Aug. 7, 1962 S. L. KRAUSS 3,048,792

TONE GENERATOR WITH SELECTIVE SWITCHING MEANS

Filed July 8, 1958

Fig. 1

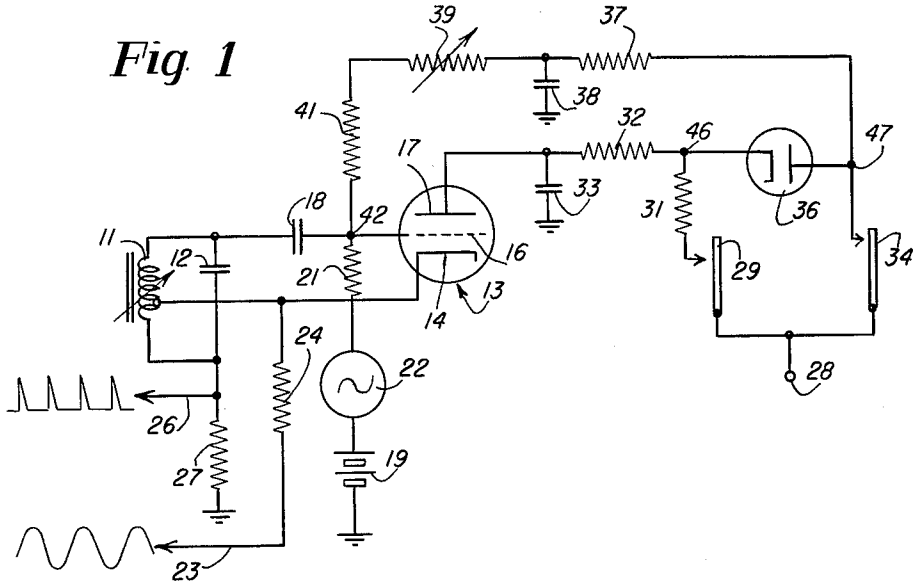
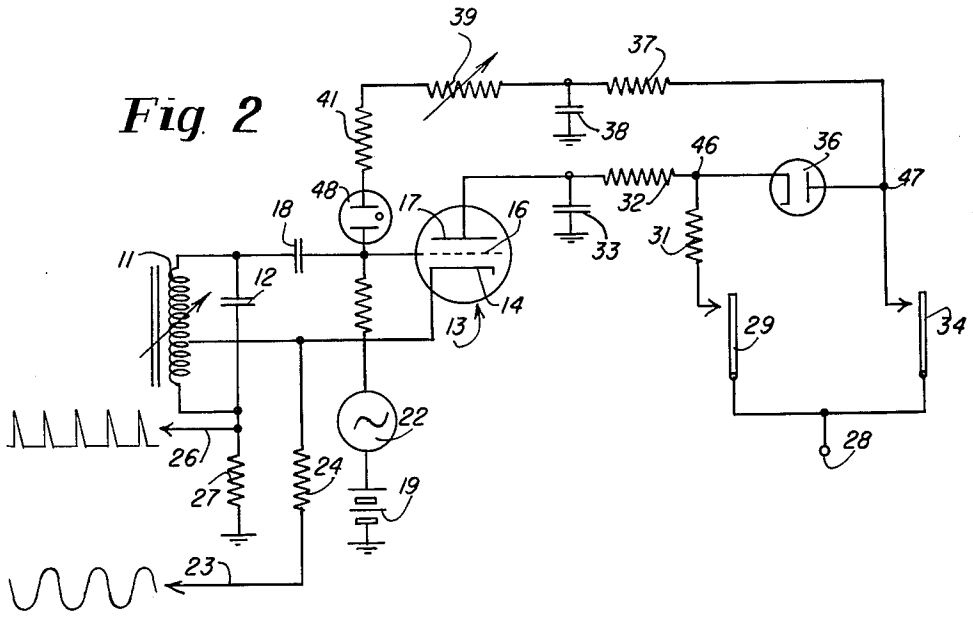


Fig. 2



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TONE GENERATOR WITH SELECTIVE SWITCHING MEANS

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This invention relates to oscillator circuits and more particularly to oscillator circuits adapted to provide a plurality of distinct musical tones for use in an electrical musical instrument, as well as to an improved method for keying such circuits.

