Feb. 21, 1950 R. P. MORK 2,498,569

VOLUME CONTROL SWITCH AND THE LIKE

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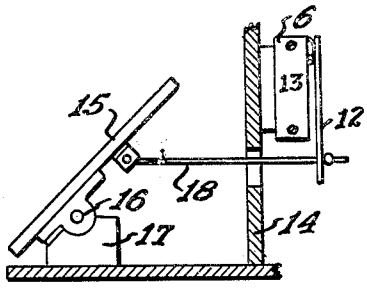


FIG. 1.

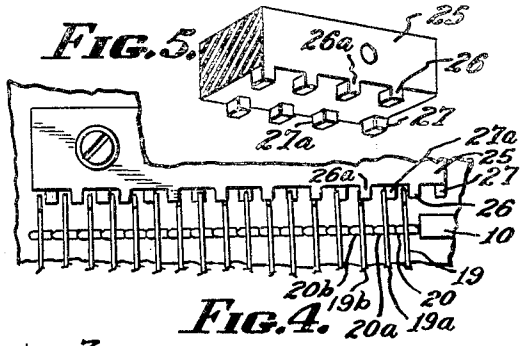


FIG. 4.

FIG. 5.

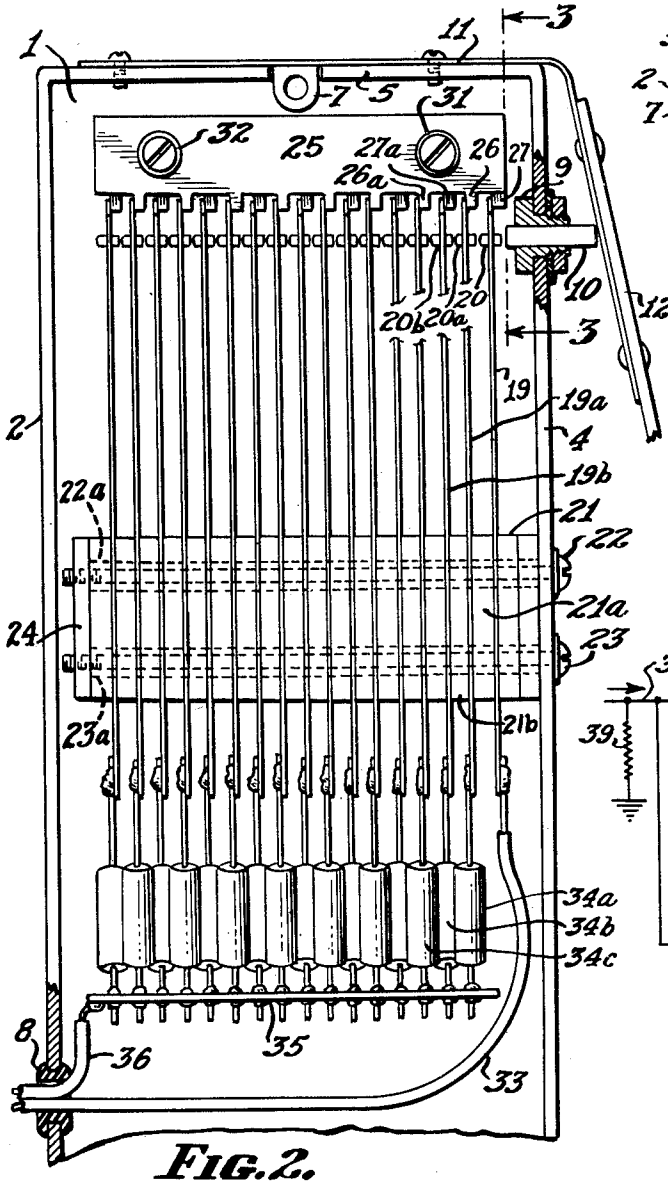


FIG. 2.

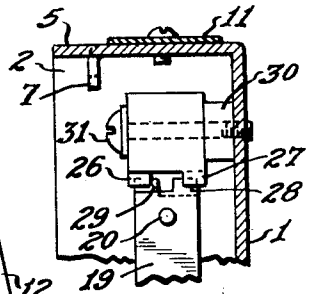


FIG. 3.

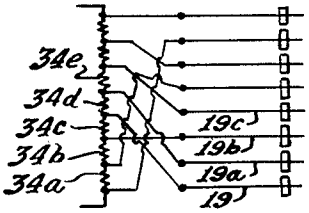


FIG. 7.

