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TONE GENERATOR SYSTEM

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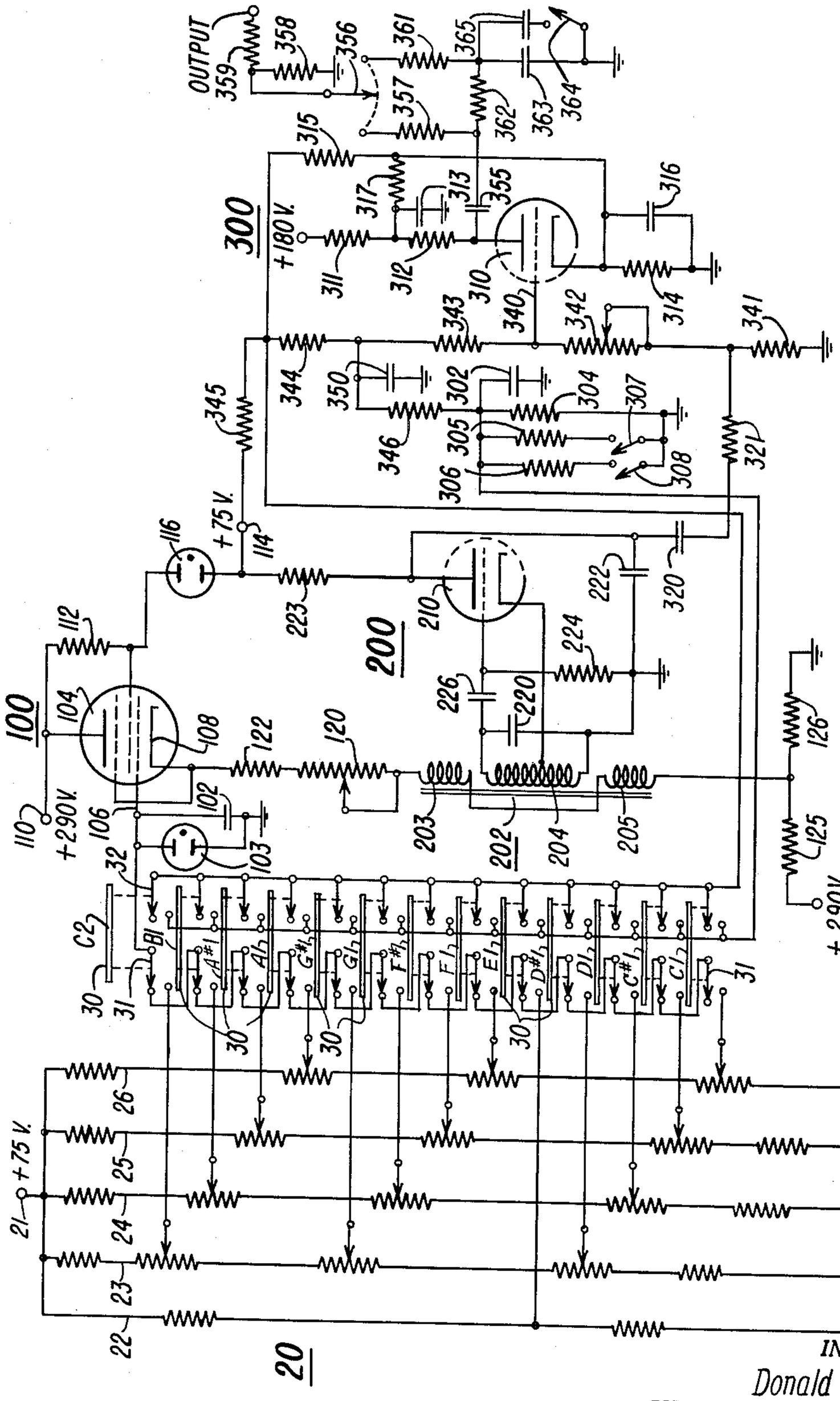

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TONE GENERATOR SYSTEM

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This invention relates generally to electric musical instruments and in particular to a tone generator circuit for an electronic organ.

During the past several years, electronic organs have been widely used, both in place of pipe organs previously used, and also in many applications where the size and cost would prohibit the use of a pipe organ. Although the compactness and tone quality of such electronic organs has made them attractive from a purchaser's viewpoint, problems have been encountered in providing faithful reproduction of musical tones and the various characteristics which were produced by pipe organs.

