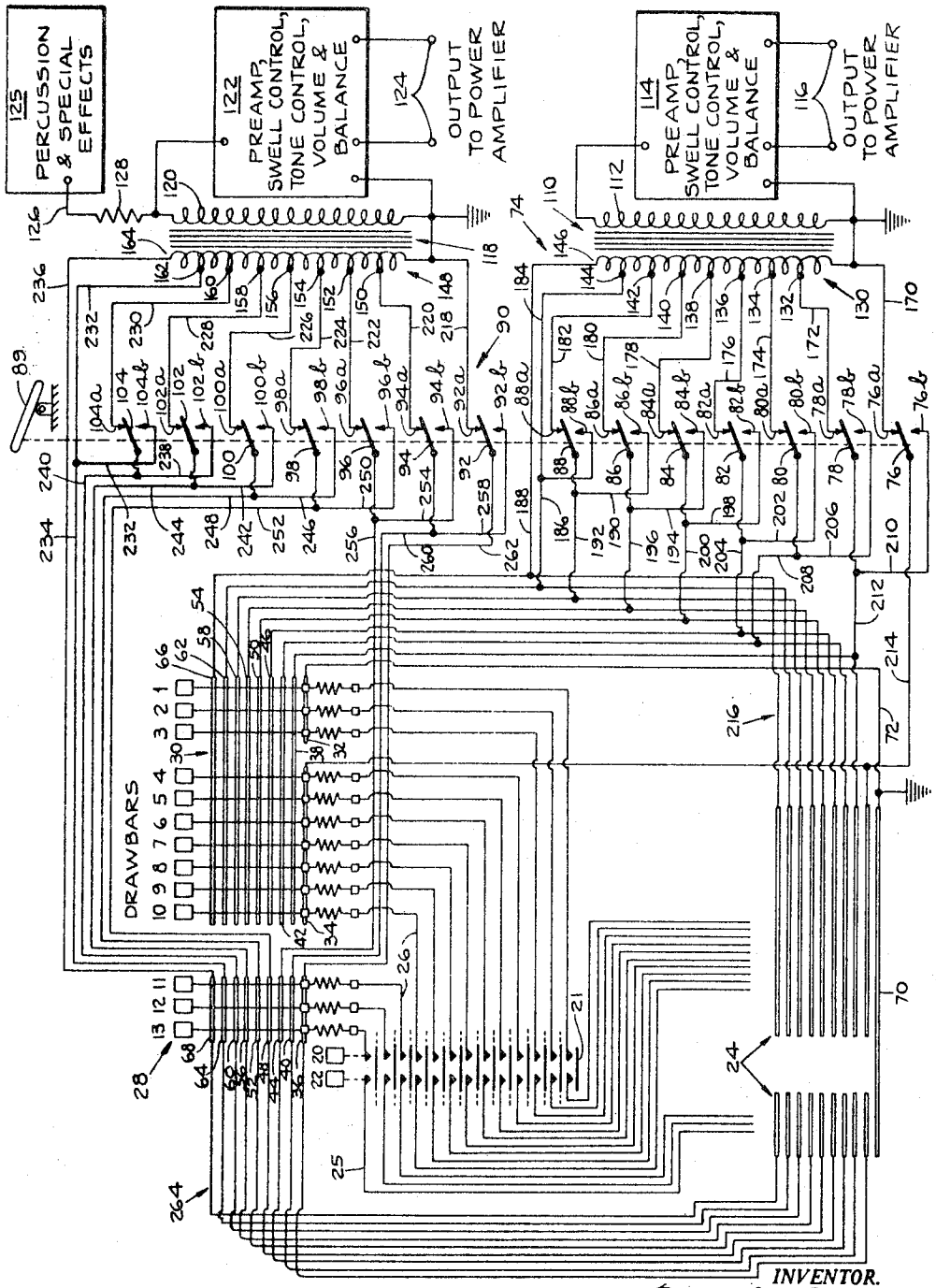
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ELECTRIC ORGAN CRESCENDO SYSTEM

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# ELECTRIC ORGAN CRESCENDO SYSTEM

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4 Claims. (Cl. 84—1.27)

The present invention relates to the electrical musical instrument art, and more particularly to a crescendo system suitable for use in electric organs.

This application is a continuation of copending application Serial No. 70,511, filed November 21, 1960, now abandoned.

One of the objects of the present invention is to supply a novel system in an electric organ which provides a true crescendo effect as opposed to a mere increase in volume.

