United States Patent

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[54] **COMBINATION OF MUSICAL EFFECT SYSTEM AND KNEE CONTROL**
4 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **84/1.24,** 84/1.18, 84/1.25, 84/1.26, 84/1.27
[51] **Int. Cl.** **G10h 1/02**
[50] **Field of Search** 84/1.18, 1.24, 1.25, 1.26, 1.27

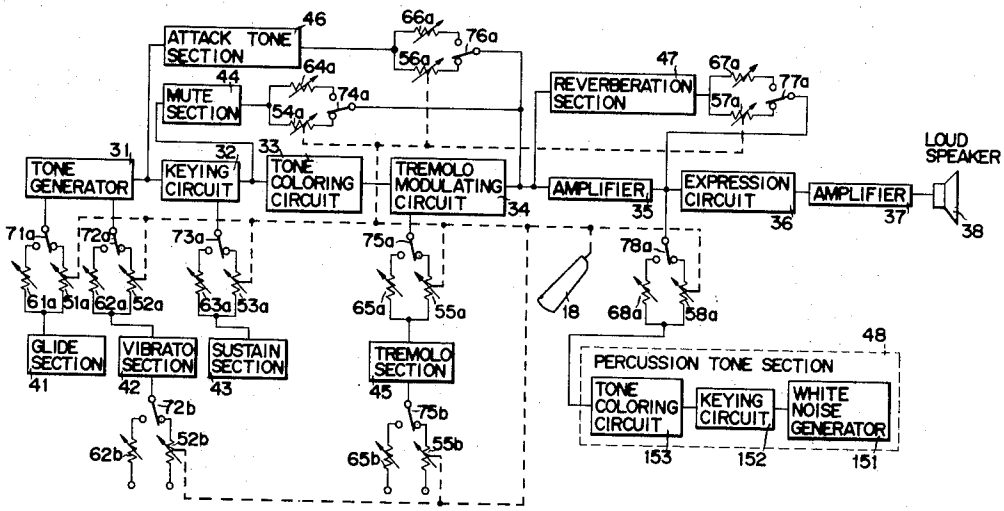
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ABSTRACT: A musical effect system for an electric organ using knee control. A tone generator circuit for generating a tone signal having a frequency according to the selective operation of a plurality of keys is connected with other circuits for attaining special musical effects. Associated with these circuits are variable resistors for simultaneously and continuously varying the individual factors producing such musical effects. The variable resistors interlock with a knee-operated lever so as to effect continuous variations in accordance with the magnitude of the displacement of the knee-operated lever. Selector switches are provided to determine which of such musical effects are rendered operative in connection with the knee-operated lever.



