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HAVING MULTIPLE USE KEYS
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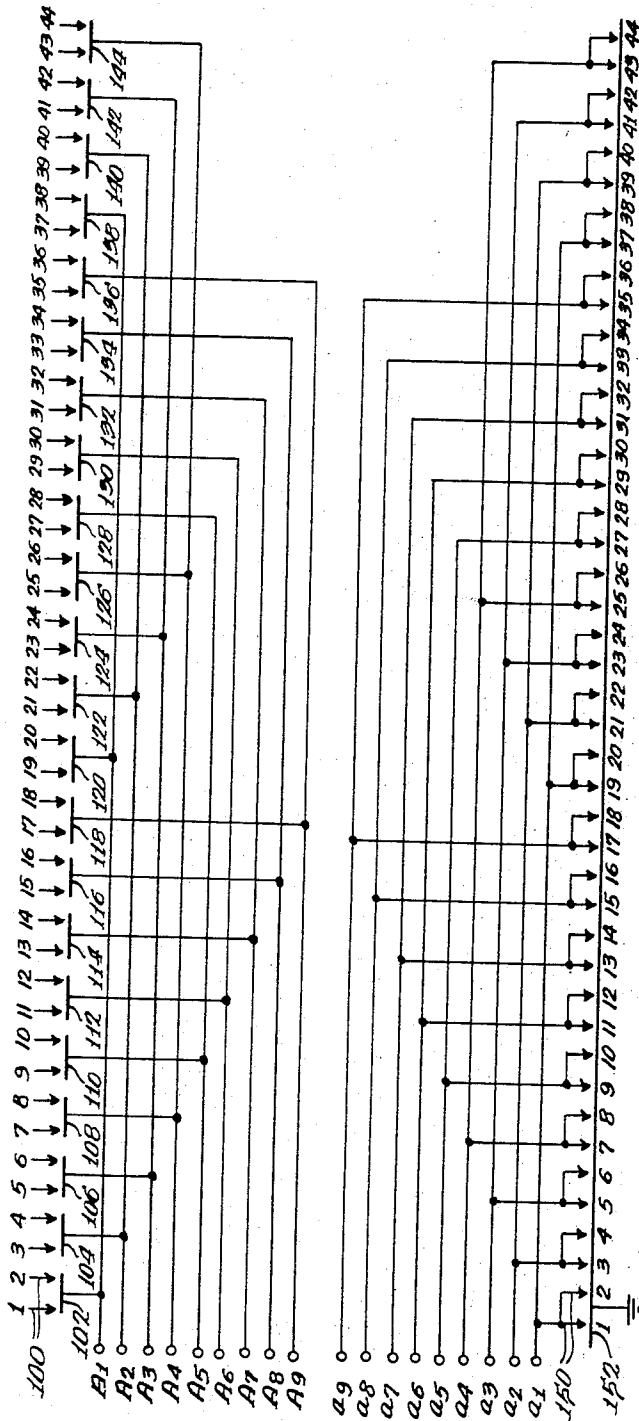
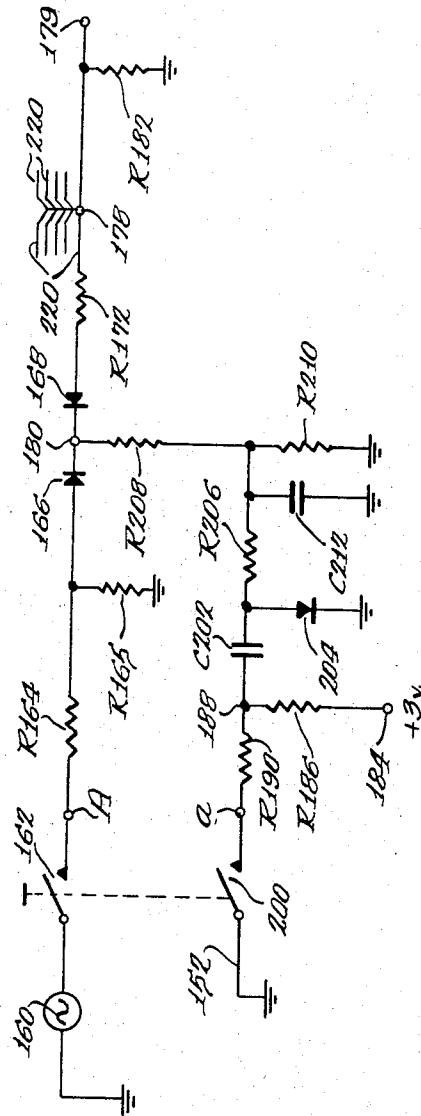


Fig. 1.