In electrical musical instruments, such as electric organs, separate circuits have been provided for the production of electrical signals corresponding in frequency to the musical notes to be played. In the interest of economy, it is desirable to provide circuits which are each capable of oscillating at different controlled frequencies so that the same circuit may be used to play a number of different notes thus reducing the total number of oscillator circuits provided and reducing the number of electronic components required. Various efforts have been made to detune oscillator circuits so that they will oscillate at some frequency shifted by a predetermined amount from their basic resonant frequency. However, in such circuits it has been found necessary to provide separate key contacts for starting the oscillator at its standard frequency and then detuning it to the shifted frequency. This requires the separate actuation of two organ key contacts and so undesirably complicates the instrument.

It is an object of the present invention to provide an oscillator circuit for an electrical musical instrument which can be keyed to a frequency shifted from its normal oscillation frequency by actuation of a single keying contact.

It is another object of the invention to provide means for instantaneously starting an oscillator circuit at substantially its normal or tuned frequency and automatically shifting it to a detuned frequency by connecting a biasing component through actuation of a single key.

A feature of the invention is the provision of an oscillator having first and second isolated contacts for keying the plate of the oscillator tube and with one of the contacts also changing the bias to the grid of the oscillator tube to thereby change the oscillator frequency.

A further feature of the invention is the provision of an oscillator selectively energized through first and second keys for providing different frequencies, with unidirectional current conducting means, such as a diode, connected between the two current carrying paths energized by the keys to provide keying precedence between the two.

Another feature of the invention is the provision of a glow lamp in the grid bias circuit of an oscillator amplifier tube which is operative to connect a grid biasing resistor into the circuit only after the oscillator circuit has been started at its normal oscillating frequency.

In the accompanying drawings:

FIG. 1 is a schematic circuit diagram of an oscillator circuit in accordance with one embodiment of the invention; and

FIG. 2 is a schematic circuit diagram showing an oscillator circuit in accordance with another embodiment of the invention.

In accordance with the present invention, an oscillator circuit for a musical instrument includes a triode tube having its plate coupled to a direct current voltage source through first and second conducting paths having a common branch. Each of these paths is controlled by a separate key contact. Unidirectional current controlling means, such as a diode, is connected between the two

paths in such a way that closing of the first key will cause current to flow through only the first current carrying path but closing of the second key alone will cause current to flow through both paths. The flow of current through the second path connects an adjustable biasing resistor to the grid of the amplifier thus decreasing the grid impedance of the tube and causing a phase shift which in turn causes the oscillator circuit to become detuned and oscillate at a different frequency. A glow lamp may be connected between the biasing resistor and the grid to isolate the grid circuit and delay connection of the biasing resistor until the oscillator starts at its tuned frequency.

The embodiment of the invention shown in FIG. 1 includes an oscillator tuned circuit comprising the adjustable inductor **11** and the capacitor **12** connected to the amplifying triode tube **13** having the usual cathode **14**, grid **16**, and plate **17**. Capacitor **18** connects the tuned circuit to the grid **16** and causes a small phase shift of the signal applied thereto so that the oscillator normally produces a tone slightly higher than the natural resonant frequency of inductor **11** and capacitor **12**. Grid bias is provided by the battery **19** through the resistor **21**. In the embodiment shown, an alternating current source **22** is provided between the battery and the resistor to apply a tremolo signal to the grid **16**. A sine wave tone signal is derived at the output terminal **23** which is connected to the inductor **11** through the resistor **24**. A pulse tone is derived at the output terminal **26** which is coupled to one end of the inductor **11** and connected to the pulse forming resistor **27**.

A direct current source for the oscillator is supplied at the input terminal **28** which is coupled to the plate **17** of the triode **13** through a first current carrying path. The first current carrying path extends from terminal **28** though the key switch means **29**, the resistors **31** and **32** and across capacitor **33** to the plate. A second current carrying path extends from input terminal **28** through key switch means **34** and diode **36** to resistor **32** and to the plate **17**. The diode **36** is connected to conduct from connection **47** to connection **46** but not in the opposite direction. The second path also includes a filter network composed of resistor **37** and capacitor **38**, adjustable resistor **39** and serially connected resistor **41** to connection **42**, which is coupled to grid **16**.