Among these problems is the provision of the proper attack and sustain characteristics of musical tones, particularly those tones which may be produced by the pedal manual. In order to produce musical tones of the proper frequency and which may be produced immediately and in rapid succession, the pedal switches of electronic organs should control an oscillator circuit which is instantaneous in operation and which is not susceptible to effects of transient voltages. Also, when providing various musical tones, it is desired that the tones be cut off sharply, or sustained, depending upon the musical composition and the tempo of the musical arrangement being played.

Therefore, it is an object of the present invention to provide an improved keyed oscillator circuit for use in the pedal tone section of an electronic organ.

Another object of the present invention is to provide an improved tone generating circuit which is keyed by the pedal switches of an electronic organ for providing musical tones of varying characteristics.

Still another object of the present invention is to provide a tone sustaining circuit in a musical instrument such as an electronic organ for producing musical tones having predetermined qualities and characteristics.

A feature of the invention is the provision of an oscillator circuit for an electronic organ which includes a voltage controlled inductor coupled to a memory circuit, which has selective voltages applied thereto by key switches of the organ.

Another feature of the present invention is the provision of an electronic organ having a tunable, continuously running oscillator circuit and a keyer circuit which is coupled to the oscillator circuit, with the keyer circuit having time delay components which provide variable tone characteristics to the tones produced by the oscillator circuit.

Yet another feature of the present invention is the provision of an electronic organ having an oscillator circuit including a saturable reactor in the tone generating section, wherein tone frequencies provided by the oscillator are controlled by current flow in the saturable reactor.

The drawing is a circuit diagram which illustrates the invention.

In practicing the invention, an electronic organ is provided having a tone generating circuit including an oscillator which is tunable for producing a plurality of musical

tones. A tuning circuit including a voltage divider provides a predetermined input voltage for each musical tone selected. A plurality of key switches are coupled to the tuning circuit to select particular voltages for application to a memory circuit including an electron discharge device. The switches may be operated by a pedal board or by other organ keys. The memory circuit maintains the voltage corresponding to the selected frequency until a new tone has been selected. The oscillator includes a saturable reactor coupled to the memory circuit and controlled by the voltage therefrom which varies according to the selected musical tone. The effective inductance value of the reactor varies with the voltage applied thereto thereby changing the frequency of the oscillator output. The pedal switches which select the initial voltage also operate a circuit in a keyer which controls the application of the signal produced by the oscillator to the audio system of the organ. The keyer includes selective time constant components to provide desired attack and sustained decay of the musical tones which may be selected by tabs of the organ.

In the drawing, there is shown a tuning circuit 20 which includes a voltage divider network having five parallel branches 22 through 26 each including a plurality of series connected resistors. Each branch is connected between terminal 21, which applies a regulated potential, and ground. A particular voltage is provided for each of the thirteen tones associated with the switches 30 by tuning circuit 20. Each voltage output from tuning circuit 20 may be adjusted except the voltage output obtained from branch 22 for note E1, which is the reference note. The voltages for the other notes are derived from adjustable contacts on the resistors of the branch circuits, and by adjustment of these contacts the notes can be tuned.

The switches 30 which couple tuning circuit 20 to memory circuit 100 may be operated by organ pedals, and each have two sections. The first section is composed of a plurality of single pole, double throw switches 31 connected so that operation of each switch applies a particular potential from circuit 20 to memory circuit 100. Interlocking wiring disconnects the tuning circuit voltage outputs for tones which are lower on the musical scale than the tone selected. Thus, if two or more tones are simultaneously selected, only the voltage corresponding to the highest tone will be applied to memory circuit 100.

The second section of each pedal switch 30 consists of a single pole, single throw switch 32, and all such switches are wired in parallel. The switches 32 operate keyer 300 when a pedal is pressed. Thus each pedal operates a switch in the first section to select a tone and a switch in the second section to control the keying of the tone.

Memory circuit 100 includes a pentode electron tube 104 which is connected as a cathode follower. The plate of tube 104 is connected to terminal 110 which provides an unregulated potential, and the screen is connected to the terminal 110 through resistor 112 and to regulated potential 114 through neon tube 116. This causes the operating point of tube 104 to vary somewhat with changes in the unregulated potential applied to the plate thereof. Capacitor 102 is connected between ground and the control grid 106 of pentode 104 and is charged by the potential provided by tuning circuit 20. Neon tube 103, bridged across capacitor 102, functions as a protective device for the control grid of tube 104, and does not draw current under normal operating conditions.