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ELECTRIC ORGAN POLYPHONIC PERCUSSION SYSTEM HAVING MULTIPLE USE KEYERS

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ABSTRACT OF THE DISCLOSURE

A polyphonic percussion system for electric organs which requires only a few keyers (nine in the illustrated embodiment) by combining tone signal connections to the keyers such that required keyer action for any signal will almost never interfere with the required keyer availability for another signal. The connections group paired adjacent semitone signals on individual keyers, which keyers also serve paired adjacent semitones having playing keys out of reach of the hand touching a playing key for one of the first group of semitones.

This invention relates to musical instruments, particularly electric organs, and is primarily concerned with the provision of a polyphonic or semipolyphonic percussion-type keying system for use in such instruments.

One of the objects of the present invention is to provide a novel essentially polyphonic percussion keying system which can be supplied at relatively low cost.

Yet another object is to provide a novel percussion keying system for an electric organ which is semipolyphonic, and which thereby saves considerable cost as compared with a completely polyphonic system, but in which the disadvantages incurred as compared with a completely polyphonic system are essentially theoretical and of little practical importance.

Other objects and advantages will become apparent from the following description of a preferred embodiment of my invention.

In the drawings in which similar characters of reference refer to similar parts throughout the several views:

FIG. 1 is a diagrammatic illustration of a keyboard actuated switching system suitable for use in practicing the present invention; and

FIG. 2 is a circuit diagram of one of a group of substantially identical percussion keyers used with the keyboard system of FIG. 1 in practicing the present invention.

In general, percussion systems used with electric organs are of two basic types. In one of these a single percussion circuit is provided at the output so that when its is connected for use, all of the signals representing the notes being played pass through the same percussion system. This system is essentially monophonic in that, when one note is played, the note will be given a percussive envelope, and if any note is played thereafter while the first key is still held, the second note will simply join the first in the output at whatever signal level the first note has decayed to by the time the signal for the second note is added thereto. Thus, the playing of the second note does not re-establish the percussion envelope; the second note simply joins the first note in the percussion envelope which has been previously established by the playing of the first note. When playing in a percussive manner on such systems, it is therefore necessary to play detached, such that each key or group of keys is released before the succeeding key or group of keys is depressed, because it is only when all of the keys are released that the percussion mechanism will be reset for the succeeding tone signal.

Another type of percussion system is individual to each

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key, and is therefore polyphonic, since the playing of any key has no effect upon the percussion circuitry associated with any other key. This system has fewer limitations than the first so far as musical expression is concerned, but the provision of a separate percussion circuit for each key (these individual percussion circuits commonly being referred to as percussion D.C. keyers, or simply hereafter occasionally, for convenience, as keyers) is expensive.

The present system provides practically all of the beneficial results of a complete system of polyphonic percussion keyers at only a relatively small fraction of the cost, and the disadvantages, which will be pointed out subsequently, are quite minor and, from a practical standpoint, largely negligible.

For the purpose of illustrating the present invention, a keyboard of 44 keys for playing 44 notes with semitone spacing has been assumed, since this is a commonly used keyboard, it being appreciated that the invention applies even though more or less keys are used. For this entire keyboard only nine keyers are necessary for supplying a percussive control of the output on a substantially completely polyphonic basis, and nine would still serve the purpose regardless of the number of keys in the keyboard.

In FIG. 1 of the drawings I have indicated at the top a plurality of contact positions numbered from 1 to 44. The contacts, indicated generally by the numeral 100, are actuated by the individual keys of the keyboard, and each of these contacts is connected through an appropriate isolation or load resistor to an oscillator or other signal source which supplies the proper tone signal for its particular key. In the interest of simplifying the drawing, the individual oscillators or other signal sources and their resistors are not shown in this figure, nor is there any physical representation of the individual keys which may be conventional.

The contacts 100 are arranged in pairs so that when the playing keys are depressed, the contacts engage short bus bars, each of the bus bars being common to two adjacent contacts. Thus when the key for note 1 is played, its contact 100 engages a bus bar 102, and similarly, when the key for note 2 is played its contact 100 also engages bus bar 102. When keys at 3 or 4 are played, their contacts 100 engage bus bar 104; 5 and 6 engage bus bar 106; and so on, the contacts 100 for the key positions 43 and 44 engaging bus bar 144.