An additional object is to accomplish the above in a novel manner at relatively low cost and with a minimum of complexity.

Yet another object is to provide a novel crescendo system which is particularly adapted for use with electric organs of the type in which the desired tone coloration is synthesized by combining fundamental tones with other simple and complex tones which bear a musical relationship to the fundamental.

Other objects and advantages will become apparent from the following description of a preferred embodiment of my invention which is illustrated in the accompanying drawings.

In the drawings, the single figure is an electrical circuit diagram illustrating the crescendo system of the present invention as applied to the pertinent portion of the circuitry of an electric organ.

The crescendo effect which is available in most of the better pipe organ installations varies from organ to organ, but in general consists in providing a control which has the effect of gradually bringing into operation all, or substantially all, of the pipes which are capable of sounding the notes being played. This causes the organ to speak progressively louder and with a voice which becomes progressively more complex with the additive effect of the strings, reeds, diapason, woodwinds, and in general whatever is available among the organ resources. This progressively increasing complexity of the tone coloration along with an increase in volume is extremely effective and highly expressive for certain purposes.

It is this overall effect that the circuitry of the present invention adds to an electric organ, particularly a tone synthesizing organ of the general character of that which forms the subject matter of Patent No. 1,956,350, issued to Laurens Hammond on April 24, 1934. Since only a portion of the circuitry of such an organ is involved in applying the present invention, the complete organ has not been illustrated, and reference is made to the beforementioned patent for any portion of the organ structure and organization which may be unfamiliar.

Near the left hand edge of the drawing there is shown a section of the keyboard, thirteen bus bars **21**, and two preset keys **20** and **22**. A portion of the circuit which is not shown, but which may be considered as conventional and which is described in the beforementioned patent, operates whenever keys are played to connect the fundamentals and various octavely or otherwise musically related tone signals individually to the keyboard bus bars **21**. Preset key **22**, when depressed, connects the keyboard bus bars **21** via leads **25** to establish any desired relative output signal level by connecting them to selected bus bars on preset panel **24** as connected for preset panel **28**. To connect bus bars **21** in the same order to a group of leads **26** which, in turn, are connected individually to



slides or draw bars of preset panel **28**, preset key **20** is depressed. These draw bars can be arranged to connect any one of the leads **26** to any one of a group of bus bars **30** which are essentially the equivalent of the bus bars comprising the preset panel **24** and which are wired in parallel therewith, as will appear presently.

In the specific example given, the draw bars of preset panel **28** have numbers applied individually thereto, these numbers being in succession from 1 to 13 inclusive. The tone signals applied to these draw bars from the keyboard bus bars **21** are as follows:

(1) Subfundamental
(2) Sub third harmonic
(3) Sub fifth harmonic
(4) Fundamental
(5) Second harmonic
(6) Third harmonic
(7) Fourth harmonic
(8) Fifth harmonic
(9) Sixth harmonic
(10) Eighth harmonic
(11) Sub octave harmonic mixture
(12) Unison harmonic mixture
(13) Octave harmonic mixture

The last three of these—that is, **11**, **12** and **13**—are harmonic mixtures, and differ from the others in that they are not simple, essentially sine wave tones, but are tones which have a complex wave form of the type, for instance, typically obtained from organ tone generators of the electronic oscillator variety. Their purpose, when used, is to add a rich harmonic structure to the synthetically organized basic tone so that the organ has the advantages of both the synthetic type and of the type in which complex tones are used as electronically generated or as modified by formant circuits.

When the draw bars of preset panel **28** are all in the off position—that is, in the positions shown in the figure— bars **1**, **2** and **3** engage a bus indicated by the numeral **32**. Similarly, draw bars **4** to **10** inclusive engage bus bar **34**, while draw bars **11**, **12** and **13** engage bus bar **36**. In the next more advanced position, all of the draw bars **1** to **10** inclusive engage bus bar **38**, while draw bars **11**, **12** and **13** similarly engage bus bar **40**. Successive more advanced bus bar positions in the group **1** to **10** inclusive are indicated in order by the numerals **42**, **46**, **50**, **54**, **58**, **62** and **66**. The similar additional bus bars in more advanced order for the draw bars **11**, **12** and **13** are indicated by the numerals **44**, **48**, **52**, **56**, **60**, **64** and **68**.

