Sept. 30, 1969 G. H. HADDEN 3,470,306

BASS REGISTER KEYING SYSTEM

Filed July 1, 1965 2 Sheets-Sheet 1

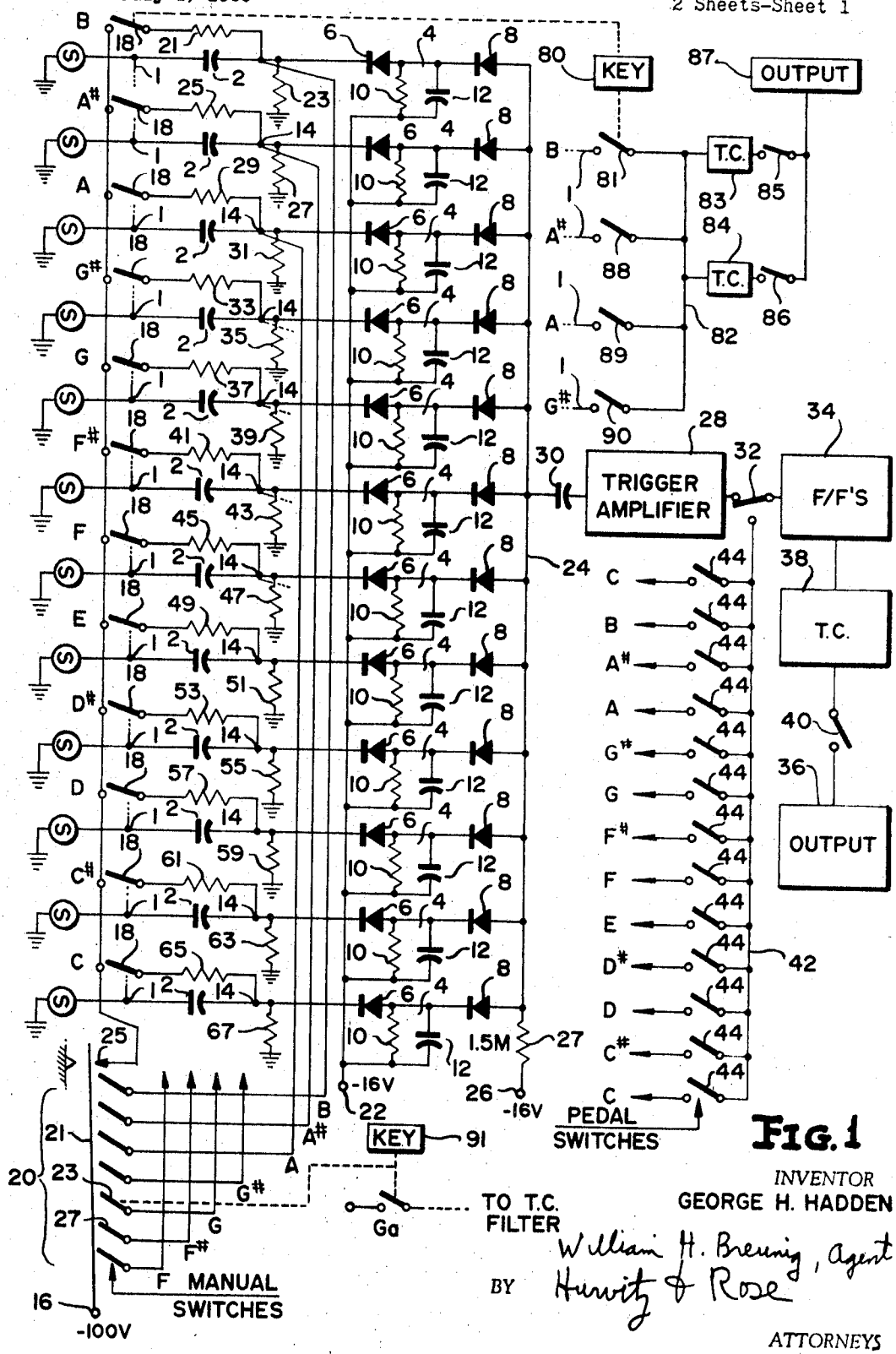

FIG. 1

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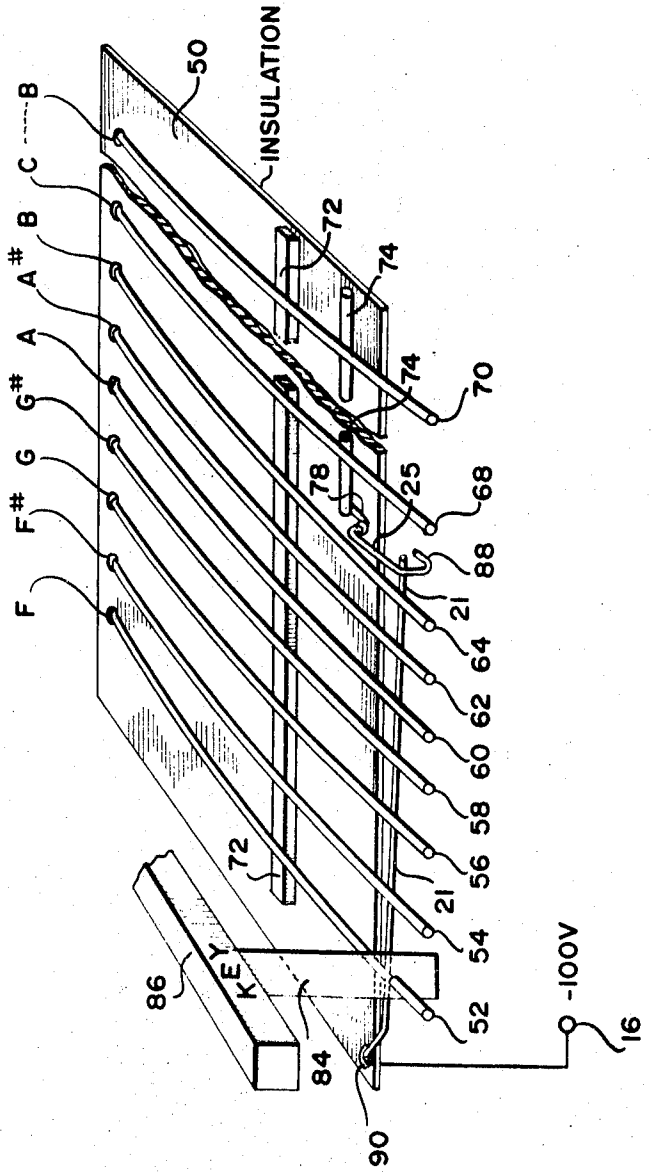

FIG. 2

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BASS REGISTER KEYING SYSTEM

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U.S. Cl. 84—1.19 12 Claims

ABSTRACT OF THE DISCLOSURE

A note an octave or two octaves below the lowest note of a chord played on the accompaniment manual of an organ is produced by a frequency-dividing flip-flop triggered by a signal selected from the chord notes by use of a preferential type of mechanical switch. This switch is comprised of a series of movable contacts parallel to, and actuated respectively by, playing keys in the lower section of the accompaniment manual. Thereby, when a chord is played, a note corresponding only with the lowest or root note of the group of keys actuated is sounded. The pitch range of such a switch is only about seven semi-tones, so if, as is preferable in a root-tone system, about an octave and a half of semi-tones is to be included, some means must be provided for extending the range to about 19 semi-tones. The preferred extension, in accordance with the invention, is to parallel the movable contacts with ordinary make-break key switches actuating diode gates preferentially biased by scaling voltage dividers. Means are provided to have one preferential system override the other, so that a double preference is exercised, operative simultaneously over the entire 19 semi-tones.

