Sept. 17, 1957 C. J. TENNES 2,806,954

OSCILLATOR FOR MUSICAL INSTRUMENT

Filed Nov. 18, 1954 2 Sheets-Sheet 1

FIG. 1

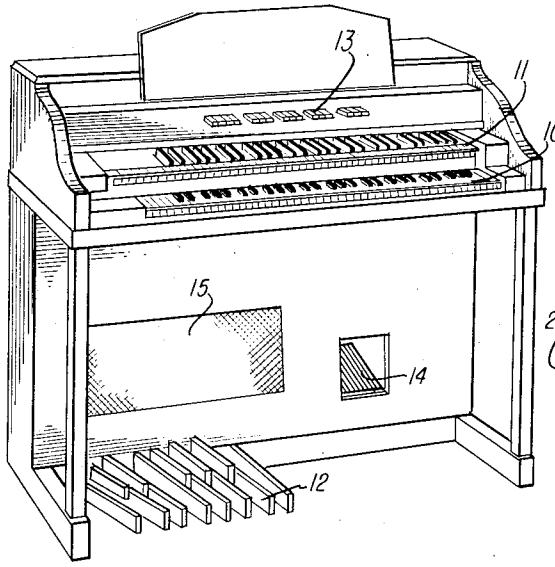



FIG. 3

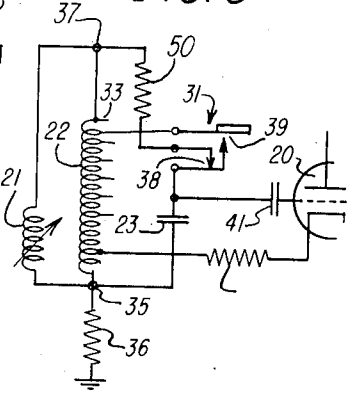
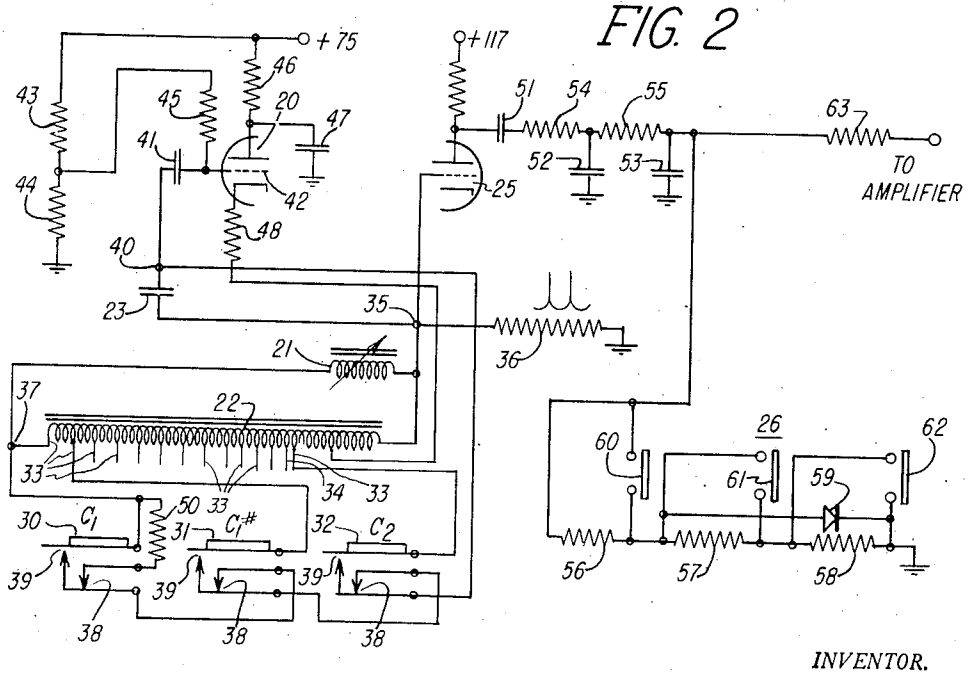



FIG. 2




INVENTOR.
Charles J. Tennes

BY

Mueller and Aichele
Attys.

