

[54] **ELECTRONIC MUSICAL INSTRUMENT
HAVING AUTOMATIC BASS TONE
SELECTOR**
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[51] Int. Cl. G10h 3/06
[58] **Field of Search** 84/1.01, 1.03, 1.24, 1.26;
307/253

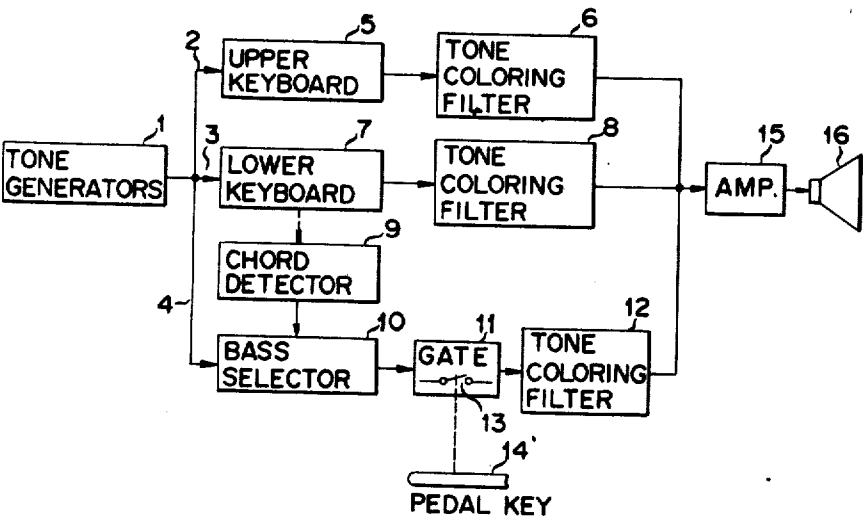
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Assistant Examiner—U. Weldon
Attorney—Flynn & Frishauf

[57] **ABSTRACT**
In an electronic musical instrument comprising an
upper keyboard for a melody performance, a lower
keyboard for a chord performance and a pedal
keyboard for a bass performance there are provided a
chord detector for detecting the type of a chord
played on the lower keyboard upon depression of the
keys thereof; a bass selector responsive to outputs
from the chord detector for selectively coupling out
from the tone generators bass tone signals correspond-
ing to a note included in the chords played on the
lower keyboard; and a gate circuit supplied with the
bass tone signals from the bass selector and so
designed as to be enabled by operation of one of the
keys of the pedal keyboard. The pedal keyboard com-
prises only one or two keys for controlling one gate
circuit supplied with one bass tone signal correspond-
ing to the root note, or two gate circuits supplied
respectively with one bass tone signal corresponding
to the root note and fifth note included in the chord
played on the lower keyboard.