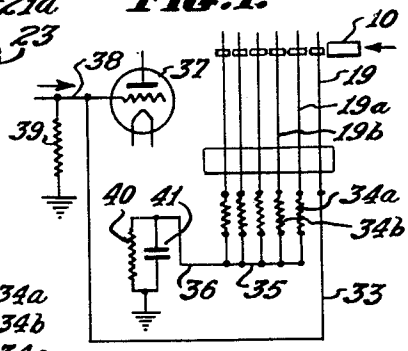


FIG. 6.

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VOLUME CONTROL SWITCH AND THE LIKE

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My invention relates to progressively acting electrical contact devices, which for convenience I shall hereinafter refer to as "switches." While the utility of my invention is not so confined, I shall describe it in an exemplary embodiment, which is a volume control switch designed primarily for use in electrical musical instruments, such as the electronic organ.

It is a primary object of my invention to provide a volume control which has long life, and is capable of performing satisfactorily after many millions of cycles of operation.

It is an object of my invention to provide a volume control or like switch which is simple and inexpensive in construction but positive in action, adequately protected in use, not likely to get out of order either by reason of physical injury or by reason of wear, and relatively simple to adjust.

It is an object of my invention to provide a switch mechanism of the type in which a plurality of blades or leaves are caused to act sequentially in making and breaking a seriese of contacts, in which simple and adequate means are provided to enforce the sequential making and breaking actions in a predetermined order.

It is an object of my invention to provide a volume control or like switch which in operation will be electrically silent and which will not develop electrical noise upon the wearing of contact elements or other injury thereto.

It is an object of my invention to provide a volume control or like switch which is small in size and self-contained in that all of the resistance elements required may be included in the casing of the switch; and it is a further object to provide a switch in which the operating devices are adequately enclosed and protected from external influences.

These and other objects of my invention, which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish in that construction and arrangement of parts of which I shall now describe the aforesaid exemplary embodiment. Reference is made to the drawings forming a part hereof and in which:

Figure 1 is an elevational view with parts in section of an exemplary embodiment of my volume control switch and the actuating pedal of a musical instrument.

Figure 2 is a partial plan view with portions in section of my volume control switch.

Figure 3 is a partial sectional view taken along the line 3—3 of Figure 2.

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Figure 4 is a partial plan view showing the blades or leaves in circuit closing positions.

Figure 5 is a partial perspective view of a stop means which I employ and which for convenience I shall refer to hereinafter as a "comb."

Figure 6 is a diagrammatic view of operating elements of my volume control switch in combination with certain circuit elements showing a mode of use of my structure.

Figure 7 is a partial circuit diagram showing a modified mode of operation.

Referring first to Figure 2, I prefer to provide a casing of metal or other suitable substance having a bottom wall 1, side walls 2 and 4 and end walls, one of which is shown at 5. This casing will be provided with a cover, not shown in Figure 2 but indicated at 6 in Figure 1. I may line the inner surface of the cover 6 with a suitable gasket material to provide a dust-tight seal. The cover may be fastened in place in any suitable way; and I have shown in Figure 2 adjacent the end wall 5 an ear 7 having a tapered perforation to receive a screw. The side wall 2 of my casing is shown perforated and provided with an insulating grommet or bushing 8 for the passage of the electrical leads from the switch. The side wall 4 is shown perforated and provided with a bushing 9 through which an insulative actuating plunger 10 is movable axially. Excepting for these two openings, the casing may be completely closed, thus protecting the interior mechanism from dust and other external influences.

The plunger 10 may be actuated in any way desired. Where the device is to be used as a volume control switch moved by the conventional foot pedal in an organ-type instrument, I may fasten a leaf spring 11 to the end wall 5 of the casing. This leaf spring is bent over beyond the side wall 4 and is provided with an actuating bar or lever 12.

The manner of connecting the switch to a foot pedal is illustrated in Figure 1. Here the switch, generally indicated at 13, is mounted upon a bracket 14 in the instrument. The foot pedal 15, pivoted as at 16, to a support 17 on the base of the instrument may simply be connected by a link 18 or other transmission element to a point near the outer end of the lever 12 such that the normal range of movement of the pedal 15 will produce the required movement of the lever 12.

