United States Patent

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[33] **Japan**
[31] **43/21336 and 43/22491**

[54] **ELECTRONIC MUSICAL SYSTEM WITH MAGNETIC FIELD RESPONSIVE SWITCH AND VOLUME CONTROL**
7 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **84/1.27**, 84/1.1
[51] **Int. Cl.** **G01h 1/02**
[50] **Field of Search** ..... 84/1.01, 1.09, 1.1, 1.14, 1.15, 1.27, 1.13, 1.26; 307/259, 309; 323/94 H; 317/235-23

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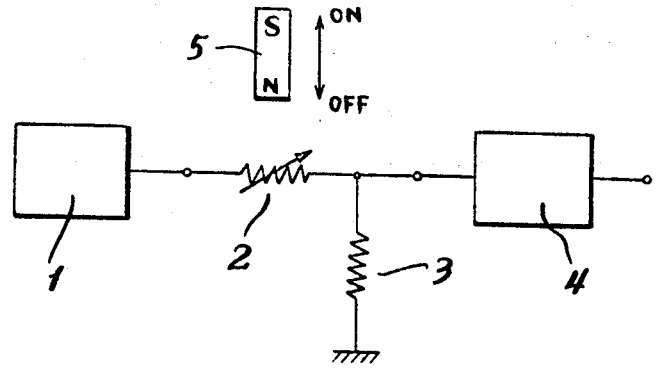
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Primary Examiner—Milton O. Hirshfield
Assistant Examiner—Stanely J. Witkowski
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ABSTRACT: An electronic musical system has a tone generator and a tone coloring circuit with a first resistance connected in series between them. A second resistance has one end connected to the series circuit between the tone coloring circuit and the tone generator and the other end connected to ground. One of the resistances is a magnetoresistor, the electrical resistance of which varies in accordance with the intensity of the magnetic field applied thereto. A key is movably mounted above the magnetoresistor with a magnet element mounted thereon close to the magnetoresistor, so that movement of the key controls the electrical resistance of the magnetoresistor depending on the amount the key is moved.



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SHEET 1 OF 2

Fig. 1

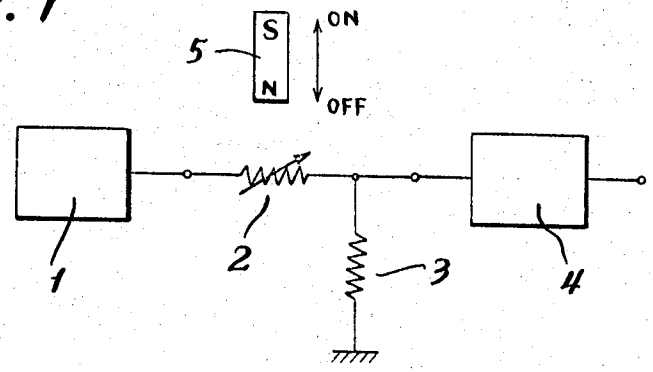


Fig. 2

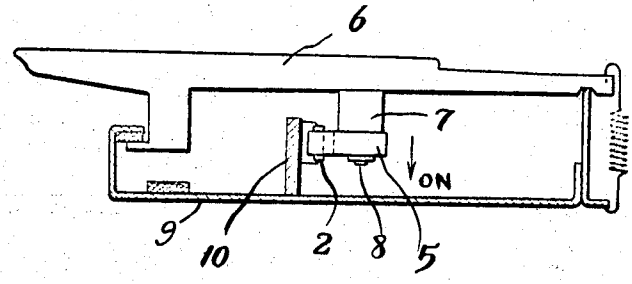


Fig. 3

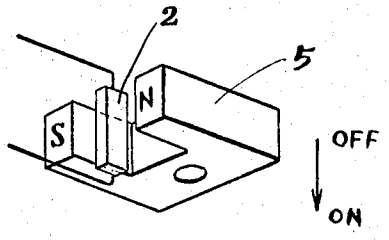
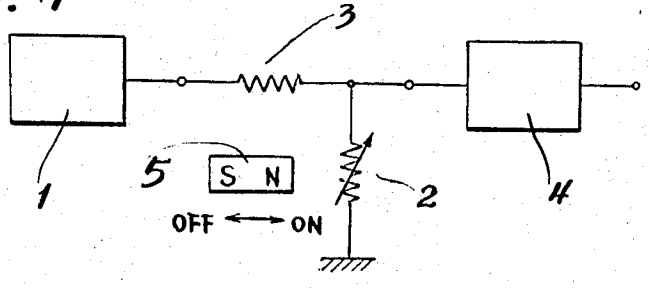