3 Claims, 12 Drawing Figures



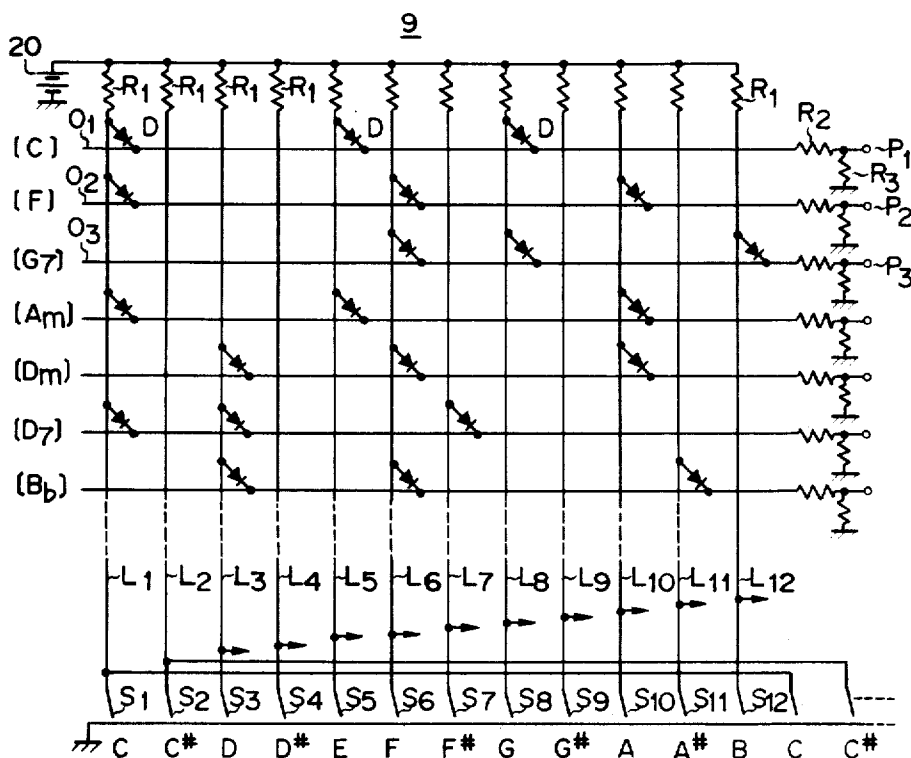
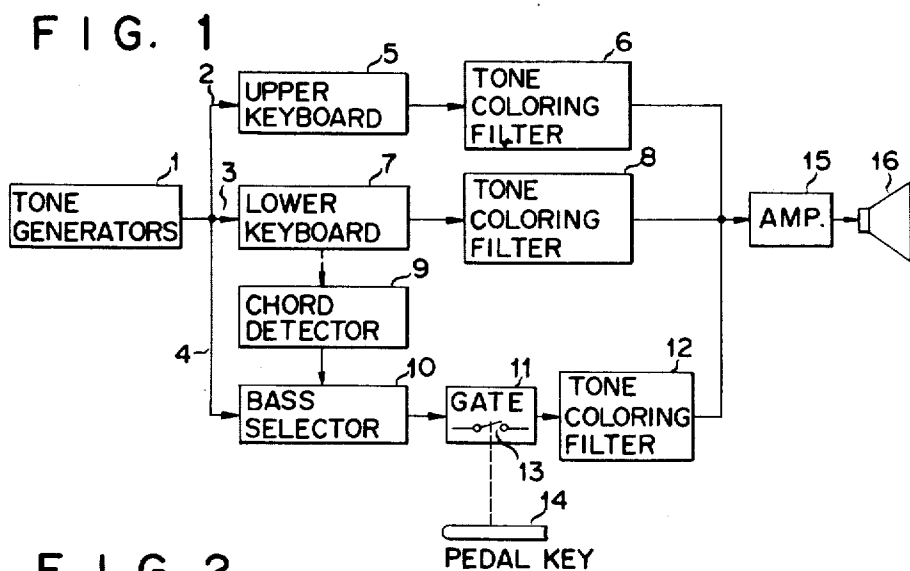


