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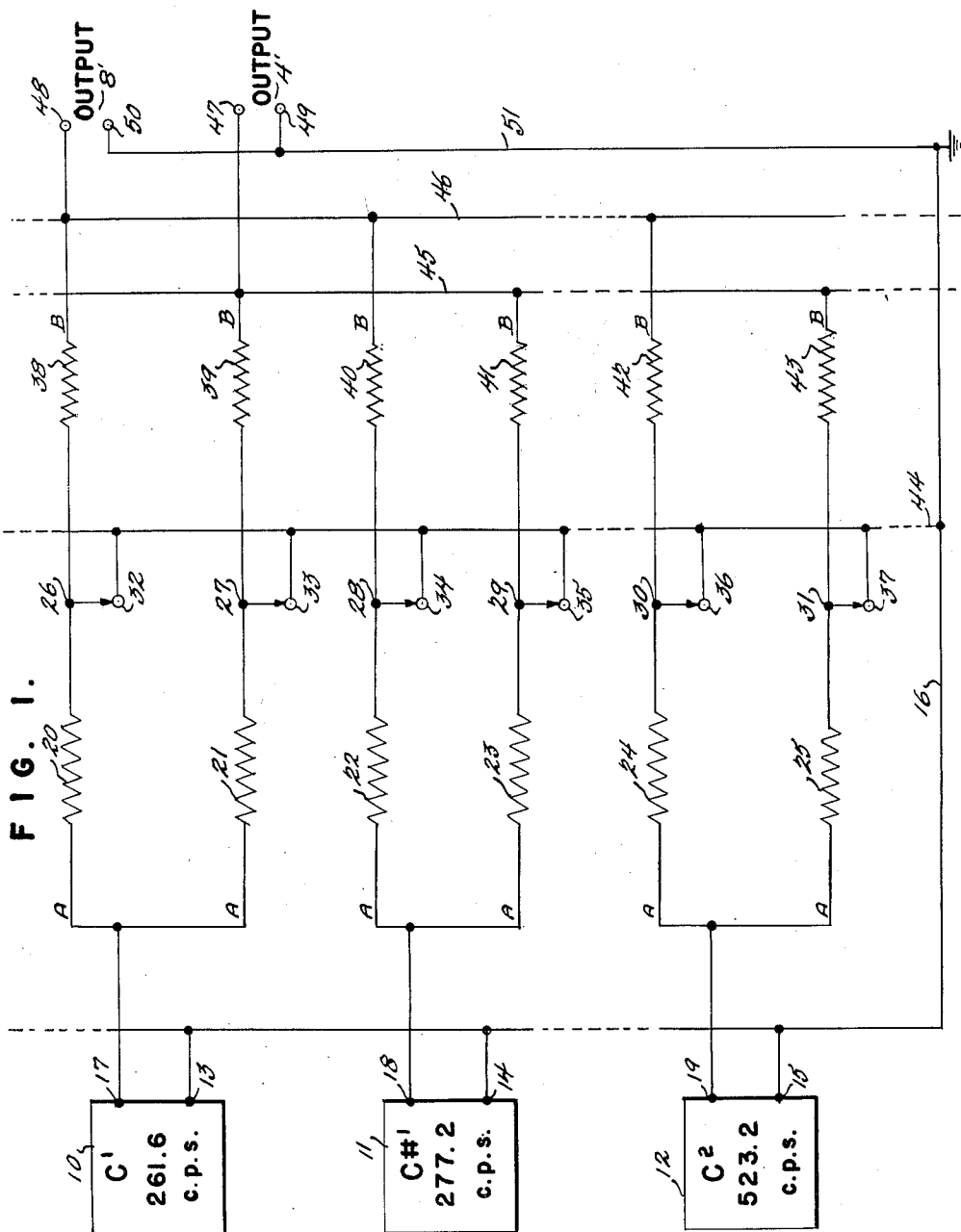
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2,599,510

