

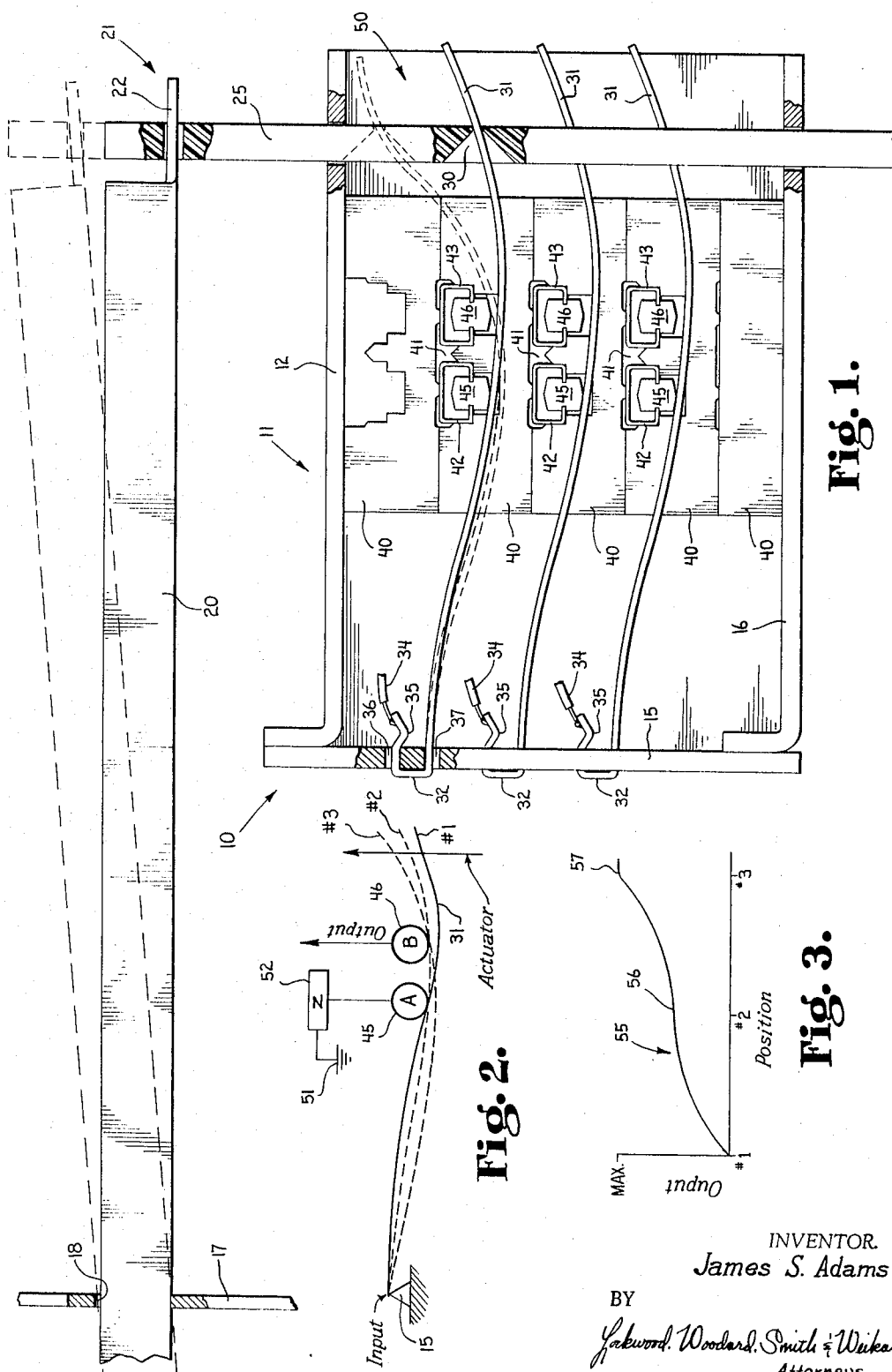
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J. S. ADAMS

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MUSICAL INSTRUMENT SWITCH DEVICE

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MUSICAL INSTRUMENT SWITCH DEVICE
James S. Adams, Fort Wayne, Ind., assignor to The Magnavox Company, Fort Wayne, Ind., a corporation of Delaware

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7 Claims. (Cl. 323-95)

This invention relates generally to electrical switching systems and more particularly to an electrical switching system particularly adapted for use in electronic organs and similar electrically operated musical instruments.