FIG. 3

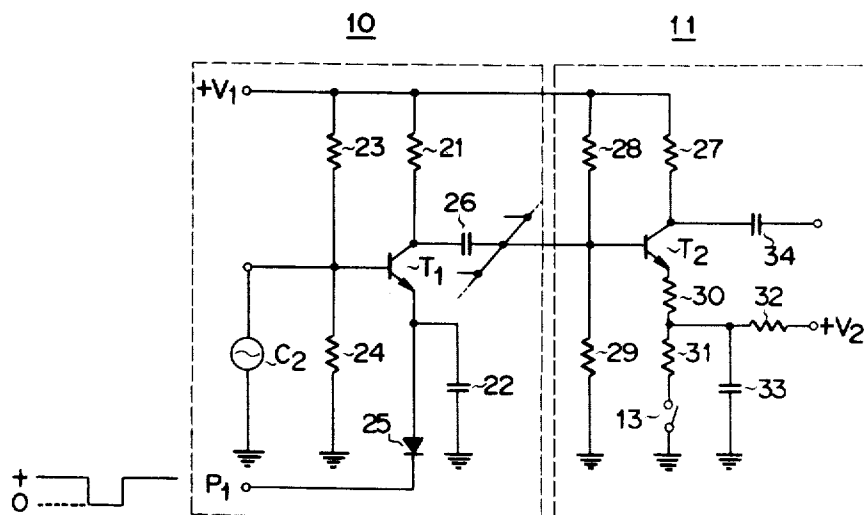


FIG. 4

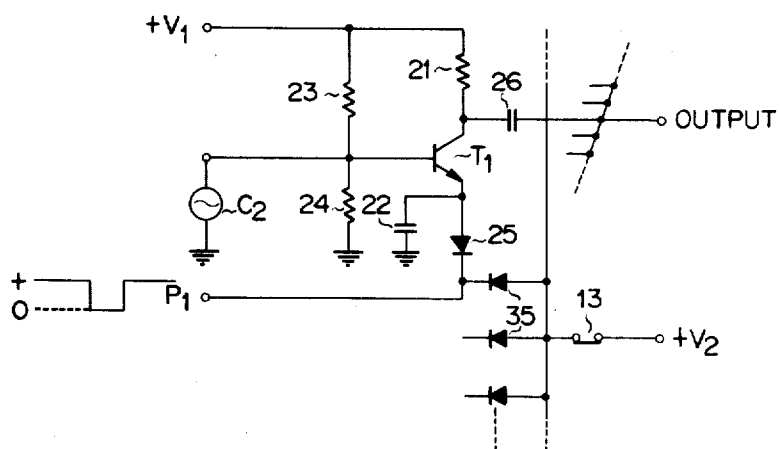


FIG. 5A

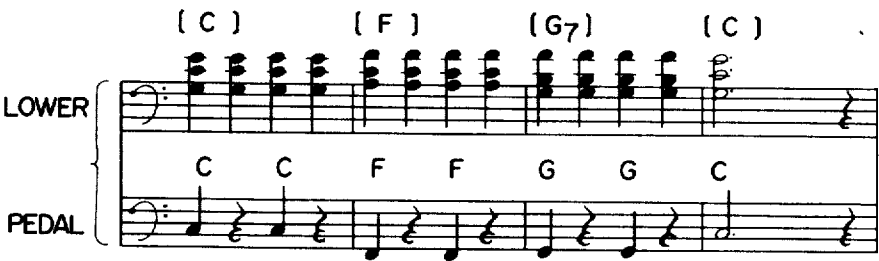


FIG. 5B

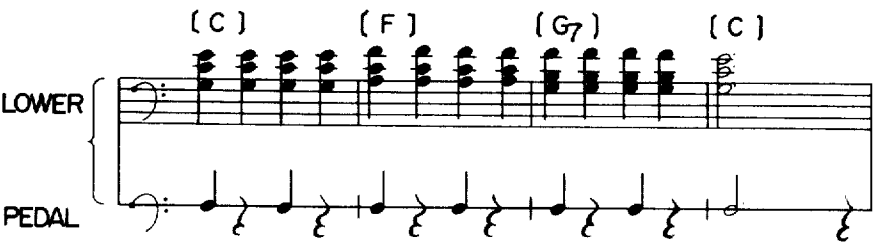
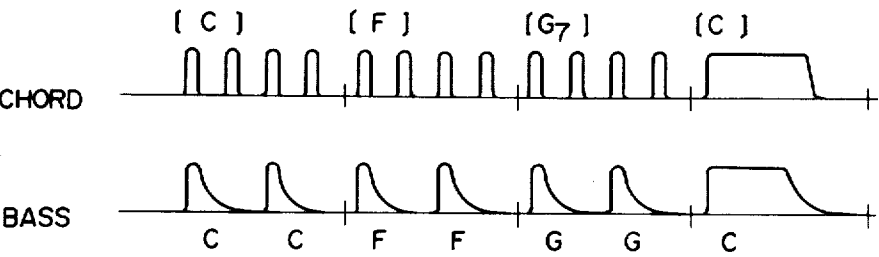