KEYING DEVICE FOR ELECTRONIC ORGANS

Filed Dec. 8, 1950

3 Sheets-Sheet 1



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FIG. 2

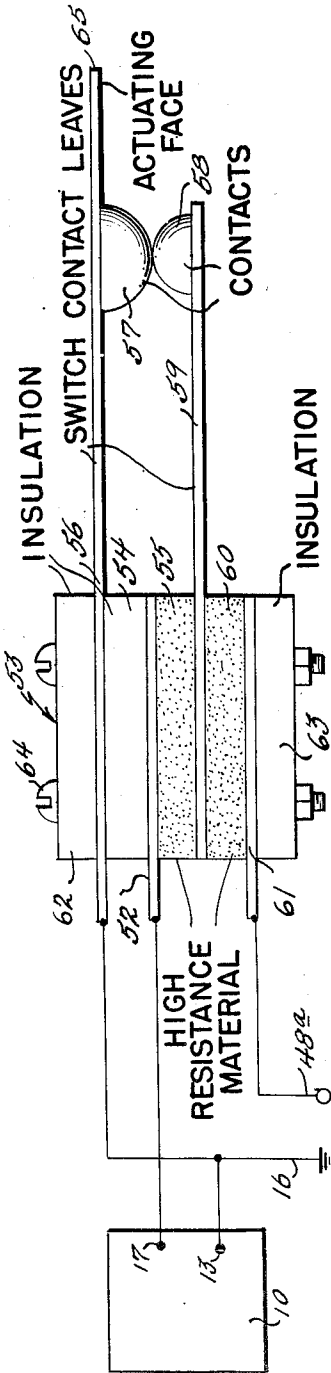
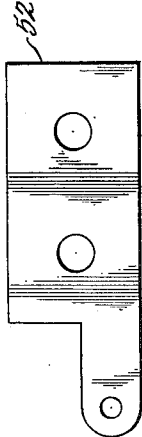


FIG. 3



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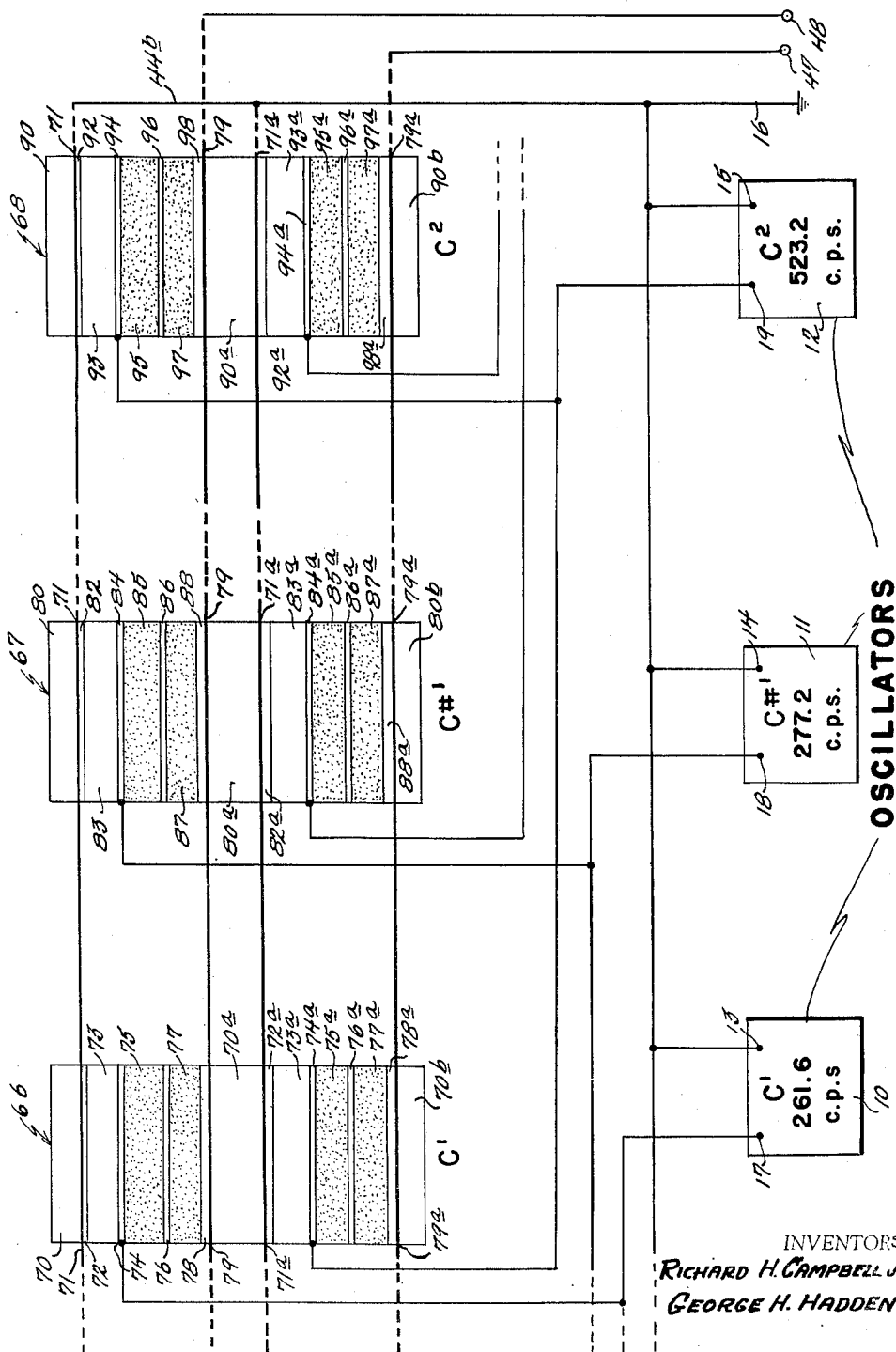
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FIG. 4.



