

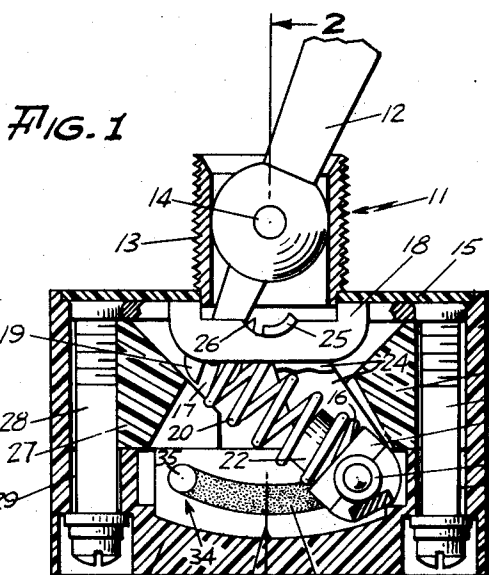
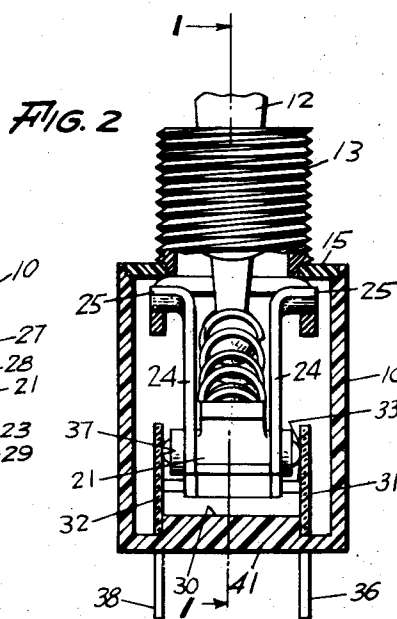
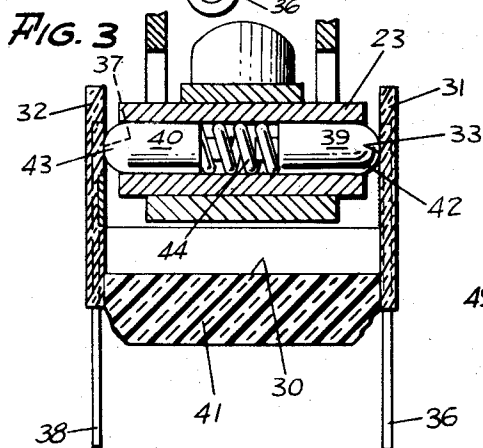
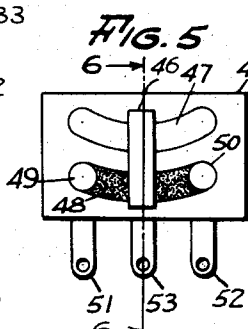
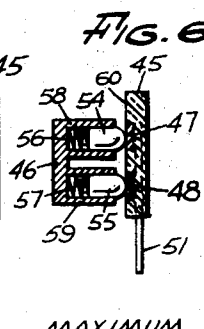
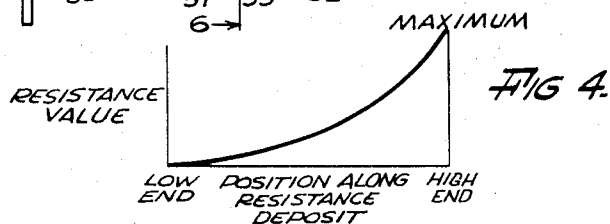
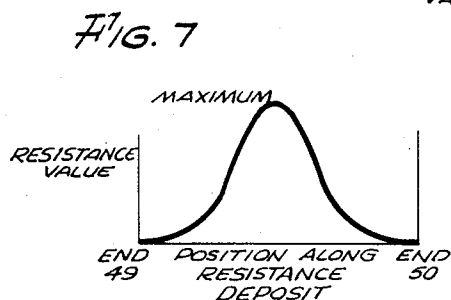
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SWITCHING DEVICES

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2,956,255

SWITCHING DEVICES

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This invention relates generally to switching devices and more particularly to fast action switches in which high frequency noise generated by switching transients is eliminated.

