

[54] MUSICAL INSTRUMENTS

[76] Inventors: **James J. Borell**, 1318 W. Oak St., Kissimmee, Fla. 32741; **Arthur R. Bonham**, 5614 LeJeune Dr., Orlando, Fla. 32808

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Primary Examiner—Stephen J. Tomskey

Assistant Examiner—Stanley J. Witkowski

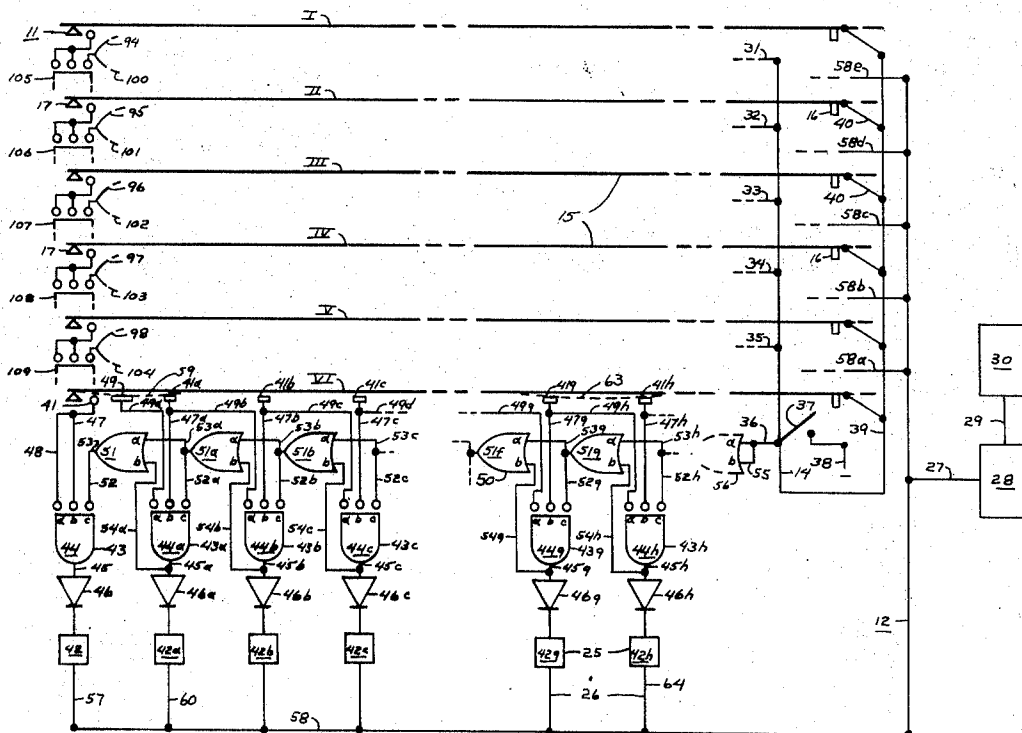
Attorney—Roger L. Martin

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ABSTRACT

Musical instruments playable in duet fashion by one player includes a stringed instrument with segmented frets. A control system for the other instrument includes a control circuit for each string and which has actuating circuits that are associated with the open and keyed string tones playable on the string. The actuating circuits associated with the second and higher string keying positions are enabled by simultaneous string contact with adjacent fret sections, and simultaneous string contact with a plate and fret segment at the first position serves to enable the actuating circuit associated with the first string keying position. A disabling circuit has components associated with each actuating circuit and which disable the associated actuating circuit in response to output signals of the actuating circuits associated with the higher keying positions. Open tone sensing circuits are avoided in one embodiment especially designed for chord playing players of the stringed instrument and in which simultaneous signals from a predetermined number of disabling circuits that are enabled by simultaneous keying of different strings serve to control an auxiliary circuit to enable the actuating circuits associated with the open tones of the unkeyed strings.