Bus bar 102 is connected to one of nine keyboard output terminals, this one being designated as A_1 , and this terminal is also connected to bus bar 120 for key positions 19 and 20 and to bus 138 for key positions 37 and 38. Similarly, a second terminal A_2 is connected to bus bars 104, 122, and 140 for key positions 3, 4, 21, 22, 39, and 40, and so on, the last of the nine terminals A_9 being connected to bus bars 118 and 136.

The above described arrangement is such that if keys at 1 or 2, or 19 or 20, or 37 or 38, are played, the signal sources for the particular notes will be connected to the terminal A_1 . On the other hand, if the keys 3 or 4, or 21 or 22, or 39 or 40, are played, the tone signals appropriate to the particular keys will be connected to the terminal A_2 and so on.

When any one of the keys is depressed to connect the source of the tone signal to one of the nine output terminals A for the keyboard in the manner described, depression of the key also operates the appropriate one of the contacts indicated generally by the numeral 150 shown at the lower portion of the drawing. For convenience, the key position numerals 1 to 44 at the top of the drawing have been duplicated at the bottom. When the key at 1 is played, for instance, its contact 100 at the top will engage bus bar 102, and the relative contact adjustment is such that momentarily thereafter its contact

150 will engage a grounded common bus 152 at the bottom of the drawing.

Contacts 150 are also grouped in pairs so that contacts 150 for keys 1 and 2 are connected together and to an output terminal a_1 for the keyboard, this terminal also being connected to the similar contacts 150 for keys 19 and 20 and to the contacts 150 for the keys 37 and 38. Similarly, the other contacts 150 are connected in pairs and to output terminals from a_2 to a_9 such that terminal a_1 is grounded whenever a signal appears at the terminal A_1 , and so on, a_9 terminal being grounded whenever a signal appears at A_9 terminal.

FIG. 2 is a representation of one of the D.C. percussion keyers used in carrying out the invention, it being appreciated that one of these keyers will be provided for each of the tone signal terminals A_1 to A_9 and that each of these keyers will be under the control of the grounding terminals, respectively, a_1 to a_9 . In FIG. 2, one of the group of oscillators or other signal sources and its load resistor referred to in the description of FIG. 1, but not specifically shown in FIG. 1, is indicated at 160. The output of this oscillator is connected through a switch 162 which is representative of any one of the contacts 100 and its bus bar from 102 to 144. This, in turn, is connected through the terminal A, which is representative of any one of the terminals A_1 to A_9 , and thence through a resistor R164 to one side of a diode 166 and to ground through resistor R165. The other side of this diode is connected to one side of a second diode 168, the other side of which is connected through a resistor R172 to the signal output terminal 178, which in turn is connected to the input terminal 179 of the output system, terminal 179 being connected to ground through load resistor R182. The diodes 166 and 168 are oriented back-to-back such that they are both conductive when a common point 180 therebetween is sufficiently negative.

Inspection of the circuit so far described will show that whenever one of the keys representative of the notes 1 to 44 is pressed, the tone signal from its generator will be connected through the appropriate terminal A_1 to A_9 to the output terminal 178, provided the point 180 between the diodes 166 and 168 is sufficiently negative. Control of the potential at this point is exercised by the remaining portion of the circuit, which comprises terminal 184 connected to a +3 volt supply, this terminal being connected through resistor R186 to a lead 188. This lead is connected through resistor R190 to the terminal a which is representative of the appropriate terminal a_1 to a_9 associated with the signal terminal A_1 to A_9 , the appropriate switch contact 150 being indicated for convenience at 200.

Lead 188 is also connected through capacitor C202 and diode 204 to ground. The common point between C202 and diode 204 is also connected through resistor R206 to the common point between resistors R208 and R210, R208 being connected to the common point 180 between diodes 166 and 168, and resistor 210 being connected to ground. Diode 204 is oriented to conduct when the common point between C202 and R206 is positive relative to ground. The common point between R206, R208, and R210 is also connected to ground through capacitor C212.

In the normal condition of the circuit, the +3 volt potential at the terminal 184 is communicated through the current limiting resistor R186 to the capacitor C202. This capacitor therefore charges quickly by way of the diode 204. The junction 180 between diodes 166 and 168 is therefore maintained at ground potential by way of the resistors R208 and R210. Conduction through the signal control diodes 166 and 168 is therefore cut off.