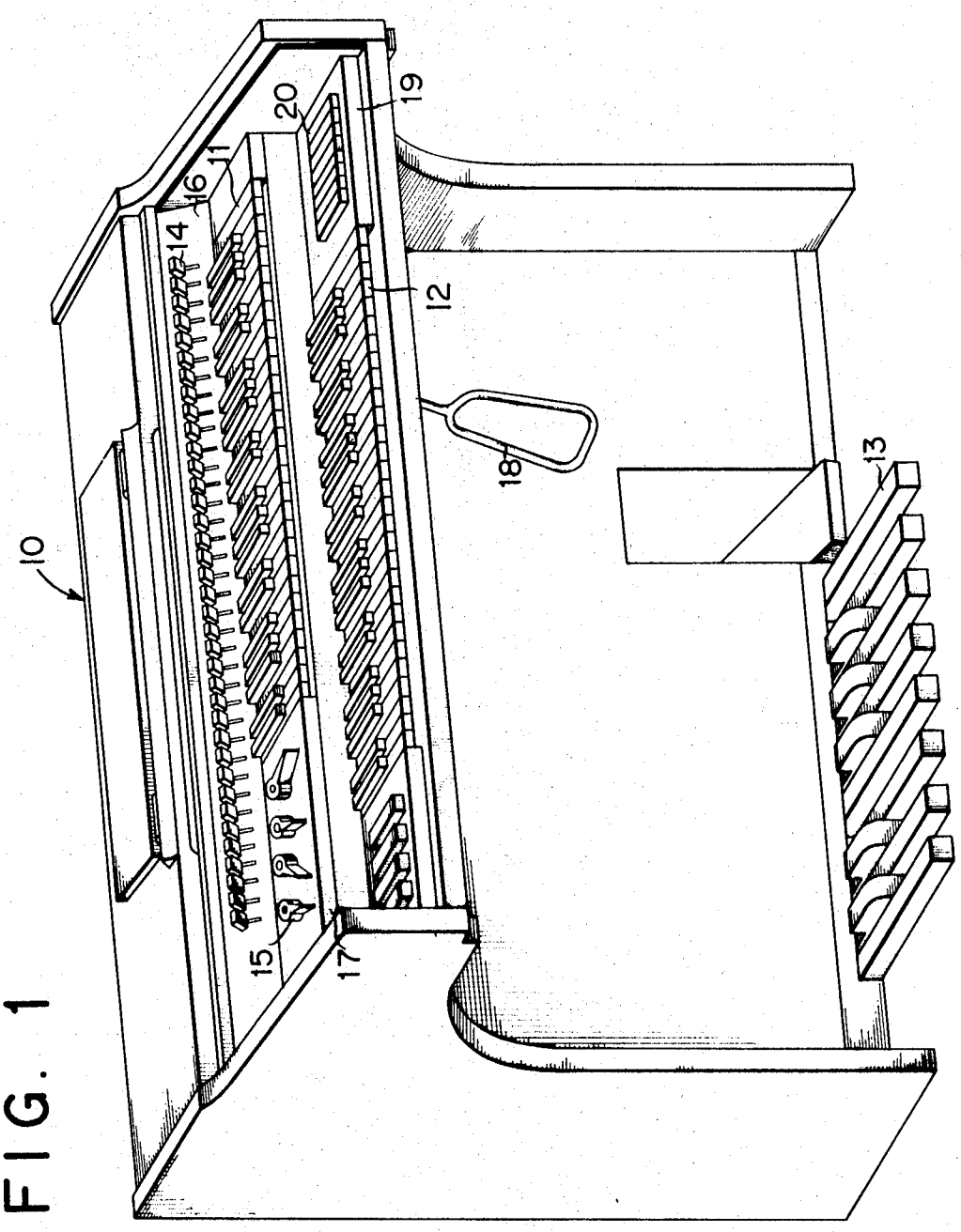


FIG. 1

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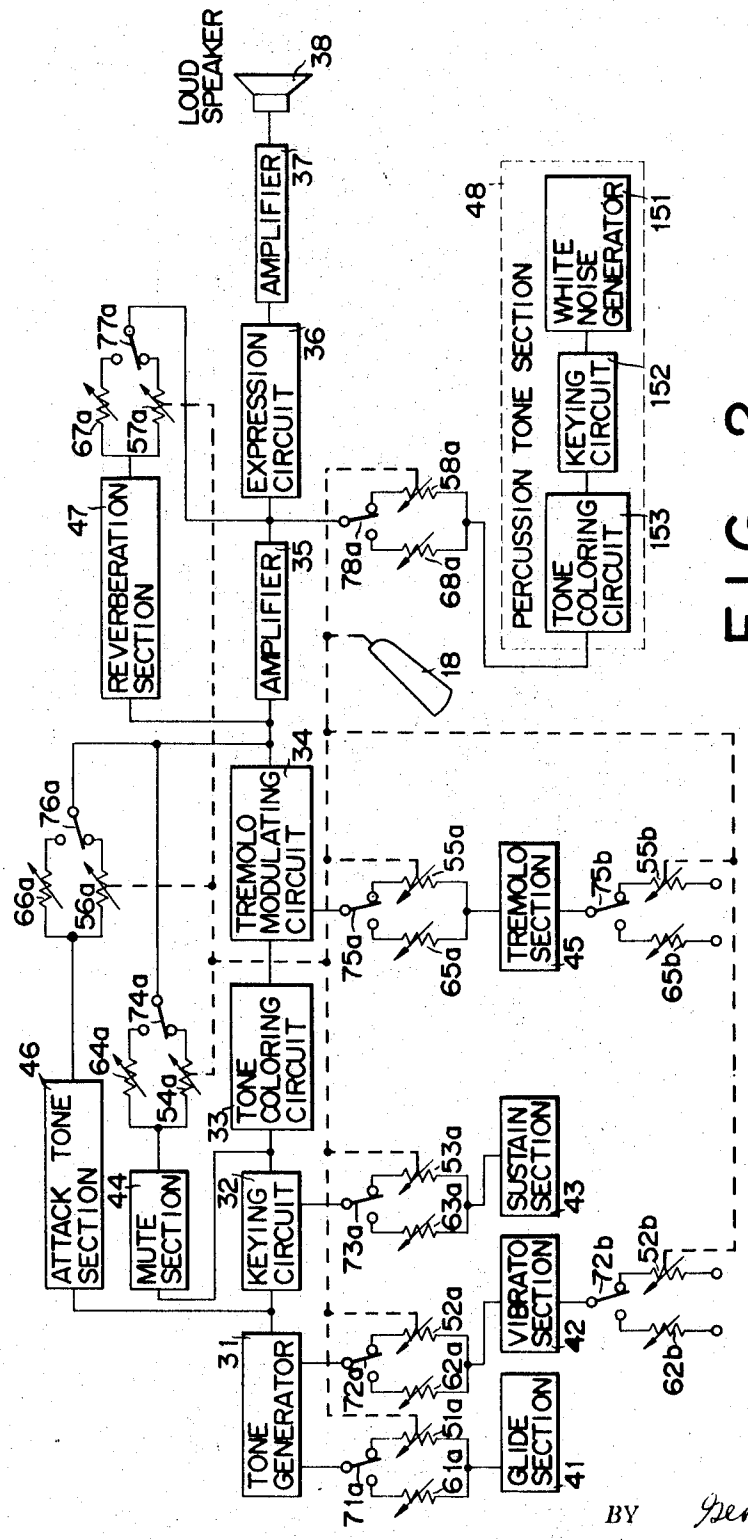


FIG. 2

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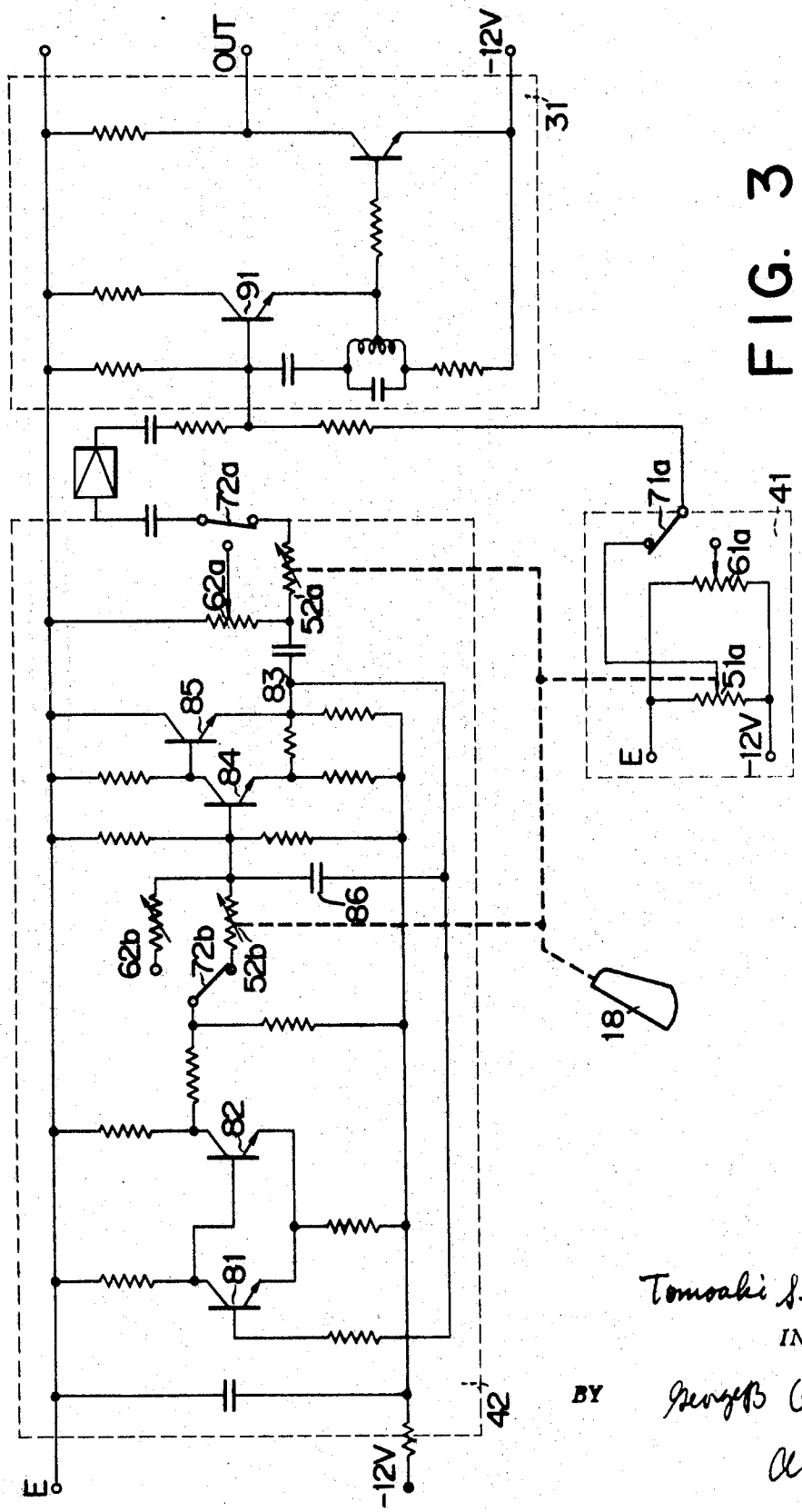