In a pipe organ the amplitude of sound emitted from the organ increases rather gradually as the air is admitted to a given pipe. In contrast to this, the sound emitted from many types of electronic organs increases to maximum amplitude substantially instantaneously when a key is operated. This produces the effect commonly known as "key thump" whereby there is more of a percussive effect than a gradual attack because of the transient voltage generated when the key-operated switch is closed.

Conventional electronic organs include various types of complex electronic circuits designed to prevent "key thump" and cause the sound output of the instrument to simulate the sound of a pipe organ. Such circuits add substantial cost and are not too successful.

The principal object of this invention is to provide a key-operated switch system for electronic organs and similar electrically operated musical instruments wherein transient effects are suppressed or damped when a key is operated and the rate of attack is controlled to produce sound simulating that of a pipe organ.

Another object of this invention is to provide, in electronic musical instruments, a simple and inexpensive control circuit for damping transient effects in key-operated circuits.

In accordance with this invention there is provided a key-operated switch and circuit comprising an elongated flexible conductor operable by a key and connected to a source of sound signals, a first contact normally closed with said conductor and comprising a compressible conductive material providing a relatively high impedance to ground, a second contact comprising conductive compressible material connected to an output circuit and normally spaced from said flexible conductor, said flexible conductor being operable to initially compress said first contact to increase current to ground and subsequently operable to engage said second contact, compressing it to gradually increase signal output therethrough while disengaging from said first contact.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

FIG. 1 is a side elevation partially in section of a switch arrangement embodying the present invention.

FIG. 2 is a schematic view illustrating the principle of operation of the switch arrangement of FIG. 1.

FIG. 3 is a graph showing output current or voltage plotted against time for the switch arrangement of the present invention.

Referring now more particularly to the drawings, there is illustrated a switch structure 10 which in one embodiment might include a frame 11 made up of a plurality of members 12, 15 and 16 fixed relative to one another. The member 15 in the present embodiment is electrically nonconductive. The frame 10 further includes a member 17 having an aperture 18 through which extends a lever 20. The lever 20 may be an organ key or connected thereto and forms part of a mechanical linkage 21 by means of which the switch structure is actuated.

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The lever 20 is pivotally mounted to the frame member 18 so that the end 22 of the lever is movable between the solid line position of FIG. 1 and the dotted line position of FIG. 1. The end 22 of the lever projects through an aperture in an elongated actuator 25 for operating it between the solid and dotted line positions. The elongated actuator 25 is formed of insulating material such as, for example, polyethylene and has a plurality of apertures 30 therethrough which slidably receive the free ends of conductive spring contact elements 31.

Each of the spring contacts 31 is formed at its proximal end 32 in the shape of a hook with a portion 35 extending inwardly toward the main body of the member 31 whereby the member 31 can be removably secured in electrically nonconductive relation to the member 15. Each member 31 extends through a pair of spaced apertures 36 and 37 in the member 15 and is thereby secured thereto.

A plurality of insulating members 40 are stacked between the members 12 and 16 and support, in turn, insulating members 41 which, in turn, fixedly support electrical buses 42 and 43. Mounted within each of the electrical buses 42 and 43 are laterally spaced electrical contacts 45 and 46 which are formed of conductive resiliently compressible material having a conductance which increases as the compressive deformation of the respective contact increases and which decreases as the compressive deformation of the contact decreases. This material might be, for example, any conventional commercially available resilient plastic or polymer such as vinyl, silicone rubber, buna rubber or any other material having the desired conductive characteristics.