Sept. 17, 1957 C. J. TENNES 2,806,954

OSCILLATOR FOR MUSICAL INSTRUMENT

Filed Nov. 18, 1954 2 Sheets-Sheet 2

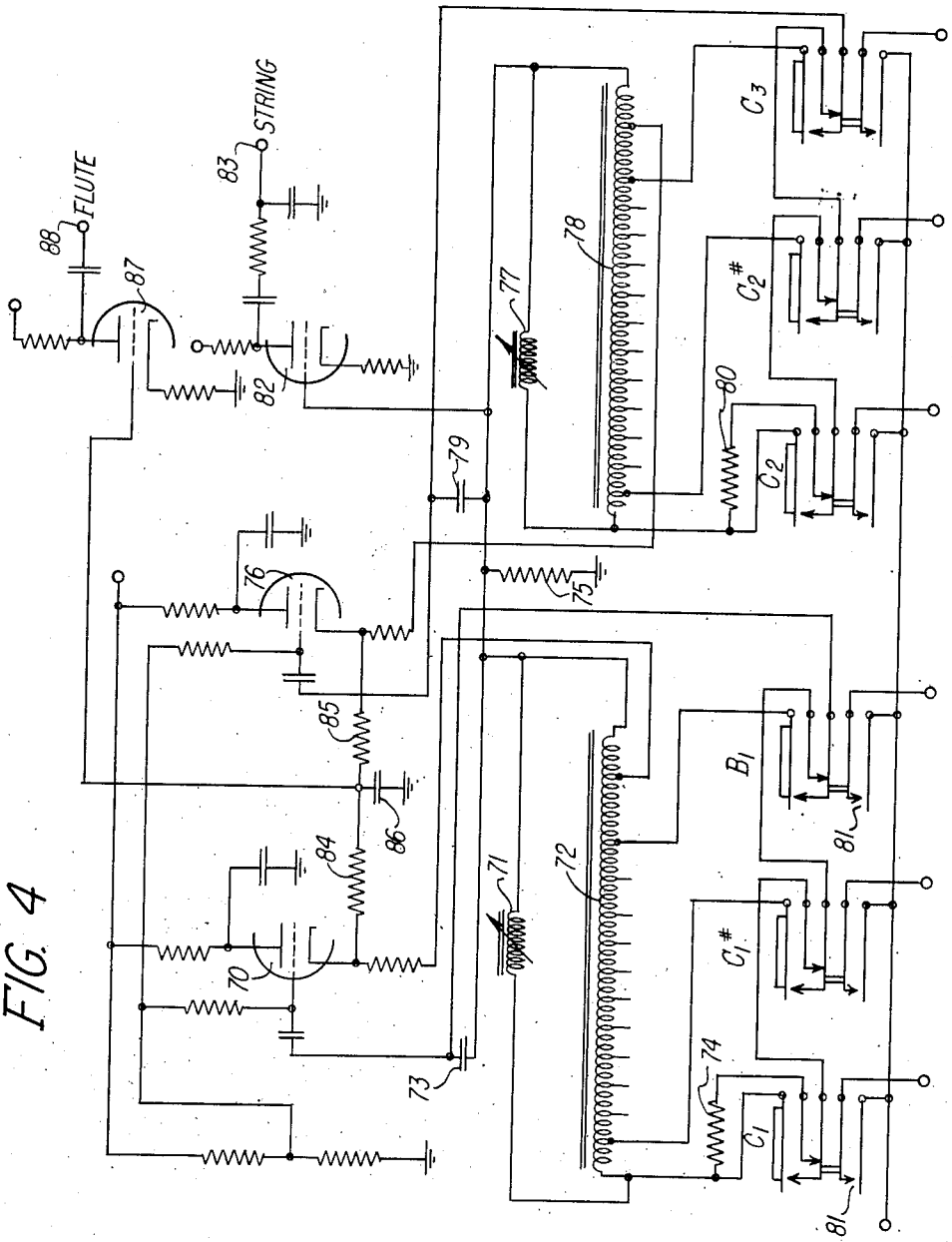



FIG. 4

INVENTOR.
Charles J. Tennes

BY
Mueller and Aichele
Attys

United States Patent Office 2,806,954 Patented Sept. 17, 1957



2,806,954

# OSCILLATOR FOR MUSICAL INSTRUMENT

Charles J. Tennes, Elkhart, Ind., assignor to C. G. Conn Ltd., Elkhart, Ind., a corporation of Indiana

Application November 18, 1954, Serial No. 469,602

10 Claims. (Cl. 250—36)

This invention relates generally to electrical musical instruments and more particularly to an oscillator which is tunable to a plurality of frequencies corresponding to musical tones such as produced by the foot pedals of an electric organ.

In providing electrical musical instruments it may be desirable to provide an oscillator which can be selectively tuned to a plurality of different frequencies corresponding to a series of musical notes. For example, it may be desired to provide the twelve semitones within an octave from a single oscillator. Although variably tuned oscillators are well-known, such oscillators do not meet the requirements for a musical instrument. In the first place it is necessary to provide tuning of the oscillator to an exact pitch, tuning of the different tones produced by the oscillator must be accomplished simultaneously without changing the relationship between the tones. Further, it is necessary that the oscillator produce the desired frequency immediately and be operable from one note to another without producing undesired transients which must be eliminated in the instrument. That is, unless it is possible to produce the tones without producing objectionable transients, additional equipment must be provided to eliminate the transients.

It is therefore an object of the present invention to provide an improved multitone oscillator for an electrical instrument.

A further object is to provide a solo tone generating system wherein a single oscillator provides various tones within an octave or more, with the oscillator being able to rapidly change from one tone to another without producing objectionable transients.

A further object of the invention is to provide an oscillator which may be caused to oscillate at different frequencies by selective operation of keys, wherein the oscillator may be easily tunable to provide the desired pitch while retaining the relative frequencies of the different tones produced thereby.

