity as polyamide fibers, polyethylene fibers or polyester fibers.

The surface switch of the present invention is formed, for example, by overlapping the conductive fabric A on the side of the conductive fabric B on which the intertwining threads **7** extend so that the conductive fabrics A and B may be opposite each other, a required clearance t may be kept between both conductive fabrics by the elastic and electrically insulative intertwining threads **7** and, when an external stress is applied on a part of the conductive fabric A, the intertwining threads **7** will flex and therefore the surfaces of the conductive fabrics A and B may come into contact with each other and, when the external stress is removed, the intertwining threads **7** and **8** may return to their original forms due to their elasticity and the contact of the conductive fabrics A and B may be broken. Therefore, the present invention operates as a surface switch having the conductive fabrics A and B as electrode surfaces.

The conductive fabric B to be used for the surface switch of the present invention can be easily made by intertwining the threads simultaneously with weaving the fabric. Also the conductive fabric A can be easily mass-produced in the same manner. Further, a switch can be formed by making the conductive fabrics A and B thin and the clearance t small. In the operation, when an external stress is applied, a contact of large conductive surfaces will taken place and, as soon as the external stress is removed, it will return to the original state. The durability of the elastic fibers is so high that the switch is endurable to the use for a long period. Further, this switch can be used also as rolled.

FIGS. 3 to 5 illustrate other embodiments. In the drawings, A and B are conductive fabrics with which are intertwined elastic and electrically insulative threads **9** and **10**. The threads **9** and **10** are intertwined with the warps of the fabrics A and B as illustrated in FIG. 4 in which **1** is a weft of the fabric A, **2** and **3** are warps, **4** is a weft of the fabric B and **5** and **6** are warps. The respective materials of the warp and weft are the same as in the preceding embodiment.

The intertwining threads **9** arranged in the longitudinal direction are shown with solid lines in FIG. 4 and are intertwined with the alternate wefts **1** and **4** in the fabrics A and B, respectively. p_1 is the intertwining pitch. The intertwining threads **10** arranged in the lateral direction are shown with broken lines and are intertwined with every fifth warp in each of the fabrics A and B. p'_1 is an intertwining pitch.

Further, these intertwining threads are arranged at a desired pitch also in the lateral direction (shown with the arrow in FIG. 3). p'_2 is a pitch of the intertwining thread **9**. p_2 is a pitch of the intertwining thread **10**. The pitches $p_2<p'_2$ and $p'_1>p_1$. As the planes formed by these two kinds of intertwining threads **9** and **10** intersect at right angles with each other, the space between the fabrics A and B is like being sectioned with small chambers. Through these intertwining threads **9** and **10**, the fabrics are opposed to each other with a gap t between them.

In the production, the fabrics A and B and the intertwining threads can be simultaneously woven instead of separately making the fabrics A and B. Therefore, the surface switch can be easily made. The material of the intertwining thread to be used is the same as in the preceding example.

FIG. 6 illustrates another embodiment of the formation of the fabrics. For the formation of the wefts, the warps **2** are so arranged as to skip several wefts so that the conducting area may be increased.

FIGS. 7 and 8 illustrate an embodiment of the surface switch of the present invention formed in the form of a tape. In the drawings, **1** is a weft and **2**, **3**, **5** and **6** are conductive warps woven with the above mentioned wefts **1**. A tape woven of insulative warps **12** and the wefts **1** and a tape woven of insulative warps **13** and the wefts **1** are provided on the respective sides of a conductive tape woven of the warps **2** and **3** with the wefts **1** so as to form a fabric A'. In the same manner, a tape woven of insulative warps **14** and the wefts **1** and a tape woven of insulative warps **15** and the wefts **1** are provided on the respective sides of a conductive tape woven of the warps **5** and **6** with the wefts **1** so as to form a fabric B'. The threads **12**, **13**, **14** and **15** are made of polyvinyl alcoholic synthetic fibers or viscose fibers. The intertwining threads **9** are intertwined with the wefts **1** and warps **12** of the fabric A' and with the wefts **1** and warps **14** of the fabric B'. The intertwining threads **8** are intertwined with the wefts **1** and warps **13** of the fabric A' and with the wefts **1** and warps **15** of the fabric B'. Said intertwining threads **8** and **9** are made of polyester fibers or polyamide fibers. These fabrics A' and B' and intertwining threads are woven simultaneously and therefore the surface switch can be very simply made.

11 is a tubular cover made of such elastic insulative material as rubber or synthetic resin to enclose the above mentioned switch elements. By fusing the tube at both ends, the switch elements within it can be prevented from being influenced by moisture and dust.

The surface switches in the first and second embodiments can be used as enclosed in cases in the same manner as in the third embodiment.

While there has been described in connection with the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is aimed, therefore, to cover in the appended claims all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electrical surface switch comprising the combination of a pair of opposed flexible contact sheets made of fabrics having electrically conductive fibers therein for making a desired electrical connection when the opposed surfaces of said sheets are brought into contact with each, and a multiplicity of resilient fibers made of electrically nonconductive material intertwined with the fabric of at least one of said contact sheets and extending between said sheets for normally biasing the contact sheets away from each other to normally open positions, said resilient fibers being adapted to flex in response to advancing movement of said sheets toward each other to a closed position where the opposed surfaces of said sheets contact each other.

2. An electrical surface switch as defined in claim **1** in which said flexible contact sheets and said resilient fibers are enclosed within a flexible sheath made of an electrically insulating material.

3. An electrical surface switch comprising the combination of a pair of opposed flexible contact sheets at least one of which is made of a woven fabric, said contact sheets having electrically conductive fibers therein and adapted to make a desired electrical connection when the opposed surfaces thereof are brought into contact with each other, and a multiplicity of resilient fibers made of electrically nonconductive material and woven as an integral part of the woven fabric of at least one of said contact sheets, said resilient fibers extending between said sheets for normally biasing the sheets away from each other to normally open positions, and flexing in response to movement of said sheets to a closed position where the opposed surfaces of said sheets contact each other.

4. An electrical surface switch as defined in claim **3** in which said flexible contact sheets and said resilient fibers are enclosed within a flexible sheath made of an electrically insulating material.

5. An electrical surface switch comprising the combination of a pair of opposed flexible contact sheets each of which is made of woven fabric having electrically nonconductive wefts woven with at least one area of electrically conductive warps between areas of electrically nonconductive warps, the areas of conductive warps being aligned in the two sheets so as to make a desired electrical connection when the opposed surfaces thereof are brought into contact with each other, and a multiplicity of resilient fibers made of electrically nonconductive material interwoven with the fabrics of both of said sheets in the areas of said nonconductive warps and extending between said sheets for biasing the sheets away from each other to normally open positions, said fibers flexing in response to movement of said sheets to a closed position where the opposed surfaces of said sheets contact each other.

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ROBERT K. SCHAEFER, *Primary Examiner.*

H. O. JONES, *Assistant Examiner.*