In using switches in communication equipment as in aircraft, marine or ground installations, for instance, when an electrical current is switched on or off, high frequency transients are generated because of the switching operation. These high frequency transient currents interfere with the communications equipment in the neighborhood of the switch and provide undesirable high frequency noise which may be picked up and distributed throughout the system. Hence, it is desirable to provide some means for eliminating this noise so that it is no longer troublesome. Such high frequency noise has been conventionally suppressed by providing a shield to enclose the switch housing and by connecting suitable filters at the input and output leads of the switch. Such means for overcoming these high frequency noise transients are not only expensive but also space-consuming in applications where space may be at a premium. This invention provides a simple switching arrangement which eliminates any necessity for shielding or connecting filter networks to the switch leads. This is done by providing within the switch housing itself a continuous deposit of resistance material over which the switch contacts pass during the switching operation. In its simplest form, one end of the resistance deposit has a very low or substantially zero resistance, and the other end, a very high resistance. As the switch is moved between its "on" and "off" positions the switch contacts are provided with a continuous resistance path in either direction. This continuous resistance path thereby causes a gradual change in current through the switch and eliminates the transient phenomena. The switch is constructed as a fast-action switch, for instance, as a toggle switch, in which the movement from one position to the other occurs within a few milliseconds. Such a switch is equivalent to a single-pole, single-throw type and represents only one of a number of different embodiments of the invention. Besides eliminating R.-F. transients, the invention also provides two other important advantages in that it eliminates arcing across the switch contacts during opening or closing operations and it prevents excessive voltage build-up when connected in inductive circuits. The construction and operation of the switch of the invention can be best described with the help of the drawing in which:

Fig. 1 represents a sectional view of one embodiment of the invention taken along the line 1—1 of Fig. 2;

Fig. 2 represents a sectional view of the invention as shown along the line 2—2 in Fig. 1;

Fig. 3 shows an enlarged sectional view of a part of the embodiment of the invention shown in Fig. 2;

Fig. 4 shows a graph of resistance values as a function of position along the deposit of resistance material shown in Figs. 1-3;

Fig. 5 shows a part of another embodiment of the invention;

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Fig. 6 shows a sectional view of the part of the embodiment of the invention along the line 6—6 of Fig. 5;

Fig. 7 shows a graph of resistance value as a function of position along the deposit of resistance material shown in Figs. 5 and 6.

In Figs. 1 and 2, the switching mechanism is shown contained within a switching case 10. Mounted at the top of the case is a switch cover assembly 11 comprising a bat handle 12 inserted within a threaded sleeve 13. Handle 12 extends to within switch case 10 as shown and is pivoted within sleeve 13 by means of pin 14. Threaded sleeve 13 is mounted on cover plate 15 of the switch case. The threaded sleeve may be inserted into an opening on a mounting panel, or the like, and secured to the panel by a nut (not shown) threaded upon the sleeve. The end of handle 12 that extends into the switch case is formed in the shape of a sphere 19 having a slot 17 which is engaged to one end of a compression spring 20. The other end of spring 20 extends to contact housing 21 and is fitted over a cylindrical upper portion 22 of said contact housing and seated against shoulder 16 of the lower portion of said housing. The lower portion of contact housing 21 includes a tubular member 23, the function of which is described below. Within switch case 10, there is shown a switch cradle 18 beneath cover plate 15 under the switch cover assembly. Switch arm 24, which, as more clearly shown in Fig. 2 is a U-shaped structure, extends from switch cradle 18 to the lower portion of said contact housing 21 and is held in place by the force of spring 20. End pieces 25 of the arms of the U-shaped structure are bent over and rest in arcuate portions 26 of switch cradle 18. At each end of switch case 10 there is located a switch spacer 27 which restrains switch arm 24 so that its motion is maintained within predetermined limits as the switch is moved between the "on" and "off" position. At each end of the switch case there are provided channels 29 into which fillister head machine screws 28 are inserted to hold switch spacers 27, switch cradle 18, and cover plate 15 in place.