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KEYING DEVICE FOR ELECTRONIC ORGANS

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7 Claims. (Cl. 84—1.01)

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This invention relates to signal switching apparatus for use in electrical musical instruments.

An object of this invention is to provide an improved signal switching device which may be manufactured efficiently and economically and which incorporates resistance circuit elements as part of the structure thereof.

Another object of this invention is to provide an improved signal switching device constructed so that it may be made with considerable saving of space and assembly labor.

Another object of this invention is to provide an inexpensive switching device incorporating associated circuit components in such a manner as to obviate wiring which would otherwise be necessary.

Another object of this invention is to provide a switching device having a physical arrangement such that considerable shunt capacitance is introduced between certain parts thereof.

Still another object of this invention is to provide a switching device employing electrical impedance spacers having a high dielectric constant so as to provide electrical capacitance between the spaced parts.

Another object of this invention is to provide a switching device for normally grounding the circuit between a source of oscillations and the load, this circuit consisting of a pair of spacers of resistance material contacting an intermediate leaf of the switching device that is grounded.

Other and further objects of this invention will be apparent to those skilled in the art to which it relates from the following specification, claims and drawing.

In accordance with this invention there is provided an electrical switching device adapted for use with electrical musical instruments wherein a number of sources of electrical oscillations of musical frequency are continuously operative. This switching device may be actuated by manual or pedal keys and is constructed with spacers of resistance material between one of the switch contact leaves and the metal lugs connecting the switch to the source of electrical oscillations and to the load circuit.

Further details of this invention are set forth in the following specification and drawing in which briefly:

Figure 1 is a schematic wiring diagram of a circuit arrangement with which switching devices of this invention may be employed;

Figure 2 is a side view of an embodiment of this switching device;

Figure 3 is a plan view of one of the metal inserts for the switch stack; and

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Figure 4 is a view of a further embodiment of this invention showing a plurality of the switch devices connected together.

This invention relates more particularly to a signal switching device adapted for use in the switching circuit disclosed and claimed in co-pending application of Richard H. Campbell, Jr., Serial No. 205,689, filed January 12, 1951.