12 Claims, 3 Drawing Figures



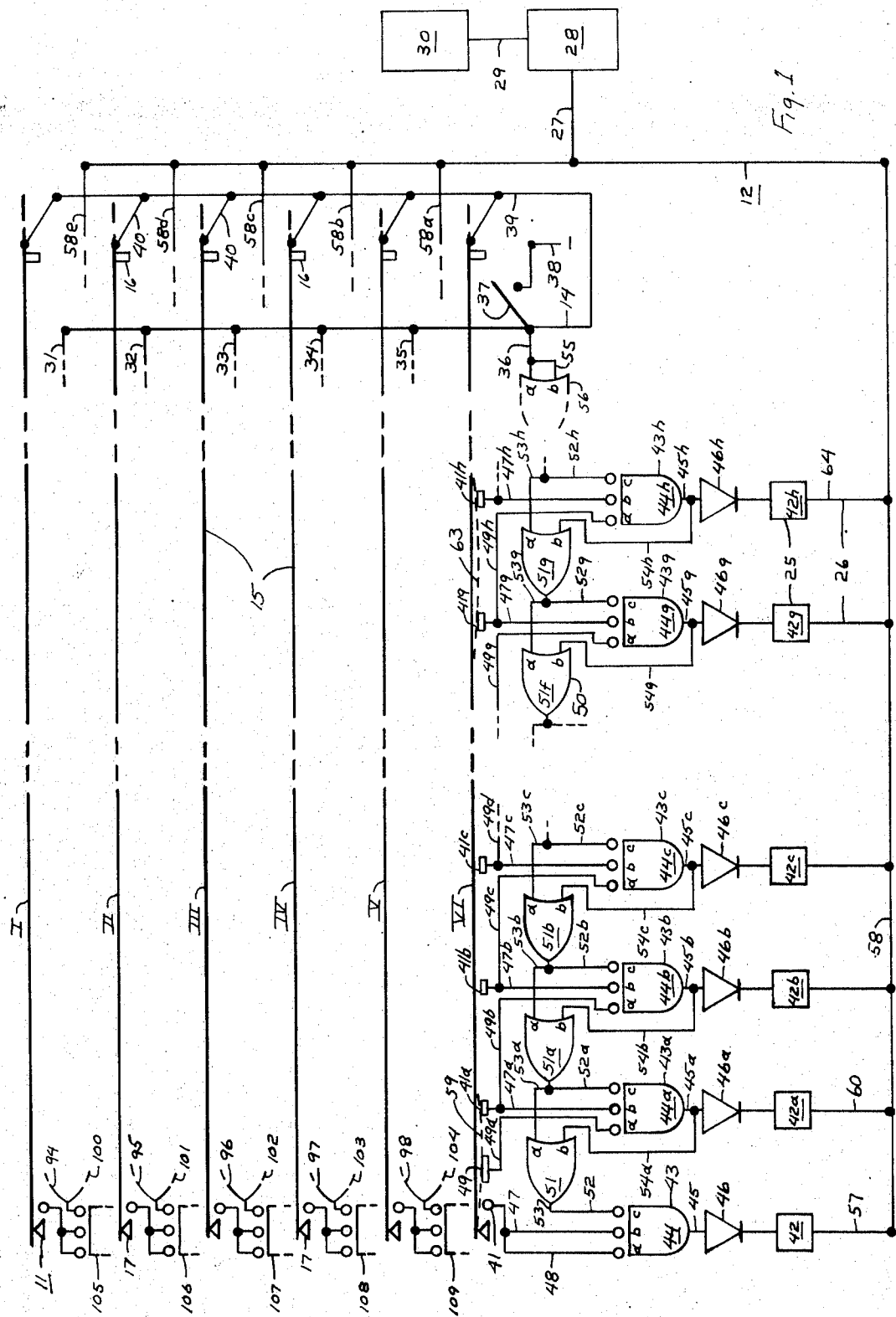
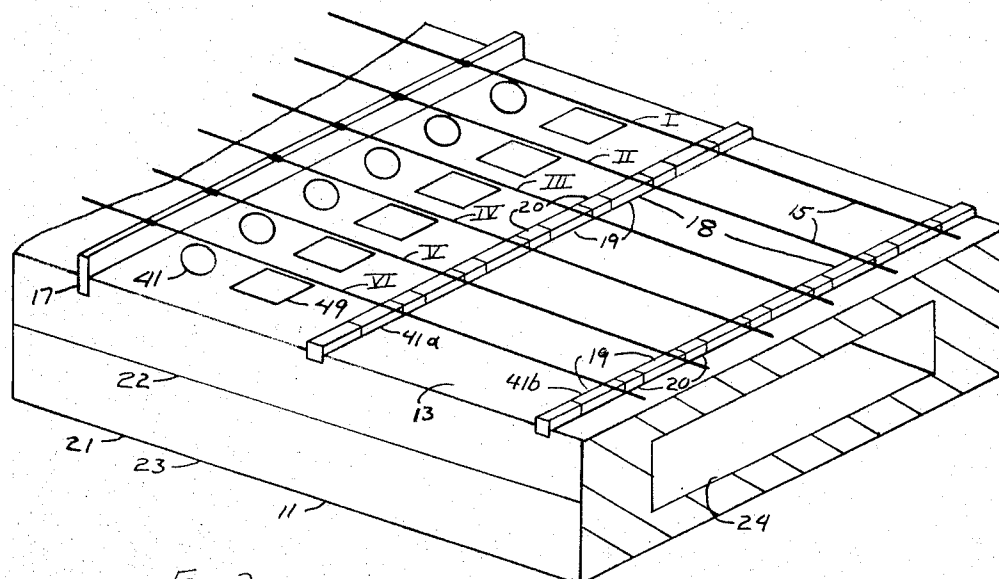