A block 41 rises from the interior surface at the bottom of the switch housing. Block 41 has a curved surface 30 to provide sufficient clearance for the contact housing as the switch is moved between its "on" and "off" positions. As best shown in Figs. 2 and 3, two relatively thin dielectric plates 31 and 32 are mounted at either side of block 41. Plate 31 contains a deposit 33 of resistance material on the surface of plate 31 adjacent contact housing 21. The deposit of resistance material is formed as an arc having substantially the same curved shape as the path of travel of contact housing 21. The arc-shaped deposit 33 of resistance material is most clearly shown in Fig. 1. End 34, designated as the low end of resistance deposit 33, has substantially zero resistance. A contact button 35, provided at end 34, is electrically connected to the zero resistance end of resistance deposit 33 and is also connected to a terminal 36. The opposite end, designated as the high end of resistance deposit 33 and concealed behind contact housing 21 in Fig. 1, has a substantially large resistance. A continuous resistance path extends from the zero resistance end to the high resistance end of resistance deposit 33.

Plate 32 contains a strip 37 of conductive material that is formed into an arc corresponding to arc shaped deposit 33 of resistance material on plate 31. A terminal 38 is connected to the end of strip 37 corresponding to end 34 of resistance deposit 33. Both terminals 36 and 38 extend downward through the bottom of the switch case.

Fig. 3 shows an enlarged sectional view of tubular member 23 and dielectric plates 31 and 32. Within tubular member 23 of the contact housing is an assembly consisting of two substantially cylindrical contact pieces

39 and 40 which are fitted into the tubular opening. The two pieces are separated by a compression spring 44 within tubular member 23. Pieces 39 and 40 are each rounded at one end and are fitted into tubular member 23 so that their rounded ends 42 and 43 protrude from the ends of the tubular member and are held in contact with resistance deposit 33 and conductive deposit 37, respectively, by the force exerted by spring 44.

The operation of the switch can be best described with the help of Fig. 1. In that figure, handle 12 is shown in the "off" position. In this position, rounded end 42 of contact pieces 39 is connected to the high resistance end of resistance deposit 32 and rounded end 43 is connected to the corresponding end of conductive deposit 37. In this way a substantially large resistance is provided between the terminals 36 and 38 to which an external electric circuit may be connected. The deposit of resistance material may be formed to provide any predetermined value of resistance at the high resistance end. For instance, the switch may be used to cause a relay to operate, in which case the resistance value need only be large enough at the high end to reduce the current through the relay coil to a point below that value for which the relay operates and need only be small enough at the low end to allow sufficient current to operate the relay. Under these conditions, for example, the value at the high end may be of the order of 100,000 ohms or more. In some cases the resistance in the "off" position may be arranged to have a value in the megohm region so that in the "off" position the switch provides substantially an open circuit.

In the "off" position the spring 20 provides a force on the contact housing 21 and the switch arm 24 in such a direction that the contact pieces 39 and 40 are held in a fixed position at the high resistance end. When the handle 12 is moved to the left toward the "on" position, the spring 20 is compressed and the end of the spring that is engaged at the slotted sphere to the inner end of the handle 12 is caused to move in an arc generally in a direction to the right in the figure. The spring eventually reaches a particular position with respect to the contact housing such that a force is provided in a direction to cause the switch arm and contact housing to move toward the left. The spring compression is thereby released and the switch arm and contact housing rapidly snap toward the opposite end of curved surface 30 due to the released force of the spring. The upper ends of switch arm 24 ride in arcuate portions 26 of switch cradle 18 during the movement of the switch arm from the "off" to the "on" position. Contact piece 39 passes from the high resistance end of the deposit of resistance material to the low or substantially zero resistance end and contact piece 40 moves to the corresponding end of conductive strip 37. Hence, throughout the travel of the contact pieces, the resistance across the terminals 36 and 38 is continuously changing from a very large to a very small value within a few milliseconds. When the contact pieces reach the opposite ends of the resistance material and conductive strip, there is provided a very small, or substantially zero, resistance between the terminals 36 and 38 and a short circuit essentially exists in the external circuit connected to said terminals. Substantially the same action takes place, only in the opposite direction, when the handle is moved from the "on" to the "off" position. This gradual reducing or gradual increasing of resistance in one direction or the other eliminates the high frequency transients that normally occur during switching action.