The invention concerns electronic organs and pertains particularly to a keying system for playing automatically, when a chord is played on a manual keyboard, lower register root tones normally heard by playing a pedal keyboard.

Piano players called upon to play electronic organs and novice organ players often have difficulty, while playing on manual keyboards, in concurrently playing pedal notes called for in organ music. Usually such players will be playing a chord on an accompaniment manual, the root note or lowest note of which chord corresponds to an octave above the pedal note desired. Therefore, it is a primary object of this invention to provide an electronic organ keying system which will automatically play in a bass register the root tone of a chord played on a manual keyboard, so that this root note may be utilized to call forth the desired pedal tone, without activating a pedal key.

A prior art system of which applicant is aware (U.S. Patent 3,001,432 to Greif) requires a rather elaborate system of special switches for accomplishing root tone operation. Therefore, it is an object of the present invention to provide an electronic organ having root tone facility which avoids complex switching arrangements. The latter are difficult to adust at the outset and may be difficult to maintain in proper adjustment after continuous usage.

The purpose of this invention can be accomplished in part, as will be explained hereinafter, by employing a switching arrangement disclosed by Walter Munch, Jr., in a co-pending application Ser. No. 233,560, assigned to the assignee of the present application, but the Munch switching system is not able to provide a sufficient range of notes for the purposes desired. Therefore, it is a further object of the present invention to provide a root tone system having an extended range of notes.

It is a still further object of this invention to provide a system of the type described which, among other components, necessitates only one additional simple, single-pole, single throw switch for each key in the range of bass register tones encompassed in a root tone system, in order to incorporate root note facility in a conventional organ.

Yet another object of this inventioon is to make it possible to select either a normal pedal keying system or an automatic root note system by activation of a simple switch.

These and other objects which will be set forth hereinafter, or will be obvious to one skilled in the art upon reading this specification, will now be described in an exemplary embodiment, reference being made to the accompanying drawing, wherein:

FIGURE 1 is a schematic circuit diagram illustrating a preferred embodiment of this invention;

FIGURE 2 is a diagrammatic showing of a "wipe-out" switch system suitable for use in the system of FIGURE 1.

Briefly, according to this invention, a note an octave or two octaves below the lowest note of a chord played on the accompaniment manual of an organ is produced by a frequency-dividing flip-flop triggered by a signal selected from the chord notes by use of a preferential or "wipe-out" type of switch, of the type disclosed in the above-mentioned Munch application. This switch is comprised of a series of movable contacts parallel to, and actuated respectively by, playing keys in the lower section of the accompaniment manual. When such a contact is actuated, it makes contact with a transversely arranged, common-contact member anchored at the lower-pitch end, so that if another movable contact is actuated by another key, the lower (in pitch) of the two contacts forces the common contact away from the upper (in pitch). Thus, the lower-frequency signal is available to trigger the flip-flop. Thereby, when a chord is played, a note corresponding only with the lowest note of the group of keys actuated is sounded.

Usually, the pitch range of a Munch-type switch is only about seven semi-tones, so if, as is preferable in a root-tone system, about an octave and half of semi-tones is to be included, some means must be provided for extending the range to about 18 or 19 semi-tones.

The preferred extension system, in accordance with this invention, is to parallel the movable contacts of the Munch-type switch with ordinary make-break key switches actuating diode gates preferentially biased by scaled voltage dividers. By this is meant that the gates, having a common output to the frequency divider, are actuated respectively by a series of voltage dividers graduated in output, arranged so that if two or more gates are keyed concurrently, the lower-pitched gate biases off the higher gates, as the former is keyed on by direct current from a common source.

The construction and operation of both phases of this invention will become clear in detail by reference to the accompanying drawings.