The bus bars for the draw bars **11**, **12** and **13** are connected individually to a similar set of bus bars arranged in the group at **24** which function with the preset key switches, similar to key **22**, which makes the illustrated connections to the leads indicated at **25**. Similarly the bus bars which make contact with the draw bars in the group numbered from **1** to **10** inclusive are connected individually to a similar set of bus bars in the preset panel **24**, and one additional bus bar in this group, indicated at **70**, is grounded and is connected by lead **72** to the short bus bar **32** which is in the off position of the draw bars **1**, **2** and **3**.

To the right of the portion of the circuit just described is shown a pair of sequenced gang switches with each of the individual switches in the gangs being of the single pole, double throw type. The lower gange is indicated generally by the numeral **74** and is made up of seven switches. Each of these switches has a shiftable contact blade, these members being indicated from the bottom by the numerals **76**, **78**, **80**, **82**, **84**, **86** and **88**. When in the "at rest" condition, each of these switch blades engages a stationary contact thereabove, these stationary

contacts being indicated by the same numeral as is applied to the switch blade with the subscript *a* so that switch blade **76** normally engages switch contact **76***a*, and so on. When the switch blades are shifted to their other alternative positions, each is separated from its *a* contact and engages a similar stationary contact indicated by the subscript *b*. The switches are so arranged that they make and break simultaneously, or as closely thereto as possible, and in so far as this action is not simultaneous it should be of the make before break type.

The switch gangs are operated by a crescendo pedal **89** in such fashion that as the pedal is slightly moved to introduce the crescendo effect, the first switch **76** is actuated from the *a* to the *b* position. With additional movement, switch **78** is shifted from the *a* to the *b* position, and so on until finally all of the switches have been shifted from the *a* to the *b* connections.

The second gang switch, indicated generally by the numeral **90**, may be considered as identical to the switch **74** and is actuated by the same pedal **89** or other crescendo control. In this switch the movable blades are indicated from the bottom in order by the numerals **92, 94, 96, 98, 100, 102** and **104**. As with the previous gang switch, each of the blades engages, when at rest, a contact having the same number as the blade but with the subscript *a*, whereas the alternatively used contacts bear the subscript *b*. These switches are also actuated in sequence in the same order as the gang at **74** and approximately simultaneously therewith, so that as the crescendo pedal is depressed and as the position is reached at which switch blade **76** is shifted from the *a* to the *b* position, switch **92** will also be shifted from its *a* to its *b* position, and so on.

A preamplifier input transformer is indicated at **110**, the secondary **112** thereof being connected to supply the input signal to the boxed circuit at **114** which may be conventional and which in the present instance performs the following functions. In this section the signal is preamplified, is controlled by the swell pedal, has vibrato introduced if desired, its overall volume is regulated between loud and soft positions, and there may be a balance control so as to proportion the amplitude of the signal leaving this section to that of other portions of the instrument. From the section **114** (the circuits of which are usually collectively referred to as a preamplifier) the signal is introduced by way of leads **116** to a conventional power amplifier which supplies conventional speakers in a well known manner, this portion of the circuit therefore not being illustrated in detail.

A similar transformer at **118** has a secondary **120** which supplies a signal to a harmonic mixture preamplifier indicated generally by the numeral **122**. In this boxed portion of the circuit the signal is preamplified, swell controlled, tone controlled, balanced, and its overall volume is regulated much in the manner of the preamplifier at **114**. As in the previous example also, the output of the circuit **122** is supplied to leads **124** which are connected to the input of a suitable power amplifier and speaker system which may be the same as that supplied by the other preamplifier **114**.

Other tonal effects not having to do specifically with the present invention, such as percussion for instance, and exemplified by the box **125**, may be introduced by way of the lead **126** connected through a resistor **128** to the ungrounded side of the transformer secondary **120** which supplies the harmonic mixture preamplifier **122**.

The transformer **110** has a tapped primary, indicated generally by the numeral **130**, which is grounded at one end and which has eight successive taps or terminals above the ground level, including the terminal at the opposite end of the primary, these taps (beginning at the one next above ground) being indicated in order by the numerals **132, 134, 136, 138, 140, 142, 144** and **146**. Because of the low impedance of this winding, it acts similar to a tapped resistor so that if a signal is connected between ground and the first tap **132**, such a signal will produce a weak response in the secondary **112**, whereas if the same signal is connected between ground and the second tap **134**, a stronger secondary signal will be produced, and so on, the strongest signal being produced in the secondary and hence in the output when the input is connected between ground and the opposite end terminal of the primary indicated by the numeral **146**.

The transformer at **118** has substantially the identical arrangement, the terminals of the primary **148** thereof in succession above ground being indicated in order by the numerals **150, 152, 154, 156, 158, 160, 162** and **164**.