A feature of the invention is the provision of an oscillator which may be rapidly tuned from one frequency to another and which includes a discharging circuit for the condenser of the oscillator circuit to hold the same discharged before a tone is produced so that objectionable transients are not provided.

A further feature of the invention is the provision of an oscillator for a musical instrument including a first inductor having taps for establishing a series of tones, a second variable inductor bridged thereacross for adjusting the frequencies of the tones, and switch means for selectively connecting a condenser to the taps of the inductor and for connecting the condenser to a discharge path when not connected to a tap on the inductor. The switch means may include make before break contacts for connecting the discharge circuit to the condenser before the condenser is connected to a tap to establish a tone. The discharge circuit may include a resistor which is connected in series with the inductors across the condenser, with the resistor having a value sufficiently high to prevent oscillation in the circuit so formed.

Another feature of the invention is the provision of an



oscillator controlled by keys to produce musical tones of different frequencies, and including portions producing tones having different characteristics, with the oscillator including means for preventing transient oscillations so that the tones may be directly used without gating to thereby provide a very simple oscillator structure for providing tones of different frequencies and characteristics.

Further objects, features and the attending advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings, in which:

Fig. 1 illustrates an electric organ which may utilize a solo oscillator circuit in accordance with the invention;

Fig. 2 is a circuit diagram of a system for producing the tones for the pedal manual of an electric organ as illustrated in Fig. 1;

Fig. 3 is a simplified diagram of the oscillator circuit of Fig. 2; and

Fig. 4 illustrates a system including two oscillators for providing a wider range of tones and for providing tones of different characteristics.