FIG. 3

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FIG. 4

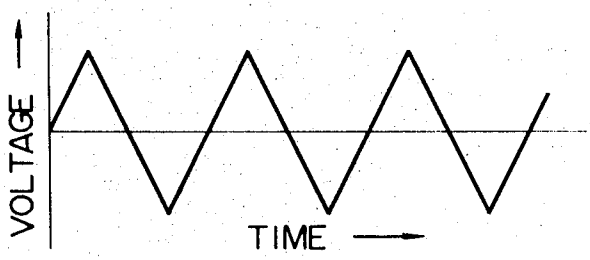


FIG. 14

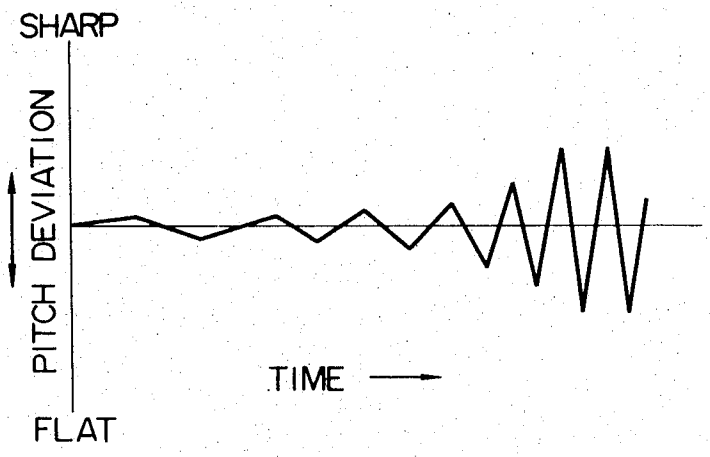
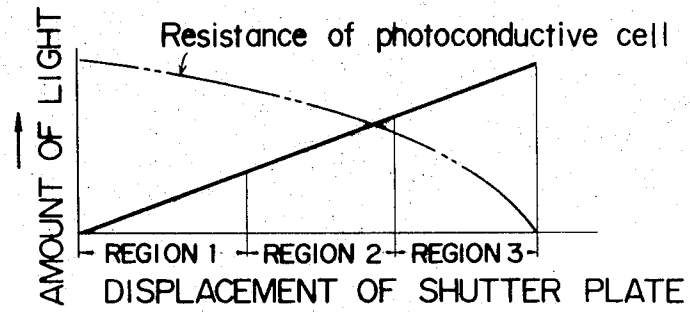


FIG. 13



Note : Region 1 .... Amount of light transmitted through smallest bore
Region 2 ... Amount of light transmitted through medium bore
Region 3 ... Amount of light transmitted through largest bore

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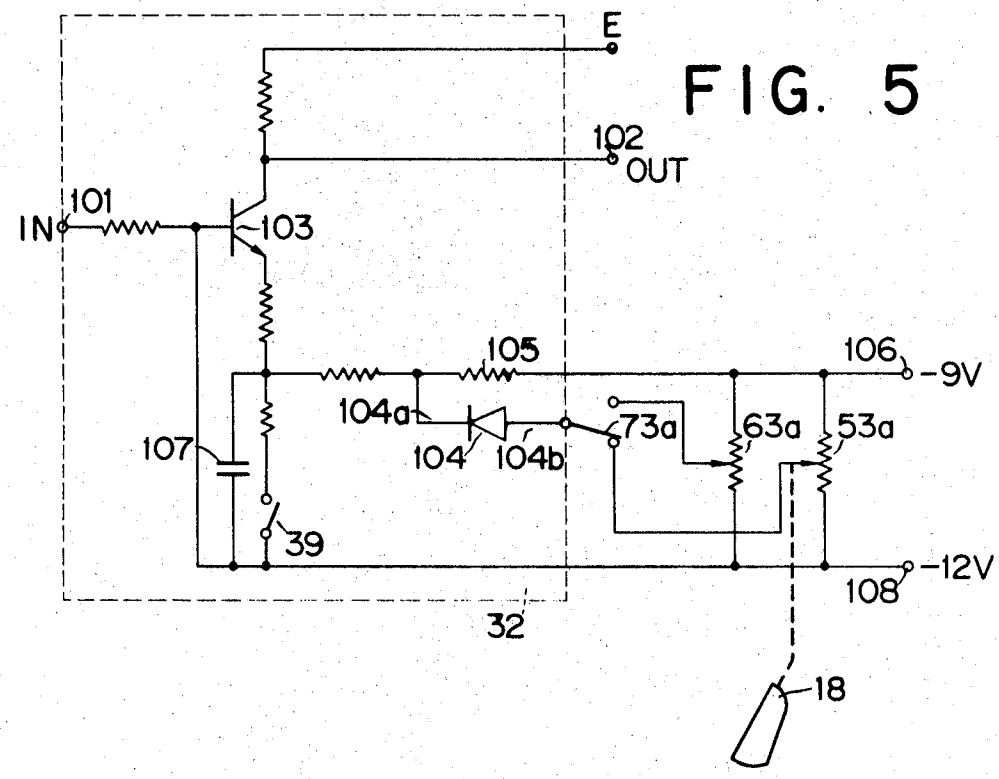
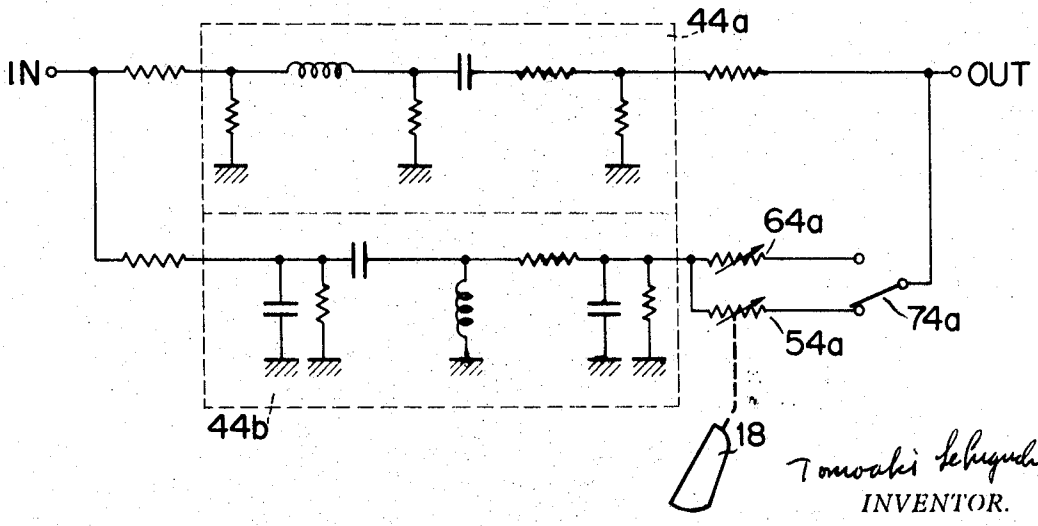