FIG. 5C



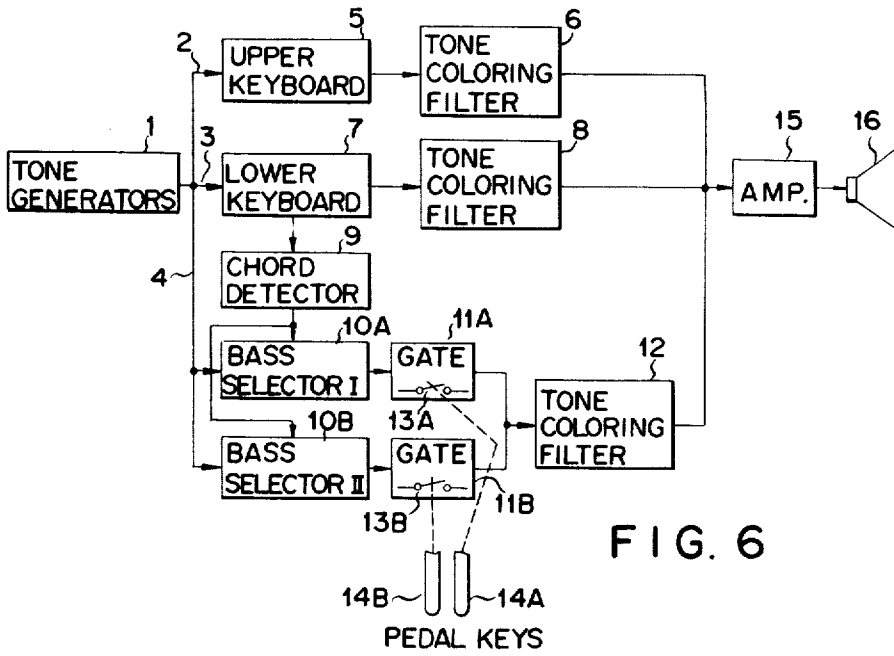


FIG. 6

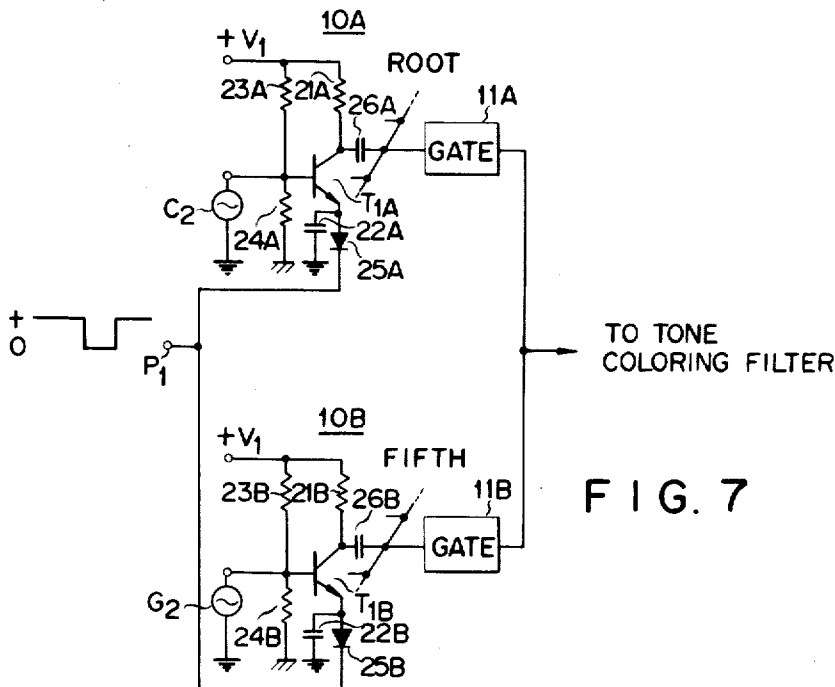


FIG. 7

FIG. 8A



FIG. 8B

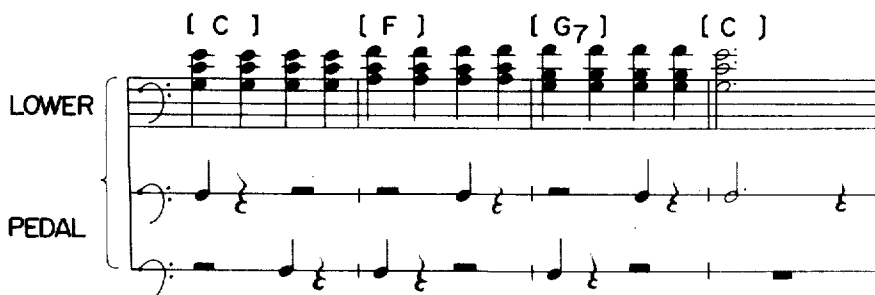
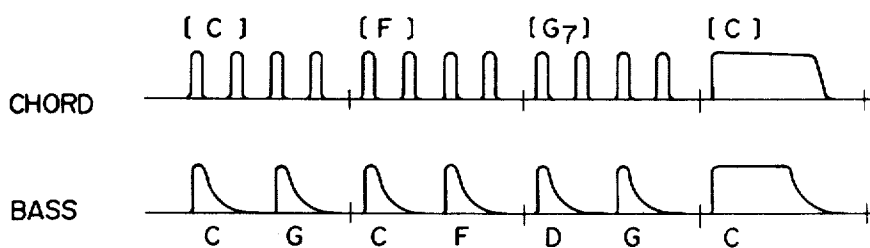


FIG. 8C



ELECTRONIC MUSICAL INSTRUMENT HAVING AUTOMATIC BASS TONE SELECTOR

The present invention relates to an electronic musical instrument and more particularly to improvements to facilitate a bass performance on the pedal keyboard.

With a conventional electronic organ having upper, lower and pedal keyboards, a melody performance is generally played by operation of the upper keyboard with the right hand, a chord performance by operation of the lower keyboard with the left hand, and a bass performance by operation of the pedal keyboard with the left foot. In this case, the left hand chord performance and the left foot bass performance are commonly conducted with a certain rhythmic pattern, like that of a march or waltz. However, the cord and bass performances with the left hand and left foot require considerable skill, because they have to be played in conjunction with the melody performance with the right hand. Particularly, a beginner finds it extremely difficult to carry out a rhythmic accompaniment of chord and bass exactly conforming with a melody performance. The chord performance is effected by depressing some of the keys of the lower keyboard at the same time as well as rhythmically, and the bass performance is carried out by selectively depressing one after another those of the thirteen pedal keys constituting a full octave which conform with the chord performance. Accordingly, the bass performance presents greater difficulties to the beginner than the chord performance.

It is, accordingly, the object of the present invention to provide an electronic musical instrument facilitating a bass performance.