In practicing the invention there is provided a solo oscillator system which is suitable for use for providing the pedal tones of an electric organ. A single oscillator may be utilized for providing the semitones from one C to the next, for example, thereby providing one full octave and an additional note or thirteen notes in all. Alternatively, two or more oscillators may be used together to provide a wider range of tones. Each oscillator includes a tapped inductor connected in parallel with a variable inductor and a condenser selectively connected to the taps to provide a resonant circuit. Connection to the various taps produces successive tones such as the adjacent semitones in the musical scale, and adjustment of the variable inductor is effective to tune all the tones of the oscillator without changing the relation therebetween. Switching may be controlled by pedals or keys which selectively connect the condenser to the taps, and which provide a circuit from the condenser to a resistor when no tap is connected. The resistor is connected to the inductors to form a discharge path for the condenser so that the condenser is discharged and the possibility of transient tones caused by residual voltages thereacross is eliminated. The switch construction may be such that the discharging circuit is not broken until after the oscillating circuit is made when a tone is played, and the discharging circuit is made before the oscillating circuit is broken at the end of a tone to thereby insure that the condenser is discharged before oscillations start. A peaking resistor may be provided in the oscillator circuit to produce tones of pulse waveform as produced by string instruments. Oscillations of sinusoidal waveform as provided by a flute may also be derived from the inductors of the tuned circuit. These various tones may be modified by filter means to change the characteristics, and the tones of sinusoidal and pulse waveform may be combined to produce various different tones as desired in an electric organ or other musical instruments.

Referring now to the drawings, in Fig. 1 there is illustrated the console of an electric organ. The organ includes first and second manuals designated **10** and **11** for selecting the tones played, which are commonly called great and swell manuals respectively. The organ includes pedals **12** for further selecting tones, and tabs **13** for controlling the characteristics of the tones produced by the great and swell manuals and by the pedals. An expression pedal **14** is provided for controlling the volume of the instrument. The instrument is illustrated as a self-contained instrument including reproducing means or loudspeakers as illustrated at **15**. It will be apparent

that the loudspeakers may be provided in a separate cabinet if this is desired.

In Fig. 2 there is illustrated an oscillator circuit suitable for providing tones for a solo tone generating system such as controlled by the pedals 12 of Fig. 1. The circuit includes an oscillator formed mainly by triode section 20, variable inductor 21, tapped inductor 22 and condenser 23. The tones from the oscillator are applied to an amplifier formed by the tube 25 with the output being controlled by a filter network 26 and applied to an amplifier for further amplification before reproduction. The condenser 23 is selectively connected to the taps on inductor 22 by switching means including keys 30, 31 and 32. Although only three keys are shown, it will be obvious that additional keys are required for the various tones to be produced by the oscillator. The coil 22 includes thirteen tapped points 33 including the left end terminal to provide the thirteen notes required for the semitones within an octave and the first tone of the next octave. An additional tap 34 may be provided for calibrating purposes if desired.

Considering the oscillator circuit more particularly, inductors 21 and 22 and condenser 23 have one common terminal 35. The resistor 36 is connected from this terminal to ground. The other sides of the inductors 21 and 22 have a common terminal 37. The other lead of the condenser 23 is connected through the key switches to the taps 33 on the inductor 22. Each of the switches includes normally closed contacts 38, and contacts 39 which are closed when the key is depressed. Operation of the key causes the contacts 39 to close first and as the key is moved further, the contacts 38 open. When the key is released, the contacts 38 will first close and then the contacts 39 will open.

Considering the operation of the circuit, when key 30 is depressed, connection of condenser 23 will be made through the normally closed contacts 38 of switches 31 and 32 and through the contacts 39 of switch 30 to the terminal 37. In the event that key switch 32 is operated, the condenser 23 will be connected through contacts 39 of the key 32 to the tap 33 on inductor 22 farthest to the right providing the highest frequency of the oscillator. It will be apparent that if two keys are depressed at the same time, the key corresponding to the highest note will sound and will open the contact 38 thereof to disable the keys corresponding to lower notes.

