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KEY SWITCHING SYSTEM FOR ELECTRICAL
MUSICAL INSTRUMENTS
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2,959,693

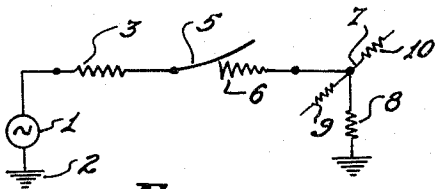


FIG. 1.

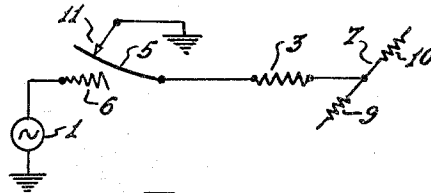


FIG. 2.

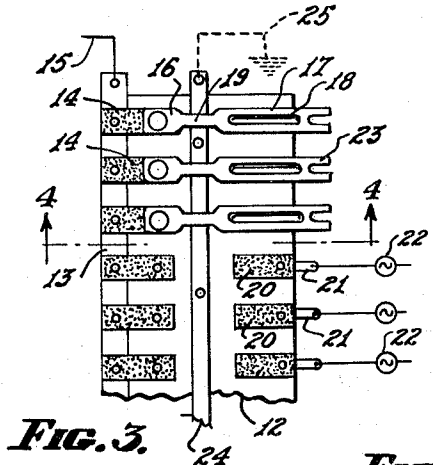


FIG. 3.

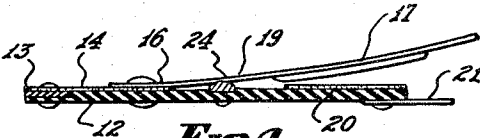


FIG. 4.



FIG. 5.

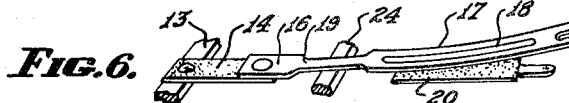


FIG. 6.

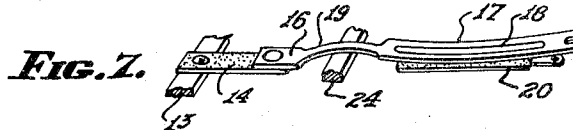


FIG. 7.

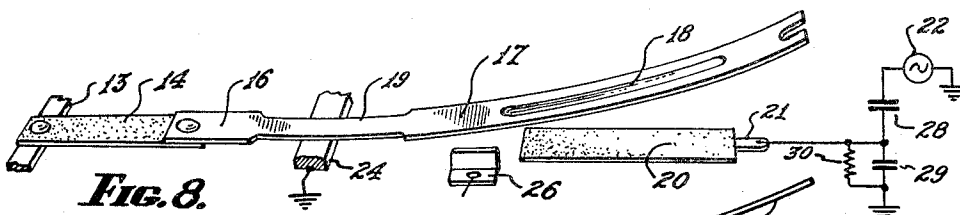


FIG. 8.

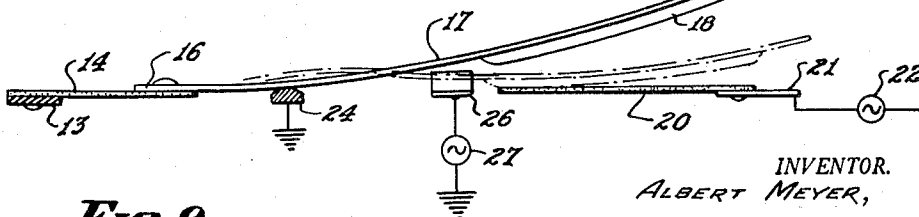


FIG. 9.