If now a key is played, the first thing that happens is that the appropriate signal source 160 is connected through its appropriate key switch 100 to its appropriate bus bar 102-144, and thence to one of the terminals A_1 to A_9 . In FIG. 2 this amounts to closing the switch 162.

The tone signals, however, cannot get through the diodes 166 and 168 to the output terminal 178. Slight incremental movement of the playing key, however, closes one of the contacts 150 against the bus bar 152, thereby grounding the appropriate one of the terminals a_1 to a_9 , which is equivalent in the circuit of FIG. 2 to closing the switch 200. This grounds the lead 188 through the resistor R190 and drops the potential of the lead 188 to ground level, current from the terminal 184 being limited by the resistor R186. This brings about discharge of the capacitor C202 through resistors R206, R208, and R210 and lowers the potential of the junction 180 momentarily to approximately -3 volts, since the capacitor C202 cannot discharge through the diode 204.

Diodes 166 and 168, therefore, conduct, and the signal from the terminal A passes through the resistors R164 and R172 to the output terminal 178 until the potential at the junction 180 rises back to ground, principally by way of the resistors R208 and R210. This rate of rise in potential at 180, and therefore the decline in signal level at the output terminal 178, of course, is a function of the size of the capacitor C202 and the values of the resistors R208 and R210. At any time that the playing key is released, the switch 200 of FIG. 2 opens and the lead 188 goes 3 volts positive, thereby almost instantaneously reestablishing the junction 180 at ground potential and cutting off the signal. Transients that might otherwise affect the output signal upon either direction of keying are prevented by R206 and C212 and, to some extent, by R190. Resistors R165 and R182 prevent any charge remaining across either of the diodes 166 and 168 when the switch 162 (key switches 100) is open.

The output terminals 178 of the nine keyer circuits are connected together, as indicated by the leads 220, and to whatever output and control system the organ has, represented by the resistor R182 and terminal 179. Since the output and control system 180 forms no part of this invention and may be entirely conventional, it is not shown.

In the specific circuit illustrated and described above, suitable values are as follows. They will change, of course, in a well known manner, depending upon the impedances of the input and output circuits and upon the type of percussive response it is desired to have, this, to some extent at least, being a matter of individual choice.

Diodes are of typical silicon junction type,

R164	-----	47K
R165	-----	4.7K
R172	-----	2.2K
R182	-----ohms--	820
R208	-----	33K
R210	-----	100K
R206	-----	4.7K
R186	-----	1K
R190	-----ohms--	150
C202	-----μf--	20
C212	-----μf--	.47

It might be thought that the provision of only nine percussion keyers would lead to the presence of dead keys during playing of the instrument; that is, that a key might be struck and then another, with the result that the second struck key would simply supply a second note through the same keyer and therefore not be effective. On the conventional keyboard, however, keys 1 and 2 are enough removed physically from keys 19 and 20, which in turn are far enough removed from keys 37 and 38 so that the musician's hand will not normally stretch to cover this span. Therefore, if keys 1 or 2 are played, there is no danger that keys 19 and 20 might also be played while 1 and 2 are still being held.

On the other hand, since keys 1 and 2 are only a semitone apart, they will almost never be played together. In those few instances where keys within a semitone of each other are played, they are almost always either played

simultaneously or in rapid succession. Of course, if they are played simultaneously, then the system described is fully effective, because even though both tone signals go through the same keyer, they will go through it simultaneously, and the shared envelope, therefore, will be fully effective for both. If the two adjacent notes which share one keyer are played in rapid succession, the keying of the first note will trigger the keyer circuit slightly before the second key is depressed, but as a practical matter the second tone signal will have joined the first before there has been any appreciable rundown of the keyer circuit, and therefore the ultimate result will be substantially as good as though entirely separate keyers were provided for the two notes.

About the only limitation brought about by this circuit occurs when the musician plays with both hands upon the same keyboard and desires to have a percussive result for all notes played with both hands. Under these conditions, it is possible to find dead or partially dead keys, but the musician can avoid the problem by playing in a staccato manner, since staccato playing permits the capacitor C202 to recharge during the brief interval while the keys are released. Thus about the only limitation which this circuit has, as compared with a full set of percussion keyers (one for each note) occurs under conditions where both hands are playing in a legato fashion on the same keyboard, and where a percussive result is desired, and this situation is sufficiently rare so that it is of small consequence as compared with the considerable saving in the cost of the instrument.