The charge across capacitor 102 is the tone controlling voltage, and this is retained until a new voltage is applied to produce a different tone when another pedal is pressed. The impedance of the resistors in tuning circuit 20 are selected so that the time constant when the resistors are coupled to capacitor 102 permits a rapid tuning change.

The cathode follower memory circuit 100 converts the high impedance input from the tuning circuit to a low impedance output. The output circuit coupled to cathode 108 of pentode tube 104 includes potentiometer 120, resistor 122, magnetizing windings 203 and 205 of saturable reactor 202, and the voltage divider including resistors 125 and 126. Potentiometer 120 provides a master adjustment for tone E1.

Oscillator circuit 200 is a Hartley type with coil 204 and capacitor 220 providing a tuned resonant circuit for controlling the frequency of the oscillator, and tube 210 sustaining oscillations in this circuit. Coil 204 of the tuned circuit is the controlled inductance winding of the saturable reactor 202. Capacitor 222 bypasses the plate of tube 210 which is coupled to the regulated potential 114 through resistor 223. Capacitor 226 couples the grid of tube 210 to the tuned circuit, and resistor 224 provides the grid return. A tap on the winding 204 is connected to the cathode of oscillator tube 210.

The two outside control or magnetizing windings 203 and 205 of saturable reactor 202 are connected in series so that any voltage applied in winding 204 will induce a voltage in the outside windings 203 and 205 which will oppose and cancel. The voltage applied to windings 203 and 205 of reactor 202 from memory circuit 100 induces current in these windings of a magnitude dependent upon the voltage applied by tuning circuit 20 and selected by switch 31. The inductance of coil 204 is governed by tuning circuit 20 due to the saturation of the core of saturable reactor 202 produced by the current in windings 203 and 205. The incremental alternating current permeability of the core of reactor 202 is a function of the degree of direct current saturation, and this controls the inductance of the coil 202 which in turn controls the frequency of oscillator circuit 200.

Keyer 300 includes electron tube 310 which may be included in the same envelope with electron tube 210. The plate of tube 310 is connected to an unregulated potential through resistors 311 and 312. Capacitor 313 filters the anode supply of tube 310. The cathode of the tube is biased by a voltage divider chain including resistors 314, 315 and 345 connected to a regulated potential 114. The cathode is bypassed by capacitor 316. Resistor 317 connects the cathode to the junction of resistors 311 and 312 to apply an unregulated component to the bias at the cathode.

Grid 340 of tube 310 is connected to the output of oscillator 200 through capacitor 320 and resistors 321 and 342. The tube 310 is biased to cut off by the voltage divider including resistors 341, 342, 343, 344 and 345. The pedal switches 32 reduce the bias on tube 310 by bridging resistor 346 across resistor 344 to increase the potential on grid 340 so that tube 310 conducts to pass the signal from the oscillator 200.

Time constant networks control the time of attack and decay to provide a sustain characteristic to the selected musical tone. Capacitor 350 controls the attack as this capacitor must charge to allow the voltage at grid 340 to rise so that tube 310 conducts. Capacitor 302 charges rapidly to develop a potential thereacross when a tone pedal switch 32 is closed so that keyer 300 will allow tube 310 to conduct even if the pedal switch is rapidly released. Thus, the operator of the electronic organ may tap the tone pedals very rapidly for quick tone passages and all of the tones will be audible. Capacitor 302 reaches ninety-five percent of full charge after 45 milliseconds. This charge is transferred to capacitor 350 and keyer circuit 300 will be operated even though the tone pedal switch is released rapidly.

Capacitor 302 also provides sustain action as it provides a potential to operate the keyer after the switch 32 opens. The sustain time of a tone is governed by the value of resistor 304 through which capacitor 302 discharges. The sustain time may be changed by grounding resistors 305 and 306 selectively by switches 307 and 308 respectively. By using resistors 305 and 306 having different values which are selectively connected in parallel with resistor 304, the time for discharge of capacitor 302 is changed and the extent of sustain can be controlled. Maximum sustain is provided when both switches 307 and 308 are open.

The output of the keyer 300 is derived from the plate of tube 310 through capacitor 355. A network is provided for modifying the tone characteristics of the output wave as may be desired. This includes a switch 356 which may be connected to resistor 357 to provide the major bass output. The output is then developed across resistor 358 and applied through resistor 359 to a succeeding stage. A sub-bass output may be obtained by connecting the switch 356 to resistor 361. This derives the output through capacitor 355 to the filter including resistor 362 and capacitor 363 which remove high frequency components. The output through resistor 361 to resistor 358 is a sub-bass output. To provide an even deeper bass tone, switch 364 may be engaged to connect capacitor 365 in parallel with capacitor 363. The output is again derived through resistor 361 and across resistor 358.