For purposes of convenience in the description which follows, only a single switch circuit, for example, 50 will be described. When the associated organ key is not depressed, the lever 20 is in the solid line position of FIG. 1 as are the actuator 25 and the spring contact 31. The contact 31 has a certain amount of resiliency or rigidity which causes it to bear against the contact 45 with a certain amount of pressure. As is indicated in schematic FIG. 2, the contact 45 is connected to ground 51 through the low impedance of the compressively deformed contact 45 as represented by impedance 52, said impedance 52 being low as compared to the output load (not shown).

The contact 46 forms the output contact for the switch while input conductors 34 may be connected to the end portions 35 of spring contacts 31. When the lever 20 is moved from the solid to the dotted line position, the switch moves from fully open to fully closed condition. This movement takes a finite period of time which is indicated in the graph of FIG. 3 as being the time on the horizontal axis between the numeral #1 and the numeral #3.

The output voltage or current desired and obtained from the present device is indicated by the curve 55 which slopes from the time point #1 at a relatively high rate and flattens centrally at 56 or time point #2, then has an increasing slope until it reaches full current at 57 or time point #3. This desired output characteristic is effected by the movement of the actuator from the illustrated solid line position to the dotted line position.

In position #1, the movable contact 31 engages the ground contact 45 with a predetermined pressure grounding the input through the normally low isolating impedance created when contact 45 is under pressure, thereby reducing the signal present on the movable contact. As the movable contact is transferred to position #2, the reduced signal is impressed upon the fixed output contact 46 through the relatively high resistance offered by the relatively low pressure between the contact 31 and the contact 46. As the contact 31 is further moved toward position #3 the resistance in series decreases due

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to the increased pressure on the fixed output contact 46. Further movement of contact 31 toward position #3 increases the resistance to ground through contact 45 because the pressure between contact 45 and contact 31 is reduced. Still further movement of contact 31 toward position #3 separates contact 31 from contact 45, and pressure between contact 31 and contact 46 reaches a maximum, thereby to provide a low series resistance between the movable contact 31 and the fixed contact 46. The above described action of contacts 31, 45 and 46 produces the output curve illustrated in FIG. 3 whereby transient voltages are damped and a gradual attack is produced, thereby to prevent key thump.

It should be understood that various alternative embodiments of the present invention are possible. For example, the output contact 46 might be located between the grounded contact 45 and the support member 15. In this embodiment, the actuator would act against the contact 31 at a point between the output contact 46 and the input end of contact 31. Similarly to the above described embodiment, this embodiment would have an initial nonactuating position wherein the contact 31 engages the contact 45 and a final fully actuated position in which the contact 31 has moved away from the contact 45 and is fully engaged with the contact 46.

It should be pointed out that the speed of closure of the contacts 31 and 46 is less than the speed of the actuator 25 because of the fulcrum action involved in the initial engagement of the contact 45 by the contact 31. This reduced closure rate also cooperates to reduce the rate of the change of resistance of the contact 46 slowing down or damping the on transient.

Various other modifications of the specific structure of the invention are possible. For example, the movable contact 31 might be a flexible wire conductor of any cross sectional shape and may or may not be plated or clad with precious metal. Preferably means are provided for opening or restoring the switch, that is, for moving the actuator back from its dotted line to its solid line position. Such means might include gravity or a suitable spring or springs. The operation of the switch is actually reversed when so opened. That is, the current or voltage output moves along the same curve as illustrated in FIG. 2 but from right to left.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. A switching system comprising an input terminal, an elongated flexible contact member fixed at one end thereof to said terminal, a pair of spaced contacts aligned with said member intermediate its ends, means connecting one of said contacts to ground, an actuator coupled to the other end of said member and normally positioned to engage said member with said one contact, and means for moving said actuator and therewith the said other end of said member to flex said member, first into simultaneous engagement with both of said contacts, and then into engagement solely with the other of said contacts, said contacts being formed of conductive deformable material having a conductance varying with pressure thereon.