FIG. 5

FIG. 6



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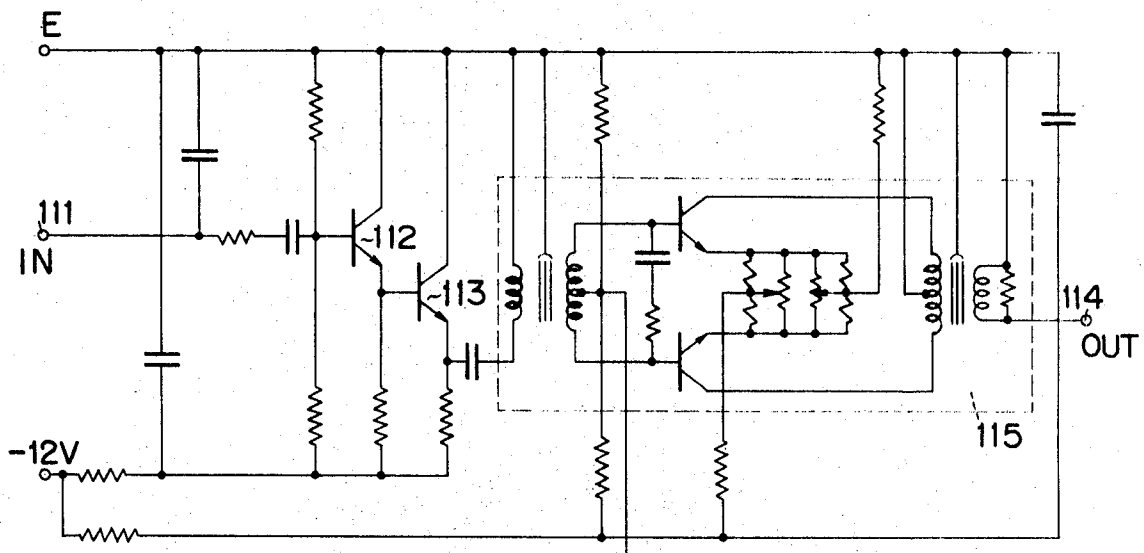
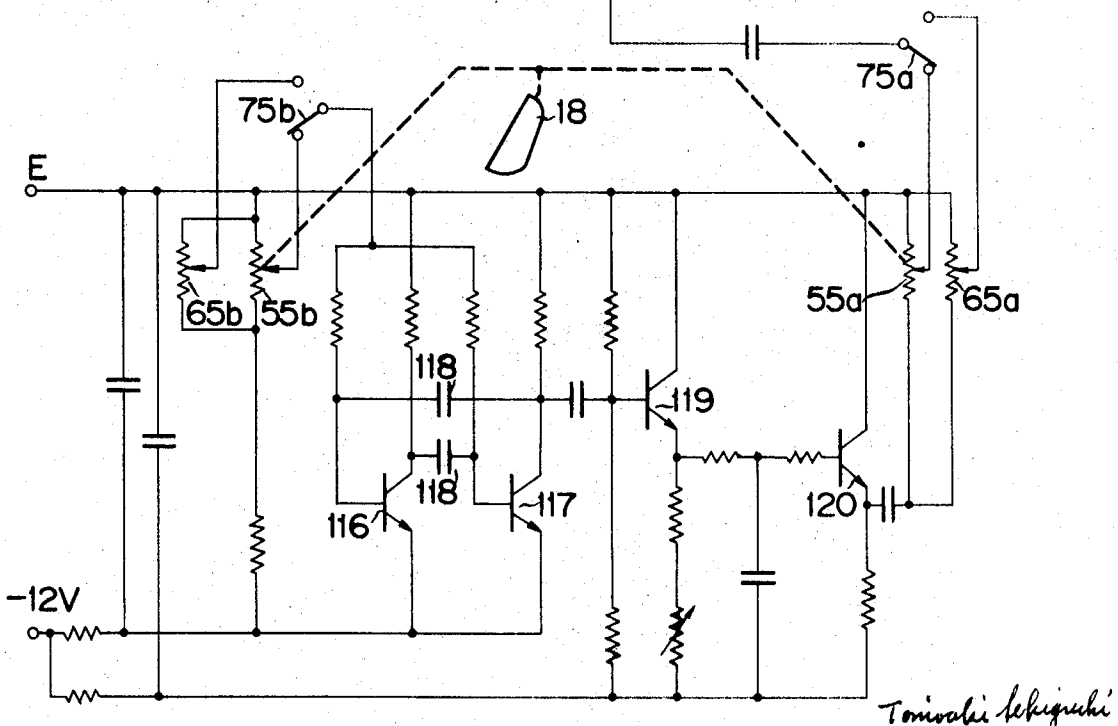


FIG. 7



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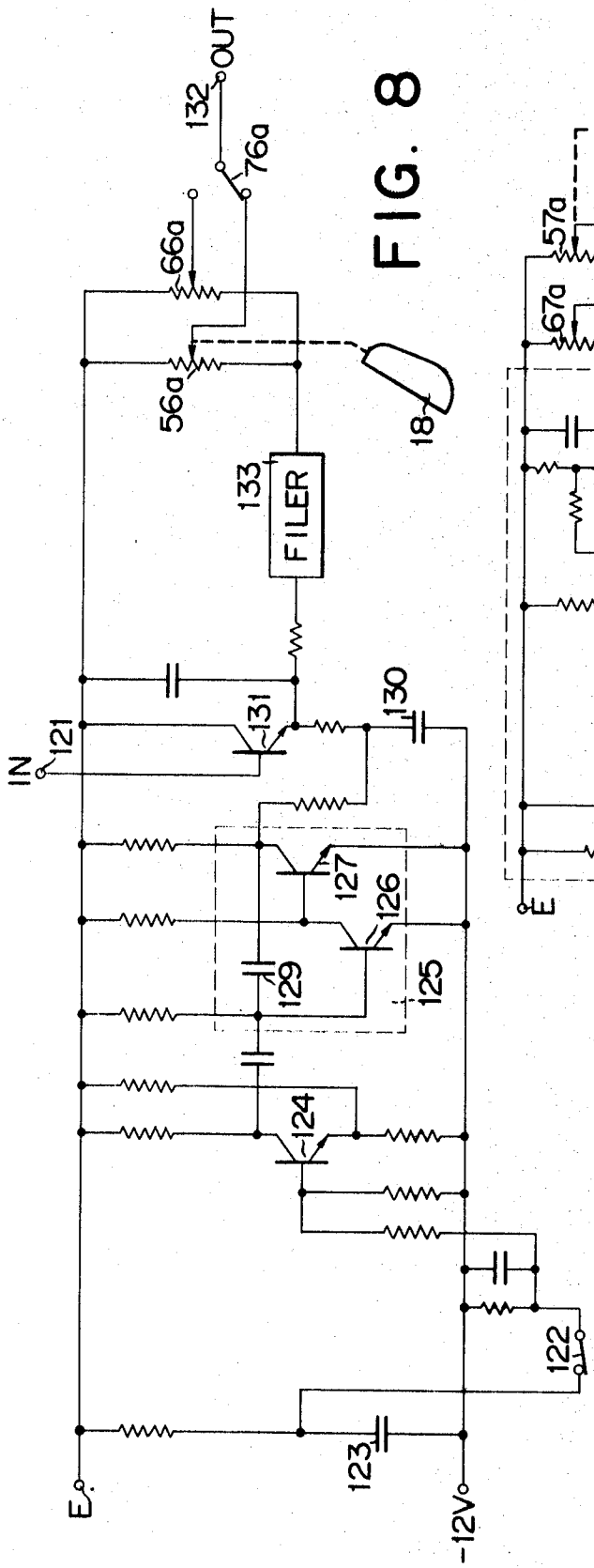