The object of the present invention is attained in that there are provided a chord detector for detecting the type of chord played on the lower keyboard upon depression of the keys thereof; at least one bass selector for selectively coupling out from the tone generators bass tone signals corresponding to a note included in the chord in response to output signal from the chord detector; and at least one bass gate circuit for receiving the bass tone signal from the bass selector, the gate circuit being conducted (i.e., enabled) upon depression of one of the keys of the pedal keyboard. In accordance with the present invention it is only required that the pedal keyboard be provided with one or two keys.

The present invention can be more fully understood from the following detailed description when taken in conjunction with the appended drawings, in which:

FIG. 1 is a block diagram of an electronic musical instrument according to an embodiment of the present invention;

FIG. 2 is a circuit diagram of a chord detector shown in FIG. 1;

FIG. 3 represents a bass selector circuit and gate circuit shown in FIG. 1;

FIG. 4 illustrates a bass selector circuit and gate circuit according to another embodiment of the invention;

FIG. 5A, 5B and 5C show musical notations useful in explaining the operation of the electronic musical instrument of FIG. 1;

FIG. 6 is a block diagram of an electronic musical instrument according to another embodiment of the invention;

FIG. 7 is a circuit diagram of the bass selectors of FIG. 6; and

FIG. 8 indicates musical notations useful in explaining the operation of the electronic musical instrument of FIG. 6.

Referring to FIG. 1, tone signals from tone generators 1 are distributed to the upper, lower and pedal keyboard channels 2, 3 and 4. As is well known, the upper keyboard channel 2 includes an upper keyboard 5 having key switch circuits for selectively keying tone signals from the tone generators 1 upon depression of the keys and tone coloring filters 6 for converting the selected tone signals to musical tone signals. Similarly, the lower keyboard channel 3 includes a lower keyboard 7 having key switch circuits for selectively keying tone signals from the tone generators 1 upon depression of the keys and tone coloring filters 8 for converting the selected tone signals to musical tone signals.

According to the present invention, there is provided a chord detector 9 for detecting the type of chord played by operation of the lower keyboard 7. Further, the pedal keyboard channel 4 of the electronic musical instrument of the invention includes a bass selector 10 for selectively coupling out from the tone generators 1 bass tone signals corresponding to a note, preferably the root note included in the chords, in response to output signals from the chord detector 9; a bass gate circuit 11 supplied with bass tone signals from the bass selector 10; and tone coloring filters 12 supplied with the bass tone signal upon conduction of the bass gate circuit 11. As illustrated in FIG. 1, the bass gate circuit 11 is provided with a key switch 13 and is conducted (i.e., enabled) by a single key 14 constituting the pedal keyboard. Depression of the pedal key 14 actuates the key switch 13 to conduct the gate circuit 11, causing a bass tone signal to be supplied from the bass selector 10 to the tone coloring filters 12.

Musical tone signals from the respective channels 2, 3 and 4 are amplified by an amplifier 15 and converted to audible sounds by a loud speaker 16.

With an electronic organ of FIG. 1, a melody performance is conducted as usual by operation of the upper keyboard 5 with the right hand, and a chord performance by operation of the lower keyboard 7 with the left hand. While the chord performance is being played on the lower keyboard, the type of chord played is distinguished by the chord detector 9, and a bass tone signal corresponding to one of the notes included in the chord is selected by the bass selector 10 responsive to the output of the chord detector 9 and then supplied from the tone generators 1 to the gate circuit 11. The rhythmic operation of the pedal key 14 causes bass tone signals to be supplied to the tone coloring filters 12 in a rhythm pattern corresponding to the operation of the pedal key 14. Namely, the present invention enables a bass performance to be carried out simply by operation of a single pedal key without the necessity of selecting one of a plurality of (thirteen) pedal keys as is the case with the prior art electronic organ.

There will now be described by reference to FIG. 2 the chord detector 9 of FIG. 1. The chord detector 9 comprises a matrix circuit having a plurality of column lines, row lines and diodes positioned at the prescribed intersections of both lines. The matrix circuit has

twelve column lines L_1 to L_{12} corresponding to the notes of one octave, the ends on one side of the column lines being grounded by normally open key switches S_1 to S_{12} operated by the respective keys of the lower keyboard 7. The switches actuated by the keys corresponding to the same notes in the different octaves are respectively connected to the same common column lines included in the matrix circuit. The ends on the other side of the column lines are connected through a resistor R_1 to one end of a common power source 20, the other end of which is grounded. The matrix has the same number of row lines or output lines $O_1, O_2, O_3, \dots$ as the kinds of chords to be played on the lower keyboard. FIG. 2 indicates seven row lines representing chords [C], [F], [G $_7$], [A $_m$], [D $_m$], [D $_7$] and [B ^{b}]. The ends on one side of the row lines are grounded through resistors R_2 and R_3 . At the prescribed intersections between the row lines denoting these chords and column lines are connected diodes in the forward direction with respect to the polarity of the power source 20 to which the column lines are connected to detect. For example, for chord [C], there are connected diodes D of the indicated polarity to three intersections defined by row line O_1 with column line L_1 , connected to switch S_1 operated by the key of the lower keyboard corresponding to note C included in chord [C], column line L_3 connected to switch S_3 corresponding to note E and column line L_8 connected to switch S_8 corresponding to note G.