In the circuit diagram shown in Figure 1, three sources 10, 11, and 12 that supply electrical oscillations of musical frequencies are shown. The source 10 produces the musical frequency C^1 261.6 C. P. S.; the source 11 produces the frequency C^1 277.2 C. P. S.; and the source 12 produces the frequency C^2 523.2 C. P. S., an octave above the frequency C^1 . It will be apparent that different numbers of such sources may be employed as will be necessary to cover the desired musical range. The output terminals 13, 14 and 15 of the sources 10, 11 and 12 are connected together to the ground 16. The terminals 17, 18 and 19 of the sources 10, 11 and 12 respectively, are the high potential output terminals of these sources as opposed to the terminals 13, 14 and 15 which are grounded. The output terminal 17 of the source 10 is connected to one terminal of each of the high impedance resistors 20 and 21. Likewise, the output terminal 18 of the source 11 is connected to a terminal of each of the high impedance resistors 22 and 23 and the terminal 19 of the source 12 is connected to a terminal of each of the high impedance resistors 24 and 25. The other terminals 26, 27, 28, 29, 30 and 31 of the resistors 20, 21, 22, 23, 24 and 25, respectively, are connected to one side of the normally closed switches or keys 32, 33, 34, 35, 36 and 37 respectively. The other sides of all of these switches or keys are connected to the wire 44 which is grounded to the same ground as the wire 16.

The terminals 26, 27, 28, 29, 30 and 31 are also connected to one side of each of the resistors 38, 39, 40, 41, 42 and 43 respectively. The other sides of the resistors 38, 40 and 42 are connected together to the output conductor 45 and the other side of the resistors 39, 41 and 43 are connected together to the output conductor 46. These output conductors 45 and 46 are connected to the output terminals 47 and 48. The other output terminals 49 and 50 of the output circuits are connected by the wire 51 to ground which in this case is the same ground as that to which the wires 16 and 44 are connected. Different numbers of output conductors such as conductors 45 and 46 may be employed and coupled to the sources through additional resistors such as resis-

tors 20 and 38. These additional resistors may also be connected to ground through a key such as the key 32.

In this arrangement the impedances 39, 39, 40, 41, 42 and 43 prevent the various inputs to the common output circuits 45 and 46 from shunting each other excessively while the impedances 20, 21, 22, 23, 24 and 25 prevent the output circuits connected to the sources 10, 11 and 12 from overloading any of these sources.

It will be observed that the impedances 20 and 21 are connected across the output of the source 10 through the normally closed switches or keys 32 and 33 respectively. Likewise, the impedances 22 and 23 are connected across the source 11 through the normally closed switches or keys 34 and 35 respectively, and the impedances 24 and 25 connected across the output of the source 12 through the normally closed switches or keys 36 and 37 respectively. These switches are thus normally at ground potential and prevent the transmission of signals to the output circuits 45 and 46 because these switches effectively ground the signal receiving terminals 26, 27, 28, 29, 30 and 31 of the resistors 38, 39, 40, 41, 42 and 43, respectively.

When it is desired to transmit signals from the sources 10, 11 and 12 to the output circuits 45 and 46 the appropriate keys of the group of keys 32, 33, 34, 35, 36 and 37 is opened to permit the desired signal to pass from the source to the output circuit. Thus, if it is desired to transmit a signal from the source 10 to the output circuit 46, the key 32 is opened removing the ground connection from the terminal 26 so that signal voltage may be applied to the circuit 46 from the source terminal 17 through the impedances 20 and 38 connected in series. In a similar manner signal voltage may be applied through the impedances 22 and 40 to the output conductor 46 simply by opening the key 34. In the case of the source 12 signal voltage therefrom may be applied to the output circuit 46 through the impedances 24 and 42 by opening the key 36. Signal voltages from the sources 10, 11 and 12 may be applied to the output circuit 45 selectively by opening the keys 33, 35 and 37 respectively.

In this embodiment, the switches 32, 33, 34, 35, 36 and 37 are actuated by the playing keys of the musical instrument. Switches 32 and 37 are co-actuated by the C¹ key of the instrument, so as to control respectively the fundamental or 8' pitch signal and the octave or 4' pitch signal of the C¹ key. Likewise the switch 33 controls the 4' pitch signal of the C key, while another switch (not shown), co-actuated with the switch 33 by the C key, controls the 8' pitch signal of that key. The other switches of the instrument are actuated in like manner by the various playing keys of the instrument.