As with the transformer at **110**, connecting a signal between ground and successively higher taps on the primary of the transformer **148** has the effect of progressively increasing the signal strength in the transformer secondary **120**, and hence in the preamplifier and output.

Connections to the transformer primary **130** are as follows: The bottom tap is grounded and is connected by lead **170** to ground the stationary switch contact **76***a*. The first tap **132** is connected by lead **172** to contact **78***a*. Similarly tap **134** is connected by lead **174** to switch contact **80***a*. Lead **176** connects contact **82***a* with tap **136**; lead **178** interconnects contact **84***a* and tap **138**; lead **180** is connected between contact **86***a* and tap **140**; contact **88***a* is connected by lead **182** to tap **142**; lead **184** connects tap **144** to contact **88***b* and by way of a branch **186** these connections are extended to bus bar **62** of the draw bar assembly. The top end of the transformer **146** is connected by lead **188** to the bus bar **66**.

Movable switch contact **88** is connected by lead **190** to stationary contact **86***b* and by a branch **192** to bus bar **58**. Similarly, switch blade **86** is connected by lead **194** to switch contact **84***b* and by a branch **196** to bus bar **54**. Switch contact **84** is connected by lead **198** to switch contact **82***b* and by branch **200** to bus bar **50**. Lead **202** interconnects switch contacts **82** and **80***b*, and a branch **204** thereof leads to bus bar **46**. Lead **206** interconnects switch contacts **80** and **78***b*, and a branch **208** leads to bus bar **42**. Lead **210** interconnects switch contacts **78** and **76***b*, and a branch **212** of this lead is connected to bus bar **38**. The lowermost movable contact **76** is connected by line **214** to bus bar **34**. Although not specifically mentioned above, each of the bus bar leads **188, 186, 192, 196, 200, 204, 208, 212** and **214** is connected by an appropriate branch, these branches being indicated generally by the numeral **216** to the appropriate bus bar in the preset panel at **24**.

In a similar manner, the grounded end of the transformer primary **148** is connected by lead **218** to switch contact **92***a*, whereas lead **220** interconnects transformer tap **150** and switch contact **94***a*; lead **222** interconnects tap **152** and contact **96***a*; lead **224** interconnects tap **154** and contact **98***a*; lead **226** interconnects tap **156** and contact **100***a*; **228** connects tap **158** to contact **102***a*; **230** connects tap **160** to contact **104***a*; **232** connects tap **162** to contact **104***b*, and a branch **234** thereof connects to bus bar **64**. The top end of the transformer **164** is connected by lead **236** to bus bar **68**. Additionally, contact **104** is connected to contact **102***b* by lead **238** having a branch **240** leading to bus bar **60**. Contact **102** is connected to contact **100***b* by lead **242** having a branch **244** leading to bus bar **56**. Lead **246** interconnects contacts **100** and **98***b*, and a branch **248** thereof leads to bus bar **52**. Lead **250** having a branch **252** interconnects contacts **98** and **96***b* and bus bar **48**. Lead **254** having a branch **256** interconnects contacts **96** and **94***b* and bus bar **44**. Lead **258** having a branch **260** interconnects contacts **94** and **92***b* and bus bar **40**. The lowermost movable contact **92** is connected by lead **262** to bus bar **36**. As in the previous example, the bus bars in the draw bar assembly are connected by a group of leads indicated generally by

the numeral 264 to the similar bus bars in the preset panel at 24.

The system operates as follows. When any one of the draw bars from 1 to 13 is all the way in, or in other words in its off position, no sound for its particular frequency will be apparent in the music played upon the instrument. For example, bus bar 34 is connected by lead 214 and by way of switch 76–76a to ground through line 170. Changes in the potential of this bus bar, therefore, do not produce any current in the transformer primary. Also bus bar 36 is connected by lead 262 and switch contacts 92 and 92a to ground through lead 218. Bus bar 32, it should be noted, is connected directly to ground by lead 72 without any intervening switch contacts. This is done because it is sometimes not desirable to have the subfrequencies, represented in this embodiment by draw bars 1, 2 and 3, enter into the crescendo effect. Inasmuch as these three draw bars are always grounded when they are in their innermost positions, these three subfrequencies do not sound during the crescendo. If it is desired to have any or all of the subfrequencies participate in the crescendo, it is necessary merely to move the appropriate draw bar 1, 2 or 3 into the second or some position other than its completely in (or off) position. All the other draw bars, however, are grounded when in the off position by way of switch contacts which can subsequently be broken, as will be explained, so as to remove the ground during the crescendo.