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KEY SWITCHING SYSTEM FOR ELECTRICAL MUSICAL INSTRUMENTS

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19 Claims. (Cl. 307—105)

In electrical musical instruments of the type in which oscillations from various sources are fed into collecting networks through key-operated non-grounding switches, there is opportunity for a feed-through effect due to the residual capacitative coupling between switch elements in the open position. The feed-through occurs primarily in the high frequency range, and is not usually apparent when the instrument is being played at a low volume level. However, when "loud" stops are left drawn and the expression pedal is fully open, the instrument being otherwise silent, there may occur enough high frequency feed-through to be apparent and therefore objectionable to the ears of some persons. Where gradual contact switches are employed to control the onset of the tones, the feed-through effect is likely to be greater because of the enhanced opportunity for capacitative coupling between the switch elements.

Feed-through of this type will not be encountered where the off positions of the individual generators are attained by shorting the generator output leads to ground. But such a system has numerous disadvantages including the fact that if any key switch fails a cipher is likely to result.

It is a primary object of this invention to provide a system and construction which eliminates high frequency feed-through even where gradual contact type switching is employed, and without the above noted disadvantage.

It is another object of the invention to provide a system and construction which is simple, low in cost, and positive in operation.

It is an object of the invention, also, to provide as an adjunct to such a construction and system, a means for introducing transient effects, as will later be explained.

These and other objects of the invention which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, are accomplished in that construction and arrangement of parts and circuits of which certain exemplary embodiments will now be described. Reference is made to the accompanying drawings wherein:

Figure 1 is a partial circuit diagram showing a form of gradual contact switching at present in use.

Figure 2 is a partial circuit diagram illustrative of the principle of operation of the means for preventing feed-through.

Figure 3 is a partial plan view of a gradual contact type switch assembly.

Figure 4 is a sectional view of a switch unit in open position.

Figure 5 is a sectional view of a switch unit in partially closed or actuated position.

Figures 6 and 7 are perspective views of switch units respectively in open and closed conditions.

Figure 8 is a semi-diagrammatic showing of a switch unit having means for the introduction of transient effects.

Figure 9 is an elevational view of the same unit.

Figure 1 diagrammatically illustrates the switching

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system used in several forms of electronic organs. An electronic oscillation generator is indicated at 1, one lead of which is grounded as at 2, the other lead being connected through an isolating resistance 3 to the blade 5 of a switch. This blade is operated by a playing key of the instrument, and when depressed makes contact with a resistance 6. As the key is further depressed the blade rides up the resistance, causing the tone to come on gradually as is well understood in the art. The resistance 6 is connected to a bus 7. This bus may be maintained at a signal potential above ground by a resistor 8, and it may have tone-balancing resistors 9, 10 at intervals throughout its length. The bus will be understood as connected through various selective tone color circuits to an amplifier and loud speaker system. Individual keys in the instrument may operate more than one switch such as has been described, so that upon the depression of any playing key it will be possible to derive oscillations of different frequencies in different headers for the purpose of more perfectly attaining desired voices. For details of an electronic organ of this general type reference may be made to Patent No. 2,233,948 in the name of Kock, dated March 4, 1941.

In Figure 2 in which like parts have been given like index numerals, it may be noted that the connections have been reversed, and the generator is now shown connected to the gradual contact resistor 6. The switch blade 5 is connected through the isolating resistor 3 to the bus 7. Additional means have been provided so that when the switch blade is in the open position it contacts a ground connection as at 11.

In the arrangement shown in Figure 1, feed-through can occur by reason of the capacitative coupling between elements 5 and 6 even when the switch is in the off position. In Figure 2, however, the switch blade is grounded when fully opened and this bypasses any feed-through, nullifying its effect. When the switch is closed the resistor 3, now located between the switch and the bus, acts as an isolating resistor for the generator 1. When the switch is fully opened its blade is grounded as described, and the resistor 3 serves, along with other similar resistors in the system, to maintain the bus at a potential above ground so that the bus can accept signals from such playing keys as may be depressed.