It should be noted that the value of the resistance may be caused to change in any particular desired fashion between its high and low resistance end. One suitable method has been to arrange the resistance such that its value changes as an exponential function from the low to the high resistance end, as illustrated in Fig. 4. Other suitable functions will occur to those skilled in the art

according to the particular application desired. The resistance material should be selected to give maximum wear compatible with design requirements.

The structure shown in Figs. 1-3 represents a basic embodiment of the invention. However, other embodiments will occur to those skilled in the art within the scope of the invention herein described. For instance, the invention may be adapted for double-throw operation in a manner similar to that for the single-throw operation as partially shown in Figs. 5 and 6. In Figs. 5 and 6 only a dielectric plate and contact mechanism are shown. The structure in these figures may easily be adapted by those skilled in the art to operate in a manner similar to the operation shown in Figs. 1-3. For the double-throw operation shown in Figs. 5 and 6, only a single dielectric plate need be mounted within the switch case. In Fig. 5, dielectric plate 45 has a deposit 48 of resistance material formed in the shape of an arc on the lower portion of the plate. On the upper portion of the plate a strip 47 of conductive material in the shape of an arc is mounted substantially parallel to resistance deposit 48. Contact buttons 49 and 50 are mounted at either end of resistance deposit 48. A terminal 51 is connected to contact button 49, a terminal 52 is connected to contact button 50, and a terminal 53 is connected to the center portion of conductive strip 47. A contact housing 46 is adapted to move in an arc substantially aligned with the arc defined by deposit 47 and strip 48.

Fig. 6 shows a sectional view of the contact housing 46 and dielectric plate. In that figure contact housing 46 has tubular members 58 and 59 perpendicular to surface 60 of dielectric plate 45. Substantially cylindrical contact pieces 54 and 55 are inserted within said tubular members 58 and 59, respectively. Compression springs 56 and 57 are used to provide a force so as to cause the rounded ends of contact pieces 54 and 55 to come in contact with conductive strip 47 and resistance deposit 48, respectively. Contact housing 46 may be adapted to be moved rapidly from one end to the other of said deposit and said strip in a manner similar to that provided in Figs. 1, 2 and 3.

The resistance material is deposited upon dielectric plate 45 so that each end, 49 and 50, has substantially zero resistance and the central portion has a maximum resistance. Fig. 7 shows a graph of the resistance value of resistance deposit 48 as a function of the position along said deposit. As seen in Fig. 7, the maximum rate of change of resistance occurs at approximately the center of the resistance deposit. When the contact housing is in a position at the left of the switch, terminals 51 and 53 are electrically connected so as to form a short circuit and terminal 52 is essentially in an open circuit position. When contact housing 46 is moved to a position at the right of the switch, terminals 52 and 53 form a short circuit and terminal 51 is essentially in an open circuit position. Hence, the switch described in Figs. 5-7 represents a single-pole, double-throw type of operation.

The concepts of this invention may be extended to other types of switching arrangements such as the double-pole, single-throw or double-pole, double-throw types of operation by utilizing combinations of the switch constructions shown in the figures within the same switch housing and adding an appropriate number of terminals.

Many other variations of the basic structures shown in the figures will occur to those skilled in the art that are still within the scope of this invention. Hence, the invention is not to be construed as limited to the embodiments specifically shown in the drawing and described herein, except as defined by the appended claims.

What is claimed is:

1. A fast action switching mechanism including, in combination, a switch case; a deposit of resistive material having substantially zero resistance value at one end, substantially large resistance value at the other end, and continuous intermediate values of resistance between said

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ends mounted in a first plane within said switch case; an electrically conductive strip mounted within said switch case in a second plane substantially parallel to and at a predetermined distance from said first plane; electrically conductive contact pieces mounted between said resistive deposit and said conductive strip whereby one of said contact pieces is maintained in electrical contact with said resistive deposit and the other of said contact pieces is maintained in electrical contact with said conductive strip; actuating means for rapidly moving said one of said contact pieces between the ends of said deposit and said other of said contact pieces between the ends of said strip; a first terminal connected to said zero resistance end of said resistive deposit; and a second terminal connected to said conductive strip.