Prior to the time the performer commences to play, he will set the draw bars 1 to 13 in whatever fashion he considers appropriate so as to produce the type of tone coloration he feels is desirable for the particular selection. Althernatively, of course, he may accomplish the same effect by actuating one of the preselect switches connected to the panel at 24.

Now if the crescendo pedal is depressed slightly, so as to shift contact 76 from contact 76a to 76b, and simultaneously to shift contact 92 from contact 92a to 92b, any tone component which has been turned off (by positioning any one of the draw bars from 4 to 10 in the off position in contact with bus bar 34) will be shifted in the same manner as if each of these draw bars had been pulled out one step so as to be in contact with draw bar 38. This is accomplished by the connection which consists of bus bar 34, lead 214, switch blade 76, contact 76b, lead 210, switch contacts 78–78a, and lead 172 to transformer tap 132. Thus each of these tone signals is disconnected from the ground position and transferred to the first tap above ground on the transformer primary 130. Similarly, bus bar 36 is connected by way of lead 262, switch contacts 92–92b, lead 258, switch contacts 94–94a, lead 220, to transformer tap 150.

As the crescendo pedal is moved slightly further, switch contact 94 will be disconnected from contact 94a and will be connected to contact 94b, and similarly switch contact 78 will be shifted from contact 78a to contact 78b. The result of this is to shift the connections of all of the tone components which are connected to bus bar 38 or bus bar 40 to the next higher bus bars; that is, bus bars 42 or 44. This shift is also accomplished with the tone components that formerly were shifted to the bus bars 38 and 40 by the first increment of movement of the crescendo pedal.

Note also that this shift takes place with draw bars 1, 2 and 3, provided these draw bars have been moved out away from the off position so as to be in contact with bus bar 38. This is accomplished as follows. As previously described, anything connected to bus bar 34 in the first instance has, by the first increment of movement of the crescendo pedal, been transferred to line 212 which leads to the second bus bar 38. Shifting of switch contact 78 to contact 78b therefore conveys this signal plus anything on bus bar 38 by way of line 212, contacts 78–78b to line 206, thence by way of contacts 80–80a to lead 174 which connects with the transformer tap at 134. This action also takes place with the other connections to the transformer primaries 148 and 130, such as those from the preset panel at 24.

With successive incremental movements of the crescendo pedal, this contact shifting activity will continue until finally contact 88 is shifted from contact 88a to 88b and contact 104 is shifted from 104a to 104b. This last shift has the effect of transferring the connections for all tone components which have been collected up to bus bars 58 and 60 to lines 184 and 232, thereby connecting tehm to the next to the highest transformer taps 144 and 162 respectively. At this juncture, therefore, the instrument sounds as if all draw bars had been pulled out to the next to the loudest position, except that there may be some draw bars which are in the loudest position, these being unaffected, and except also that there may be some of the subfundamentals which are in the off position and which, as previously explained, remain off.

From the above it will be seen that regardless of the original setting of the draw bars, or of the preset panel which is the equivalent thereof, movement of the crescendo pedal or other crescendo control have the effect of gradually adding to the tones originally played, all of the harmonically related or otherwise musically related tones. This builds up the volume and also changes the nature of the tone so as to provide a sound of increasing complexity with increasing movement of the crescendo control. In the present embodiment, this applies both to the arrangement which permits synthesizing tones from the various susbtantially sine wave tone components and also to the more complex tones which in the present instance have been referred to as harmonic mixtures, these tones being represented by the draw bars 11, 12 and 13. Additionally, as explained, the subfundamental, sub third harmonic, and sub fifth harmonic may or may not be used in the crescendo effect, depending upon whether the draw bars are all the way in to their off position or whether one or more of these draw bars has been advanced to at least its first on position.

One of the important considerations is that this crescendo effect can be added to the instrument merely by the addition of the sequencing switches 74 and 90 together with their control pedal or other control arrangement, plus some additional wiring, the other components in the circuit being substantially unchanged over what would normally be available in any event. The additional cost, therefore, of introducing the crescendo effect into the organ is relatively small in comparison with the important musical effect gained thereby.

