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ELECTRIC SWITCH PROVIDED WITH A STATIONARY
ELECTROCONDUCTIVE RUBBER CONTACT
Filed Feb. 20, 1967

3,363,076

FIG. 1

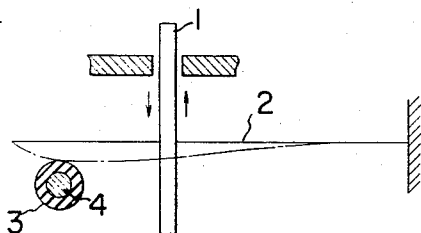


FIG. 2

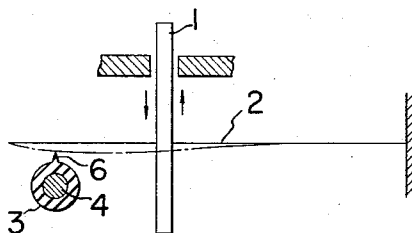


FIG. 3

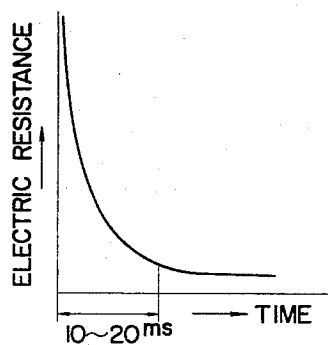


FIG. 4

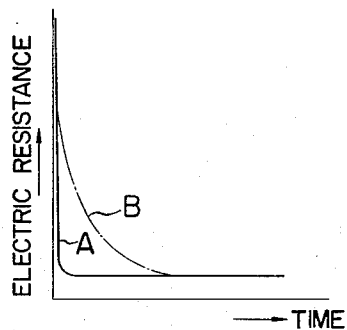


FIG. 5

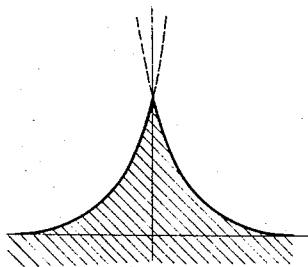
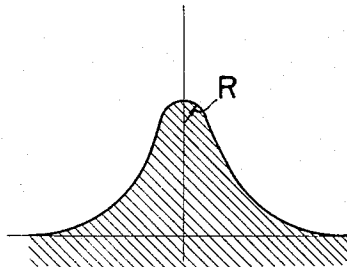


FIG. 6



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ELECTRIC SWITCH PROVIDED WITH A STATIONARY ELECTROCONDUCTIVE RUBBER CONTACT

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ABSTRACT OF THE DISCLOSURE

A stationary electroconductive rubber contact adapted to cooperate with a movable contact is provided with a projection of suitable configuration at the point of engagement with the movable contact to provide a contact resistance characteristic which varies exponentially.

This invention relates to an electric switch having an electroconductive rubber contact, and more particularly to such a contact especially useful for electrical musical instruments.

In electrical musical instruments, sounds are generally produced by opening and closing sound signal circuits by means of pairs of cooperating metal contacts having operating surfaces plated with a noble metal. However, such conventional metal contacts are not suitable for use in electrical musical instruments because they produce an unpleasant "click noise" and musical sounds of unnatural rising amplitude at the instant when they engage and disengage. As one approach to this problem a so-called indirect keying system has been proposed, but this system is disadvantageous in that it is accompanied by frequent defective operation and in that it is expensive. Further, contacts made of electroconductive rubber have been substituted for metal contacts, but even with these rubber contacts the difficulties mentioned above cannot be eliminated.

As will be more fully discussed later, an unpleasant click noise and musical sound of unnatural rising amplitude heretofore encountered in musical instruments employing metal contacts to open and close sound signal circuits are mainly caused by an abrupt change in the contact resistance between cooperating contacts which results in an abrupt build-up of sound signals. While electroconductive rubber contacts can alleviate these difficulties to some extent, they cannot completely solve the problem. This is because the contact resistance between an electroconductive rubber contact, usually in the form of a short cylinder, and a cooperating movable contact of metal strip or wire does not vary materially as the contact pressure is increased. In other words, the contact resistance between these contacts varies abruptly in substantially the same manner as in metal contacts.

Accordingly, it is the principal object of this invention to provide an improved switch which can control exponentially the current flowing therethrough at the time of opening and closing.

A more specific object of this invention is to provide electroconductive rubber contacts for use in controlling sound signals in electrical musical instruments. Briefly stated, the invention provides an electric switch comprising a movable contact and a stationary contact made of electroconductive rubber. The stationary contact is preferably in the form of a short cylinder, and a radial projection is formed integral with the cylinder at the point of engagement with the movable contact, with said radial projection also extending in the axial direction of the cylinder.