FIG. 8

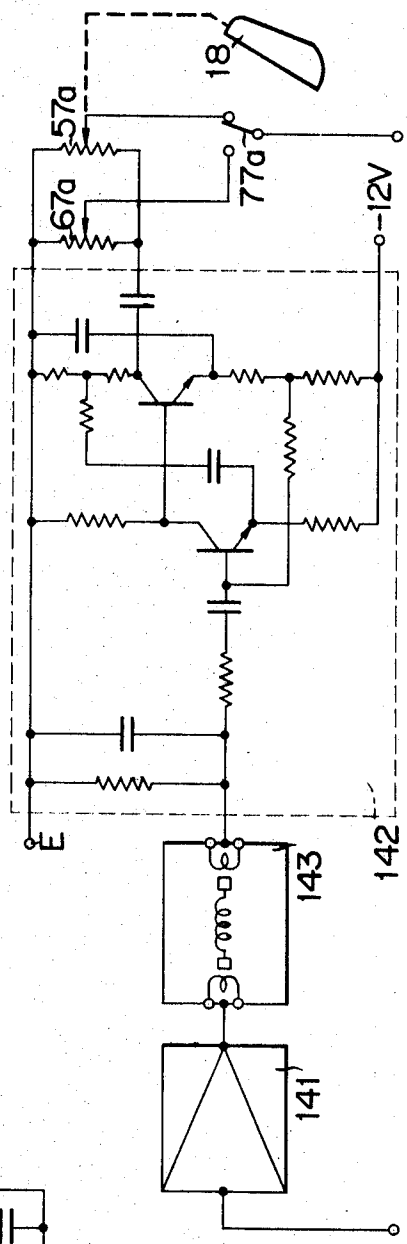


FIG. 9

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FIG. 10

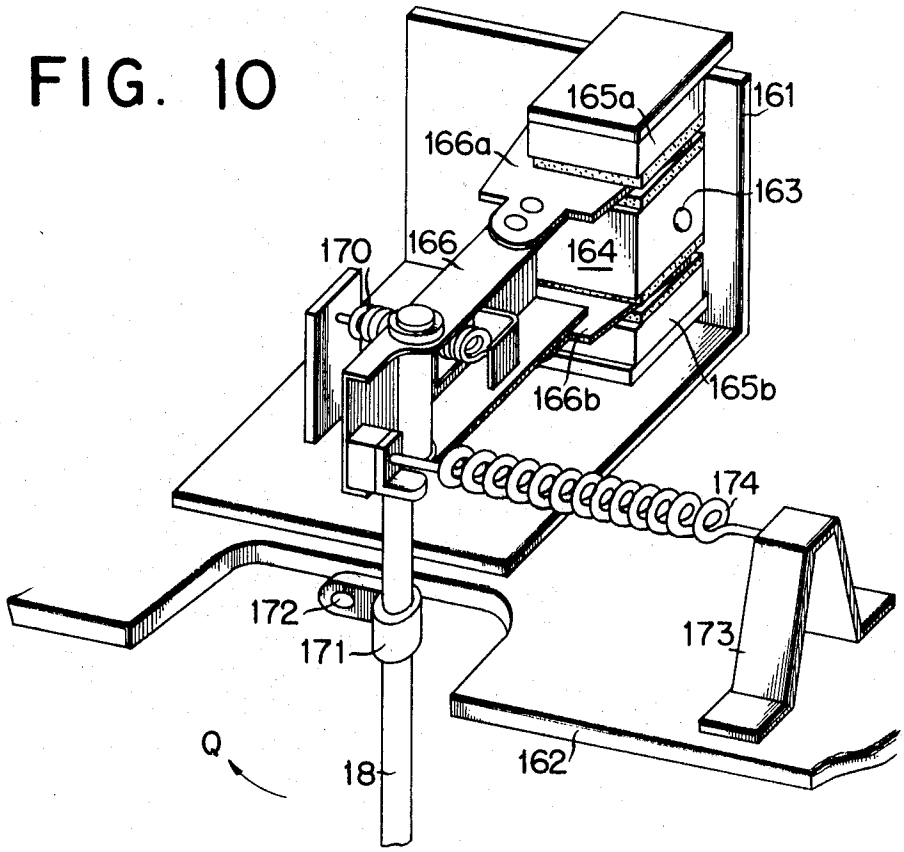


FIG. 12

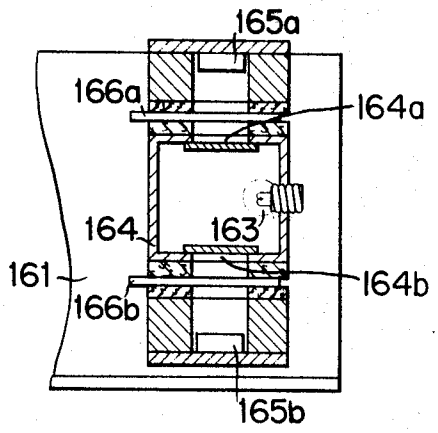
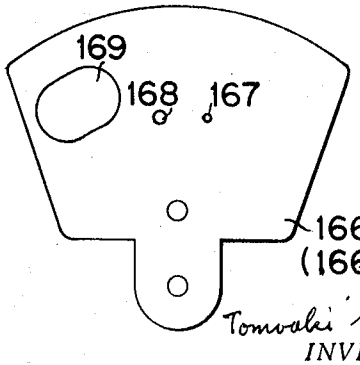


FIG. 11



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COMBINATION OF MUSICAL EFFECT SYSTEM AND KNEE CONTROL

BACKGROUND OF THIS INVENTION

This invention relates to electronic musical instruments such as electronic organs and more particularly is concerned with a combination of musical effect system and knee control.

Conventional electronic musical instruments include a plurality of control elements such as knobs which are arranged on a panel and used for varying the degrees of individual factors conducive to special musical effects such as a vibrato effect, tremolo effect, sustain effect and reverberation effect.

However, such arrangement of the control knobs on the panel disturbs the player's creative rendition of music. Namely, he must remove his hands from the keyboards for manipulation of the control knobs so that such manipulation can only be effected during the very short intervals, namely, rests or breaks in course of performance.

Accordingly, it is difficult to very the degrees of musical effects, much more so sensitively to control such variations so sufficiently as to allow the player to exhibit his musical techniques during performance.

It is also difficult simultaneously to control desired knobs at intervals afforded during performance, with the result that the rendition of music is unavoidably subject to great restriction.

SUMMARY OF THE INVENTION

An object of this invention is to provide a combination of musical effect system and knee control improved so as sensitively to control with ease the continuous variation of the degrees of individual factors conducive to such musical effects.

Another object of this invention is to provide a combination of musical effect system and knee control improved so as simultaneously to vary the degrees of the factors as desired.