Referring to the operation of the aforesaid chord detector, the diodes are connected to the intersections of the row lines and column lines in the forward direction with respect to the positive source voltage, so that the potential of the detection terminal of the row line, or the juncture between resistors R_2 and R_3 is normally kept positive. Depression of the keys of the lower keyboard corresponding to, for example, notes C, E and G causes switches S_1, S_3 and S_8 to be closed and in consequence column lines L_1, L_3 and L_8 to be grounded. Accordingly, the power source 20 is short-circuited with column lines L_1, L_3 and L_8 by the resistor R_1 , preventing row line O_1 connected to column lines L_1, L_3 and L_8 by the diodes from being impressed with voltage, so that the potential of the detection terminal P_1 of row line O_1 , that is, the voltage across the resistor R_3 is reduced to zero. At this time, the potentials of the detection terminals $P_2, P_3, \dots$ of the other row lines are still kept positive. From the fact that the potential of the detection terminal of row line O_1 associated with the chord [C] was changed from positive to zero, the chord performed by operation of the lower keyboard is distinguished as [C]. The detected output controls the bass selector 10. This selector 10 may be constructed as illustrated in FIG. 3.

FIG. 3 illustrates one of the selector circuits included in the bass selector 10 and a common bass gate circuit 11, the selector circuit being associated with the chord [C]. The selector circuit includes, for example, an NPN type transistor T_1 , the collector of which is connected to a positive power source through a resistor 21, the emitter of which is grounded through a capacitor 22 and the base of which is connected to the juncture between resistors 23 and 24 which are disposed between the power source and earth. The base of the transistor T_1 is normally supplied by the tone genera-

tors 1 with a bass tone signal C_2 corresponding to the root note C of the chord [C]. The emitter of transistor T_1 is connected to the output terminal P_1 included on the chord detector 9 for detection of the chord [C] shown in FIG. 2 through a diode 25 disposed in the same direction as the base-emitter diode of transistor T_1 . A bass tone signal from the selector circuit is drawn out from the collector of transistor T_1 through a coupling capacitor 26 and supplied to the bass gate circuit 11. Bass tone signals from the other selector circuits included in the bass selector 10 are also impressed on the same gate circuit 11 through respective coupling capacitors.

The bass gate circuit 11 includes, for example, an NPN type transistor T_2 , the collector of which is connected to a power source ($+V_1$) through a resistor 27, the base of which is connected to the juncture between resistors 28 and 29 arranged in series between the power source and ground, and also to the capacitor 26 of the selector circuit, and the emitter of which is grounded through resistors 30 and 31 and the key switch 13 of FIG. 1 in this order. The juncture between the resistors 30 and 31 is connected to a control voltage source ($+V_2$ through a resistor 32, and a circuit including the resistor 31 and key switch 13 connected in series is shunted by a capacitor 33. The output from the gate circuit 11 is drawn out from the collector of the transistor T_2 through a capacitor 34.

There will now be described the operation of the circuit of FIG. 3. When the output terminal P_1 of an output line O_1 for detection of the chord [C] of FIG. 2 is supplied with positive voltage by the power source 20, the transistor T_1 is rendered inoperative to cease the supply of the bass tone signal C_2 to the bass gate circuit 11. When the chord [C] is played on the lower keyboard, namely when there are depressed the keys corresponding to the notes C, E and G, then the potential of the output terminal P_1 is reduced to zero as shown in FIG. 3 to cause the transistor T_1 to be rendered operative and the bass tone signal C_2 to be supplied to the gate circuit 11.

The capacitor 33 connected to the emitter of transistor T_2 of the bass gate circuit 11 is charged by the voltage source ($+V_2$, whose voltage is high enough to render the transistor T_2 normally nonconductive. When the key switch 13 is closed by operation of the pedal key 14, the charged voltage is dissipated through the resistor 31 and key switch 13 to decrease the emitter potential and in consequence render the transistor T_2 operative. Namely, when the key switch 13 is closed, a bass tone signal from the bass selector circuit T_1 which has already been energized is drawn out from the collector of transistor T_2 of the bass gate circuit 11. The capacitor 22 connected to the emitter of transistors T_1 of the selector circuit 10 is intended to allow the transistors T_1 to remain conductive for a predetermined length of time (preferably about 0.5 second), though, after the lower keyboard ceases to be operated, the voltage impressed on the output terminal P_1 of the chord detector 9 rises from zero to the same level as the source voltage.