Within the casing I provide a plurality of blade-like leaves 19, 19a, etc. Each of the blades is provided with contact elements indicated at 20. The blades are clamped in parallelism be-

tween insulating blocks 21, 21a, etc. Various modes of mounting may be employed. I have illustrated a pair of threaded bolts 22 and 23 which extend through the insulating blocks and leaves respectively, and through the side wall 4 of the casing. At the opposite end of the stack these bolts engage in threaded perforations in a metal member 24 so that the assembly may be strongly clamped by tightening the bolts 22, 23. It will be understood that the leaves 19, 19a, etc. are provided with oversize holes where the bolts 22, 23 pass through the assembly so that electrical contact between the blades is avoided. Insulative bushings 22a and 23a around the screws 22 and 23 respectively pass through these oversize holes and through similarly sized holes in the insulative blocks 21, 21a, etc. The bolts 22, 23 may be carried through the opposite wall of the casing for rigidity if desired.

In the operation of this sort of switch mechanism, the blades 19, 19a, etc. are intended normally to be so positioned that their various contacts 20, 20a, etc. are separated. An axial inward movement of the plunger 10 will bring it against the blade 19 or the contact element 20 thereon, and, moving the blade end to the left in Figure 2, will bring the contact 20 against the contact 20a on the blade 19a. A further movement will produce contact between element 20a and element 20b, and so on throughout the series. This, however, presupposes an accurate initial positioning of the several blades with their contact elements separated, as shown in Figure 2. I accomplish this by providing stop members for each of the blades so positioned as to maintain the desired initial relationship of the blades, and by biasing the blades against the several stops resiliently.

Figure 4 shows the assembly of blades fully actuated to contact closing position. It will be noted that the first blade 19 will be required to move a greater distance than the next blade 19a, and so on throughout the assembly. Further, since the blades are in parallelism and closely spaced, it will be noted that the distance which the end of the first blade must move is greater than the normal distance between blades and hence between blade stops. Provision must be made for these factors, and I do so by dividing the stops into two or more rows, arranging them in staggered formation, and providing the blades with tongues on alternate sides in such fashion that any blade is permitted to move past the stop for the next succeeding blade.

Referring to Figure 5, I have shown a stop mechanism 25 in the form of a comb made of insulative substance. At each side of one edge I provide series of actual stops, one series being indicated at 26, 26a, etc. and the other at 27, 27a, etc. The stops in the two series are shown in offset relationship.

Referring to Figure 3, it will be seen that the blade 19 is provided with a tongue 28 which will engage the stop 27 but will pass the stop 26. The next succeeding blade 19a is provided with a tongue 29 which will engage the stop 26 but not the stop 27a. Thus when the several blades are moved or deflected by the plunger 10, each blade may move from its stopped position, past the next succeeding stop, and as far as the second succeeding stop in the series. However, I may make the plunger 10 of such length that its outer end is flush with the bushing 9 when all contacts are closed, thus preventing injury to the blades due to their being pushed against the

stops. In an assembly in which the dimensional relationships and number of blades are substantially as shown, this range of movement is sufficient. For larger numbers of blades it is within the scope of my invention to divide the several stops into more than two series, and provide tongues on the blades which will contact the stops in only one series for any one blade. Since the required movement of my blades is progressive from one side of the assembly to the other, it is also within the scope of my invention to graduate the distances between stops in the several series, if desired, to make them proportional to the required movements of the several blades. By such arrangements I may provide a structure in which movement of the several blades is permitted, as illustrated in Figure 4, to bring their several contacts successively into closed circuit position, while when the blade assembly is released by outward movement of the operating lever 12, the blades will return to position against their respective stops with the contacts all open, as shown in Figure 2.

The comb element 25 is mounted in its proper position in the casing in any suitable way. I have illustrated it as mounted upon spacing washers 30 against the back wall 1 of the casing by means of bolts 31 and 32.

The ends of the leaves 19, 19a, etc. opposite their contact ends may be connected as desired into any appropriate form of electrical circuit. A particular arrangement having advantages where the device is to be used as a volume control for electrical musical instruments is illustrated in Figures 2 and 6. Here the first blade 19 is directly connected to an electrical lead, the remaining blades 19a, 19b, etc. are interconnected by resistance or other impedance elements 34a, 34b, 34c, etc., which are in turn connected to a bus bar 35. An electrical lead 36 is also connected to this bus bar; and the leads 33 and 36 pass through the bushing 8 in the side of the switch.