In this circuit arrangement the electrostatic capacities of the switches 32, 33, 34, 35, 36 and 37 have no tendency to introduce signal leakage between the sources and the output or load circuits 45 and 46 since one side of the switch is connected to ground. Also, signals are transmitted between the sources and the load circuits when the switches are open so that signal leakage across the switch would be of no consequence. Furthermore, signal leakage in this apparatus can be virtually eliminated by arranging the component parts physically so as to minimize the capacitance between the points A and B.

In Figure 2, there is shown a physical embodiment of the switching device and coupling cir-

cuit constructed according to this invention. In this figure only one switching unit connecting a source, such as, the source 10 to an output circuit, is illustrated. However, it will be understood that as many switching units of the type shown in Figure 2 as is desired may be employed in the circuit arrangement shown in Figure 1. Further, it will be understood that two or more switching units of the type shown in Figure 2 may be mounted, one above another, in a single stack as shown in Figure 4 and described hereinafter. In the latter case, each of the switches in one stack will be co-actuated by a single playing key.

The source 10 has its terminal 17 connected to the metal insert 52 of the assembled stack 53 of the switching device. A plan view of this insert 52 is shown in Figure 3. An insulation spacer 54 is positioned on the top of the metal insert 52 and a high resistance electrically conductive spacer 55 is positioned on the bottom of the insert 52. This resistance spacer 55 corresponds to the resistance unit 20 shown in Figure 1.

On the top of the insulation spacer 54 is positioned the switch contact leaf 56 which is connected to ground and which supports an electrical contact 57 that corresponds to one of the contacts of the switch 32 shown in Figure 1. The other contact 58 corresponding to the other contact of this switch 32 is supported by the switch contact leaf 59 that is positioned on the bottom of the conducting spacer 55. The connection between the leaf 59 and the bottom of the resistance spacer 55 corresponds to the point 26 of the circuit shown in Figure 1.

Below the leaf 59 is positioned the spacer 60 which is also of electrically conducting material and the resistance of this spacer 60 corresponds to the resistance element 38 of Figure 1. The bottom of the spacer 60 is connected to the insert 61 which is connected to the output terminal 46a that corresponds to the terminal 48 of Figure 1. Additional insulation spacers 62 and 63 are provided to the top and bottom, respectively, of the stack 53 and the stack may be held together by suitable machine screws 64 that are positioned in the holes formed in the stack. However, the inserts 52 and 61, the leaves 56 and 59 and the resistance spacers 55 and 60 are insulated from these screws 64 by providing suitable spacing or sleeving therebetween.

Contacts 57 and 58 of the switch device are normally closed. However, the circuit of these contacts may be opened by applying a suitable actuating force to the end 65 of the leaf 56 so as to move this leaf upward. By providing a suitable leverage or linkage between several switches, such as the switch shown in Figure 2, a number of such switches may be opened at the same time.

Furthermore, the resistance spacers 55 and 60 may consist of a core of insulation material and the electrically conductive high resistance material may be painted or printed on the surface of these spacers, each of said painted or printed resistors being arranged to pass through a hole in the spacer or around the edge thereof, and being insulated, except at its end points, by suitable lacquer or other material, so that the end points only make contact with the surfaces of the inserts 52 and 61 and the leaf 59. In addition, the resistive spacers 55 and 60 may be replaced by insulating spacers of high dielectric constant if it is desired to use capacitive impedances for

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the impedances 20, 21, 22, 23, 24 and 25 and 38, 39, 40, 41, 42 and 43 of Figure 1.

Where resistive rather than capacitive spacers are used, a certain amount of shunt capacitance will none the less be present due to the physical arrangement of the resistive material between parallel conductors. Such capacitance is desirable since it will compensate for the tendency, otherwise present, wherein the capacitance between switch contacts, when open, shunts some of the higher frequency components of the signal and reduces the tonal brilliance.