The selector circuit including the transistor T_1 shown in FIG. 3 may be allowed to concurrently act as the gate circuit including the transistor T_2 . FIG. 4 illustrates such case. The same parts of FIG. 4 as those of

FIG. 3 and denoted by the same numerals. The junction between the diode 25 connected to the emitter of transistors T_1 included in the bass selector circuit 10 and the output terminal P_1 of the chord detector 9 is connected to the control voltage source ($+V_2$) through a circuit including a diode 35 and the normally closed key switch 13 connected in series. The diodes 35 is disposed in the forward direction with respect to the voltage source ($+V_2$). The transistors T_1 of the other selector circuits are supplied with the control voltage through respective diodes 35, and common key switch 13.

In the circuit of FIG. 4, while the key switch 13 is closed, the transistor T_1 is rendered inoperative due to the control voltage ($+V_2$), though the potential of the output terminal P_1 of the chord detector 9 is made to otherwise become zero. Opening of the key switch 13 by depression of the pedal key 14 separates the emitter circuit of transistor T_1 from the control source and thus a bass tone signal can be derived from the collector of transistor T_1 as long as the potential of the output terminal P_1 of the chord detector 9 is zero.

There will now be described by reference to FIGS. 5A, 5B and 5C the operation of the electronic musical instrument of FIG. 1. FIG. 5A illustrates musical notations for the chord and bass performances which it is desired to play on the lower and pedal keyboards. It will be apparent from the illustration that the chords [C], [F], [G₇] and [C] are played in turn at the respective measures and that the bass performance is conducted by the root notes of the chords defined by the measures and that the bass performance is conducted by the root notes of the chords defined by the measures.

FIG. 5B indicates the manner of operation of the lower and pedal keyboards when the notations of FIG. 5A are to be played. As seen from the illustration, the lower keyboard should be rhythmically operated four times for each measure, whereas a single key constituting the pedal keyboard has only to be operated twice for each measure.

FIG. 5C shows musical tones produced by the keyboard operation indicated in FIG. 5B. It is seen that bass tones last longer than chord tones. This is due to the action of the capacitor 22 connected to the emitter of transistors T_1 included in the bass selector circuit as shown in FIGS. 3 and 4.

The foregoing embodiment relates to the case where the bass performance was carried out according to the root note on the chord alone, that is, only by operation of a single pedal key. However, the bass performance may also be conducted according to both the root and fifth notes of the chord and by operation of two pedal keys to provide a better musical effect. This embodiment is presented in FIG. 6.

According to the embodiment of FIG. 6, the pedal keyboard channel 4 includes a first bass selector 10A for selectively drawing out a bass tone signal corresponding to the root note of the chord; a second bass selector 10B for drawing out a bass tone signal corresponding to the fifth note of the chord; a first bass gate circuit 11A supplied with the bass tone signal by the first bass selector 10A; and a second bass gate circuit supplied with the bass tone signal from the second bass selector 10B. Output signals from the first and

second bass gate circuits 11A and 11B are conducted to the common tone coloring filters 12. The pedal keyboard is comprised of two keys 14A and 14B. The key switches 13A and 13B actuated by the keys 14A and 14B respectively are disposed in the first and second bass gate circuits 11A and 11B. FIG. 7 shows the circuits of the bass selectors 10A and 10B of FIG. 6. These gate circuits 10A and 10B are of the same arrangement as that of FIG. 3 and the same parts of FIG. 7 as those of FIG. 3 are denoted by the same numerals. Elements included in the selector circuit of the root note are indicated by reference notations suffixed with the letter A and elements included in the selector circuit of the fifth note bear reference notations suffixed with the letter B.

In this case, the base of transistor T_{1A} of the selector circuit 10A for the root note is supplied with a bass tone signal C_2 corresponding to the root note C of the chord [C]. And the base of transistor T_{1B} of the selector circuit 10B for the fifth note is supplied with a bass tone signal G_2 corresponding to the fifth note G of the chord [C]. The emitters of transistors T_{1A} and T_{1B} are jointly connected to the output terminal P_1 of the chord detector 9 through diodes 25A and 25B respectively.