In operation of the circuit shown in FIG. 1, the oscillator is actuated to produce a first note by closing the key **29** which connects the plate **17** to the terminal **28**. Current is carried by the first path but not by the second path. The tank circuit composed of inductor **11** and capacitor **12** oscillates in the usual manner. As stated above, the oscillation frequency is somewhat higher than the resonant frequency of the tank circuit because of the small phase shift in the signal applied to the grid **16** due to the presence of the capacitor **18**. The second current carrying path is not connected to terminal **28** because diode **36** blocks current flow from point **46** to point **47**.

Playing a note one-half tone higher is accomplished by closing the key **34**. This makes electrical connection between the input terminal **28** and the connection **47**. Because the diode **36** is connected to conduct the current from connection **47** to connection **46**, it electrically connects the second current carrying path to the first path between connection **46** and the plate **17**. This applies a voltage to the plate permitting the oscillator to operate. At the same time, current flows through the second current carrying path to grid **16**. The circuit including resistors **39** and **41** provides a positive bias current which decreases the grid impedance and causes an additional phase shift of the signal applied to the grid. This detunes the oscillator and produces a higher fre-

quency tone. The amount of frequency change may be regulated by controlling the ohmic value of the resistor **39**. Normally, a frequency shift of one-half tone is provided. It will be seen that because of the placement of the diode **36** keying precedence is provided between the keys **29** and **34** and the closing of key **34** both keys and detunes the oscillator. Closing key **29** with key **34** closed has no effect on the oscillator and closing key **34** with key **29** closed detunes the oscillator smoothly.

Although the frequency shift described may be accomplished by simply providing the adjustable resistor **39**, it is preferred to include the network composed of resistor **37** and capacitor **38** in order to suppress transients introduced by way of the resistance path which might tend to block the oscillator.

Detuning of the oscillator tends to reduce the signal across the tuned circuit. In order to equalize the level of the two tone signals selectively produced by actuation of keys **29** and **34**, an equalizing resistor **31** may be provided in the first current carrying path between the key **29** and the diode **36**.

FIG. 2 illustrates an embodiment of the invention which differs from that shown in FIG. 1 in that a gas-filled glow lamp **48** is added to the grid bias circuit. Any suitable ionizable gas, such as neon, may be used to fill the lamp. The lamp **48** will not conduct until the gas therein becomes ionized so that when the key **34** is closed, bias is not applied to the grid **16** until after a predetermined time interval. The presence of the glow lamp **48** thus permits the oscillator to start before the bias is applied and this is in general desirable since it is somewhat difficult to start an oscillator at a detuned frequency. The time required to ionize the gas in the glow lamp **48** is very short so that the only signal heard by closing of the key **34** is that characteristic of the shifted frequency.

In addition, the presence of the glow lamp **48** isolates the sensitive grid circuit of the oscillator from the keying leads thus preventing undesirable cross-coupling between the latter.

In a specific embodiment of the invention, the amplifier triode **13** is one section of a vacuum tube type 12AU7 and the diode **36** is one section of a vacuum tube diode type 12AL5. Table I below gives specific values for the various components in the circuit shown in FIG. 2 which may be used to provide the tones for one octave. It will be understood that pairs of notes in this octave, such as C and C# are shared between a single oscillator circuit with the C being played by the closing of the first key **29** and the higher semitone being played by the closing of the key **34** which introduces the positive bias of resistor **39** into the grid circuit. Thus, the total number of circuits required to play the 12 notes listed is only six. The specific component values given are for the sixth octave.