It should be noted that the metal inserts, insulating spacers, and switch leaves and contacts shown in Figure 2 and described herein may be made of standard design and manufacture to reduce the cost thereof and facilitate assembly.

In Figure 4 there is shown a rear view of three switch stacks 66, 67 and 68 similar to the stack 53 of Figure 2 but containing two co-actuated switches in each stack, and forming a portion of a set of switch stacks as used in an electrical musical instrument. Certain points in these stacks are connected together by suitable shim material running through the stacks. The switches of stack 66 are actuated by the C¹ key of the instrument, those of stack 67 by the C² key, and those of stack 68 by the C³ key. The stack 66 consists of the top insulation spacer 70, a connecting shim 71 that runs through all of the stacks 66, 67 and 68 that is connected to grounded conductor 44b which corresponds to the ground connection 44 shown in Figure 1. Next to the shim 71 is the switch contact leaf 72 corresponding to the leaf 56 of Figure 2 and below this is positioned the insulation spacer 73 which corresponds to the spacer 54. Below the spacer 73 is the metal insert 74 that is connected to the terminal 17 of the source 10. The high resistance electrically conductive spacer 75 corresponding to the spacer 55 of Figure 2, is positioned below the insert 74 and the bottom of this resistance spacer rests on the contact leaf 76 that corresponds to the leaf 59 of Figure 2. High resistance spacer 77 corresponding to the spacer 60 of Figure 2 is positioned below the leaf 76 and above the insert 78. The insert 78 is positioned in contact with the shim 79, which extends through all the stacks, constituting the first collector bus of the instrument, and which is connected to the output terminal 43 corresponding to the terminal 43 of Figure 1.

Below the connecting shim 79 in the stack 66 is an insulating spacer 70a and a second switching unit comprising a grounded connecting shim 71a in contact with the switch leaf 72a, the insulating spacer 73a, the metal insert 74a connected to the terminal 19 of the C² 523.2 C. P. S. source 12, the high resistance spacer 75a, the switch leaf 76a, the resistance spacer 77a, the metal insert 78a in contact with the connecting shim 79a which constitutes the second collector bus of the instrument and which is connected to the output terminal 47 corresponding to the terminal 47 of Figure 1, and the bottom insulating spacer 70b. This second switch corresponds to the switch 37 of Figure 1.

The next stack 67 is similar to the stack 66 and consists of the top insulation spacer 80, the grounded shim 71 contacting the leaf 82, the insulation spacer 83, the metal insert 84 connected to the source 11, the high resistance spacer 85, the switch leaf 86, the high resistance spacer 87, the metal insert 88, the metal shim 79 which is connected to the output terminal 43 correspond-

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ing to the terminal 48 of Figure 1, and the insulation spacer 80a.

Below the shim 79 in the stack 67 is an insulating spacer 80a and a second switching unit comprising the grounded connecting shim 71a in contact with the switch leaf 82a, the insulating spacer 83a, the metal insert 84a connected to the C² oscillation source (not shown), the high resistance spacer 85a, the switch leaf 86a, the resistance spacer 87a, the metal insert 88a in contact with the connecting shim 79a and the insulation spacer 80b.

The stack 68 is similar to the stacks 66 and 67 and consists of the insulation spacer 90, the grounded shim 71, the switch leaf 92, the insulation spacer 93, the metal insert 94 that is connected to the terminal 19 of the source 12, the high resistance spacer 95, the switch leaf 96, the high resistance spacer 97, the metal insert 98, the metal shim 79 that is connected to the output terminal 48 and the insulation spacer 90a.

Below the shim 79 in the stack 68 is an insulating spacer 90a and a second switching unit comprising the grounded connecting shim 71a in contact with the switch leaf 92a, the insulating spacer 93a, the metal insert 94a connected to the oscillation source supplying the frequency C³ 1046.4 C. P. S. (not shown), which is one octave above the frequency of the C² source 12, the high resistance spacer 95a, the switch leaf 96a, the resistance spacer 97a, the metal insert 98a in contact with the connecting shim 79a and the insulation spacer 90b.