2. A switching system comprising an input terminal, an elongated flexible contact member fixed at one end thereof to said terminal, a pair of spaced contacts aligned with said member intermediate its ends, means connecting one of said contacts to ground, an actuator coupled to the other end of said member and normally positioned to engage said member with said one contact with predetermined pressure to provide predetermined current flow to ground, and means for moving said actuator and there-

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with the said other end of said member to flex said member, first into simultaneous engagement with both of said contacts, and then into final engagement solely with the other of said contacts, said contacts being formed of conductive deformable material having a conductance varying with pressure thereon, said one ground connected contact and said member comprising a means for gradually increasing the voltage at said other contact as said actuator moves said member from its normal position to its final engagement with said other contact.

3. A switch arrangement comprising an input terminal, an output contact formed of conductive resiliently compressible material having a conductance varying directly as the compressive deformation of the output contact, a further contact formed of conductive resiliently compressible material having a conductance varying directly as the compressive deformation of the further contact, a flexible conductor electrically connected to said terminal and engaging said further contact, means for actuating said flexible conductor to move it into engagement with said output contact and out of engagement with said further contact.

4. A switching system comprising an input terminal, an output contact formed of conductive resiliently compressible material having a conductance varying directly as the compressive deformation of the output contact, a further contact connected to ground, said further contact being positioned adjacent said output contact and being formed of conductive resiliently compressible material having a conductance varying directly as the compressive deformation of the further contact, an elongated flexible conductor electrically connected to said terminal and engaging said further contact with sufficient pressure to provide a low impedance to ground, and means for actuating said flexible conductor to move it into engagement with said output contact and out of engagement with said further contact.

5. A switch comprising a frame, a conductive element secured at one end to said frame, an actuator reciprocally mounted on said frame and coupled to said element, a pair of electrical contacts mounted in spaced relation on said frame in the path of movement of said element, said contacts being formed of conductive resiliently compressible material having conductances which increase as the compressive deformation of the respective contact increases and which decrease as the compressive deformation of the respective contact decreases, said actuator being movable between a first position in which said element forcibly engages one of said contacts and not the other and a second position in which said element forcibly engages the other of said contacts and not the one, said actuator when moving between said first and second positions also moving through an intermediate position wherein said element engages both of said contacts with a lesser force.

6. A switching system comprising a frame including a conductive terminal, an elongated spring element secured at one end to said terminal, an actuator connected to said spring element and reciprocally mounted for longitudinal movement on said frame, a pair of electrical contacts mounted in spaced relation on said frame, and in the plane of movement of said spring element, said contacts being formed of conductive resiliently compressible material having conductances which increase as the compressive deformation of the respective contact increases and which decrease as the compressive deformation of the respective contact decreases, said actuator being movable between a first position in which said spring element forcibly engages one of said contacts and not the other and a second position in which said spring element forcibly engages the other of said contacts and not the one, said actuator when moving between said first and second positions also moving through an intermediate position wherein said spring element engages both of said contacts with a lesser force.

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7. A switching system comprising a frame including a
conductive terminal, an elongated spring element secured
at one end to said terminal, an actuator formed of insulat-
ing material and reciprocally mounted for longitudinal
movement on said frame, said actuator having an aper- 5
ture therein through which the other end of said spring
element projects, a pair of electrical contacts mounted in
spaced relation on said frame, said contacts being formed
of conductive resiliently compressible material having con-
ductances which increase as the compressive deformation 10
of the respective contact increases and which decrease
as the compressive deformation of the respective contact
decreases, said actuator being movable between a first
position in which said spring element forcibly engages 15
one of said contacts and not the other and a second po-
sition in which said spring element forcibly engages the
other of said contacts and not the one, said actuator when

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moving between said first and second positions also mov-
ing through an intermediate position wherein said spring
element engages both of said contacts with a lesser force,
said other contact being connected to the output load,
said one contact being connected to ground to provide
impedance to ground which is low compared to said out-
put load when said actuator is in said first position.

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JOHN F. COUCH, *Primary Examiner.*
A. D. PELLINEN, *Assistant Examiner.*