The lead of condenser 23 which is selectively connected to the taps of inductor 22 to produce oscillations, (designated 40) is connected through condenser 41 to the grid 42 of the tube 20. This grid is biased by the voltage produced by the network including resistors 43 and 44 which form a voltage divider, and resistor 45 connected from the divider to grid 42. Potential is applied to the plate of the tube through resistor 46 with the plate being by-passed by condenser 47. The cathode of the triode is connected by resistor 48 to a tap on the inductor 22 below the taps 33.

In order to provide a discharge path for condenser 23 of the tuned circuit, and also for the coupling condenser 41, the resistor 50 is provided which is connected from the common terminal 37 of the inductors 21 and 22 to the contact 38 of key switch 30. Accordingly, a continuous circuit is provided when no key is depressed from terminal 40 of condenser 23 to terminal 37 of the inductors. This operates to provide a discharge path for condensers 23 and 41 so that there will be no voltage across these condensers when a key is operated to produce an undesired transient tone. This is very important since any voltage across the condensers at the time oscillations are initiated might cause transient oscillations which would produce objectionable sounds in the instrument.

The value of the resistor 50 is somewhat critical since this resistor must be sufficiently small to provide a discharge path so that the condensers are discharged within the time available between playing of successive notes.



On the other hand, the resistor 50 must be sufficiently large so that oscillations will not be produced when no key is depressed. It will be apparent that the resistors 50 complete a tuned circuit when no key switch is operated, and if the value of resistance 50 is not large enough, low frequency oscillations might be produced in this circuit.

Fig. 3 shows the circuit of the oscillator of Fig. 2 in simplified form and is believed to make the operation of the oscillator more apparent. Only one key (31) is illustrated in Fig. 3 but it will be apparent that additional keys may be provided for connection to different taps on the inductor to thereby produce different tones. Biasing circuits are not shown in this figure. It will be apparent from Fig. 3 that the inductors 21 and 22 and condenser 23 are connected in parallel, with the common bottom terminal 35 being connected through resistor 36 to ground. The common top terminal 37 of the inductors is connected to resistor 50 which is connected through the normally closed contacts 38 of the key switches to the condenser 23. As the switches operate the condenser 23 is connected to the taps 33 on the inductor 22.

When a key is depressed to cause operation of the oscillator, a wave of pulse waveforms is developed across the resistor 36. This wave is applied to the grid of triode tube 25 wherein the wave is amplified. The output of the triode 25 is applied to a filter including condensers 51, 52 and 53 and resistors 54 and 55 which are permanently connected in the circuit. The selective filter 26 provides various desired changes in the characteristics of the waves. This filter includes resistors 56, 57 and 58 connected in series to ground with rectifier 59 being connected across resistors 57 and 58. Switches 60, 61 and 62 are provided, which may be controlled by tabs 13 in an organ as illustrated in Fig. 1. These switches selectively short out resistors 56, 57 and 58 respectively. The filters shown are suitable for use with an oscillator providing pedal tones with the switch 60 when operated providing an echo bass, switch 61 providing sub-bass, and switch 62 providing major bass. The output of the selective filter may be applied through resistor 63 to an audio amplifier such as the output amplifier feeding the reproducing means illustrated at 15 in Fig. 1.

Referring now to Fig. 4, in this figure there is illustrated a system for generating tones in an electrical instrument wherein two oscillator sections are provided, with the frequency of the second oscillator continuing from the frequency of the first so that a wider range of tones is provided. Each oscillator is of generally the same construction as the oscillator shown in Fig. 2. The first oscillator is formed by triode section 70, variable inductor 71, tapped inductor 72 and condenser 73. The condenser 73 is selectively connected to taps on inductor 71 through the key switches designated C1, C1# and B1. It will be obvious that additional key switches will be provided between C1# and B1 connected to the taps indicated on the inductor 72. A resistor 74 is provided for discharging condenser 73 of the tuned circuit as well as a coupling condenser of the oscillator as has been previously described. Resistor 75 has been provided for connecting the tuned circuit to ground and as previously stated, waves or pulse waveform will be developed across this resistor.