Of course, it will be observed that any number of these stacks may be positioned side by side as shown in Figure 4 and interconnected by suitable shims to complete the desired circuit between the stacks so as to make up the complete switch control of an electric organ. Furthermore, the high resistance spacers of the stacks 66, 67, and 68 may be replaced by suitable dielectric material if it is desired to replace these spacers with capacitive impedances.

By employing the shims for interconnecting the various stacks further simplicity in constructing the unit is achieved and these shims may be produced by stamping corresponding metal parts for the several adjacent stacks from a single piece of sheet metal.

While we have described certain embodiments of this invention in detail, it is not desired to limit this invention to the exact details shown and described except in so far as they may be defined by the claims.

We claim:

1. A signal switching device for use in electrical musical instruments comprising a source of electrical oscillations of musical frequencies, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device having a pair of conducting members, a pair of spacers of resistive material positioned between said members, a switch contact leaf between said pair of spacers of resistive material, a second switch contact leaf, normally closed contacts supported by said leaves, connections for connecting one of said members to said source of oscillations and the other of said members to said load circuit and connections for grounding said second switch contact leaf so that said first mentioned switch contact leaf is grounded to prevent the transmission of electrical oscillations from said source to said load circuit until said normally closed contacts are opened.

2. A signal switching device for use in electrical musical instruments comprising a source of electrical oscillations of musical frequencies, said source having a high impedance output circuit, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device having a pair of contact supporting leaves, means for grounding one of said leaves, a pair of members of resistive material positioned one on each side of the ungrounded one of said leaves, normally closed contacts supported by said leaves to prevent the transmission of electrical oscillations from said source to said load circuit, and means for opening said normally closed contacts to permit transmission of electrical oscillations to said load circuit.

3. A signal switching device for use in electrical musical instruments comprising a source of electrical oscillations of musical frequencies, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device having a switch contact leaf, a pair of conducting members of high resistance material, one of said members positioned on one side of said leaf and the other of said members positioned on the other side of said leaf, means for connecting one of said members to said source of oscillations, means for connecting the other of said members to said load circuit, normally closed contact means for grounding said switch contact leaf to prevent the transmission of electrical oscillations from said source to said load circuit until said normally closed contact means is opened.

4. A signal switching device for use in electrical musical instruments comprising a source of electrical oscillations of musical frequencies, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device having a switch contact leaf, a pair of impedance elements, one of said impedance elements positioned on one side of said leaf and the other of said impedance elements positioned on the other side of said leaf, means for connecting one of said impedance elements to said source of oscillations, means for connecting the other of said impedance elements to said load circuit, normally closed contact means for grounding said switch contact leaf to prevent the transmission of electrical oscillations from said source to said load circuit until said normally closed contact means is opened.

5. A signal switching device for use in electrical musical instruments comprising a source

of electrical oscillations of musical frequencies, said source having a high impedance output circuit, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device having a pair of contact supporting leaves, means for grounding one of said leaves, a pair of spacer members positioned one on each side of the ungrounded one of said leaves, a coating of high resistance electrically conducting material for said spacer members, normally closed contacts supported by said leaves to prevent the transmission of electrical oscillations from said source to said load circuit, and means for opening said normally closed contacts to permit transmission of electrical oscillations to said load circuit.

6. A signal switching device for use in electrical musical instruments comprising a source of electrical oscillations of musical frequencies, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device comprising a switch contact leaf, a second switch contact leaf, spacer means of resistive material for supporting at least one of said contact leaves, contacts supported by said leaves, and connections for connecting one terminal of said keying device to said source of oscillations and another terminal to said load circuit.

7. A signal switching device for use in electrical musical instruments comprising a source of electrical oscillations of musical frequencies, a load circuit for converting the electrical oscillations from said source into musical sound vibrations, a keying device having a pair of conducting members, spacers of resistive material positioned between said members, a switch contact leaf held against at least one of said spacers of resistive material, a second switch contact leaf, contacts supported by said leaves, and connections for connecting one of said members to said source of oscillations and the other of said members to said load circuit.

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