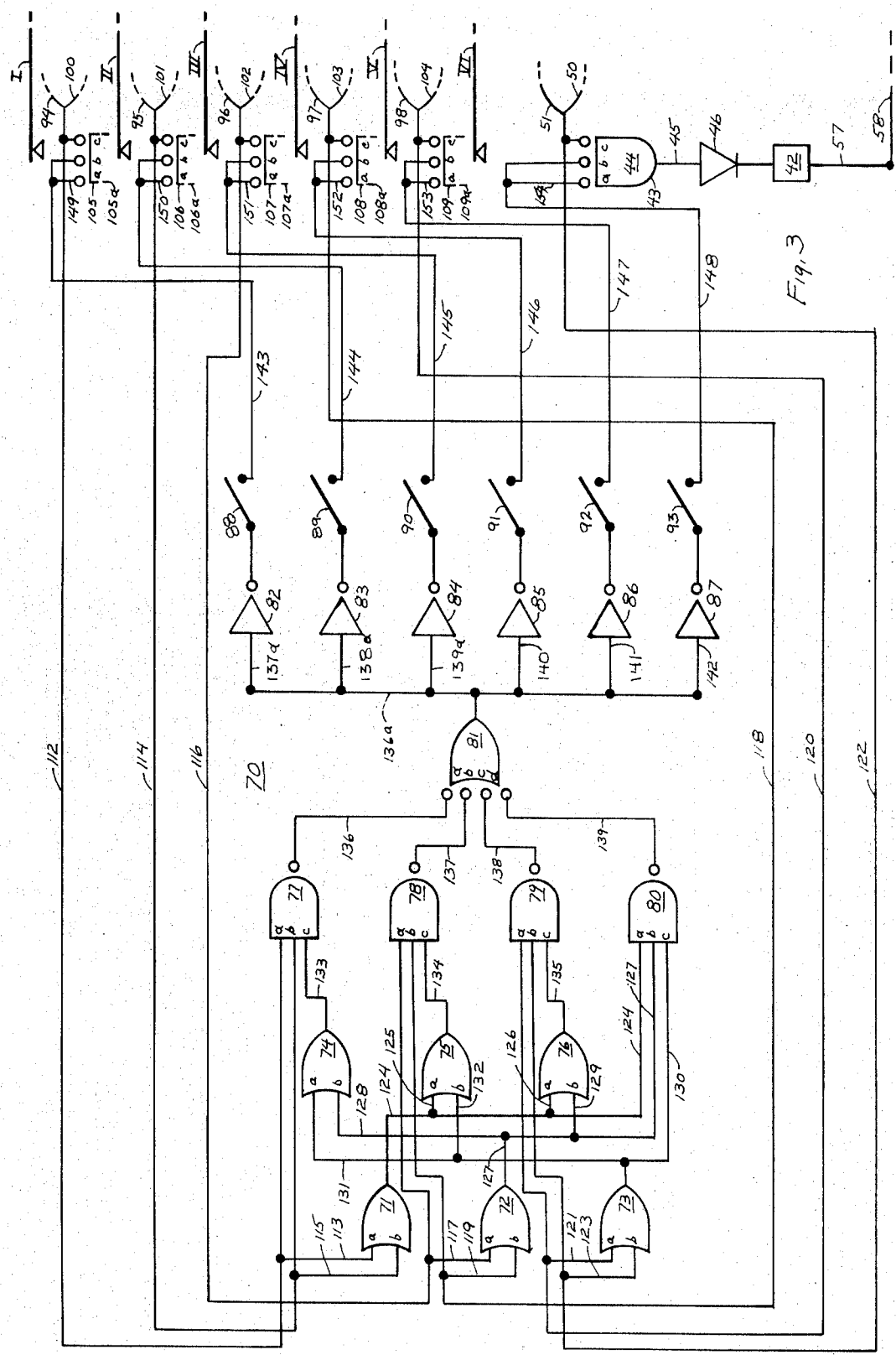
Fig. 1

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MUSICAL INSTRUMENTS

BACKGROUND OF THE INVENTION

This invention relates to musical instruments and more particularly to control systems for musical instruments which may be played in duet fashion by a single player of but one of the instruments.

Systems for controlling the operation of the tone producing components of one musical instrument from the keyboard of another musical instrument of the string type so that both instruments may be played in duet fashion by one person are known. Prior to the invention disclosed in Borell U.S. Pat. No. 3,465,086, systems for controlling the operation of the tone producers of one musical instrument from the keyboard of a second musical instrument of the string type were unsatisfactory because special finger manipulations were required of the player of the stringed instrument in order to actuate the tone producing components of the other instrument and which were associated with the open string tones of the stringed instrument. Borell in the aforementioned patent, discloses several different means for sensing the mechanical movement of the string when the open tone is played thereon and of then actuating the associated tone producing components of the other instrument.

The aforementioned patentee also shows various switching arrangements used in actuating the tone producing components associated with the keyed string tones, and as the art has developed in practice, it has been found that switching systems involving the use of auxiliary switches having movable components that are encountered by the player during the string keying process are less than fully satisfactory. The main objection has been that the movable component imparts an abnormal feeling to the players fingers as the strings are keyed. As a consequence, the art in practice is developing around the use of switching systems that rely on an electrical contact being made between the string and a fret associated with the keyed string tone involved in playing the stringed instrument. The frets of the instruments in such cases are bifurcated or segmented and composed of electrically conductive sections or segments that are associated with the respective strings of the instrument. The circuits actuating the tone producing circuits associated with the fret sections rely on the completion of an energized circuit which involves the fret section and a string being keyed in order to produce the desired keyed string tone.

One of the difficulties which has been encountered in developing a switching system that is founded on the need for an electrical contact being made between the string and a fret segment arises from the fact that the player of the stringed instrument, in playing a keyed string tone at a string keying position, depresses the string into contact with the keyboard at a point which is located between the fret section associated with the keying position and the fret section associated with the next lower keying position. As a result, the string contacts both the desired fret section and the adjacent fret section associated with the next lower tone playable on the string. Although disabling circuits, such as the arrangement shown in the aforementioned patent, may be used to disable the circuitry associated with the adjacent keying position, many stringed instrument players have a tendency to slide the finger along the

string in establishing the keyed string position. This tendency frequently causes initial contact between the string and fret section that is associated with the lower keyed string tone before string contact with the desired fret section is secured. This, of course, results in a momentary discord emanation from the musical instrument being controlled by the circuitry and of course, is unsatisfactory in practice.

The skills of many guitar players are also somewhat limited to the playing of chords as opposed to the playing of individual tones in an orderly sequence. In this chord-type of instrument play on a guitar for example, it is usual practice to key three or four of the strings of the guitar in accord with the keyed string requirements for the chord and to simultaneously strum all of the strings of the guitar when the chord is being played. The open tones of the unkeyed strings under such circumstances are accordingly played by the guitar player and systems which utilize the open tone sensing circuits such as those disclosed in the aforementioned patent for playing the tones associated with the unkeyed strings are admirably suited to securing from the second instrument all tones corresponding in pitch to the open string tones while the chord is being played by the player of the stringed instrument. However the need for locating the sensors in close proximity to the strings of the stringed instrument involves costly modifications of the instrument structures and, accordingly, there is a desire for a less costly control system for actuating the tone producers of the second instrument which are associated with the open string tones emanating from the stringed instrument when chords are being played.

STATEMENT OF THE INVENTION

One aspect of the invention has to do with the problems with discord which result from the playing of a key string tone and which are caused by the premature encounter of the string with the adjacent fret section associated with the lower keyed string tone playable on the string. In accord with this aspect of the invention provisions are made for enabling the switching circuit to actuate the tone producing components associated with the keyed string tone only when the string is in contact with both the fret section associated with the desired keyed string tone and the adjacent fret section associated with the lower keyed string tone at the keying position on the keyboard. The tone producing component of the second instrument is thus only responsive to simultaneous string contact with the two fret sections involved at the keying position so that the discord problem is avoided. At the first position for keying a string of the stringed instrument, an auxiliary contact is provided and, as will be subsequently seen, circuitry is also provided which disables the switching circuits associated with the open tone and keyed string tones associated with the lower numbered positions for keying the string.

Another aspect of the invention has to do with the provision of circuitry which responds when a predetermined number of strings on the stringed instrument are being keyed and actuates the tone producing components of the second instrument that are associated with the open string tones of the unkeyed strings of the stringed instrument, again through the use of suitable gating logic. The circuitry, as will be subsequently seen, is responsive to the conditioning circuit output of the control circuit for the organ control system and is de-

signed to key the tone producers associated with the open string tones of the unkeyed strings of the stringed instrument and in a circuit that avoids the need for open string tone sensors.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention, itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 diagrammatically illustrates certain components of an electronic organ together with certain components of a system for controlling the organ from the keyboard of a six-string musical instrument of the guitar type;

FIG. 2 shows a neck fragment at the nut end of the guitar embodying components diagrammatically illustrated in FIG. 1; and

FIG. 3 shows a circuit modification of the embodiment illustrated in FIG. 1, as modified to eliminate open string tone sensing components and to incorporate circuitry for actuating organ tones associated with open string tones of unkeyed strings to be selectively played when chords are being played on the guitar.