Further object of this invention is to provide a novel varying means interlocking with a single knee-operated lever so as to effect such variations in accordance with the magnitude of displacement of the knee-operated lever.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a perspective view of an electronic musical instrument with a musical effect system and knee control embodying this invention;

FIG. 2 is a block diagram of a main circuit with separate circuits for attaining special musical effects embodying this invention;

FIG. 3 is an illustration of a tone generator circuit with separate circuits for supplying signals conducive to respective vibrato and glide effect;

FIG. 4 is an illustration of the waveform of the specific signal supplied from the vibrato effect circuit to the tone generator circuit;

FIG. 5 is an illustration of a keying circuit with means for supplying signals conducive to a sustain effect;

FIG. 6 is an illustration of a filter circuit;

FIG. 7 is an illustration of a circuit for supplying signals conducive to a tremolo effect;

FIG. 8 is an illustration of a circuit for modifying tone signals so as to attain an attack effect;

FIG. 9 is an illustration of a circuit for modifying tone signals so as to attain a reverberation effect;

Flg. 10 is a perspective view of a device for varying the degrees of individual factors conducive to the musical effect, the device interlocking with a single knee-operated lever;

FIG. 11 is a plan view of a shutter plate provided in the device shown in FIG. 10;

FIG. 12 is a vertical cross section of the device shown in FIG. 10;

FIG. 13 is a graph indicating the variations of resistance of a conductive cell corresponding to the variations of displacement of the shutter plate; and

FIG. 14 is an illustration of the wave form of the specific signal applied so as jointly to vary the depth and speed of the vibrato effect.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a perspective view of an electronic organ **10** which has an upper keyboard **11**, a lower keyboard **12** and a pedal keyboard **13**. The organ is provided with a plurality of control elements, the knobs of which are divided into two groups **14** and **15** for operating convenience, the knobs of the group **14** being arranged in a row on an upper inclined panel **16** and the knobs of the group **15** on a side panel **17** disposed on the same plane as the upper keyboard **11**. A single knee-operated lever **18** is disposed at a suitable position of the organ for the player to perform music while operating the lever **18** with his knee in a most convenient way. On a side panel **19** arranged on the same plane as the lower keyboard **12** are located the control tablets **20** of a large number of selector switches as later described. Said control tabs **20** are employed for accomplishing the desired rendition of music so as selectively to apply one or more special musical effects to the performance.

FIG. 2 indicates a main circuit which involves means for generating a tone signal having a frequency (or pitch) according to the selective operation of a plurality of keys juxtaposed on the upper, lower and pedal keyboards respectively, and is accompanied with separate circuits for attaining respective special musical effects. Namely, in this embodiment, said separate circuits consist of eight musical effect sections, i.e. a glide section **41**, a vibrato section **42**, a sustain section **43**, a mute section **44**, a tremolo section **45**, an attack tone section **46**, a reverberation section **47** and a percussion tone section **48**.

To described in greater detail, said tone-generating means has a plurality of generators corresponding to the number of tones, for example, **97** tones. In FIG. **2** are diagrammatically indicated the generators **31** in block. The main circuit is provided with the generators **31**, keying circuits **32**, and tone-coloring circuits **33**. The main circuit is further provided with a tremolo-modulating circuit **34**, an amplifier **35**, an expression control **36**, a power amplifier **37** and means for converting electric tone signals to sounds or musical tones such as those of a loudspeaker **38**.

Each of said keying circuits **32** is provided with a key switch **39** (as shown in FIG. **5**) interlocking with a key so as to control the supply of the tone signal from said generator to said loudspeaker.

The musical effect circuits are associated with means for varying the degrees of individual factors conducive to the aforementioned musical effects. In this embodiment, there are used a large number of variable resistors as degree-varying means. There will now be described the musical instrument of the present invention. In the first place, the glide section **41** is associated with one variable resistor **51***a*, the vibrato section **42** with two variable resistors **52***a* and **52***b*, the sustain section **43** with one variable resistor **53***a*, the mute section **44** with one variable resistor **54***a*, the tremolo section **45** with two variable resistors **55***a* and **55***b*, the attack tone section **46** with one variable resistor **56***a*, the reverberation section **47** with one variable resistor **57***a* and the percussion tone section **48** with one variable resistor **58***a*. These variable resistors interlock with the knee-operated lever **18**.

In the second place, variable resistors **61***a*, **62***a*, **62***b*, **63***a*, **64***a*, **65***a*, **65***b*, **66***a*, **67***a* and **68***a* are respectively associated with those of the musical effect sections bearing the referential numerals of the forties whose digits of the first place accord with those of the above-mentioned resistors of the sixties. Said resistors of the sixties can be freely and individually controlled regardless of the operation of the knee-operated lever **18**.

The musical instrument is further provided with changeover switches for selector switches **71***a*, **72***a*, **72***b*, **73***a*, **74***a*, **75***a*, **75***b*, **76***a*, **77***a* and **78***a*. Among the aforementioned degree-

varying means or variable resistors, these switches are respectively associated with every two thereof bearing the referential numerals whose digits of the first place, as well as the letters suffixed thereto, accord with those of said switches. Each of said changeover switches is manually operated to cause each group of two variable resistors to be alternatively used, thereby to pass electric signals through either one thereof.

In operation, as shown in FIG. 3, a specific signal generated in the vibrato circuit **42** has a symmetric triangular wave (as shown in FIG. 4) whose amplitude depends upon the predetermined offset voltage caused by a Schmitt circuit consisting of transistor **81** and **82**. The specific signal is brought to a junction **83** through either of variable resistors **52***b* and **62***b* used as an integrator by its combination with a capacitor **86** (this figure shows the former resistor **52***b* selectively used by the operation of the changeover switch **72***b*) as well as through an amplifier consisting of serially connected transistors **84** and **85**, and then to the base electrode of a transistor **91** of the tone generator **31** through either of the variable resistors **52***a* and **62***a* (this figure shows the former resistor **52***a* selectively used by the operation of the changeover switch **72***a*).

When passing through the integrator comprising the capacitor **86** and the variable resistor **52***b* (or **62***b*), the specific signal has the integration constant of its waveform varied by the control of the variable resistor **52***b* (or **62***b*) and thus only its frequency continuously varied within the predetermined range, for example, 2 to 10 Hz.

When further passing through the variable resistor **52***a* (**62***a*), the specific signal having the desired waveform defined by the control of the former resistor **52***b* (or **62***b*) has its amplitude continuously varied by the control of the variable resistor **52***a* (**62***a*).

Consequently, a tone signal from the tone generator **31** has the degrees of its frequency modulation (vibrato depth) defined in accordance with the varying magnitude of resistance determined by the operation or control of the variable resistor **52***a* (or **62***a*), and the frequency of said modulation (vibrator speed) is set in accordance with the varying magnitude of resistance of the resistor **52***b* (or **62***b*).

The specific signal generated in the glide circuit **41** has its voltage divided by the operation or control of either of the variable resistors or voltage dividers **51***a* and **61***a* (this figure shows the former divider **51***a* selectively used by the operation of the changeover switch **71***a*), with the result that a tone signal from the tone generator **31** has its frequency shifted in accordance with the varying magnitude of voltage defined by the control of the variable resistor **51***a* (or **61***a*).

FIG. **5** indicates in detail the keying circuit **32** with sustain section **43**, wherein the supply of a tone signal from an input terminal **101** to an output terminal **102** is controlled by the change of the emitter potential of the transistor **103**.