Thus, the invention provides for an improved circuit to be used to provide the pedal tones for an electronic organ. The circuit includes a saturable reactor which controls the frequency of the oscillator circuit in response to a voltage applied to the saturable reactor through a memory circuit from a voltage divider network coupled to the pedal switches which select a voltage for a particular musical note. The oscillator operates continuously, providing the same tone until a pedal switch is actuated to produce a different tone. This memory action, which is necessary to provide the sustained operation, makes it unnecessary to provide a mechanical memory device, such as the use of latching switches.

The system includes a keying circuit which selectively applies the tones from the oscillator to the organ amplifier and provides the desired attack and decay characteristics. This circuit is free of transient voltages which may produce undesirable tone characteristics such as "popping." The output of the keyer may be modified to provide the desired tone characteristics.

I claim:

1. A generator for producing signals of a plurality of different frequencies corresponding to musical tones including in combination, tuning circuit means including voltage divider means for supplying a plurality of different potentials, memory circuit means, key switch means having first and second portions, means connecting said first switch portions between said tuning circuit means and said memory circuit means for selectively applying said potentials individually thereto, oscillator circuit means including an inductor having a variable inductance winding and a control winding, means connecting said memory circuit means to said control winding for controlling said variable inductance winding to thereby control the frequency of the tone produced by said oscillator circuit means, and keyer circuit means coupled to said oscillator circuit means and to said second switch portions, said second portion of the key switch means rendering said keyer circuit means operative to conduct the tone from said oscillator circuit means.

2. A musical tone generator circuit for producing signals of a plurality of different frequencies corresponding to the tones of musical notes, including in combination, tuning circuit means including voltage divider means for

supplying a plurality of different potentials, said voltage divider means including a plurality of circuit branches for connection across a potential source, and a plurality of potentiometers connected in said branches and having movable taps which are adjustable to provide a plurality of potentials differing in steps, memory circuit means including an electron valve having a control electrode and output electrodes, and capacitor means connected to said control electrode, key switch means including a plurality of individually operable switch portions having contacts, means connecting said contacts of each switch portion between one of said taps and said capacitor means for selectively applying said potentials individually to said capacitor means to charge the same and provide a potential at said control electrode, oscillator circuit means including a frequency controlling circuit, saturable reactor means having variable inductance winding means connected in the frequency controlling circuit of said oscillator circuit means and control winding means for controlling the inductance of said variable inductance winding means, circuit means connected to said output electrodes of said electron valve of said memory circuit means and including said control winding means for controlling the current therethrough in accordance with the potential on said capacitor means, whereby the inductance of said variable inductance winding means is changed in steps by operation of said switch portions to control the frequency of said oscillator circuit means in steps corresponding to the tones of musical notes.

3. A generator for producing signals of a plurality of different frequencies corresponding to musical tones including in combination, tuning circuit means including voltage divider means having a plurality of taps for supplying a plurality of potentials differing in steps, key switch means having first and second portions each having a plurality of individually operable contacts, means connecting said contacts of said first switch portion individually to said tuning circuit means, oscillator circuit means including inductor means having variable inductance winding means and control winding means with the inductance of said variable inductance winding means controlling the frequency of signals developed by said oscillator circuit means, circuit means connecting said contacts of said first switch portion to said control winding means for applying signals to said control winding means for controlling the inductance of said variable inductance winding means to thereby control the frequency of the signals produced by said oscillator circuit means, keyer circuit means coupled to said oscillator circuit means for selectively passing the signals produced thereby to provide output signals, and means connecting said contacts of said second portion of said key switch means to said keyer circuit means for selectively rendering said keyer circuit means operative to pass the signals from said oscillator circuit means.

4. A generator for producing signals of a plurality of different frequencies corresponding to musical tones including in combination, tuning circuit means including voltage divider means for supplying a plurality of different potentials differing in steps, memory circuit means, key switch means having first and second portions, means connecting said first switch portion between said tuning circuit means and said memory circuit means for selectively applying said potentials individually thereto, oscillator circuit means including inductor means having variable inductance winding means and control winding means with the inductance of said variable inductance winding means controlling the frequency of signals developed by said oscillator circuit means, means connecting said memory circuit means to said control winding means for applying signals to said control winding means for controlling the inductance of said variable inductance winding means to thereby control the frequency of the signals produced by said oscillator circuit means, keyer circuit means coupled to said oscillator circuit means for

selectively passing the signal produced thereby to provide output signals, and means connecting said second portion of said key switch means to said keyer circuit means for selectively rendering said keyer circuit means operative, said keyer circuit means including capacitor means across which a voltage is developed for controlling the attack and decay of the output signals passed by said keyer circuit means.