TABLE I

Values for Various Notes

Component	C & C#	D & D#	E & F	F# & G	G# & A	A# & B
Capacitor 12 in mfd.	.0082	.0056	.0047	.0039	.0033	.0022
Capacitor 18 in mfd.	.0022	.0018	.0018	.0015	.0012	.00082
Capacitor 33 in mfd.	.056	.056	.056	.056	.056	.056
Capacitor 38 in mfd.	.0027	.0027	.0027	.0027	.0027	.0027
Resistor 24 in megohms	.82	.82	.68	.56	.56	.56
Resistor 37 in megohms	.33	.33	.33	.33	.33	.33
Resistor 39 in megohms	.75	1.0	1.0	1.0	1.0	1.5
Resistor 41 in megohms	.33	.33	.33	.39	.39	.56
Resistor 21 in megohms	1.0	1.0	1.0	1.0	1.0	1.0
Resistor 31 in thousands of ohms	18	18	18	18	18	18
Resistor 32 in thousands of ohms	82	82	82	82	82	82
Battery 19 in volts	4	4	4	4	4	4
Inductance 11 in henrys	3	3	3	3	3	3

The present invention thus provides an effective and relatively simple shared oscillator circuit for use in an electric organ. A single contact operates to key and control the frequency of the oscillator. The use of the diode to establish keying precedence enables either of two notes to be played from the same oscillator by the closing of only one key at a time. The provision of a glow lamp in the grid circuit of the oscillator amplifier triode enables the oscillator to be started at its tuned frequency and quickly shifted to a detuned frequency by the depression of only a single key. In addition, the presence of the glow lamp prevents undesirable cross-coupling between the keying leads.

I claim:

1. An oscillator circuit for an electrical musical instrument including in combination, a tuned tank circuit, an amplifier device having a cathode, a grid and a plate and being connected to said tank circuit, input means for connection to a direct current potential source, a first current carrying path between said plate and said input means for applying energizing potential to said amplifier device for sustaining oscillations in said tank circuit, first switch means connected in said first path, a second direct current carrying path between said grid and said input means for applying a direct current bias potential to said grid to increase the frequency of oscillations, second switch means in said second path, and unidirectional current conducting means connected between said first and second paths so that current flows selectively through said first path upon closing of said first switch means and through said first and second paths simultaneously upon closing of said second switch means.

2. An oscillator circuit for an electrical musical instrument including in combination, a tuned tank circuit, an amplifier triode having cathode, grid and plate and connected to said tank circuit, input means for connection to a direct current power source, a first direct current carrying path between said plate and said input means, a first key connected in said first path and adapted to open and close the same, a second direct current carrying path between said grid and said input means, a biasing resistor, a resistance-capacitance network and a second key in said second path, and unidirectional conducting means connected between said first and second paths so that current flows selectively through said first path upon closing of said first key and through said first and second paths simultaneously upon closing of said second key with said second path providing a direct current bias to said grid to increase the frequency of oscillation of the oscillator circuit.

3. An oscillator circuit for an electrical musical instrument including in combination, a tuned tank circuit, an amplifier triode having cathode, grid and plate and connected to said tank circuit, input means for connection to a direct current power source, a first current carrying path between said plate and said input means, a first key connected in said first path and adapted to open and close the same, a second current carrying path between said grid and said input means including a biasing resistor, an ionizable gas filled glow lamp, a resistance-capacitance network and a second key connected in series, and unidirectional conducting means connected between said first and second paths so that current flows selectively through said first path upon closing of said first key and through said first and second paths simultaneously upon closing of said second key with the completion of said second path being delayed until the glow lamp conducts and providing a direct current bias to said grid to increase the frequency of oscillation of said oscillator circuit.

4. An oscillator circuit for an electrical musical instrument including in combination, a tuned tank circuit, an amplifier triode having cathode, grid and plate and connected to said tank circuit, input means for connection to a direct current power source, a first current carrying path between said plate and said input means, a first key connected in said first path and adapted to open and close

the same, a second current carrying path between said grid and said input means, a biasing resistor, gas-filled glow lamp, a resistance-capacitance network and a second key connected in series in said second path, a diode connected between said first and second paths so that current flows through said first path selectively to provide a first tone signal upon closing of said first key and through said first and second path simultaneously upon closing of said second key, with the completion of said second path being delayed by said glow lamp and said second path applying a direct current bias to said grid to provide a second tone signal, and a resistor in said first path to equalize the level of said tone signals.