Namely, when the key switch **39** is closed, the tone signal passes through the transistor **103**. When a diode **104** is biased in the forward direction with the movable element of either of variable resistors **53***a* and **63***a* (this figure shows the former resistor **53***a* selectively used by the operation of the changeover switch **73***a*) being positioned closest to the power source terminal **106**, i.e. the cathode side **104***a* of the diode **104** is conductive to a power source terminal **106**, and a condenser or capacitor **107** is so charged by opening the key switch **39** as rapidly to raise the emitter potential of the transistor **103**, so that the transistor is immediately cut off.

When the key switch **39** is again closed where the movable element assumes the aforementioned position, the condenser **107** is discharged so as to lower the emitter potential and conduct the tone signal through the transistor **103**.

Let it be assumed that the diode **104** is biased in the reverse direction, i.e. the cathode side **104***a* of the diode is not conductive to the anode side **104***b*, with the movable element of either of variable resistors **53***a* and **63***a* being positioned closest to the power source terminal **108**. When the key switch **39** is opened in such case, the condenser **107** is charged via the resistor **105** so as slowly to raise the emitter potential, and gradually attenuate the tone signal at the output terminal **102**.

When the key switch **39** is opened wherein the diode **104** is biased in the reverse direction, the closer movable element is brought to the power source terminal **108**, the more slowly the emitter potential is raised. Namely, the variable resistor **53***a* (or **63***a*) can be operated continuously to vary the potential of the specific signal at the emitter side of the gate transistor **103**. As a result, the sustain effect is accomplished with a corresponding duration to the varying magnitude of resistance of the variable resistor.

FIG. **6** indicates the tone-coloring circuit with the mute section **44**. Said mute section **44** consists of two coloring filters **44***a* and **44***b* mutually connected in parallel, the former filter **44***a* being actuated to produce brass sounds and the latter filter **44***b* to produce oboe sounds.

The tone signal supplied to the tone-coloring circuit passes through both filters from the input terminal to the output terminal. In this case, the signal component passing through the filter **44***b* has its level varied by the control of either of variable resistors **54***a* and **64***a* (the figure shows the former resistor **54***a* selectively used by the operation of the changeover switch **74***a*).

Said signal component from the filter **44***b* is superposed on the signal component from the other filter **44***a*. In this case, the level of the former signal component relative to the latter one defines the degree of the mute effect. Consequently, the tone signal passing through the tone-coloring circuit is modified so as finally to produce the tone color of the desired musical instrument.

As shown in FIG. **7**, the tone signal is supplied through an input terminal **111** to the tremolo modulation circuit **34**, where said signal is amplified via serially connected transistors **112** and **113** and then is carried to an output terminal **114** through a push-pull amplifier **115**.

On the other hand, a special signal having a predetermined frequency, for example, 13 Hz. is generated in the tremolo section **45** (indicated as a mandolin effect circuit in this embodiment) due to the operation of a signal oscillator or astable multivibrator mainly consisting of two transistors **116** and **117** and condensers **118**. Said special signal has its low frequency varied by the control of either of the variable resistors **55***b* and **65***b* (this figure shows variable resistor **55***b* selectively used by the operation of the changeover switch **75***b*) and then is supplied to the base electrode of a transistor **119** which is serially connected with a transistor **120**. Furthermore, said special signal is supplied to the input side of the push-pull amplifier **115** through either of the variable resistors **55***a* and **65***a* (the variable resistor **55***a* is selectively used by the operation of the changeover switch **75***a*).

At this time, said special signal has its amplitude varied in accordance with the magnitude of the resistance component obtained by dividing the entire resistance of the resistor **55***a* by the movable element thereof.

Consequently, the tone signal from the tremolo modulation circuit **34** has the degree of its amplitude modulation varied by the control of the resistor **55***a* so as finally to modify the tremolo depth, and has its tremolo speed varied by the control of the resistor **55***b*.

FIG. **8** is a circuit for attaining the attack effect. A tone signal a few octaves, for example, 2 octaves higher than the specified one among those supplied from the generators **31** to the keying circuits **32** is carried to the terminal **121** of said attack effect circuit **46**.

When there is closed a key switch **122** which synchronously cooperates with the key switch **39**, the electric charge of a condenser **123** is instantly discharged. The electric signal from the condenser **123** passes through a transistor **124** and has its wave shaped while passing through a monostable multivibrator **125** consisting of two transistors **126** and **127** and condenser **129**, and then is carried to a condenser **130**, in which said electric signals jointly cause the emitter potential of a gate transistor of a gate transistor **131** to be reduced and as a result the gate transistor to be biased across its emitter and base electrodes in the forward direction. Since the gate is opened only for a predetermined time, for example, 100 msec. defined

by the operation of the monostable multivibrator **125** immediately after the close of the key switch **122**, said tone signal is supplied during said period to an output terminal **132** through a filter **133** and either of the variable resistors **56***a* and **66***a* (this figure shows the variable resistor **56***a* selectively used by the operation of the changeover switch **76***a*). Said attack tone signal has its amplitude varied by the control of the actuating variable resistor, and thus is superposed on the tone signal passing through the main circuit.

FIG. **9** indicates the reverberation circuit **47** involving two amplifiers **141** and **142** and a reverberation unit **143**, which includes a mechanical reverberation device such as a coiled spring. The former amplifier **141** is sued to amplify the tone signal which has bypassed the amplifier **35**. Said amplified tone signal is carried to the reverberation unit so as to be converted to vibration at the forward end of the mechanical device. Said vibration is then transmitted to the rear end of the device and again converted to the residual signals which are more delayed with the accompaniment of the gradual attenuation of signal energies than the tone signal of the main circuit. Said reverberation signal is amplified by the operation of the latter amplifier **142** and carried to the input side of the expression circuit **36** through either of the variable resistors **57***a* and **67***a* (this figure shows the resistor **57***a* selectively used by the operation of the changeover switch **77***a*).

At this time, said reverberation signal has its amplitude varied by the control of the resistor **57***a* so as finally to control the degree of the reverberation effect rendered in the performance.

The aforesaid percussion tone section **48** as shown in FIG. **2** may be of the conventional type and involves in this embodiment a white noise generator **151**, keying circuits **152** and tone-coloring circuits **153**. Said coloring circuit **153** is connected with the input side of the expression circuit **36** through either of the variable resistors **58***a* and **68***a* (this figure shows the resistor **58***a* selectively used by the operation of the changeover switch **78***a*). Accordingly, said percussion tone signal to be brought to the main circuit has its amplitude varied by the control of the resistor.

As understandable from the above-mentioned description of the embodiment, if all of the changeover switches are set up for use of the variable resistors bearing the number of the fifties as shown in the drawings, the player can simultaneously control the degrees of all of the special musical effects merely by pushing the knee-operated lever to the right with his knee.

On the other hand, when he selects those special musical effects whose degrees are varied by the control of the knee-operated lever, the player operates the changeover switches except those he has selected to use the corresponding variable resistors of the hand-operated group. In this case, if he desires to try his creative rendition of music under the musical effects caused only by the control of the knee-operated lever, the introduction of unnecessary musical effects will be entirely excluded, provided those variable resistors set as aforementioned by operating the remaining switches are hand-controlled so as substantially to eliminate the supply of the musical effect signal conducive to the individual musical effects. The exclusion of the unnecessary musical effects may be accomplished by severing the connection of the main circuit with musical effect sections to be excluded. For this purpose, there may be provided separate switches, which are not, however, used in this embodiment.