Fig. 4



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Fig. 5

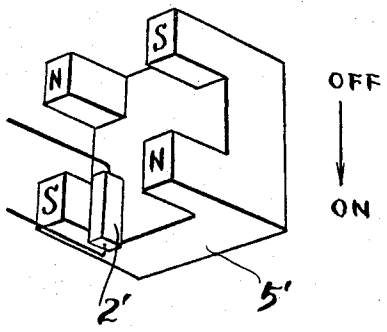


Fig. 6

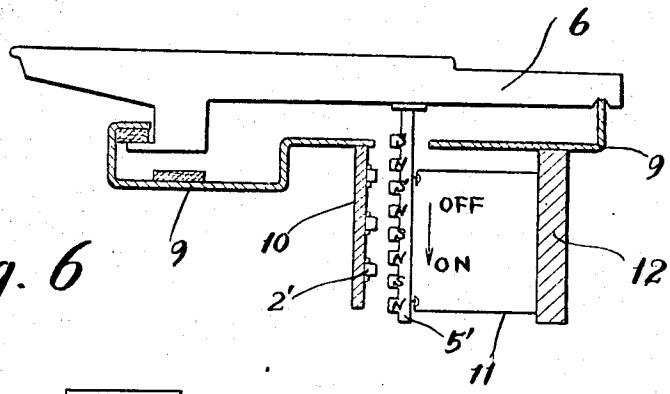


Fig. 7

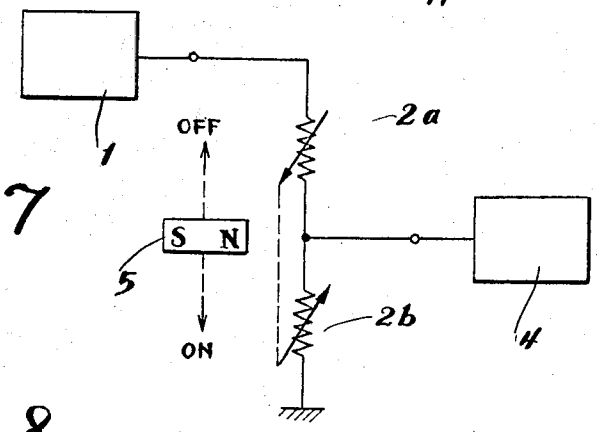
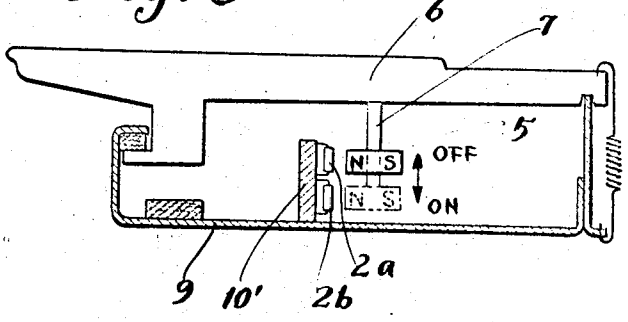


Fig. 8



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ELECTRONIC MUSICAL SYSTEM WITH MAGNETIC FIELD RESPONSIVE SWITCH AND VOLUME CONTROL

BACKGROUND OF THE INVENTION

Heretofor, electronic musical instruments have ordinarily been provided with tone generators and switches which control the outputs of said tone generators. Accordingly, many electric contacts are always necessary for electronic musical instruments, and for the electric contacts, metal-to-metal contacts or metal-to-conductive-rubber contacts have been used conventionally. But, these are liable to cause bad contacts owing to the formation of sulfides or oxides of metals or deposits of dust on the surfaces of the contacts, and therefore they are unreliable, and furthermore they causes a click signal in the moment of closing or opening of the switches. Moreover, said contacts can only switch electric signals, and it is impossible to vary the volumes of sounds simply by varying the strength with which the keys are depressed.