The second oscillator is formed by triode section 76, variable inductor 77, tapped inductor 78 and condenser 79. The condenser is selectively connected to taps on inductor 78 by key switches C2, C2# and B3, and again additional switches are required between C2# and C to fill out the semitones within the octave. Resistor 80 is effective to discharge condenser 79 and the coupling condenser of the oscillator. Resistor 75 is common to the two oscillators so that waves produced by either oscillator appear as pulse waveforms across the resistor 75.

Each of the key switches C1, C1#, B1, C2, C2#, and C3 is illustrated as including normally closed and normally open contacts providing make-before-break action as previously described and as required for controlling the frequency of the oscillators. Additional contacts **81** are provided in each of the key switches in the system of Fig. 4. These contacts may be used to connect other oscillators (not shown) of an organ or other instrument as the keys are operated. In organ operation it is often desired to couple one or more additional notes with the main note played. As an example, when the note B1 is played, in addition to the tone produced by the oscillator illustrated, it may be desired to produce the same note in a higher octave. This can be accomplished by energizing through the contacts **81** of the key switch for B1 an additional generator provided in the instrument and normally operated by a different keyboard.

As previously stated, the voltage developed across resistor **75** is of pulse waveform and generally corresponds to that produced by stringed instruments. In the circuit of Fig. 4, pulse waves of two separate frequencies may appear simultaneously across resistor **75** resulting from the simultaneous operation of keys of the two oscillators. These waves are applied to the grid of triode **82** which serves as an amplifier. The output of the triode **82** may be applied through a filter to an output terminal **83** for pulse or string-type tones.

It will be apparent that when oscillations are produced in the oscillator circuits, currents of sine wave form are developed in the inductors. As the cathodes of the tubes **70** and **76** are coupled to taps on the inductors **72** and **78** respectively, voltages of sine wave form having the frequencies of the oscillators appear at these cathodes. These sine waves at the cathodes of the tubes may be applied through resistors **84** and **85** respectively to the condenser **86**. Such waves may be applied to the grid of amplifier **87** and the output at **88** thereof will be formed of waves of substantially sinusoidal waveform as produced by a flute. Accordingly, waves of two different frequencies will be provided at the output terminal **88** in the event that both oscillators are simultaneously connected by operation of the key switches.

It will be apparent from the above that by selectively connecting to terminals **83** and **88**, tones of the same frequency (or frequencies) but of different characteristics can be provided. The tones from each of the terminals may be selectively modified by filter networks such as that illustrated at **26** of Fig. 2 to selectively vary the characteristics. Also, the tones of different forms from terminals **83** and **88** may be combined to provide still other characteristics to make up the various different voices which may be desired in an electrical instrument such as an electric organ.

Solo tone generating oscillators as has been illustrated have been thoroughly tested and found to be highly satisfactory. The following values have been used in an instrument as illustrated in Fig. 2 for providing tones from C1 to C2 covering the frequencies from 32.7 to 65.4 cycles per second:

| | |
|---|---|
| Tube **220** | 12AU7. |
| Inductor **21** | 10,000 turn, #39 AWG wire coil on iron core with variable air gap. |
| Inductor **22** | 10,000 turn, #39 AWG wire tapped coil on iron core. |
| Condenser **23** | .22 microfarad. |
| Resistor **36** | 820 ohms. |
| Condenser **41** | .10 microfarad. |
| Resistor **43** | 39,000 ohms. |
| Resistor **44** | 3,900 ohms. |
| Resistor **45** | 1 megohm. |
| Resistor **46** | 100,000 ohms. |
| Condenser **47** | .22 microfarad. |
| Resistor **48** | 1,500 ohms. |
| Resistor **50** | 27,000 ohms. |



As previously stated, the value of resistor **50** is somewhat critical. The use of a resistor of 15,000 ohms may result in a tendency of the oscillator to produce low frequency oscillations when no key switch is depressed. The value of 27,000 ohms has been found adequate to prevent oscillations and it is desirable to use a value of this order rather than larger values which would increase the time required for the condenser of the tuning circuit and the coupling condenser to discharge between notes and the condensers might not be completely discharged when a note is played.