The principles illustrated in Figure 2 may be embodied in various forms of apparatus. Large use is made today of gradual contact type switches as described in Patent No. 2,215,124 in the name of Kock et al., dated September 17, 1940. In the structure of this patent switch units are assembled on an insulative base. Along one edge of the base, lugs or the like are provided for connection to the various generator circuits. The lugs are in electrical union with resistive strips (preferably in the form of coatings, sprayed or otherwise deposited on the base) and extending part way toward the opposite edge of the base. A metallic bus is similarly formed along the said opposite edge and this bus has in connection with it resistive coatings in inner spaced relationship each extending toward and in alignment with one of the first mentioned resistive coatings, the several coatings having their ends interspaced. Switch blades are connected at one end each to the inner end of one of the first mentioned resistive coatings and extend over one of the second mentioned resistive coatings but normally out of contact therewith. The portions of the switch blades which overlie the second mentioned resistive coatings are curved in cross section and are stiffened by longitudinal corrugations or depressions. These portions are connected with the first mentioned portions by necks of reduced lateral dimension and therefore enhanced flexibility. The switch assembly may be located in a suitable housing provided with plungers for the blades which

plungers are to be actuated by the playing keys of the instrument.

When a switch blade is depressed its stiffened forward portion first comes in contact with the inner end portion of one of the resistive coatings in contact with the bus. As the switch blade is further depressed it rocks on the resistive coating, the point of contact steadily approaching the bus, whereby the resistance in the circuit is diminished. If the blade is depressed far enough it may make direct contact with the bus itself. Because the forward portion of the blade is stiffened in an arcuate configuration, as the blade is depressed the reduced neck bows upwardly. But the resilience of the bowed neck is such as to raise the blade out of contact with the bus and the resistive coating when the key is released.

In a preferred form of my invention as illustrated in Figures 3 to 7 a certain reversal of the parts is effected. In Figure 3 the insulative base 12 is shown as having a bus 13 formed along one of its edges with inwardly extending resistive coatings 14 in electrical contact therewith. The bus may be understood as connected through a lead 15 (which may contain a tone-balancing resistor such as 9 and/or 10) to other buses in the system or to a tone color assembly feeding an amplifier and loud speaker system. The switch blades each comprise an attachment end 16 and an opposite end portion 17 stiffened by a corrugation or depression 18, and arcuate in configuration, the two portions being connected by a reduced resilient neck 19.

The opposite edge of the base 12 will be provided with gradual contact resistive coatings 20, each provided with lugs 21 to be connected to the circuits of generators 22. The forward ends of the switch blades may be provided with bifurcations 23 for connection with reduced portions of the operating plungers aforesaid.

To this combination there is added a bar 24 affixed to the base and underlying the necks 19 of the switch blades. This bar may be a separate metallic piece fastened to the base as shown or it may be a metallic or other conductive coating on the base. In any event, the relationship of the parts is such, as illustrated in Figures 4 and 6, that when the switch blade is in the released or open position the neck 19 will lie resiliently in electrical contact with the bar 24. The bar will be grounded as at 25 in Figure 3.

Thus, while there may be capacitive coupling between the switch blade portion 17 and the resistive coating 20 when the switch is open, there will be no feed-through to the bus 13 because the switch blade is directly grounded as described. When the switch blade is depressed, however, as by actuation of the playing key, as illustrated in Figures 5 and 7, the fore part 17 of the switch blade will be brought down into contact with the resistive coating 20 and will rock thereon, the point of contact approaching that of the lug 21. At the same time the neck 19 of the switch blade will bow upwardly because of the rocking action, thereby coming out of contact with the bar 24. The ground connection is thus broken and oscillations from the proper source will be fed to the bus through the resistor 14 now operating as an isolating resistor for the source. When the playing key is released the switch blade returns to the position indicated in Figures 4 and 6 re-establishing contact with the grounded bar.