SUMMARY OF THE INVENTION

A principal object of the present invention is to provide a switch device for an electronic musical instrument with so-called touch-sensitive control, wherein magnetic field applied to a magnetoresistor is varied by the strength with which the key is depressed so as to control the sound volume.

The magnetoresistor of the present invention is an element the electric resistance of which increases as the intensity of the applied magnetic field increases or varies as the variation of intensity and direction of the applied magnetic field.

Other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein several embodiments of the invention are illustrated. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram of a first embodiment of a switch device according to the invention;

FIG. 2 is a vertical cross section of a keyboard fitted with said circuit;

FIG. 3 is a schematic perspective view of the main part of said switch device;

FIG. 4 is a circuit diagram illustrating a second embodiment of a switch device according to the invention;

FIG. 5 is a schematic perspective view of the main part of the switch device of the second embodiment;

FIG. 6 is a vertical cross-sectional view of a keyboard fitted with a plurality switch devices.

FIG. 7 is a circuit diagram illustrating a third embodiment of a switch device according to the invention; and

FIG. 8 is a vertical cross-sectional view of a keyboard fitted with said circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the figures, the numeral 1 designates a tone generator the details of which are omitted. Magnetoresistors are shown at 2, 2', 2*a* and 2*b*, respectively, 4 designates a tone coloring circuit the details of which are omitted and 5 and 5' are magnets.

In FIG. 1, a magnetoresistor 2 is connected in series between a tone generator 1 and a tone coloring circuit 4, and a fixed resistor 3 is connected between the output side of the magnetoresistor 2 and ground, and a potential divider is formed by said magnetoresistor 2 and the fixed resistor 3. Said magnetoresistor 2 is an element the electric resistance of which increases as the intensity of an applied magnetic field increases, and the intensity of the magnetic field of the magnet 5 applied to the magnetoresistor 2 becomes a maximum when the key is in an off-state and the intensity of the magnetic field of the magnet 5 applied to the magnetoresistor 2 becomes less or zero when the key is in an on-state. In said device, no output signal from the tone generator 1 will appear at the output side of the magnetoresistor 2 when the key is in the off-state, as the electric resistance of the magnetoresistor 2 is a maximum, and the output signal of the tone generator 1 will be supplied to the tone coloring circuit 4 when the key is in the on-state, as the electric resistance of the magnetoresistor 2 is reduced. In this case, as the intensity of the magnetic field of the magnet 5 applied to the magnetoresistor 2 decreases gradually the resistance of the magnetoresistor 2 decreases gradually. Thereby, touch sensitive control is possible by the manipulation of a key; that is, when a key is depressed to a small extent the signal supplied to the tone coloring circuit 4 is weak, and when the key is depressed to a large extend the signal supplied to the tone coloring circuit 4 becomes stronger.

FIGS. 2 and 3 illustrate the magnet 5 and the magnetoresistor 2, wherein the magnet 5 is horseshoe shaped and fixed with a screw 8 to a key 6 with a nonmagnetic spacer 7 between the magnet and the key, and the magnetoresistor 2 is fixed to a holding piece 10 which is fitted to a keyboard frame 9. Consequently, the magnetoresistor 2 is fixed and the magnet 5 moves with the key 6. And the magnet 5 and the magnetosensitive element 2 are set as near as possible, for instance, as shown in FIG. 3, such that the magnetoresistor 2 is held between the north pole and the south pole of the magnet 5, and moreover, they are set such that the intensity of the magnetic field applied by the magnet 5 to the magnetoresistor 2 becomes a maximum when the key is in the off-state and becomes less or zero when the key is in the on-state.

FIG. 4 shows another circuit diagram of a second embodiment of the invention, wherein the positions of the magnetoresistor 2 and the fixed resistance 3 as shown in FIG. 1 are interchanged. When the magnetoresistor 2 is similar to that of FIG. 1, wherein the intensity of the magnetic field applied by the magnet 5 to the magnetoresistor 2 becomes a minimum when the key is in the off-state, and the intensity of the magnetic field applied by the magnet 5 to the magnetoresistor 2 becomes larger when the key is in the on-state, then the same result as in the case of FIG. 1 is attained.