Outputs from the selector circuits of the root notes of the other chords are coupled to the gate circuit 11A. Similarly, outputs from the selector circuits of the fifth notes of the other chords are coupled to the gate circuit 11B. The circuit of FIG. 7 arranged as described above is operated in the same manner as that of FIG. 3. When the potential of the output terminal P_1 of the chord detector 9 decreases as shown in FIG. 7, the selector circuits T_{1A} and T_{1B} are jointly rendered operative to cause bass tone signals C_2 and G_2 to be drawn out therefrom and supplied to the gate circuits 11A and 11B. These circuits 11A and 11B are alternately conducted by either of the two pedal keys 14A and 14B.

FIG. 8A illustrates the musical notations of the chord and bass performances which it is desired to play by the electronic musical instrument of FIG. 6. It will be apparent from the illustration that the bass performance is carried out alternately according to either of the root and fifth notes of the chord. To this end, the two pedal keys have only to be operated alternately as shown in FIG. 8B. Consequently, desired musical tones can be produced as shown in FIG. 8C.

The foregoing embodiments of FIGS. 3 and 7 relate to the cases where was conducted a bass performance according to the root note of one chord and the root and fifth notes thereof respectively. Where it is desired to carry out a bass performance by three or more bass tone signals with respect to one chord, namely, where, in case of, for example, the chord [C], it is desired to produce three bass tones corresponding to the root note C, fifth note G and other note E of the chord, it is only required to use one more bass selector circuit and one more gate circuit, and one more pedal key for control of the additional gate circuit.

What I claim is:

1. An electronic musical instrument comprising:
 - a plurality of tone generators;
 - an upper keyboard for melody performance having key switch circuits for selecting tone signals from said tone generators;

a lower keyboard for chord performance having key switch circuits for selecting tone signals from said tone generators;

a matrix-connected chord detector coupled to said lower keyboard for detecting and identifying the type of chords played on said lower keyboard by detecting which keys of said lower keyboard are actuated, said chord detector comprising:

a plurality of column lines, one end of each of which is grounded through a detector switch actuated through operation of said lower keyboard and the other end of each of which is connected to a D.C. source through a resistor;

a plurality of row lines provided for each different chord and intersecting said plurality of column lines, said row lines being grounded at one end through a resistor; and

at least two diodes connected in the forward direction with respect to said D.C. source polarity between each row line and at least two of said plurality of column lines connected to said detector switches operated by the keys of said lower keyboard actuated according to the chord, whereby upon operation of the keys of said keyboard to play a chord, those of said plurality of column lines which are connected to said detector switches actuated by the keys are grounded and said power source is also grounded through resistors connected to the column lines, causing said row line to be disconnected from said D.C. power source and in consequence the voltage across said resistor connected to said row line to be varied, thus providing detection of the type of chord played;

at least one bass selector coupled to said chord detector and to said tone generators and responsive to the output of said chord detector for coupling out from said tone generators selected bass tone signals corresponding to one predetermined note included in said detector chords being played;

at least one gate circuit coupled to said bass selector for receiving said selected bass tone signals from said bass selector;

said bass selector and gate circuit including:

a common transistor having an emitter, base and collector;

a first diode disposed in the forward direction with respect to the base-emitter diode junction of said common transistor and coupling said

emitter to said chord detector;

a capacitor coupling said emitter to ground;

means coupling the juncture between said first diode and said chord detector to a control power source, said coupling means including a normally closed pedal switch opened by one pedal key and a second diode disposed in the forward direction with respect to said control power source;

said base being connected to the corresponding one of said tone generators; and

a coupling capacitor connected to said collector; and

a pedal keyboard for bass performance provided with at least one key for selectively operating said gate circuit to couple the selected bass tone signals received by said gate circuit to an output terminal to cause bass performance.

2. The electronic musical instrument according to claim 1 wherein said bass selector includes a plurality of selector circuits, each selector circuit being connected to receive a bass tone signal corresponding to the respective root notes of the chords played on said lower keyboard, said gate circuit being connected to said each selector circuit and said pedal keyboard is provided with a signal key and including means for selectively operating said gate circuit by its operation. single

3. The electronic musical instrument according to claim 1 wherein:

said bass selector comprises first and second selectors coupled to said tone generators, each selector including a plurality of selector circuits and each selector circuit of said first bass selector being responsive to said chord detector to couple out from said tone generators a bass tone signal corresponding to the respective root notes, and each selector circuit of said bass selector being responsive to said chord detector to couple out from said tone generators a bass tone signal corresponding to the respective fifth notes of the chords played on said lower keyboard;

said gate circuit comprises first and second gate circuits, said first gate circuit being connected to said first bass selector and said second gate circuit being connected to said second bass selector; and

said pedal keyboard is provided with at least two keys which include means for selectively operating said first and second gate circuits respectively.

* * * * *