The invention can be more fully understood from the

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following description taken in connection with the accompanying drawing, in which:

FIG. 1 is a schematic representation of a switch for use in electrical musical instruments utilizing a conventional electroconductive rubber contact;

FIG. 2 is a similar view of a switch for use in electrical musical instruments utilizing an electroconductive rubber contact embodying this invention;

FIG. 3 is a plot showing an ideal contact resistance characteristic of a switch for use in electrical musical instruments;

FIG. 4 is a graph to compare contact resistance characteristics of a prior switch and of a switch employing the novel electroconductive rubber contact, and

FIGS. 5 and 6 show different configurations of the projection of electroconductive rubber contact.

Referring now to FIG. 1 which illustrates one form of a switch for electrical musical instruments, the switch is shown as comprising a movable contact 2 in the form of a metal sheet or wire actuated by a driving means 1 which may be a metal strip and an electroconductive rubber contact 3 cooperating with the movable contact and supported by a stationary arbor 4, and one end of the movable contact 2 is supported by a fixed support. When the driving means 1 is depressed, the movable contact 2 is urged against the stationary contact 3. Although, as the electroconductive rubber, one having sufficient resiliency, electrical conductivity and excellent temperature characteristic is selected, the contact area between the movable and stationary contacts does not vary materially irrespective of the increase in the downward pressure applied by the movable contact. As a consequence, the contact resistance between the movable and stationary contacts varies abruptly as shown by curve A in FIG. 4. Thus, electroconductive rubber contacts of prior design can not eliminate the click noise and unnatural sound mentioned above.

The invention contemplates increasing the variation in the contact area or contact resistance during contact closing and opening operations by providing a sharp projection on an electroconductive rubber contact at the point of engagement with the movable contact. The configuration of this projection varies depending upon the required contact resistance, viz, the time characteristic. In the following description, however, application of the electroconductive rubber contact as the fixed contact of a switch for electronic organs is considered.

In electronic organs, sounds are produced most naturally when their sound volume (in decibels) increases linearly, or when the contact resistance of switches inserted in the sound signal circuits varies exponentially as shown by FIG. 3. The interval of time required for the contact resistance to assume a constant value or steady state is about 10 to 20 microseconds. Such an ideal resistance characteristic can be realized by employing an electroconductive rubber contact provided with a radial projection having a cross-section defined by symmetrical exponential curves as shown in FIG. 5. Thus, according to this invention, in order to provide the required contact resistance characteristic a radial projection 6 is provided on the periphery of the cylindrical electroconductive rubber contact 3, as shown in FIG. 2.

FIG. 4 shows a comparison between the contact resistance characteristics of cylindrical electroconductive rubber contacts with and without a projection, respectively. Curve A represents the contact resistance characteristic of a prior cylindrical electroconductive rubber contact not provided with a projection. This curve shows that the contact resistance varies abruptly substantially in the same manner as prior metal contacts. Curve B shows the contact resistance characteristic of the novel

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electroconductive rubber contact which is essentially identical with the ideal characteristic shown in FIG. 3.

As can be readily understood by those skilled in the art, the configuration of the characteristic curve B is determined by such factors as the configuration of the projection 6, the speed of the movable contact, conductivity of the same, configuration of the contact area (especially its radius of curvature) between stationary and movable contacts, contact pressure and the like. A radial projection having a cross-section defined by symmetrical exponential curves as shown in FIG. 5 was found to give a substantially ideal contact resistance characteristic. However, a projection having a rounded tip as shown in FIG. 6 is preferable because the projection of the shape as shown in FIG. 5 is not always satisfactory from the standpoint of keying durability (or life) and workability. The radius of curvature R of the projection is preferably smaller than the diameter of the metal wire constituting the movable contact.

It is of course important to eliminate the wiping action of the movable contact to decrease the contact resistance, to increase the radius of curvature of the projection, and to impart proper resilience and stiffness to the rubber in order to prolong the useful life of the electroconductive rubber contact provided with the projection. Although in the foregoing description, the electroconductive rubber contact has been shown in the form of a short cylinder, it may be shaped to have any desired cross-sectional configuration.

Thus, it will be obvious that the switch utilizing the contact of this invention can vary the current exponentially or can linearly vary the sound volume of electrical musical instruments so that problems of producing a click noise and sound of unnatural rising amplitude can be solved by simple means.

While the invention has been shown and described as

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applied to switches for use in electrical instruments, it will be clear that the novel electroconductive rubber contact of this invention can also be used in any application where exponential change of current at the time of contact operation is desired.

What is claimed is:

1. An electric switch comprising a movable contact, a stationary contact of electroconductive rubber, said stationary contact being in the form of a cylinder, an integral projection on the cylinder at the point of engagement with said movable contact, and said projection extending in the radial direction, as well as in the axial direction of said cylinder.
2. An electric switch comprising a movable contact, a stationary contact of electroconductive rubber, and an integral projection on said stationary contact at the point of engagement with said movable contact, said projection having a sectional configuration defined by a pair of symmetrical exponential curves in the plane of movement of the movable contact.
3. The electric switch as claimed in claim 2 in which the outer contact edge of said projection is rounded.
4. The electric switch as claimed in claim 3 in which said stationary contact is in the form of a cylinder and said projection extends in the radial direction as well as in the axial direction of said cylinder.

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