Furthermore, when the element is a magnetosensitive diode in which the electric current which flows varies according to the intensity of applied magnetic field, almost the same results are obtained as in the case of a magnetosensitive resistor. FIG. 5 illustrates an example of a switch device having a large control ratio utilizing the characteristics of the magnetosensitive diode. That is, a magnetosensitive diode 2' is used, said diode 2' being positioned so as to move between pairs of poles of a multipolar magnet 5' which has pairs of poles in reversed positions as shown in FIG. 5, wherein, the key is in the on-state the magnetic field is in a direction to permit an electric current to flow through magnetosensitive diode 2', and when the key is in the off-state the magnetic field is in the opposite direction so that an electric current does not flow through magnetosensitive diode 2'. With this arrangement, there is no fear of signal leakage in the off-state of the key.

FIG. 6 illustrates an example of a key construction comprising a multiple switch device having a plurality of magnetoresistors and a multipolar magnet. The plurality of magnetoresistors 2', 2', ... are fixed to a holding piece 10 at suitable distances from each other and said holding piece 10 is fixed to the keyboard frame 9. The multipolar magnet 5' is fixed to a spring holder 12 by spring plates 11 so as to be driven directly or indirectly through a driving piece by the action of the key 6, and said spring holder 12 is fixed to the keyboard frame 9. The magnet 5' and each magnetoresistors 2' are to be positioned as near as possible to each other and such that the intensity of the magnetic field caused by the multipolar magnet 5' is applied to each magnetoresistors 2' becomes a maximum when the key is in the off-state and becomes less or zero when the

key is in the on-state. Furthermore, if each element is a magnetosensitive diode, and when it is used such that the direction of magnetic field applied to each magnetosensitive diode is reversed with a change in the position of the key from the on to the off-position, the controllable ratio of the signal becomes larger and this is more effective.

FIG. 7 illustrates the third embodiment according to the invention, wherein a magnetoresistor 2*a* is connected in series between a tone generator 1 and a tone coloring circuit 4 and another magnetoresistor 2*b* is connected between the output side of the magnetoresistor 2*a* and ground a potential divider being formed by said two magnetoresistors 2*a* and 2*b*. Said elements are magnetoresistors the electric resistances of which increase as the magnetic field intensity increases. The intensity of magnetic field of the magnet 5 to the magnetoresistor 2*a* becomes a maximum and the intensity of the magnetic field of the magnet 5 to the magnetoresistor 2*b* becomes a minimum when the key is in the off-state, and on the contrary, the intensity of magnetic field of the magnet 5 applied to the magnetoresistor 2*a* becomes a minimum and the intensity of magnetic field of the magnet 5 applied to the magnetoresistor 2*b* becomes a maximum when the key is in the on-state.

Accordingly, when the key is in the on-state, a large output signal from the tone generator 1 is transmitted to the tone coloring circuit 4, because the electric resistance of the magnetoresistor 2*a* becomes minimum and the electric resistance of the magnetoresistor 2*b* becomes maximum.

Next, when the key is in the off-state, only a small part of the signal from the tone generator 1 is transmitted to the tone coloring circuit 4, because the electric resistance of the magnetoresistor 2*a* becomes a maximum and the electric resistance of the magnetoresistor 2*b* becomes a minumum. Generally, a magnetoresistor has some value of resistance even when a magnetic field is not applied thereto, and furthermore, it is impossible to diminish the intensity of the magnetic field applied to the magnetoresistor 2*b* to zero owing to the structural limitation of the distance between the magnetoresistor 2*a* and the magnetosensitive element 2*b*. According to the present embodiment, however, even in such case, the electric voltage across the terminals of the magnetoresistor 2*b* becomes small and the output signal from the tone generator 1 diminishes almost to zero, because the electric resistance of the magnetoresistor 2*a* becomes high.

Due to the action of the key in the on or off position, the values of the resistances of the magnetoresistors 2*a* and 2*b* vary oppositely to each other so the control ratio of the output signals becomes extremely large.