DESCRIPTION OF EMBODIMENTS

Reference is now made to FIGS. 1 and 2 and wherein certain aspects of the invention are illustrated as embodied in a combination of musical instruments that include a six-string guitar 11 and an electronic organ. In this instance, the signal generators of the electronic organ 12 are controlled from the keyboard 13 of the guitar 11 by means of a control system 14 that responds when the strings of the guitar are keyed at the various keying positions to electrical contact made between the frets and strings of the guitar.

The strings 15 of the guitar 11 illustrated in the drawings are strung between an electrically nonconductive bridge 16 and an electrically nonconductive nut 17. The frets 18 underlie and are located spacedly below the strings 15 and are arranged transversely and spaced part along the keyboard 13. The frets in this instance are segmented with each fret being composed of electrically conducted fret sections or segments 19 that underlie the respective strings and are spaced apart from the other conductive segments of the fret by electrically insulating segments designated at 20. The neck of the guitar, as seen in FIG. 2, is composed of upper and lower sections 22 and 23 that are secured together and shaped to provide an elongated opening 24 within the neck that serves to house wiring components associated with the organ control system 14.

The organ 12 is shown in the illustration as including a plurality of tone signal generators 25 that are actuated in accord with the condition of control system 14. The signal generators have outputs 26 that are fed through appropriate lead lines designated at 58, 58a, 58b, etc., to the input lead 27 of an amplifier 28 when the signal generators are actuated. The output 29 of the organ amplifier 28 is in turn fed to a reproducer or loudspeaker 30 that translates the output signals into appropriate audible tones, as will be apparent to those skilled in the art. Only the tone signal generators asso-

ciated with the sixth string of the guitar are generally illustrated in FIG. 1. It will be apparent however that the organ has other tone signal generators and that the oscillator may also be associated with the control circuits of the other strings and thus capable of actuation when the same tone is played on another string. The tone signal generators illustrated are of the type that are energized when actuated but it will be apparent that signal generators which are continuously energized may be used and that their actuation under such circumstances will complete a circuit feeding the signals to the amplifier and audio output.

The system 14 for controlling the organ in accord with the keyed and open string tones that are played on the guitar 11 includes a separate control circuit for each string of the guitar. The separate control circuits for the individual musical strings that are identified by roman numerals I through VI in the drawings, are designated at 31 through 36 respectively. The control circuits 31 through 36 are generally arranged in parallel circuits that are in turn connected in series through a single pole, single throw control switch 37 to a source 38 establishing a negative potential condition. An electrical lead 39 is also connected to source 38 through switch 37 and each of the electrically conductive musical strings I through VI inclusive is electrically connected to lead 39 as by means of a suitable electrical lead 40 that is tapped into line 39.

It may be well at this point to state that the expressions "negative" and "positive" as used herein with reference to signals and potential conditions should be understood as having reference to relative voltage levels which are respectively lower and higher by comparison. Thus a negative signal or potential condition should be understood as having reference to a voltage level that may be either negative or positive but which is nevertheless lower by comparison to a signal or potential condition indicated herein as being positive.

The control circuits 31 through 35 associated with strings I through V are similar to the control circuit 36 which is illustrated for string VI and hence the following detailed description concerning control circuit 36 should be understood as basically also explaining the composition of and operation of circuits 31 through 35.

Control circuit 36 includes a transducer 41 for sensing vibrational movement of string VI when the open string tone is being played thereon. It also includes the electrically conductive fret segments 41a, 41b, 41c, etc., that are associated with the first and higher positions for keying string VI against keyboard 13. The fret segments 41a, 41b, etc. associated with string VI are spaced apart one adjacent the next in a row that underlies the string VI and are contacted by string VI when the string is keyed against the first, second and higher keying positions along the keyboard 13. The keyed string tones that are playable on the string VI are progressively higher pitched than the open string tone that may be played on the string and these keyed string tones are played, of course, by keying the string with the finger against the keyboard at the first and subsequent string keying positions. The tone signal generators that are associated with the open string tone for string VI and the tones obtained through keying the string at the first and higher keying positions are respectively designated at 42, 42a, 42b, etc. The actuating circuits for the signal generators 42, 42a, 42b, etc., are designated in the drawings at 43, 43a, 43b, 43c,

etc., and each is associated with a tone playable on string VI. Each of these circuits 43, 43a, 43b, etc., has a three input position positive "nor" gate with an output signal that is fed through a diode to the tone signal generator associated with the circuit. The "nor" gates are designated at 44, 44a, 44b, etc., while the respective output signals are designated at 45, 45a, 45b, etc., and the diodes at 46, 46a, 46b, etc. When the input condition at each of the input positions of a "nor" gate is negative, the gate opens and provides a positive output signal.

Transducer 41 generates a negative output signal 47 when the open tone vibration of string VI is sensed, and this signal 47 is fed to the *b* input position of gate 44. This signal 47 is tapped and also delivered to the *a* input position for gate 44 as by lead 48. The normal condition at the *a* and *b* inputs of gate 44 is positive and hence if the gate is conditioned with a negative potential at the *c* input, as will be subsequently seen, the gate is opened by the delivery of the negative output signal to the *a* and *b* positions.

The fret segments 41a, 41b, 41c, etc., are respectively associated with the first, second and higher positions for keying string VI and are electrically connected by respective leads 47a, 47b, 47c, etc., to the *b* input positions for the respective gates 44a, 44b, 44c, etc., as seen in the drawings. Circuit 36 has a small electrically conductive plate 49 that underlies string VI in the first position for keying the string. This plate 49 is electrically connected to the *a* input position of gate 44a by lead 49a. The *a* input positions for the gates 44b, 44c, etc., associated with the second and higher keying positions for string VI are connected by leads 49b, 49c, 49d, etc., to the leads 47a, 47b, 47c, etc., that are associated with the next lower keying positions as seen in FIG. 1.