FIGURE 1, which illustrates the overall electrical circuitry, shows a series of continuously running signal sources labeled (reading from bottom to top) C, C♯, D, D♯ . . . A♯, B, encompassing an octave of the equally-tempered scale. The sources are preferably, though not necessarily, corresponding stages in a gamut of twelve transistor frequency dividers of the flip-flop type with square-wave output which preferably are used with conventional keying circuits for supplying organ tones. A point 1, associated with such signal source, indicates where signals would be carried to conventional keying circuits, so that each source provides signal to two sets of gates, one responsive to a conventional manual, and the other,

illustrated in FIGURE 1, providing tone for root tone generation.

In accordance with the teachings of U.S. Patent 2,233,948 to Kock, tone signals may be passed to collecting and tone-filtering circuits to provide the normal tone output called forth by keys which, as will be explained hereinafter, are used with the present invention. From the sources, C, C♯, D . . . , via coupling capacitors **2**, signals are carried to diode gates **4**, each composed of a pair of series-connected, solid-state diodes **6** and **8**, at the junction of which is provided a by-pass impedance composed of resistor **10** and capacitor **12**. Voltage dividers for supplying direct current to actuate each gate are comprised of series resistor pairs, as **21** and **23**, **25** and **27**, **29** and **31** . . . , the tap between each being the output point **14** for feeding each gate **4**. The direct-current keying voltage for these dividers is supplied from a source (not shown) of −100 volts connected to a terminal **16** via accompaniment keyboard key switches **18**. Parallel keying circuits for sources B down to F are shown as "wipe-out" key switches **20**, connected one for one to the voltage-divider taps **14**. The switches **20** for note F is the lowest one in the accompaniment keyboard, while the key switch **18** for note B is the highest affected key in the keyboard range. The conventionally keyed keyboard will usually extend higher. Switches **20** are arranged as illustrated in FIGURE 2 of the present application and are described in detail hereinafter, as well as in the above mentioned application of Walter Munch, Jr.

A source (not shown) of −16 volts direct current is connected to terminal **22**, common to all by-pass impedances **10**, **12**. Bus **24**, which provides common output for the gates **4**, is connected both to a source (not shown) of −16 volts at terminal **26** via 1.5 megohm resistor **27** and via capacitor **30**, to a trigger amplifier **28**. The output of the amplifier **28** is connected via one contact of a single-pole, double throw selector switch **32** to a frequency-dividing flip-flop system **34**, the output of which is carried on to an appropriate electroacoustic output system **36** via tone-color filter **38** and stop switch **40**.

To the alternate contact of switch **32** is connected a second bus **42** to which are connected in parallel a series of pedal keyboard switches **44**, connected respectively to tone signal sources C, C♯, D . . . B, C.

In operation, if switch **32** is in the lower position, signals keyed by pedal switches **44** pass via bus **42** to the flip-flops **34** where their frequencies are respectively divided by four. The wave form of the signals is modified by the tone-color filter **38** and tone signals are converted to sound in the output system **36**, if the stop switch **40** is closed. If, however, the organ player desires to have a low frequency signal occur in the output, when keys are played on the accompaniment manual, the selector switch **32** is thrown to the upper position. If no key switches are actuated, signals from sources C, C3, D . . . B, C are blocked from passage to the output buss **24** by virtue of the −16 volt bias applied to the anodes of the several diodes **6** and **8**. If, however, one of the switches **20** is actuated—say the one for note G—the moving contact **23** forces the movable common contact **21** to the left an amount depending upon the travel of the contact **23**. Under this condition, the series switch **25** is opened and direct current from the terminal **16** passes via switch contacts **21** and **23** to the tap **14** of the **37**, **39** voltage divided for the source G. The diode **4** for source G is opened in response to the high negative voltage applied to the cathodes of the diodes **6** and **8** of that diode gate. Signal then appears on bus **24** for passage to the trigger amplifier **28** via coupling capacitor **30**, which, incidentally prevents the D.C. keying voltage from being applied to the amplifier **28**. The amplifier **28** output triggers the flip-flop **34** (since switch **32** allows signal passage), supplying signal for modification by tone-color filter **38** and transmittal to the output system **36**, when desired, by closure of stop switch **40**.