It is therefore seen that there is provided an improved tone generating oscillator adaptable for use in electrical organs or other electrical instruments. The oscillator may provide a plurality of different frequencies or tones with the generation of the tones being controlled by operation of key switches. The key switches are arranged to provide the connections for establishing the required frequencies, and also establish a connection for discharging the condenser of the tuned circuit when oscillations are not produced. This produces tones free from objectionable transients so that no gating is required when using the tones. The various tones are produced by the use of taps on a single coil to provide a very inexpensive over-all construction. The instrument can be tuned by a variable inductor in parallel with the tapped inductor so that the spacing of the tones remains fixed in the presence of tuning to produce variations in the pitch of the tones. A plurality of oscillators may be coupled together to provide a wide range of frequencies and the oscillators may produce waves of sinusoidal and pulse waveform which can be individually modified and/or combined to provide various different tone characteristics which may be required in an electrical instrument.

I claim:

1. An oscillator for producing a plurality of different frequencies corresponding to musical tones including in combination; tuned circuit means including a first variable inductor, a second inductor having first and second end terminals and a plurality of intermediate taps thereon, said first inductor being connected in parallel across at least a portion of said second inductor, condenser means having first and second leads with said first lead being connected to said first end terminal, and switch means operable to selectively connect said second lead of said condenser means to said taps on said second inductor to form a resonant circuit with said first and second inductors; a discharge device coupled to said tuned circuit means in oscillation sustaining relation therewith, and resistor means having first and second connectors with said first connector being connected to said second end terminal, said switch means including portions normally connecting said second connector of said resistor means to said second lead of said condenser means so that a discharge circuit is provided for said condenser means, said resistor means having a value such that oscillations are not produced through said discharge path, said switch means being operable to break the connection from said second lead to said second connector and to connect said second lead to one of said taps on said second inductor to render said tuned circuit means oscillating.

2. An oscillator for producing a plurality of different frequencies corresponding to successive musical tones including in combination, tuned circuit means including a first variable inductor, a second inductor having a first end terminal and a plurality of other terminals spaced therealong, said first inductor being connected in parallel with at least a portion of said second inductor, condenser means having one terminal thereof connected to said first terminal of said second inductor; and switch means for selectively connecting the other terminal of said condenser means to said other terminals on said second inductor to form a resonant circuit with said first and second inductors; an electron device coupled to said tuned circuit means in oscillation sustaining relation there-

with, and resistor means connected to said other terminal of said second inductor remote from said first end terminal thereof, said switch means including portions normally providing a connection from said other terminal of said condenser means to said resistor means so that a discharge circuit is provided for said condenser means through said resistor means, said resistor means having a value such that oscillations are not produced in said discharge path, said switch means operating to break the connection between said condenser means and said resistor means and to connect said other terminal of said condenser means to one of said taps on said second inductor.

3. An oscillator for producing a plurality of different frequencies corresponding to successive musical tones including in combination, tuned circuit means including a first variable inductor, a second inductor having taps thereon, condenser means, and circuit means connecting said inductors and said condenser means in a resonant circuit including switch means selectively operable to connect said condenser means to said taps on said second inductor so that the resonant circuit is tuned to various frequencies, an electron discharge device connected to said tuned circuit means for sustaining oscillations in said resonant circuit, and resistor means, said switch means including portions normally connecting said resistor means in said resonant circuit to provide a discharge path for said condenser means, said switch means operating to break said discharge path and connect said condenser means to a tap on said second inductor, said resistor means having a value sufficiently large to prevent oscillations in said discharge path, so that oscillations are produced only when said switch means is operated and said condenser means is connected thereby to one of said taps on said second inductor.