5. A generator in accordance with claim 4 wherein said keyer circuit means includes discharge circuit means connected to said capacitor means and said discharge circuit means includes a portion selectively operable to control the rate of discharge of said capacitor means and thereby control the sustain of signals passed by said keyer circuit means.

6. A circuit for producing signals of a plurality of different frequencies having varying characteristics corresponding to musical tones including in combination, tuning circuit means including voltage divider means for supplying a plurality of predetermined potentials, memory circuit means including a first electron discharge device and a first capacitor connected to an input thereof, key switch means having first and second portions, means coupling said first switch portion between said tuning circuit means and said memory circuit means for selectively applying said potentials to said capacitor, said memory circuit means producing an output current which varies with the potential across said capacitor, oscillator circuit means providing an output signal and including a second electron discharge device and an inductor having a variable inductance winding and a control winding, said variable inductance winding being connected in said oscillator circuit means to control the frequency thereof, said control winding being coupled to said memory circuit means and controlling the inductance of said variable inductance winding in accordance with the current from said memory circuit means, keyer circuit means coupled to said oscillator circuit means, means connecting said second switch portion to said keyer circuit means for selectively rendering the same operative, said keyer circuit means including a third electron discharge device and sustain circuit means including a second capacitor, said second portion of the key switch means causing said keyer circuit means to pass the output signal from said oscillator circuit means, said keyer circuit means controlling the attack and decay characteristics of said output signal by action of said second capacitor.

7. A circuit for producing signals of a plurality of different frequencies having varying characteristics corresponding to musical tones including in combination, tuning circuit means including voltage divider means for supplying a plurality of predetermined potentials, memory circuit means including a first electron discharge device and first capacitor means connected to the input thereof, key switch means including first and second portions, means coupling said first switch portion between said tuning circuit means and said memory circuit means for selectively applying said potentials to said capacitor means, said memory circuit means producing an output current which varies with the potential across said capacitor, oscillator circuit means providing an output signal and including a second electron discharge device and an inductor having a variable inductance winding and a control winding, said variable inductance winding being connected in the frequency controlling portion of said oscillator circuit means to control the frequency thereof, said control winding being coupled to said memory circuit means and controlling the inductance of said variable inductance winding in accordance with the current from said memory circuit means, keyer circuit means coupled to said oscillator circuit means, said keyer circuit means including a third electron discharge device and sustaining circuit means including second capacitor means, means coupling said second switch portion to said keyer circuit means, said second switch portion being operative to charge said

second capacitor means to control the conductivity of said third electron discharge device so that the output signal from said oscillator circuit means is selectively conducted thereby.

8. A circuit for producing signals of a plurality of different frequencies having varying characteristics corresponding to musical tones including in combination, tuning circuit means including voltage divider means for supplying a plurality of predetermined potentials, memory circuit means including a first electron discharge device and a first capacitor connected to the input thereof, key switch means having first and second portions, means coupling said first switch portion between said tuning circuit means and said memory circuit means for selectively applying said potentials to said capacitor, said memory circuit means producing an output current which varies with the potential across said capacitor, oscillator circuit means providing an output signal and including a second electron discharge device and a frequency controlling circuit portion, an inductor having a variable inductance winding and a control winding, said variable inductance winding being connected in said frequency controlling circuit portion of said oscillator circuit means to control the frequency thereof, said control winding being coupled to said memory circuit means and controlling the inductance of said variable inductance winding in accordance with the current from said memory circuit means, keyer circuit means coupled to said oscillator circuit means, said keyer circuit means including a third electron discharge device and sustaining circuit means including second and third capacitors, means coupling said second switch portion to said keyer circuit means, said second switch portion operative to charge said second and third capacitors to control the conductivity of said third electron discharge device so that the output signal from said oscillator circuit means is selectively conducted thereby, said second capacitor controlling the attack characteristics of the tone from said keyer circuit means, and said third capacitor controlling the decay characteristics thereof.