The manner in which the invention operates to prevent feed-through will be clear from what has been stated above. Those skilled in the art will understand that the resistors (3 in Figure 2, or 14 in the remaining figures) will have parallel connection to ground through all key switches connected to bus B which are open at any given time. If all other conditions remain the same, this will result in some attenuation of the signal in the bus being derived from generators connected to the bus through switches which are closed at the same time. The skilled worker will also understand, however, that this can be

compensated for by proper circuit balance and the use of additional amplification.

The system thus far outlined lends itself to the making of provision for the introduction of transient effects in the reproduced tones. Such transient effects are desirable for various purposes. For example, in the tones of woodwind instruments there is usually a hissing sound or wind noise detectable by the ear at the onset and at the cessation of the tone itself. In some instruments the actual harmonic content of the tone is different at the beginning and at the end. To counterfeit the tones of other instruments, it is desirable to provide means whereby the tone builds up at the beginning or dies away at the end in accordance with certain predetermined patterns.

As illustrated in Figures 8 and 9, this may be accomplished in the practice of this invention by locating a capacitive electrode 26 on the insulative base of the switch structure on the generator side of the bar 24, and connecting this electrode with a generator. In these figures like parts have been given like index numerals and will not be redescribed. The generator 27 coupled to the electrode may take various forms. It may be a generator of oscillations having a predetermined pitch or frequency the same as or related to the frequency of generator 22, but characterized by a different harmonic content, or it may have only an approximate frequency response characteristic, or it may be entirely random in nature, such as a generator of so-called "white noise," depending upon the effect desired.

There will be a capacitive coupling between the electrode 26 and the switch blade portion 17, even when the switch is open; but this will have no effect upon the bus 13 and circuits connected therewith because the switch blade will be grounded through the bar 24 as explained above. When, however, the switch is actuated and its blade is brought against the resistive coating 20, the connection with ground will be broken. The capacitive relationship between the electrode 26 and the switch blade portion 17 will be such as to produce an attenuated but perceptible signal in the bus 13. At the same instant the signal from generator 22 will be clearly attenuated by the resistive coating 20 giving relative importance to the first mentioned signal. However, as the switch blade is further depressed the effect of the resistive coating 20 will diminish and finally may disappear altogether, thus giving the effect of relative attenuation of the signal from generator 27.

In the light of the teachings herein it will be within the skill of the worker in the art, taking into account the mode of motion of the element 17, to position and shape the electrode 26 so as to get various effects of attenuation or the reverse in accordance with predetermined patterns. Thus it may be arranged to have the switch blade either approach or recede from the electrode 26 as the switch blade is progressively actuated. Also the capacitive electrode 26 may be so shaped or configured that the capacitive effect between it and the switch blade increases or decreases with movement of the latter irrespective of variation in the closest distances between them, upon movement of the latter.

In Figure 8 the actual generator 22 is shown connected to the lug 21 through a network comprising a series capacity 28, and a capacity 29 and resistance 30 which are in parallel between the generator lead and ground. In this construction, as the switch blade rocks over the resistive coating 20 its impedance to ground decreases. Hence less of the signal from the electrode 26 will appear in the bus 13 as the switch is progressively actuated so that the transient tone thus decays as the tone from generator 22 builds up. When the switch is fully on, the effect of capacity 29 may be essentially to short the signal from electrode 26 to ground so that to all intents and purposes only the musical tone from generator 22 remains and is reproduced. This arrangement may be employed

to confine the effect of the transient tone to the beginning and end only of the musical tone.

Modifications may be made in the invention without departing from the spirit of it. The invention having been described in certain exemplary embodiments, what is claimed as new and desired to be secured by Letters Patent is:

1. In an electrical musical instrument, a switch construction for the purpose described comprising a switch element connected to a source of oscillations, a cooperating movable switch element connected to an output circuit, said movable switch element adapted to be brought into and out of contact with said first mentioned switch element, a grounded contact element located so as to contact said movable element when said movable element is in unactuated position but to break contact therewith when said movable switch element makes contact with said first mentioned switch element, and a resistor electrically located between said movable switch element and said output circuit.