In addition to actuating circuits 43, 43a, 43b, 43c, etc., circuit 36 includes a conditioning circuit 50 for conditioning the actuating circuits 43, 43a, 43b, etc., for the reception of gate opening signals and for disabling the actuating circuits that are associated with the lower tones playable on the string when the string is keyed at one of the fret positions. The conditioning circuit 50 includes a plurality of series arranged two position positive "or" gates 51, 51a, 51b, etc. The outputs of these "or" gates are connected by leads 52, 52a, 52b, etc., to the *c* input positions for gates 44, 44a, 44b, 44c, etc., as seen in the drawings. The positive "or" gates provide a positive output signal when a positive potential condition is established at either of the input terminals, and the output signals of gates 51a, 51b, etc., are tapped by leads 53a, 53b, 53c, etc., so as to also deliver the output signal to the *a* position of the "or" gate associated with the next lower tone playable on string VI, as seen in the drawings. Each "or" gate is associated with one of the actuating circuits and, except for the "or" gate 56 associated with the actuating circuit at the highest string keying position, the *b* positions of the "or" gates are connected by leads 54a, 54b, 54c, to receive the output signal of the "nor" gate that is associated with the next higher tone playable on string VI. The *b* input of gate 56 on the other hand is tied to the *a* input lead 55 so as to receive the negative output from source 38 through switch 37.

When switch 37 is placed in the closed position, a negative potential condition is established along each of the electrically conductive musical strings I through VI. Closure of switch 37 also establishes a negative

condition at the *a* input position of each of the "or" gates 51, 51a, 51b, etc., and by virtue of the line taps 54a, 54b, 54c, etc., and the tie-in 55 for gate 56, a negative potential condition is established at the *b* position for each of the "or" gates in the conditioning circuit 50. Under these circumstances a negative potential condition is established at each of the *c* positions for the "nor" gates 44, 44a, 44b, etc., and each of the circuits 43, 43a, 43b, etc., is readied and conditioned to actuate the tone signal generators when the other inputs of the gate receive negative signals.

Under the existing ready conditions, if string VI is strummed to provide the open string tone associated with the string, transducer 41 senses the vibrational movement and generates a negative signal that is passed to the *a* and *b* input positions of gate 44. In view of the readied condition of the gate 44, this sends a positive signal 45 via the diode 46 to signal generator 42 and in turn actuates generator 42 to provide an output signal 57. Signal 57 is fed by lead 58 to input line 27 of amplifier 28. The amplified output signal 29 is then delivered to loudspeaker and translated into an open tone signal corresponding in pitch to that of the open string tone played on string VI.

When string VI is keyed at the first position to provide the keyed string tone associated with the fret segment 41a at this position, the string VI is keyed against the keyboard and assumes a position such as designated at 59. Under these circumstances, string VI is in electrical contact with plate 49 and also with the fret segment 41a. The electrical contact between string VI and segment 41 establishes a negative potential condition at the *b* position of "nor" gate 44a while the contact between string VI and plate 49 establishes a negative potential condition at the *a* position of gate 44a. With gate 44a readied by the conditioning circuit 50 that provides a negative potential at the *c* input of the gate, the gate is opened under these circumstances and delivers a positive output signal 45a via diode 46a to signal generator 42a. When gate 44a opens a positive signal is also delivered to the *b* position of "or" gate 51, and this opens the gate and delivers a positive signal to the *c* terminal of gate 44. This, of course, disables gate 44. As long as the positive signal is being delivered to the signal generator circuit 42a, the oscillator is energized and delivers an output signal 60 via lead 58 and input line 27 to amplifier 28. The amplified output 29 of course is delivered to the loudspeaker 30 for translation into an audible organ tone signal corresponding in pitch to that secured by keying string VI at the first position. It will be evident that for gate 44a to be enabled, string VI must continuously contact plate 49 and segment 41a and that any discontinuity in the string contact with either the plate 49 or fret segment 41a will close the gate 44a and de-activate the generator circuit 42a.

When string VI is keyed in the eighth position, the string assumes the position generally illustrated at 63 and comes into electrical contact with fret segments 41g and 41h. Contact with segment 41h establishes a negative potential condition at the *b* input position of "nor" gate 44h while the string contact with segment 41g establishes a negative potential condition at the *a* input position of gate 44h. By virtue of the readied condition provided by circuit 50 at the *c* input of gate 44h, the gate opens and delivers a positive output signal 45h via diode 46h of the actuating circuit 43h to the tone

signal generator circuit 42h associated with the eighth keying position. When gate 44h opens, the positive output signal is also delivered to the *b* input terminal of gate 51g. This opens the gate and delivers a disabling positive signal to the *c* input terminal of gate 44g and this disables circuit 43g. The positive signal is also fed to the *a* terminal of gate 51f so that all the "or" gates associated with the open string tone and the string keying positions lower than the eighth position are opened and deliver circuit disabling positive signals to the *c* positions of the "nor" gates associated with the open and lower keyed string tones. As a result, the actuating circuits associated with the lower tones playable on the string are disabled.

The output signal 64 from generator 42a during the period when string VI is in contact with both of the segments 41g and 41h is fed via lead 58 and input lead 27 to amplifier 28 and the amplified output 29 is translated into an audible musical tone in loudspeaker 30.

The conditioning circuits for strings I through V of guitar 11 are designated at 100, 101, 102, 103 and 104 in FIG. 1 and the "or" gates associated with the open string tones of these circuits are designated at 94, 95, 96, 97 and 98 respectively. The actuating circuits associated with the open string tones of strings I through V inclusive are designated at 105, 106, 107, 108 and 109 respectively and from the foregoing description it will be evident that when any of the strings of the guitar are keyed against the keyboard a disabling positive output signal is impressed upon the *c* input terminal of the actuating circuit associated with the open string tone of the string. With this in mind, reference is now made to FIG. 3 and wherein the embodiment illustrated in FIGS. 1 and 2 is shown as modified to avoid the need for sensing the open string tones of the guitar 11 in order to actuate the organ 12 oscillators associated with the open string tones when chords are being played on the stringed instrument.