2. A fast action switching mechanism including, in combination, a switch case; a first dielectric member mounted in a first plane within said switch case; a resistive material deposited on said first dielectric member whereby a continuous resistance path is provided on the surface of said dielectric member; a second dielectric member mounted in a second plane substantially parallel to and at a predetermined distance from said first plane within said switch case; a conductive material deposited on said second dielectric member; electrically conductive contact pieces mounted between said dielectric members whereby one of said contact pieces is maintained in electrical contact with said resistive deposit and the other of said contact pieces is maintained in electrical contact with said conductive deposit; actuating means for rapidly moving said one of said contact pieces between the ends of said resistive deposit and said other of said contact pieces between the ends of said conductive deposit; a first terminal connected to one end of said resistive deposit and a second terminal connected to one end of said conductive deposit.

3. A fast action switching mechanism substantially as described in claim 1 wherein said actuating means comprises a handle, a spring engaged at one end to said handle and at the other end to said contact pieces, said handle being pivoted so that said handle, said spring, and said contact pieces thereby cooperate for rapidly moving said contact pieces.

4. A fast action switching mechanism including, in combination, a switch case; a dielectric member mounted within said switch case; a resistive material deposited on said dielectric member whereby a continuous resistance path is provided on the surface of said dielectric member, said continuous resistance path having substantially zero resistance at each end and a substantially large resistance at the center of said path, a conductive strip deposited on said dielectric member whereby a continuous conductive path is provided on said surface of said dielectric member substantially parallel to said resistance path; electrically conductive contact pieces mounted adjacent said dielectric member whereby one of said contact pieces is maintained in electrical contact with said resistive deposit and the other of said contact pieces is maintained in electrical contact with said conductive deposit; actuating means for rapidly moving said one of said contact pieces between the ends of said resistive deposit and said other of said contact pieces between the

ends of said conductive strip; a first terminal connected to one of said zero resistance ends of said resistive deposit; a second terminal connected to the other of said zero resistance ends of said resistive deposit; and a third terminal connected to said conductive strips.

5. A fast action switching mechanism including, in combination, a switch case; a plurality of deposits of resistive material mounted in a first plane within said case, each of said plurality of deposits having a substantially zero resistance value at one end, a substantially large resistance value at the other end, and continuous intermediate values of resistance between said ends; a plurality of electrically conductive strips mounted within said switching case in a second plane substantially parallel to and at a predetermined distance from said first plane; said plurality of conductive strips being substantially opposite said plurality of resistive deposits; a plurality of electrical conductive contact pieces mounted between said plurality of resistive deposits and said plurality of conductive deposits whereby a first group of said contact pieces is maintained in electrical contact with said resistive deposits and a second group of contact pieces is maintained in electrical contact with said conductive strips; actuating means for rapidly moving said first group between the ends of said deposits and said second group between the ends of said strips; a plurality of first terminals connected to said zero resistance ends of said resistive deposits; and a plurality of second terminals connected to said conductive strips.

6. A fast action switching mechanism including, in combination, a switch case; a plurality of dielectric members mounted within said switch case; resistive material deposited on each of said dielectric members whereby a continuous resistance path is provided on the surfaces of said dielectric members, each of said continuous resistance paths having substantially zero resistance at each end and a substantially large resistance at the center; a plurality of conductive strips deposited on each of said dielectric members whereby a continuous conductive path is provided on the surfaces of said dielectric members, said conductive paths being substantially parallel to said resistance paths; a plurality of electrically conductive contact pieces mounted adjacent said dielectric members whereby a first group of said contact pieces is maintained in electrical contact with said resistive deposits and a second group of said contact pieces is maintained in electrical contact with said conductive deposits; actuating means for rapidly moving said first group of contact pieces between the ends of said resistive deposits and said second group of said contact pieces between the ends of said conductive strips; a plurality of first terminals connected to said zero resistance ends of said resistive deposit; and a plurality of second terminals connected to said conductive strips.

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