9. A circuit for producing signals of a plurality of different frequencies having varying characteristics corresponding to musical tones including in combination, tuning circuit means including voltage divider means for supplying a plurality of predetermined potentials, memory circuit means including a first electron device and a first capacitor connected to the input thereof, key switch means having first and second portions, means coupling said first switch portion between said tuning circuit means and said memory circuit means for selectively applying said potentials to said capacitor, said memory circuit means producing an output current which varies with the potential across said capacitor, oscillator circuit means providing an output signal and including a second discharge device and a frequency controlling circuit portion, an inductor having a variable inductance winding and a control winding, said variable inductance winding being connected in said frequency controlling circuit portion of said oscillator circuit means to control the frequency thereof, said control winding being coupled to said memory circuit means and controlling the inductance of said variable inductance winding in accordance with the current from said memory circuit means, keyer circuit means coupled to said oscillator circuit means, said keyer circuit means including a third electron device and sustaining circuit means including second and third capacitors, means coupling said second switch portion to said keyer circuit means, said second switch portion operative to charge said second and third capacitors to control the conductivity of said third electron device so that the output signal from said oscillator circuit means is selectively conducted thereby, said second capacitor controlling the attack characteristics of the tone signal from said keyer circuit means as said capacitor charges, and said third capacitor controlling the sustain characteristics of the tone signal from said keyer circuit means as said capacitor discharges, means coupled to said third capacitor for selectively controlling the discharge rate thereof, and output circuit means connected to said keyer circuit means for modifying the frequency characteristics of said tone signal.

10. A circuit for producing signals of a plurality of different frequencies having varying characteristics corresponding to musical tones including in combination, oscillator circuit means providing an output signal and including an inductor having a variable inductance winding and a control winding, tuning circuit means including a plurality of voltage divider means for supplying a plurality of different potentials, memory circuit means coupled to said oscillator circuit means, key switch means having first and second portions connected to said tuning means, said memory means responsive to said first switch portion to selectively apply control current of different values to said control winding, keyer circuit means coupled to said oscillator circuit means, and including an electron discharge device and sustaining circuit means including first and second capacitors, means connecting said second switch portion to said keyer circuit means and operative to charge said first and second capacitor to control the conductivity of said electron discharge device and thereby control the output signal from said keyer, said first capacitor controlling the attack characteristic of the output signal from said keyer as said capacitor charges, said second capacitor charging rapidly and controlling the decay characteristics of said output signal as said capacitor discharges.

11. A circuit for producing signals of a plurality of different frequencies having varying characteristics corresponding to musical tones including in combination, oscillator circuit means providing an output signal and including an inductor having a variable inductance winding and a control winding, tuning circuit means including a plurality of voltage divider means for supplying a plurality of different potentials, memory circuit means coupled to said oscillator circuit means, key switch means having first and second portions connected to said tuning circuit means, said memory means responsive to said first switch portion to selectively apply control currents of different values to said control winding, keyer circuit means coupled to said oscillator circuit means and including an electron device and sustaining circuit means including first and second capacitors, means connecting said second switch portion to said keyer circuit means and operative to charge said first and second capacitors to control the conductivity of said electron device and thereby control the output signal from said keyer circuit means, said first capacitor controlling the attack characteristic of the tone signal from said keyer circuit means as said capacitor charges, said second capacitor charging rapidly to cause said electron device to conduct when said key switch means is operated for a short time, said second capacitor further controlling the sustain characteristics of the tone signal from said keyer circuit means as said capacitor discharges, and tone control means connected to said keyer circuit means, said tone control means including portions selectively rendered operative to control the frequency characteristics of the tone applied thereto by said keyer circuit means.

12. A musical tone generator circuit for producing signals of a plurality of different frequencies corresponding to the tones of musical notes, including in combination, tuning circuit means including voltage divider means for supplying a plurality of different potentials, said voltage divider means including a plurality of circuit branches for connection across a potential source and a plurality of taps on said branches to provide a plurality of potentials differing in steps, key switch means including a plurality of individually operable switch portions individually connected to said taps, oscillator circuit means including a frequency controlling circuit, saturable reactor means having variable inductance winding means con-

nected in the frequency controlling circuit of the oscillator and control winding means for controlling the inductance of said variable inductance winding means, and circuit means connected to said control winding means and including a plurality of portions each connected to one of said switch portions for controlling the current through said control winding means in accordance with the potential applied to said one switch portion, whereby the inductance of said variable inductance winding means is changed in steps by operation of said switch portions to apply different potentials to said control winding means, to thereby control the frequency of said oscillator circuit means in steps corresponding to the tones of musical notes.

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