In the embodiment illustrated in FIG. 3 the control system is the same both in components and operation as that illustrated in the previous embodiment except that the actuating circuits associated with the open string tones of the stringed instrument are modified and controlled by an auxiliary circuit 70 that is designed to respond to the simultaneous keying of any three of the strings I through VI of the guitar and to enable the actuating circuits associated with the open string tones of the unkeyed strings. Most chords playable on the guitar require that at least three strings be keyed, and hence the circuit 70 is designed to respond when three or more strings are keyed to actuate the tone producers associated with the open tones of the unkeyed strings.

Circuit 70 includes two input position positive "or" gates 71, 72, 73, 74, 75 and 76, three input position positive "nand" gates, 77, 78, 79 and 80, a four input position positive "nand" gate 81, inverters 82, 83, 84, 85, 86 and 87, and single pole, single throw switches designated at 88, 89, 90, 91, 92 and 93. The positive "nand" gates open when all inputs are positive and provide a negative output signal to gate 81. Gate 81 provides a positive output signal when any input is a negative signal as will be apparent to those skilled in the art.

The "or" gates associated with the open string tone actuating circuits for strings I through V of guitar 11 are designated at 94, 95, 96, 97 and 98 in FIG. 3, and the conditioning circuits of the control circuits 31, 32, 33, 34 and 35 are designated at 100, 101, 102, 103 and

104 respectively. The actuating circuits associated with the open string tones playable on strings I through V inclusive are designated at 105, 106, 107, 108 and 109 respectively while the "nor" gates of these actuating circuits are designated at 105a, 106a, 107a, 108a and 109a.

In the illustration, the output signal of "or" gate 94 is tapped by lead 112 of circuit 70 and delivered to the *a* position of gate 77. By a lead 113 tapped into line 112, the signal is also delivered to the *a* position of gate 71. The output signal of "or" gate 95 is tapped by lead 114 of circuit 70 and delivered to the *b* position of gate 77. By a lead 115 tapped to line 114, the signal is also delivered to the *b* position of gate 71. The output signal of gate 96 is tapped by lead 116 and delivered to the *a* position of gate 78. By a lead 117 tapped in line 116, the signal is also delivered to the *a* position of gate 72 as seen in the drawing. The output of "or" gate 97 is tapped by line 118 and delivered to the *b* position of gate 78 and by another lead 119 tapped in line 118 is also delivered to the *b* position of gate 72. The output of "or" gate 98 is tapped by line 120 and delivered to the *a* position of gate 79. By virtue of another line tap, the signal is also delivered by lead 121 to the *a* position of gate 73. Insofar as the circuitry associated with the sixth string is concerned, the output of "or" gate 51 is tapped by lead 122 of circuit 70 and delivered to the *b* position of gate 79 and also to the *b* position of gate 73 by lead 123 tapped in line 122.

The output terminal of gate 71 is connected by lead 124 to the *a* terminal of gate 80 and the output signal of gate 71 is also delivered to the *a* input terminal of gates 75 and 76 as by leads 125 and 126 which are tapped into line 124. The output terminal of gate 72 is connected by lead 127 to the *b* input terminal gate 80 and the signal from this gate 72 is also delivered to the *b* input terminals of gates 74 and 76 by leads 128 and 129. The output terminal of gate 73 is connected to the *c* input terminal of gate 80 by lead 130 and the output signal of this gate is also delivered to the *a* input terminal of gate 74 by lead 131. The output signal of gate 73 is also delivered to the *b* input terminal of gate 75 by means of a lead 132 that is tapped into line 131. The outputs of gates 74, 75 and 76 are delivered to the *c* input terminals of gates 77, 78 and 79 respectively as by leads 133, 134 and 135.

As seen in the drawings, the output terminals of gates 77, 78, 79 and 80 are connected by leads 136, 137, 138 and 139 to the input terminals of gate 81. The output of gate 81 is delivered to trunk lead 136a in circuit 70 and then delivered by leads 137a, 138a, 139a, 140, 141 and 142 to the inverters 82 through 87 respectively.

The output signals of inverters 82 through 87 are delivered by leads 143, 144, 145, 146, 147 and 148 respectively to the *b* input terminals of the "nor" gates respectively associated with actuating circuits 105, 106, 107, 108, 109 and 43, and also to the *a* input terminals of the gates 105a, 106a, 107a, 108a, 109a and 44 by virtue of tie-in leads designated at 149, 150, 151, 152, 153 and 154 in FIG. 3.

Switches 88 through 93 inclusive are connected in lines 143 through 148 respectively. Most chords that are played on the guitar involve the strumming of all the six strings and hence under such circumstances, all of the switches 88 through 93 are maintained in the closed position. Occasions arise however when certain chord sequences involve the strumming of less than all

the strings and under such circumstances the switch or switches associated with the strings that are not normally strummed during the chord playing sequence would naturally be opened by the player.

Operation of the embodiment shown in FIG. 3 will now be explained under the assumption that switches 88 through 93 are in the closed positions. Under such circumstances, once the strings I through VI and conditioning circuits 100, 101, 102, 103, 104 and 50 are energized, the actuating circuits 105, 106, 107, 109, 109 and 43 are conditioned to receive enabling signals. Under such circumstances a negative potential condition is established at each of the *c* input positions for "nor" gates 105, 106a, 107a, 108a, 109a and 44. Under these ready conditions all of the gates 71 through 81 inclusive are closed and the negative potential condition existing at the inputs of inverters 82 through 87 establishes gate disabling positive potential conditions at the *a* and *b* inputs of gates 105a, 106a, 107a, 108a, 109a and 44.