2. The structure claimed in claim 1 wherein said first mentioned switch element is a gradual contact switch element.

3. The structure claimed in claim 1 including an electrode for connection to a second source of oscillations, said electrode having capacitive coupling with said movable switch element.

4. The structure claimed in claim 1 including an electrode for connection to a second source of oscillations, said electrode having capacitive coupling with said movable switch element, said capacitive coupling being variable upon movement of said movable switch element.

5. The structure claimed in claim 1 including a base, said movable switch element being in the form of a resilient metallic strip fastened adjacent its rear end to said base, its forward end normally overlying said first mentioned switch element which is also mounted on said base, the said forward end having a fulcrum portion whereby when said movable switch element is depressed a portion intermediate its end portions will be bowed upwardly, said grounded contact constituting an element mounted on said base beneath said intermediate portion.

6. The structure claimed in claim 5 wherein said first mentioned switch element comprises elongated resistive means, the forward portion of said movable switch element being downwardly arcuate in configuration and relatively stiff, whereby upon depression of said movable switch element the forward portion thereof progressively rides over said resistive means.

7. The structure claimed in claim 6 wherein said resistor electrically interposed between said movable switch element and said output circuit is also mounted on said base.

8. The structure claimed in claim 5 including an electrode for connection to a separate source of oscillations, said electrode being mounted on said base in a capacitive relation to said movable switch electrode.

9. The structure claimed in claim 7 including a multiplication of the recited elements on the same base, providing a gang-switch construction.

10. The structure claimed in claim 8 including a multiplication of the recited elements on the same base, providing a gang-switch construction.

11. The structure claimed in claim 9 in which said base supports an output bus interconnecting the ends of said interposed resistors furthest from said movable

switch electrodes, said grounded contact being common to the said several movable switch elements and constituting a bus supported by said base.

12. In an electrical musical instrument a plurality of oscillation generators, an output bus, switches each comprising a fixed element and a movable element adapted to be brought into and out of contact with said fixed element, connections between said fixed elements and said generators respectively, connections between said movable elements and said bus, each such connection containing a resistor, and a grounded contact so located with respect to said movable switch element as to ground it when said movable switch element is in unactuated position.

13. The structure claimed in claim 12 in which each fixed element is a switch element of the gradual contact type.

14. The structure claimed in claim 13 wherein an electrode for connection to another oscillation generator is located adjacent each movable switch electrode and has a capacitative relationship therewith.

15. The structure claimed in claim 14 in which each of the first mentioned generators is connected respectively through a network comprising a bypass to ground containing a resistance and a capacity in parallel.

16. A switch structure comprising an insulative base, a movable switch element in the form of a resilient metallic strip fastened adjacent its rear end to said base, a second switch element on said base underlying the forward end of said movable switch element, the said forward end of said movable switch element having a fulcrum portion whereby when said movable switch element is brought into contact with said second mentioned switch element, a portion of said movable switch element lying intermediate its end portions will be bowed upwardly and away from said base, and a contact element mounted on said base beneath said intermediate portion of said movable switch element so as to make contact with said intermediate portion when said movable switch element is in the unactuated position, said intermediate portion of said movable switch element moving away from and breaking contact when said movable switch element is actuated.

17. The structure claimed in claim 16 wherein the forward end of said movable switch element is arcuate in configuration, convex toward said second mentioned switch element, and relatively stiff whereby to produce a fulcruming action.

18. The structure claimed in claim 17 wherein said second mentioned switch element is a resistive element, and wherein another resistive element is located on said base and electrically connected to the rear end of said movable switch element.

19. The structure claimed in claim 18 including an electrode on said base for connection to a second source of oscillations, said electrode having capacitive coupling with said movable switch element, said capacitive coupling being variable upon movement of said movable switch element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,215,124	Kock et al.	Sept. 17, 1940
2,329,544	Larsen	Sept. 14, 1943
2,573,895	Evett	Nov. 6, 1951
2,599,510	Campbell	June 3, 1952