5. An oscillator for an electrical musical instrument including in combination, resonant circuit frequency controlling means, amplifier means coupled to said frequency controlling means for sustaining oscillations therein, first circuit means for applying energizing potential to said amplifier means and including a first key for actuating the same, second circuit means connected to said amplifier means for applying a direct current bias thereto to thereby increase the frequency of oscillators, said second circuit means including delay means connected in series with a second key for activating said second circuit means, unidirectional current conducting means connected between said first and second circuit means for applying current from said second circuit means to said first circuit means for energizing said first and second circuit means upon operation of said second key, with the application of the direct current bias through said second circuit means being delayed by said delay means, said unidirectional conducting means being non-conducting to current flow from said first circuit means to said second circuit means whereby operation of said first key activates only said first circuit means.

6. A tone generating system for an electrical musical instrument including in combination, oscillator means including resonant circuit means and including an electron valve having a control electrode for sustaining oscillations in said resonant circuit means, said sustaining means having a first terminal adapted to receive a direct current energizing potential to initiate oscillations and a second terminal connected to said control electrode and adapted to receive a direct current bias potential to increase the frequency of said oscillations, first circuit means connected to said first terminal and including first switch means for connection to direct current potential supply means for selectively applying an energizing potential through said first circuit means to said first terminal, second circuit means connected to said second terminal and including second switch means for connection to direct current potential supply means, said second circuit means selectively applying a direct current bias potential to said control electrode through said second terminal, and unidirectional current conducting means connected between said first and second circuit means and being conductive to current flow from said second circuit means to said first circuit means and nonconductive to current flow from said first circuit means to said second circuit means, whereby operation of said first switch means applies a potential only to said first terminal to produce oscillations of a first frequency and operation of said second switch means applies potentials to said first and second terminals to produce oscillations of a second different frequency.

7. A tone generating system for an electrical musical instrument including in combination, oscillator means including resonant circuit means for controlling the frequency of oscillations and means for sustaining oscillations in said resonant circuit means, said oscillator means having a first terminal adapted to receive a direct current energizing potential to initiate oscillations and a second terminal adapted to receive a direct current bias potential to increase the frequency of oscillations, first circuit means connected to said first terminal and including first switch means for connection to direct current potential supply means for selectively applying an energizing potential through said first circuit means to said first terminal, second circuit means connected to said first terminal and including second switch means for connection to direct current potential supply means, said second circuit means selectively applying a direct current bias potential to said second terminal and including delay means for delaying the application of potential to said second terminal upon operation of said second switch means so that oscillations of said first frequency are initiated by operation of said second switch means and the frequency of oscillations is then changed to said second frequency, and unidirectional current conducting means connected between said first and second circuit means and being conductive to current flow from said second circuit means to said first circuit means and nonconductive to current flow from said first circuit means to said second circuit means, whereby operation of the first switch means applies a potential only to said first terminal to produce oscillations of a first frequency and operation of said second switch means applied potentials to said first and second terminals to produce oscillations of a second different frequency.

8. A tone generating system for an electrical musical instrument including in combination, oscillator means including resonant circuit means for controlling the frequency of oscillations and means for sustaining oscillations in said resonant circuit means, said oscillator means having a first terminal adapted to receive a direct current energizing potential to initiate oscillations and a second terminal adapted to receive a direct current bias potential to increase the frequency of oscillations, first circuit means connected to said first terminal and including first switch means for connection to direct current bias supply means for selectively applying an energizing potential through said first circuit means to said first terminal, second circuit means connected to said second terminal and including second switch means for connection to direct current potential supply means, said second circuit means selectively applying a direct current bias potential to said second terminals, with one of first and second circuit means including impedance means selected to equalize the level of oscillations of said first frequency and of said different frequency, and unidirectional current conducting means connected between said first and second circuit means and being conductive to current flow from said second circuit means to said first circuit means and nonconductive to current flow from said first circuit means to said second circuit means whereby operation of said first switch means supplies a potential only to said first terminal to produce oscillations of a first frequency and operation of said second switch means supplies potentials to said first and second terminals to produce oscillation of a second different frequency.

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