The by-pass impedance comprised of resistor **10** and capacitor **12** is selected so that it provides a low impedance relative to the non-conductive impedance of the diodes **6** and **8** but relatively high impedance compared to the conductive impedance of the diodes **6** and **8**. Thus, signal feed-through is reduced in the off-condition of a gate without appreciable by-pass of signal in the on-condition.

If the key for a lower note in the scale, say F♯, is actuated, the movable contact **27** forces the common contact member **21** farther to the left and out of contact with contact **23**, so the direct current is channeled via contact **27** to the top **14** of voltage divider **41**, **43** for source F♯. In a manner similar to that described for note G, an octave-lower F♯ signal will appear in the output system **36**. Thus, the series of notes F–B, associated with the key switches **20**, will occur on a preferential basis, depending upon the lowest-note switch player, if several switches **20** are concurrently actuated. As previously pointed out, about an octave and a half of pedal-equivalent notes are desirable, so when a key switch **18** for a note in the range from C up to B is actuated, an additional octave of signals is provided. If one of the switches **18** is actuated at the same time as one of the switches **20**, nothing happens because the series switch **25** is open, and direct current cannot get to the bus **19**. If, however, none of the switches **20** is closed, signals can be keyed on by switches **18**, because the bus **19** will be charged with direct current via closed series switch **25**.

Assuming, however, one switch **18** is already closed and causing signal, say E, to proceed to the output, and then the D♯ switch **18** is closed, whatever direct current output is available at tap **14** of the voltage divider **53**, **55** for the D♯ gate will be applied to the D♯ gate **4**, while direct current available at tap **14** for the divider **49**, **51** for the note E will be applied to its gate **4**. Both gates are not concurrently opened, however, since the resistors **21**, **25**, **29** . . . and hence the outputs of several voltage dividers, as **21** and **23**, **25** and **27**, etc., are scaled, so that the lower-note dividers supply a higher bias than the adjacent higher note. For example, if the E voltage divider provides a −80 volt keying voltage and the D♯ voltage divider provides a −90 keying voltage, then when the D♯ gate is on, the bus **24** is biased up to −90 volts, resulting in the right-end of the E gate being 10 volts more positive than the left-end gate, so the E gate is biased off and the D♯ signal alone controls the flip-flop **34**.

So long as only keys **18** are closed, then one form of preference circuit is operative, i.e. that employing differential bias and described in the last preceding paragraph. If any of switches **20** is activated, control by keys **18** is disabled, and only switches **20** control operation.

Thus, for any combination of notes played in the C up to B octave, the lowest note will always take precedence over the higher ones.

Consequently, the objects set forth above will be provided because in either the "wipe-out" switch **20**, **21** range or in the diode gate range, or any combination thereof, the lowest note will always sound automatically, when selector switch **32** is "up."

Turning now to FIGURE 2, there is diagrammatically shown a switching arrangement which, while primarily designed for use with manual keyboards in electrical musical instruments is nevertheless adaptable for use with the more extended types of pedal claviers, and which corresponds mechanically and in construction with switches **20** of FIGURE 1. A switching arrangement extending over the range from F through B is shown to correspond with the range of switches **20** of FIGURE 1. On an insulative base **50** there are fastened a series of wire-like movable switch contacts **52**, **54** . . . **64**, inclusive. The righthand end of the switch assembly is shown as broken; but it may be understood that movable contact elements **68** and **70** are representative respectively of the lowest generator in the generator rank and of a generator twelve semitones

thereabove. The contact elements **52** to **64** are indicated as connected respectively with generators F to B, inclusive. Contact element **68** will also be connected to generator C, while contact element **70** will be connected to generator B. These connections will be effected via the resistive voltage dividers referred to in FIGURE 1, and which are there shown as involving switches **18**.