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

Having described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

1. In an organ of the tone synthesizing type in which there is provided a multiplicity of sine wave tone generators according to the musical scale, a plurality of busses individual to the fundamental and various harmonics of the fundamental, playing keys adapted when played to connect appropriate generators to the busses so that appropriate busses have applied thereto the fundamental and various harmonics of the fundamental, an output system having a plurality of input terminals of graded effectiveness from no effectiveness to low effectiveness, to higher effectiveness, to still higher effectiveness, and so on progressively up to high effectiveness, a plurality of controls operable to connect each of said busses individually to any selected one of said input terminals to determine the effectiveness in the output of the fundamental and various harmonics of the notes being played, and a crescendo system comprising a plurality of switches ganged together, a control for progressively actuating switch members of said gang as said control is progressively moved, connections

from said ganged switches to said input terminals such that progressive actuation of said ganged switches by their control progressively first removes the connections of whatever busses there are that are connected to the no effectiveness terminal and connecting these busses to the terminal of low effectiveness, next removes the bus connections from the terminal of low effectiveness and connects these busses to the terminal of higher effectiveness, next removes whatever bus connections there are to said terminal of higher effectiveness and connects these busses to said terminal of still higher effectiveness, and so on progressively until all said bus connections have been removed from all less effective terminals and connected to said terminal of high effectiveness.

2. In an organ of the tone synthesizing type in which there is provided a multiplicity of sine wave tone generators according to the musical scale, a plurality of busses individual to the fundamental and various harmonics of the fundamental, playing keys adapted when played to connect appropriate generators to the busses so that appropriate busses have applied thereto the fundamental and various harmonics of the fundamental, an output system having a plurality of input terminals of graded effectiveness from low effectiveness, to higher effectiveness, to still higher effectiveness, and so on progressively up to high effectiveness, a plurality of controls operable to connect each of said busses individually to any selected one of said input terminals to determine the effectiveness in the output of the fundamental and various harmonics of the notes being played, and a crescendo system comprising progressively operable switching means, a control for progressively actuating said switching means as said control is progressively moved, connections from said switching means to said input terminals such that progressive actuation of said switching means progressively first switches the connections of whatever busses there are that are connected to the low effectiveness terminal to the terminal of higher effectiveness, next switches whatever bus connections there are to said terminal of higher effectiveness to said terminal of still higher effectiveness, and so on progressively until all said bus connections have been switched from all less effective terminals to said terminal of high effectiveness.

3. In an organ of the tone synthesizing type in which there is provided a multiplicity of tone generators according to the musical scale, a plurality of busses individual to the fundamental and tones variously related to the fundamental, playing keys adapted when played to connect appropriate generators to the busses so that appropriate busses have applied thereto the fundamental and various of said related tones, an output system having a plurality of input terminals of graded effectiveness from low effectiveness, to higher effectiveness, to still higher effectiveness, and so on progressively up to high effectiveness, a plurality of controls operable to connect each of said busses individually to any selected one of said input terminals to determine the effectiveness in the output of the fundamental and various related tones being played, and a crescendo system comprising progressively operable



switching means, a control for progressively actuating said switching means as said control is progressively moved, connections from said switching means to said input terminals such that progressive actuation of said switching means progressively first switches the connections of whatever busses there are that are connected to the low effectiveness terminal to the terminal of higher effectiveness, next switches whatever bus connections there are to said terminal of higher effectiveness to said terminal of still higher effectiveness, and so on progressively until all said bus connections have been switched from all less effective terminals to said terminal of high effectiveness.

4. In an organ of the tone synthesizing type in which there is provided a multiplicity of sine wave tone generators according to the musical scale, a plurality of busses individual to the fundamental and various harmonics of the fundamental, playing keys adapted when played to connect appropriate generators to the busses so that appropriate busses have applied thereto fundamental and various harmonics of the fundamental, an output system having a plurality of input terminals of graded effectiveness from no effectiveness to low effectiveness to higher effectiveness to still higher effectiveness and so on progressively up to high effectiveness, a plurality of controls operable to connect each of said busses individually to any selected one of said input terminals to determine the effectiveness in the output of the fundamental and various harmonics of the notes being played, and a crescendo system comprising a plurality of single pole double throw switches ganged together, a control for sequentially actuating switch poles in said switch gang as said control is progressively moved, connections from said switches to said input terminals such that progressive actuation of said switch poles by their control first removes the connection of whatever busses there are that are connected to the no effectiveness terminal and connecting these busses to the terminal of low effectiveness, next removes the bus connections from the terminal of low effectiveness and connects these busses to the terminal of high effectiveness, next removes whatever bus connections there are to said terminals of higher effectiveness and connects these busses to said terminal of still higher effectiveness and so on progressively until all said bus connections have been removed from all less effective terminals and connected to said terminal of high effectiveness.


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