In the above description, although the cases wherein the key is in the extreme on or off position has been described, the portion of the output signal from the tone generator 1 applied to the tone coloring circuit 4 may be varied corresponding to the extent of depression of the key, because the values of the resistances of the magnetoresistors 2*a* and 2*b* vary gradually corresponding to the extent of the depression of the key. Therefore, so-called touch-sensitive control effect is attained.

FIG. 8 illustrates an arrangement of said magnet and said magnetoresistor, wherein the magnet 5 is fixed to the key 6 through a nonmagnetic spacer 7, and magnetoresistors 2*a* and 2*b* are fixed to an electric insulating holder plate 10′ mounted on the keyboard frame 9. Consequently, the magnetoresistor 2*a* and 2*b* are immovable and the magnet 5 moves with the key 6. In this case, the magnet 5 and the magnetoresistors 2*a* and 2*b* are positioned as near as possible to each other, and the intensity of magnetic field of the magnet 5 applied to the magnetoresistor 2*a* becomes a maximum and the intensity of the magnetic field of the magnet 5 applied to the magnetoresistor 2*b* becomes a minumum when the key is in the off-state. On the contrary, the intensity of magnetic field of the magnet 5 applied to the magnetoresistor 2*a* becomes minumum aNd the intensity of the magnetic field of the magnet 5 applied to the magnetoresistor 2*b* becomes a maximum when the key is in the on-state.

Furthermore, in the circuit of the third embodiment as shown in FIG. 7, it is clear that the same effect is obtainable when the tone generator 1 and the tone coloring circuit 4 are substituted for each other so as to supply the output signal of the tone generator 1 to the magnetoresistor 2*b* and through magnetoresistor 2*a* to the tone coloring circuit 4.

In the above embodiments, it will be understood that a plurality of magnets may be used in place of the multipolar magnet, or electromagnets may be used instead of the permanent magnets.

Although, in the above all embodiments, the magnet is fixed to the key and the magnetoresistor to the stationary part, it is clear that the same effect can be obtained even when the magnetoresistor is fixed to the key and the magnet to the stationary part.

As above described, the switch device of this invention is very effective from a practical standpoint, overcoming completely the defects in switching the signal such as miscontacts and click signals without using any contacts, and increasing the reliability and making the device itself small. Moreover, it makes possible touch-sensitive control with a large control ratio.

The foregoing description contains a limited number of embodiments of the present invention. It will be understood, however, that such embodiments are only illustrative and that numerous variations are possible without departing from the purview of the invention as defined in the following claims.

I claim:

1. An electronic musical system comprising a tone generator, a tone coloring circuit, a first resistance means connected in a series circuit between said tone generator and said tone coloring circuit, a second resistance means having one end connected to the series circuit between said first resistance means and said tone coloring circuit and the other end connected to ground, at least one of said resistance means being a magnetoresistor the electrical resistance of which varies in accordance with the intensity of the magnetic field applied thereto, a key means movably supported in said system so as to be depressed when it is moved, and a magnet element mounted on said key means close to said magnetoresistor and controlling the electrical resistance of said magnetoresistor in accordance with the amount said key means is moved.

2. An electronic musical system as claimed in claim 1 wherein said first resistance means is said magnetoresistor and said second resistance means is a fixed resistor.

3. An electronic musical system as claimed in claim 1 wherein said first resistance means is a fixed resistor and said second resistance means is said magnetoresistor.

4. An electronic musical system as claimed in claim 1 wherein both said first and second resistance means are magnetoresistors the electrical resistance of which varies in accordance with the intensity of magnetic field applied thereto, and said magnet element is positioned close to and controls both of said magnetoresistors so that the electrical resistance of said magnetoresistors varies oppositely from each other.

5. An electronic musical system as claimed in claim 1 wherein said magnet element is a magnet having two opposite poles spaced from each other, and said magnetoresistor faces one of said poles when said key means is not moved so as to be depressed and faces the other of said poles when said key means is depressed.

6. An electronic musical system as claimed in claim 5 wherein said two poles are positioned in parallel in a horizontal direction.

7. An electronic musical system as claimed in claim 5 wherein said two poles are arranged on a collinear vertical line.