Assuming now under the readied condition strings II, IV and V are depressed by a player of the stringed instrument to play a chord. Under such circumstances, gates 95, 97 and 98 are opened and impress a gate disabling positive potential at the *c* inputs of gates 106a, 108a and 109a. The positive output signals from gates 95, 97 and 98 are also delivered to gates 71, 72 and 73 and which opens these gates and delivers positive gate opening signals to each of the "or" gates 74, 75 and 76 as well as to the "and" gate 80. Gates 77, 78 and 79 remain disabled under these circumstances but the opening of gate 80 delivers a gate opening negative signal to gate 81 which impresses a positive voltage condition at the inputs of each of the inverters 82 through 87 inclusive. In turn and by virtue of leads 143 through 148 inclusive, negative potential conditions are established at the *a* and *b* positions of each of the "nor" gates 105a, 106a, 107a, 108a, 109a and 44. This enables circuits 105, 107 and 43 and actuates the signal generators associated with the open string tones of the unkeyed strings I, III and VI, while the conditioning circuits 101, 103 and 104 associated with the keyed strings II, IV and V, render the actuating circuits associated with the open tones and lower keying positions disabled. Tracing of the circuitry shown in FIG. 3 will show that gate 77 opens when strings I and II and any one of the strings III, IV, V or VI are keyed against the keyboard. It will also show that gate 78 opens when strings III and IV and any one of the strings I, II, V and VI are keyed against the keyboard while gate 79 opens when strings V and VI and any one of the strings I, II, III or IV are keyed against the keyboard. Gate 80 on the other hand opens when simultaneously one string from each of the pairs of strings I and II, strings III and IV and strings V and VI are keyed against the keyboard. Accordingly, when any three strings are keyed simultaneously, one of the four gates 77, 78, 79 and 80 opens to deliver a gate opening signal to gate 81 which in turn results in the enabling of the circuits associated with the unkeyed strings.

From the foregoing description it will be apparent that when three or more strings are keyed in the playing of a chord the actuating circuits associated with the open tones and lower keying positions are disabled and that circuit 70 responds to the condition and delivers a circuit enabling signal to the actuating circuit associated with the open string tone of the unkeyed strings.

While only certain preferred embodiments of this invention have been shown and described by way of illustration, many modifications will occur to those skilled in the art and it is, therefore, desired that it be understood that it is intended herein to cover all such modifications as fall within the true spirit and scope of this invention.

What is claimed as new and what it is desired to secure by Letters Patent of the United States is:

1. The combination comprising

a. a first musical instrument which includes

1. a keyboard having a nut end, and

2. musical strings that are keyed against said keyboard at string keying positions when keyed string tones are played on said strings,

b. a second musical instrument having tone producing means for producing audible tones that correspond in pitch to keyed string tones which are playable on said strings, and

c. a control circuit for controlling said tone producing means to simultaneously produce an audible tone that corresponds in pitch to a keyed string tone being played on one of said strings,

said control circuit comprising

1. a plurality of fret segments that are mounted on said keyboard and spaced apart one adjacent to the next in a row which underlies said one string and which commencing at said nut end extends remotely of said nut end, and

2. a plurality of actuating circuits that are connected to the respective fret segments and to said tone producing means,

each of said fret segments being located at a respective one of said string keying positions and being arranged for contact by said one string when said one string is keyed against the keyboard thereat, said one string having string tones which are playable thereon and which include

1. an open string tone, and

2. a plurality of keyed string tones of progressively higher pitch than said open string tone,

said keyed string tones of progressively higher pitch being respectively associated with said fret segments and being playable on said one string when said one string is keyed into contact with the fret segment associated therewith,

each of said actuating circuits being to actuate said tone producing means to produce an audible tone that corresponds in pitch to the respective one of said keyed string tones of progressively higher pitch that is associated with the fret segment connected thereto,

said actuating circuits including

a first circuit for actuating said tone producing means to produce an audible tone that corresponds in pitch to the keyed string tone that is associated with the one of said fret segments connected to said first circuit,

said first circuit being responsive to simultaneous contact by said one string with said one fret segment and with another of said fret segments that is located next adjacent thereto in said row, and the other of said fret segments being further located between said nut end and said one fret segment.

2. The combination in accord with claim 1 where said first circuit has an output signal, where said control circuit comprises

a second circuit which is connected to said actuating circuits, and
 where said second circuit is controlled by said first circuit and responsive to said output signal to disable the actuating circuits which are connected to the fret segments located between said nut end and said one fret segment. 5

3. The combination in accord with claim 2 where said control circuit comprises

a third circuit that is connected to said tone producing means and responsive to the playing of said open string tone on said one string for actuating said tone producing means to produce an audible tone that corresponds in pitch to said open string tone, and 15

where said second circuit is connected to said third circuit and also disables said third circuit in response to said output signal.

4. The combination comprising

a. a first musical instrument which includes 20

a keyboard, and

musical strings that are keyable against said keyboard,

b. a second musical instrument having 25

tone producing means for producing audible tones that correspond in pitch to string tones playable on said strings, and

c. a control system that includes

a plurality of control circuits that are respectively associated with said strings, 30

each of said strings having string tones which are playable thereon and which includes

1. an open string tone, and

2. a plurality of keyed string tones of progressively higher pitch than said open string tone, 35

each of said control circuits being connected to said tone producing means for controlling said tone producing means to produce audible tones that correspond in pitch to string tones playable on a respective one of said strings and including 40

a first circuit component which is connected to said tone producing means for actuating said tone producing means to produce an audible tone that corresponds in pitch to the open string tone of said respective one string, and 45

a second circuit component which is connected to said first circuit for disabling said first circuit component when said respective one string is keyed against said keyboard, 50

said second circuit component having an output signal when said first circuit component is disabled, and

said combination comprising

an auxiliary circuit connected to receive the output signals from the second circuit components of said control circuits and being responsive to the simultaneous receipt of the output signals from a predetermined number of said control circuits for enabling the first circuit components of the control circuits associated with the unkeyed ones of said strings, 60

said predetermined number being less than the total number of strings.

5. The combination in accord with claim 4 where each of said control circuits includes 65

a plurality of fret segments that are mounted on said keyboard and spaced apart one adjacent the

next in a row which underlies said respective one string and which commencing at said nut end extends remotely of said nut end, and

a group of actuating circuits that are connected to the respective fret segments and to said tone producing means,

each of said fret segments being located at a respective one of said string keying positions and being arranged for contact by said respective one string when said respective one string is keyed against the keyboard thereat,

the keyed string tones of progressively higher pitch playable on said respective one string being respectively associated with said fret segments and being playable on said respective one string when said respective one string is keyed into contact with the fret segment associated therewith,

each of said actuating circuits being to actuate said tone producing means to produce an audible tone that corresponds in pitch to the respective one of said keyed string tones of progressively higher pitch that is associated with the fret segment connected thereto,

said actuating circuits including

a third circuit for actuating said tone producing means to produce an audible tone that corresponds in pitch to the keyed string tone that is associated with the one of said fret segments connected to said third circuit,

said third circuit being responsive to simultaneous contact by said respective one string with said one fret segment and with another of said fret segments that is located next adjacent thereto in said row, the other of said fret segments being located between said nut end and said one fret segment, and

where said second circuit is connected to said actuating circuits and controlled to respond to said third circuit and disable said first circuit and the actuating circuits which are connected to the fret segments between said nut end and said one fret segment.