If it is desired to introduce a constant or preset degree of the special musical effect into his performance during en entire movement or several syllables without knee operation, the changeover switches corresponding to the musical effect sections to be selected may be operated so as to use the desired variable resistors associated with the control elements. In this case, the respective position of the control elements are set in a manner to exhibit the desired degree of the musical effect.

The above-mentined embodiment of this invention indicates some circuits for musical effects designed by these inventors or cooperators. However, said circuits may of course, be replaced by the circuits of conventional types.

Furthermore, this electronic musical instrument does not always require all the musical effect sections herein disclosed or a larger number thereof. The instrument maker will be able to design a musical instrument involving any number of musical effect sections demanded by the user. Further, the number of the variable resistors and more particularly the number of those interlocking with the knee-operated lever may be freely determined when designed.

In this invention, there may be used variable resistors multi-interlocked with a knee-operated lever so as simultaneously to vary the degree of a number of musical effects by the displacement thereof.

Finally, such novel variable resistor device of double-control type will be detailed hereinafter. Said variable-resistor device, as shown in FIGS. **10**, **11** and **12**, consists of a bracket plate **161** vertically mounted on a key bed **162**, an electric lamp **163**, a container **164** mounted on the front wall of the bracket **161** and containing an electric lamp **163** therein, a pair of photoconductive cells **165***a* and **165***b* such as CdS (cadmium sulfide) mounted on the bracket **161** and spatially disposed above and below the lamp container or box **164** respectively, and a control member **166** having a pair of shutter plates **166***a* and **166***b*, each shutter plate being movable through the gap between the cell and lamp box. Said lamp box **164** has two window bores **164***a* and **164***b* disposed on the upper and lower sidewalls thereof in a manner to face the photoconductive cells respectively. The lamp **163** is positioned away from the centerline of the window bores.

Therefore, the lamplight is distributed over the plane defined by the edge of the window bore in such manner that the density of light progressively varies from one side to the other of the window bore directed toward the other side.

The shutter plate **166***a* has three circular bores **167**, **168** and **169** of different diameters, said bores being spatially disposed so that the total amount of light supplied through those bores to the photoconductive cell is continuously increased in accordance with the displacement of the shutter plate as indicated in FIG. **13**.

Said control member is secured movably around a vertical axle mounted on the key bed. A coil spring bias **170** is adapted rotatably to urge the control member. When the control member is urged by the action of the coil spring, the shutter plate sufficiently prevents light from being supplied from the lamp to the photoconductive cell so as to preserve the great resistance of the photoconductive cell. Accordingly, the electric signal conducive to the musical effect is hardly carried through the photoconductive cell to the main circuit.

On the other hand, the knee-operated lever **18** has its joint portion **171** pivoted around a horizontal pin **172** mounted on the key bed and extends downwards through a bore drilled in the key bed. On the key bed is disposed a separate bracket **173** which carries one end of a coil spring **174**. The other end of the coil spring **174** is connected with the top end of the knee-operated lever so as to pull the lever away from the control member.

Accordingly, when the player causes the knee-operated lever to be turned around the pin **172** against the bias of the spring **174**, the top of the lever is attached to the forward end of the control member. If the knee-operated lever is further gradually turned, the control member travels around the vertical axle against the bias of the spring **170** with the result that the shutter plate permits the amounts of light supplied from the lamp to the cell, i.e. through the area of the bore of the shutter plate corresponding to the window bore, to be gradually adjusted in accordance with the displacement thereof.

Therefore, the resistance of the cell is progressively reduced so as to perform the musical effect signal with ease.

In this embodiment, the photoconductive cells may be used at the variable resistors **52***a* and **52***b* indicated in FIG. **3** for controlling the degree of factors conducive to the joint display of the depth and speed of the vibrato effect. The aforesaid degree-varying means may, of course, be substituted by the conventional variable resistors.

Furthermore, the spring for the knee-operated lever may be used as a toggle spring to keep the lever in a horizontal direction where not required after the turn of the lever as arrowed at Q.

If necessary, the variable resistors **52***a* and **52***b* may interlock with the knee-operated lever **18**. In this case, the variable resistors are simultaneously so controlled that, as shown in FIG. **14**, the more the vibrato depth is increased, the more the vibrato speed is increased. Such control will enable the player fully to carry out his creative rendition in performance.

I claim:

1. In an electronic organ having a console with upper and bottom sides, a combination musical effect system and control arrangement having: a main tone-generating circuit including tone signal-generating means in said organ for generating electric tone signals having a frequency corresponding to those of tones to be produced; converting means in said organ for converting said electric signals to sounds; keys on said console upper side operatively connected with switches for controlling the supply of signals from said generating means to said converting means; a separate musical effects circuit in said organ including degree-varying means for varying the degrees of individual factors producing said special musical effects, said separate circuit being coupled to, and selectively operated with said main circuit; and, a single knee-operated lever connected to the lower side of said console interlocking with said degree-varying means so as to control such continuous variations in accordance with the magnitude of displacement of the knee-operated lever the improvement therein wherein said musical effects circuit includes circuit means to produce at least two different effects, tabs on said console corresponding to each of said effects and tab circuits operatively connecting said tabs and said lever so that said musical effects circuit is adapted to supply specific effects to the main circuit, and said degree-varying means control the frequency of said signals in accordance with the magnitude of displacement of the knee-operated lever.

2. A control arrangement claimed in claim **1**, in which there are further provided separate tab degree-varying means on said console which can be freely controlled regardless of the operation of the knee-operated lever, and a changeover switch connected to said separate tab degree-varying means and to said knee-operated lever to cause them to be alternately used.

3. A control arrangement as claimed in claim **1**, wherein said degree-varying means interlocking with said knee-operated lever includes a lamp box for containing a lamp, said box having at least one window bore, a photoconductive cell arrangement acting on said degree-varying means facing the window bore, and spaced therefrom, and a rotatable control member interlocking with said knee-operated lever having shutter plates movably mounted through the space between the window bore and cell, said shutter plate having a plurality of similar apertures of progressively changing sizes, said apertures being spatially disposed, so that the lamplight is distributed over the plane defined by the window bore in such manner that the intensity of light progressively varies from one side to the other of the window bore, so that the total amount of light supplied through those apertures to the photoconductive cell is continuously changing with the displacement of the shutter plate.

4. An electromechanical arrangement for varying the degree of individual factors producing a special musical effect comprising in combination, an electric lamp, a lamp box for containing said lamp having at least one window bore therein, a photoconductive cell arrangement facing the window bore and spaced therefrom, tone generators and pickup means operatively coupled to said photoconductive cell arrangement, and a rotatable control member with an interlocking knee-operated lever having shutter plates movably mounted through the space between the window bore and cell arrangement, said shutter plate having a plurality of circular bores of progressively different diameters, said circular bores being spatially disposed, so that the lamplight is distributed over the plane defined by the edge of the window bore in such a manner that the intensity of light progressively varies from one side to the other of the window bore, so that the total amount of light supplied through those bores to the photoconductive cell is continuously changed with the displacement of the shutter plate.

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