Normally, in instruments employing a rank of continuously operating generators, resistive or gradual-contact switch means are employed for the derivation of oscillations in accordance with the requirements of a musical composition. The use of such gradual contact switches avoids key thump and key click. Any type of resistive switch may be employed, such as the structures shown in U.S. Patent No. 2,215,124 in the names of Kock and Jordan, dated Sept. 17, 1940. However, with diode gating the need for resistive switches is obviated. Therefore a preferred switching arrangement for the righthand portion of the switching assembly of FIGURE 2 is a modified form of the type (without the variable resistance feature) set forth and claimed in a co-pending application in the name of Marion B. Gregory entitled Variable Resistance Key Switch, filed Oct. 29 1962, Ser. No. 233,529. Thus, the base or panel **50** is shown as carrying an insulative fulcrum bar **72** to control the action of the wire-like movable contacts, and the stationary contact means is a bus or wire **74**. The bus **74** corresponds to the bus **19** of FIGURE 1. An extension **78** of the bus **74** is shown bent to reach contact element **25** corresponding to contact **25** of FIGURE 1, which cooperates with contact arm **21**. In FIGURE 2 is shown a purely diagrammatic version of a connection **84** between a movable contact member **52** and a playing key **86**, it being understood that the several movable switch elements **52, 54, 56** . . . will be connected respectively with playing keys in a manual or clavier, in the manner illustrated for key **86**. An insulative sleeve **88** on the contact element **25** prevents the contact **21** making electrical contact with element **25** in the depressed position of any key **86**. Upon the depression of any of the movable contact elements **52, 54, 56** . . . by its appropriate playing key, circuit will be made with contact **21**, which is shown as extending transversely beneath the movable contact elements **52, 54, 56** . . . and −100 volts is supplied to the appropriate diode gate, FIGURE 1. Accordingly, contacts **52, 54, 56** . . . correspond with contacts such as **23, 27** of FIGURE 1.

The contact **21**, which is fastened to the panel **50** at one end, as at **90**, not only extends beneath the movable contact elements **52, 54, 56** . . . but extends at a small angle to the plane of these contact elements. The free end of the contact **21** will usually lie within bracket-shaped contact **25** which is covered with the anti-friction, insulative sleeve **88**, thus serving to guide the motion of the wire. Upon depression of any one of the movable contact elements **52, 54, 56** . . . by means of its appropriate key, it will be brought out of contact with the contact element **25**, and into contact with contact **21**. Because of the geomerical relationship between the contact **21** and the contacts **52, 54** . . . , if any two contacts of the latter group are simultaneously depressed, the lower-pitched one of the two will force the contact **21** away from the higher-pitched contact. Thus, the arrangement of FIGURE 2, as incorporated into the system of FIGURE 1 will always produce a note an octave below the lowest-pitched note played on the keyboard, provided the switch **32** of FIGURE 1 is in the upper position.

A typical key is illustrated at **80**, and another at **81**. The key **80**, when actuated, closes a gradual resistance switch **81**, which causes tone to pass from generator B, lead **1**, to tone bus **82**, and thence to tone color filters **83, 84**, selected by switches **85, 86** for passage to an output circuit **87**. The latter may be the same as output **36**, or may be separate and independent, but in any event, comprises an amplifier and speaker. Key switch **81** is typical of further key switches **88, 89, 90**, which call forth tone

from generators A♯, A, G♯ . . . and these keys are the normal and usual accompaniment manual keys of an organ and call forth the normal and usual tones. Key **91** is a similar key but belongs to a note G an octave below that G called forth by a switch **18**. Key **91** closes, in addition to its normal tone switch G_a, a switch **23**, which is one of the preference switches **20**.

Accordingly as the accompaniment manual is played, combinations of tones are called forth precisely as they would be in absence of the present invention. The present invention provides for the calling forth of root tones, in addition to the normal and usual tones.