6. The combination comprising

a. a first musical instrument which includes

1. a keyboard and

2. musical strings that are keyed against said keyboard in playing keyed string tones thereon,

b. a second musical instrument having tone producing means for producing audible tones that correspond in pitch to string tones playable on said strings, and

c. a plurality of control circuits that are respectively associated with said strings,

each of said control circuits being connected to said tone producing means for controlling said tone producing means to produce audible tones that correspond in pitch to string tones playable on the respective one of said strings that is associated with the control circuit,

said respective one string having string tones which are playable thereon and which includes

a. an open string tone, and

b. a plurality of string tones of progressively higher pitch than said open string tone,

said control circuit comprising

a first circuit component connected to said tone producing means for actuating said tone producing means to produce an audible tone that corre-

sponds in pitch to the open string tone playable on said respective one string, and
 a second circuit component which is connected to said first circuit component for disabling said first circuit component when said respective one string is keyed against said keyboard,
 said second circuit component having an output signal when said first circuit component is disabled, and
 an auxiliary circuit which is connected to receive the output signals from the second circuit components of said control circuits and which is responsive to the simultaneous receipt of the output signals from a predetermined number of said control circuits for enabling the first circuit components of said control circuits which are associated with the then unkeyed ones of said strings,
 said auxiliary circuit being connected to each of the first circuit components of said control circuits, and
 said predetermined number being less than the total number of said strings.

7. The combination comprising

- a guitar which includes a keyboard having a nut end, and strings that are keyed against the keyboard at string keying positions in playing keyed string tones on said strings,
- an electronic organ having tone signal generators, and
- a control circuit connected to said generators for controlling said generators to simultaneously produce a tone signal that is translatable to an audible tone which corresponds in pitch to a string tone being played on one of said strings, said control circuit comprising
 - a plurality of fret segments that are mounted on said keyboard and spaced apart one adjacent to the next in a row which underlies said one string and which commencing at said nut end extends remotely of said nut end, and
 - a plurality of actuating circuits for actuating the respective generators,
 each of said fret segments being located at a respective one of the string keying positions and being arranged for contact by said one string when said one string is keyed against the keyboard thereat,
 said one string having string tones that are playable thereon and which include
 an open string tone, and
 a plurality of keyed string tones of progressively higher pitch than said open string tone,
 said keyed string tones of progressively higher pitch being respectively associated with said fret segments and being playable on said one string when said one string is keyed into contact with the fret segment associated therewith,
 said plurality of actuating circuits comprising
 a group of circuits that are connected to the respective fret segments,
 each of the grouped circuits being connected to a respective one of said generators for actuating the respective one generator to produce a tone signal that is translatable to an audible tone which corresponds in pitch to the one of said keyed string tones that is associated with the fret segment connected thereto,
 said grouped circuits including

a first circuit for actuating the generator connected thereto to produce a tone signal that is translatable to an audible tone which corresponds in pitch to the keyed string tone that is associated with the one of said fret segments connected to said first circuit,
 said first circuit being responsive to simultaneous contact by said one string with said one fret segment and with another of said fret segments that is located next adjacent thereto in said row, and the other of said fret segments being further located between said nut end and said one fret segment.

8. The combination in accord with claim 7 where said first circuit includes first gate means having an output signal,
 where the generator connected to said first circuit is connected to receive and actuated during the receipt of said output signal, and
 where said first gate means is enabled during said simultaneous contact to produce said output signal.

9. The combination in accord with claim 8 where said generators include
 a first generator that is actuatable to produce a tone signal that is translatable to an audible tone which corresponds in pitch to the open string tone playable on said one string,
 where said plurality of actuating circuits comprise
 a second circuit for actuating said first generator and which is responsive to and has means for sensing said open string tone,
 where said control circuit comprises
 a third circuit connected to said plurality of actuating circuits and having second gate means operating under the control of said first gate means for disabling said second circuit and the grouped circuits which are connected to the fret segments between said nut end and said one fret segment,
 said second circuit and the grouped circuits which are connected to the fret segments between said nut end and said one fret being controlled by said second gate means, and
 said second gate means being connected to receive said output signal and being enabled during the receipt of said output signal.

10. The combination in accord with Claim 8 where said control circuit comprises
 second gate means operating under the control of said first gate means for disabling the grouped circuits which are connected to the fret segments between said nut end and said one fret segment,
 said second gate means being connected to receive and being enabled during receipt of said output signal.

11. The combination comprising

- a guitar having a keyboard and strings that are keyable against said keyboard,
- an electronic organ having tone signal generating means, and
- a plurality of control circuits that are respectively associated with said strings for controlling said generating means to simultaneously produce tone signals that are translatable to audible tones which respectively correspond in pitch to keyed string tones being played on said strings,
 each of said strings having string tones which are playable thereon and which include an open string tone and a plurality of keyed string tones of pro-

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gressively higher pitch than said open string tone, each of said control circuits being connected to said generating means and including

1. a first circuit for actuating said generating means to produce a tone signal translatable to an audible tone corresponding in pitch to the open string tone playable on the string associated with the control circuit, and
2. a second circuit for disabling said first circuit when a keyed string tone is being played on the string associated with said control circuit and having an output signal when said first circuit is disabled,

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said first circuit being connected to receive said output signal from said second circuit, and an auxiliary circuit which is connected to receive the output signals from the second circuits of said control circuits and which is responsive to simultaneous receipt of a predetermined number of said output signals from said second circuits for enabling the first circuits of the control circuits that are associated with the unkeyed ones of said strings.

12. The combination in accord with claim 11 where said predetermined numbers is three.

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