In Figure 6 where like index numerals indicate the same parts of the switch mechanism itself, I have shown at 37 an electronic tube which may be considered as part of an amplifier. An input circuit 38 is shown as connected to the grid of this tube. It will be maintained at a desired signal level above ground by means of a resistance 39, and will, of course, carry to the tube electrical pulses from the musical instrument, which pulses are to be amplified and reproduced.

The blade 19 of my switch is connected by means of the lead 33 to the input circuit 38 of the tube 37. The bus 35, to which the several resistances 34a, 34b, etc of the blades 19a, 19b, etc. are connected is grounded by the lead 36, through a resistor 40 bypassed by a capacity 41. When my switch is in the open position, as illustrated in this figure, the volume of the electrical pulsations which are amplified and reproduced in the instrument will be determined by the value of the resistor 39. When the blade 19 is moved to the left until it makes electrical contact with the blade 19a, a resistor 34a is connected to ground in parallelism with resistor 39, as will be evident. A greater percentage of the electrical pulsations in the input circuit 38 will then be bypassed to ground, and the volume will be diminished. When the blades 19 and 19a are moved further to the left until contact is made with blade 19b, resistance 34b will be connected to ground in parallelism with resistor 34a, and a further percentage of the input will be bypassed

to ground, and so on. In this circuit the open position of my switch is the position of maximum volume in the reproduction system.

An advantage of the circuit illustrated in Figure 6 is that it enables me to use higher values for individual resistors, which is desirable in relatively low resistance controls. It also simplifies the soldering problem, as will be evident.

In the use of my structure resistors may be connected between the blades in such fashion as to be by-passed by the progressive contacting of the blades as will be readily understood. A modified system is illustrated in Figure 7, where the resistors **34***a*, **34***b*, etc. are connected together in series. Blades **19** and **19***a* are as shown, respectively connected to the opposite sides of a resistor **34***d* in the center of the series so that when these blades are brought into contact, the resistor will be bypassed. Blade **19***b* is connected to the outer terminal of an adjacent resistor **34***c* in the series. Blade **19***c* is connected to the outer terminal of a resistor **34***e* lying on the opposite side of the resistor **34***d* in the series. This mode of connection is followed throughout, each successive blade being connected to the outer terminal of a resistor alternately on one side or the other of resistors connected to preceding blades.

The series of resistors **34***a*, **34***b*, etc. may be connected to an input lead **38** of a thermionic tube **37**, in place of the resistor **39** in Figure 6, i. e., one side of the resistive network **34***a*, **34***b*, etc. may be connected to the lead **38**, and the other side to ground.

Contact between the first two blades bypasses a resistor **34***d* in the series. Contact between the next two blades bypasses a pair of resistors **34***d* and **34***c* in series. Contact between the third and fourth blades bypasses resistors **34***e*, **34***d* and **34***c* in series, and so on. But it will be seen in this system that each pair of contacts, as it closes is effective in bypassing a series combination of all of the resistors previously bypassed plus one, so that variations in electrical contact between preceding pairs of blades will not be productive of electrical noise. In other words, after contact has been established between any two blades in the switch other than the first two blades, the opening of contacts between preceding blades would have no electrical effect on the circuit. This arrangement is of value in minimizing electrical noise such as might be produced by foreign matter between the contacts. If the resistive network **34***a*, **34***b*, etc. of Figure 7 is substituted for the resistor **39** of Figure 6 the amplitude of the input to tube **37** will be smallest when all contacts are closed, as illustrated in Figure 4. It is possible, of course, to connect the resistive network **34***a*, **34***b*, etc. of Figure 7 in series in the lead **38** of Figure 6, in which event the position of greatest volume input will be the closed position of the contacts.

The above mentioned initial bias of the blades **19**, **19***a*, etc. against the stops eliminates what may be called contact bounce which could occur if the blades were left free. One type of bounce may occur when contact is made, one of the contact elements tending to bounce away from the adjacent one before the blades are stressed enough to insure positive contact. The other type of bounce may occur on closely spaced contacts such as herein illustrated, this spacing being as close, in instances, as .003 to .005 inch. If the blades were not resiliently biased against the stops, then when the contacts are opened, the blades would tend to vibrate freely in such manner that adjacent contacts might reclose momentarily or repeatedly. Since bouncing could cause electrical noise in circuits such as those described herein, I have provided by the means described, for practically noiseless operation of my structure.