When a single gate **4** is selected, by activation of a chord called forth by switches **18** only, that tone proceeds to flip-flops **34** and controls generation of a tone two octaves below the tone appropriate to the one selected gate. When one or more of switches **20** is actuated, as part of the chord or as the entire chord, a single gate **4** is again selected. But that gate calls forth a note one octave above the note called forth by the actuating key, since in any case the only tone sources available are B, A♯ . . . C. The note then called for causes, due to flip-flop **34**, sounding of a note two octaves low with respect to the gated through generator, but the latter note is now only one octave below the note required by the actuated key switch **20**. This procedure is musically sound, since only thirteen notes are normally available in a pedal clavier, but results in nineteen keys calling forth a total of thirteen pedal tones.

Whereas a wipeout switch has been shown for the lower register of notes, it will be understood by one skilled in the art that the preferentially-biased, diode-gate section may be used alone for a root tone system of extended range. However, the wipeout section for the lowest seven notes, as incorporated in the illustrated embodiment, serves only to de-activate the top twelve circuits, in order to allow any note in the lowest seven keys to prevail over any note above the seven keys regardless of pitch.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In an electronic organ having at least one manual keyboard, a pedal clavier and an output system, the combination comprising:

a plurality of sources of tone signals corresponding to notes of a musical scale,

switching means actuable by keys of said manual keyboard for causing selected signals from all said sources to be heard simultaneously in said output system.

switching means actuable by selected keys in said pedal clavier for causing other selected signals from said sources to be heard in said output system,

auxiliary switching means for at will causing certain further keys in said at least one manual keyboard which are additional to said selected keys to derive notes in said output system from said sources of tone signals which normally would be heard only by actuation of keys in said pedal clavier.

2. In an electronic organ having an output system, an accompaniment keyboard with keys, a pedal clavier with keys, and a plurality of sources of tone signals corresponding to tones of a musical scale, the combination comprising:

a first plurality of switches associated respectively with said keys of said accompaniment keyboard for deriving accompaniment tones in said output system simultaneously from all of said sources of tone signals,

a second plurality of switches distinct from said first plurality of switches associated respectively with said

keys of said pedal clavier for deriving pedal tones in said output system from said sources of tone signals, and

a third plurality of switches operative respectively by further ones of said keys of said accompaniment keyboard for deriving in said output system from said plurality of tone signals tones which normally would be derived in said output system only by said second plurality of switches, and

means associated with only said first and third pluralities of switches for preferentially sounding only the one tone called for when more than one of said first and third plurality of switches are actuated concurrently.

3. The combination according to claim 2, said means associated with said third plurality of switches including:

an elongated common contact having a fixed end and a free end,

means for forcing said common contact away from one individual switch contact when another individual contact is concurrently actuated, said last mentioned individual contacts being of a series of such contacts connected respectively to individual contacts operated by keys corresponding to tones an octave higher in said accompaniment keyboard.

4. In an electronic organ having at least one manual keyboard, a pedal clavier, and an output system, the combination comprising:

a plurality of sources of tone signals corresponding to notes of a musical scale,

a plurality of switching means actuated by first keys in said manual keyboard for causing signals from said sources to be heard in said output system,

a plurality of switching means actuated by second keys in said pedal clavier for causing signals from said sources to be heard in said output system,

third keys in said manual keyboard,

auxiliary switching means associated with at least some of the first keys for causing to be heard in said output system only the tone signal selected by the lowermost of said at least some of said first keys when more than one of said first keys is depressed concurrently,

means associated with said auxiliary switching means for rendering said auxiliary switching means effective to cause said tone signal selected by only one of said third key to sound in said output system, and

means for predetermining whether tones selected by said pedal clavier only or tones selected by said manuel keyboard only shall proceed to said output system.