A variation in the above which I have found to be useful has to do with the relative adjustment of the contacts 100 and 150. As described previously, the contacts 100 close upon playing of a key slightly prior to closure of the contacts 150. This insures that the tone generating system will be connected prior to operation of the keyer; thus the full percussive envelope is certain to be used. If this situation is reversed so that contacts 150 close just prior to contacts 100, the percussive attack is somewhat sharper, because the brief rise time to full output of the percussion circuit can be eliminated, since the percussion circuit in effect has a slight head start. This arrangement also gives some touch response to the instrument; that is, if a key is played slowly, the percussion circuit will run down more before the tone signal is connected, and therefore the signal will not be as strong when it first appears. Thus, by pressing the keys slowly, certain notes can be played more softly.

From the above description of a preferred embodiment of my invention it will be appreciated that changes may be made without disturbing the essential relationship or departing from the scope of the invention, and that, therefore, the scope of the invention is to be determined by the scope of the following claims.

I claim:

1. A polyphonic keying system comprising, a plurality of playing keys and key actuated contacts having connections for a plurality of semitone spaced tone signals, said contacts being arranged in sets of two, each of the contacts in a particular set being for adjacent semitones, a bus for each of said contact sets, means connecting said buses in groups, the buses in said groups being for key contact sets separated by a distance exceeding a normal hand span on said keyboard, a group of D.C. actuated percussion keyers connected one to each of said groups, a keyer contact for each of said playing keys for actuating said D.C. keyers, said keyer contacts being connected together in sets of two, said keyer contact sets being connected together in groups, said keyer contact groups being connected individually to keyers in said keyer groups for the actuation thereof, and said keyer contact sets, said keyer

contact groups and the connections from said keyer contact groups to said group of keyers corresponding respectively to the first said contact sets, groups, and group connections to said keyers.

2. A polyphonic keying system comprising, a plurality of playing keys and key actuated contacts having connections for a plurality of semitone spaced tone signals, said contacts being arranged in sets, each of the contacts in a particular set being for adjacent semitones, a bus for each of said contact sets, means connecting said buses in groups, the buses in said groups being for key contact sets separated by a distance exceeding a normal hand span on said keyboard, a group of D.C. actuated percussion keyers connected one to each of said groups, keyer contact means for said playing keys for actuating said D.C. keyers, said keyer contact means being connected for actuating said keyers to correspond with the connections to said keyers established by the first said contact sets, said keyer contact means being connected in groups, said keyer contact means, said keyer contact groups, and the connections from said keyer contact groups to said group of keyers corresponding respectively to the first said contact sets, groups, and group connections to said keyers.

3. A polyphonic keying system comprising, a plurality of playing keys and key actuated contacts having connections for a plurality of semitone spaced tone signals, said contacts being arranged in sets, each of the contacts in a particular set being for adjacent semitones, a bus for each of said contact sets, means connecting said buses in groups, the buses in said groups being for key contact sets separated by a distance exceeding a normal hand span on said keyboard, a group of D.C. actuated percussion keyers connected one to each of said groups, a keyer contact for each of said playing keys for actuating said D.C. keyers, said keyer contacts being connected together in sets, said keyer contact sets being connected together in groups, said keyer contact groups being connected individually to keyers in said keyer groups for the actuation thereof, and said keyer contact sets, said keyer contact groups and the connections from said keyer contact groups to said group of keyers corresponding respectively to the first said contact sets, groups, and group connections to said keyers.

4. A polyphonic keying system for a keyboard instrument comprising a plurality of semitone spaced tone signal sources, a common output system, a playing key for each of said sources, a plurality of keyer circuits connected for supplying the common output system, each of said keyer circuits having connections to serve a pair of adjacent semitone signal sources and at least one other pair of adjacent semitone signal sources with the spacing between the first adjacent semitone pair and the second adjacent semitone pair being greater than an octave.

5. A polyphonic keying system for a keyboard instrument comprising a plurality of semitone spaced tone signal sources, a common output system, a playing key for each of said sources, a plurality of keyer circuits connected for supplying the common output system, each of said keyer circuits having connections to serve a pair of adjacent semitone signal sources and at least one other pair of adjacent semitone signal sources with the spacing between the first adjacent semitone pair and the second adjacent semitone pair being of the order of an octave and a half.

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