The dimensions and spacing of my blades and of the other features of my switch are not limitations upon the invention. By way of a single example, however, I have produced switches of this type employing blades ¼ in. wide by .010 in. thick, formed of phosphor bronze with hard platinum alloy contact elements. In these structures the free length of the spring is limited to about 1⅝ in., and the blades are resiliently preloaded by one-quarter of an ounce or more per blade. These switches are performing satisfactorily after more than 10 million cycles of operation.

Modifications may be made in my invention without departing from the spirit of it. Having thus described my invention in a certain exemplary embodiment, what I claim as new and desire to secure by Letters Patent is:

1. In a structure of the class described, a series of resilient conductive blades supported in spaced positions and in electrical isolation, so as to have freely extending end portions, pressure exerted upon an end portion of the first blade of said series serving to move it into electrical contact with the second blade and to move said second blade toward the third and so on throughout the series, an actuator for exerting said pressure on said first blade, said blades being resiliently biased in a direction toward said actuator, and stops for said several blades individually, the biasing of said blades bringing them to rest against said stops in the absence of said pressure, the stops being located to retain said blades out of contact.

2. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a different row.

3. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a different row, said stops forming part of an insulative structure in which the stops of the several rows are staggered with respect to each other.

4. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a different row, said stops forming part of an insulative structure in which the stops of the several rows are staggered with respect to each other, and including a casing in which said blades are so supported in clamped relationship between insulative blocks, in which said insulative stop structure is supported and in which said actuator comprises a plunger element movable axially through an opening in a wall of said casing.

5. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a dif-

ferent row, said stops forming part of an insulative structure in which the stops of the several rows are staggered with respect to each other, and including a casing in which said blades are so supported in clamped relationship between insulative blocks, in which said insulative stop structure is supported and in which said actuator comprises a plunger element movable axially through an opening in a wall of said casing, and further includes a resilient element attached to a wall of said casing and having a free portion with a lever arm thereon for moving said plunger.

6. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a different row, said stops forming part of an insulative structure in which the stops of the several rows are staggered with respect to each other, and including a casing in which said blades are so supported in clamped relationship between insulative blocks, in which said insulative stop structure is supported, said casing also containing impedances electrically interconnecting some at least of said blades.

7. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a different row, said stops forming part of an insulative structure in which the stops of the several rows are staggered with respect to each other, and including a casing in which said blades are so supported in clamped relationship between insulative blocks, in which said insulative stop structure is supported, said casing also containing impedances electrically interconnecting some at least of said blades, said impedances being connected respectively between all blades excepting the first and a bus bar, and leads from said first blade and said bus bar passing through an opening in a wall of said casing.

8. The structure claimed in claim 1, wherein said stops are arranged in a plurality of rows and wherein said blades have tongues each located to contact a stop in one only of said rows, each successive blade tongue contacting a stop in a different row, said stops forming part of an insulative structure in which the stops of the several rows are staggered with respect to each other, and including a casing in which said blades are so supported in clamped relationship between insulative blocks, in which said insulative stop structure is supported, said casing also containing impedances electrically interconnecting some at least of said blades, said impedances being

connected respectively between all blades excepting the first and a bus bar, and leads from said first blade and said bus bar passing through an opening in a wall of said casing, said casing having a cover completing a substantially dust-tight enclosure of the parts within the casing.

9. A volume control switch having the structure claimed in claim 1, in which all of said blades excepting the first are connected by impedances to a grounded bus bar and in which said first blade is connected to a circuit the volume of which is to be controlled, which circuit is maintained at a signal level above ground by a grounded impedance, whereby the exertion of pressure on said blades to bring them successively into electrical contact with each other results in the connection of an increasing number of said first mentioned impedances in parallelism with the last mentioned impedance to decrease progressively the effective signal level in said circuit.

10. A volume control switch having the structure claimed in claim 1, in which an impedance network is provided having impedance portions in series, wherein the first pair of blades are connected to successive impedance portions lying alternately on opposite sides of the first mentioned portion so that the effecting of electrical contact between any two blades other than the first pair, will bypass a series of impedance portions to which preceding blades are intermittently connected, for the purpose described.

11. In a progressive contact switch mechanism, a series of blades supported in spaced relationship in electrical isolation and having free ends extending in the same direction so that pressure exerted in one direction on the first blade of said series will bring it into electrical contact with the second blade and move it toward the third and so on throughout the series, said blades being biased in the direction from which said pressure is exerted, and individual stops related to the blades of the series to retain them in substantial parallelism and out of electrical contact with each other, the relationship between the blades and stops being such that each blade can move past the stop for a succeeding blade.

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