5. In an organ system,

an octave of tone sources,

at least one frequency divider connectible in cascade with all said tone sources,

separate gating means for each of said tone sources,

an output circuit,

a plurality of keys of a manual,

means responsive to actuation of plural ones of said keys and including said tone sources and said gating means for sounding a chord corresponding with all the actuated keys by gating through tones from said octave of tone sources, and

preference means further responsive to actuation of said plural ones of said keys for sounding only one tone subharmonically related to only the lowest tone of said chord,

wherein said first mentioned keys encompass one octave and wherein is further provided

additional preference means responsive to actuation of keys other than said first mentioned keys for disabling said first mentioned preference means and preferentially sounding only one tone sub-harmonically related to only the lowest tone of said chord by gating through tones from said octave of tones.

6. In an organ, a keyboard, said keyboard having

a first octave of keys and a set of further keys additional to said octave of keys,

means responsive to actuating a plurality of said first octave of keys calling forth only one note corresponding with the lowest note represented by said plurality of said first octave of keys,

means responsive to the called forth note for sounding a note two octaves below said called forth note, and

means responsive to actuation of any plurality of keys of said keyboard including those of said first octave of keys and of said set of further keys additional to said octave of keys for calling forth only one note corresponding with the lowest note called for by said set of further keys.

7. In an electronic organ,

a manual keyboard,

a pedal keyboard,

a plurality of tone signal sources corresponding with notes of a musical scale and common to said manual and said pedal keyboards,

an output system including a frequency divider, a tone color filter and a loudspeaker, all in cascade,

means responsive to operation of said manual keyboard for directing selected ones of said tone signals to a first common bus,

means responsive to operation of said pedal keyboard for directing selected ones of said tone signals to a second common bus,

said frequency divider having an input circuit, and

a switch for selectively and at will connecting one of said first common bus and of said second common bus to said input circuit.

8. In an electric organ,

an array of tone sources corresponding with notes of the musical scale,

an array of electronic gates connected one for one in cascade with said tone sources,

an array of first keys correlated one for one with said tone sources,

a further array of keys additional to said first keys,

means responsive to simultaneous actuation of plural ones of said first keys for enabling only one of said gates corresponding with the root note of said first keys and disabling the remainder of said gates, and

means responsive to actuation of one of said further array of keys together with plural ones of said first keys for rendering conductive only one of said gates corresponding with the actuated one of said further array of keys and for rendering non-conductive the remainder of said gates.

9. In an electronic organ,

an array of tone signal sources,

an array of electronic gates always connected one for one with said tone signal sources,

a first array of keys operatively associated one for one with said gates,

means normally maintaining said gates all non-conductive,

means responsive to actuation of plural ones of said keys to play a chord for rendering conductive only that one of said electronic gates corresponding with the root note of said chord,

a further array of keys, and

means responsive to actuation of at least one of said further array of keys for rendering conductive one of said electronic gates representative only of said at least one of said further array of keys regardless of the actuated condition of said first array of keys.

10. In an electronic organ,

an aray of tone signal sources,

an array of first keys corresponding one for one with said tone signal sources,

means responsive to playing of a chord by simultaneous actuation of plural ones of said first keys for audibly calling forth only the root note of said chord,

an array of further keys each corresponding to a musical tone of frequency differing from any frequency of said first mentioned array, and

means responsive to playing of a further chord by simultaneous actuation of certain of said first keys and certain of said further keys for calling forth audible tone from only one note of said further chord.

11. In an electronic organ,

an array of tone signal sources,

an array of first keys corresponding one for one with said tone signal sources,

an array of further keys corresponding one for one with certain of said tone signal sources,

a first preference system responsive to actuation of plural ones of said first keys for selecting only one of said tone signal sources for acoustic translation,

a second preference system responsive to actuation of plural ones of said further keys for selecting only one of said tone signal sources for acoustic translation, and

means responsive to operation of said second preference system for disabling said first preference system.

12. The combination according to claim **11** wherein the selected tone signal sources are those of lower frequency in preference to those of higher frequency.

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