4. An oscillator for producing a plurality of different frequencies corresponding to musical tones including in combination, tuned circuit means including a first variable inductor, a second inductor having a first end terminal and a plurality of other terminals spaced from said first terminal along said second inductor, said first inductor being connected in parallel with at least a portion of said second inductor, first condenser means having first and second leads with said first lead being connected to said first terminal, and switch means operable to selectively connect said second lead of said first condenser means to said other terminals on said second inductor to form a resonant circuit with said first and second inductors, a discharge device including a plurality of electrodes with one electrode coupled to one of said other terminals on said second inductor, second condenser means connecting said second lead of said first condenser means to another electrode of said discharge device, and resistor means having first and second connectors with said first connector being connected to said the one of said other terminals remote from said first end terminal, said switch means including portions normally connecting said second connector of said resistor means to said second lead of said first condenser means so that a discharge circuit is provided for said first and second condenser means, said resistor means having a value such that oscillations are not produced through said discharge path, said switch means being operable to break the connection from said second lead of said first condenser means to said second connector of said resistor means and to connect said second lead of said first condenser means to one of said other terminals on said second inductor to thereby render said tuned circuit means oscillating.

5. An oscillator for producing a plurality of different frequencies corresponding to musical tones including in combination, tuned circuit means including first variable inductor means, second inductor means having an end terminal and taps thereon spaced from said end terminal, said first inductor means being connected in parallel across at least a portion of said second inductor means, first condenser means having first and second leads with said first lead being connected to said end terminal, and switch means operable to selectively connect said second lead of said first condenser means to said taps on said second inductor means to form a resonant circuit with said first and second inductor means, a discharge device including a plurality of electrodes with one electrode coupled to a tap on said second inductor means, second condenser means connecting said second lead of said first condenser means to another electrode of said discharge device, first resistor means connecting said end terminal to a reference potential, second resistor means having first and second connectors with said first connector being connected to said tap remote from said end terminal, said switch means including portions normally connecting said second connector of said second resistor means to said second lead of said first condenser means so that a discharge circuit is provided for said first and second condenser means, said second resistor means having a value such that oscillations are not produced through said discharge path, said switch means being operable to break the connection from said second lead of said first condenser means to said second connector of said resistor means and to connect said second lead of said first condenser means to one of said taps on said second inductor means to thereby render said tuned circuit means oscillating, and means connected to said first resistor means for deriving the voltage developed thereacross, said last named means including filter means for varying the characteristics of the wave derived from said first resistor means.

6. An oscillator for producing a plurality of different frequencies corresponding to successive musical tones including in combination, tuned circuit means including a first variable inductor, a second inductor having an end terminal and taps thereon spaced from said end terminal, condenser means, and circuit means connecting said inductors and said condenser means to form a resonant circuit first resistor means connecting said end terminal of said second inductor to a reference potential, said circuit means including switch means selectively operable to connect said condenser means to said taps on said second inductor to tune the resonant circuit, an electron discharge device having a plurality of electrodes with one electrode being connected to a tap on said second inductor, means coupling said condenser means to another electrode of said discharge device, second resistor means, said switch means including portions normally connecting said second resistor means in series with said inductors across said condenser means to provide a discharge path therefor, said switch means operating to break said discharge path and connect said condenser means to a tap on said second inductor, said second resistor means having a value sufficiently large to prevent oscillations in said discharge path, so that oscillations are produced only when said switch means is operated and said condenser means is connected thereby one of said taps on said second inductor, and means connected to said first resistor means for deriving the voltage developed thereacross.

7. An oscillator for producing a plurality of different frequencies corresponding to successive musical tones including in combination, tuned circuit means including first variable inductor means, second inductor means having taps thereon, condenser means, first resistor means connecting one terminal of said first and second inductor means and said condenser means to a reference potential, switch means selectively operable to connect the other terminal of said condenser means to said taps on said second inductor means to form a resonant circuit with said inductor means, an electron discharge device having a plurality of electrodes with one electrode being connected to a tap on said second inductor means, means coupling said other terminal of said condenser means to another electrode of said discharge device, second resistor means, said switch means including portions normally connecting said second resistor means in series with said

inductor means across said condenser means to provide a discharge path therefor, said switch means operating to break said discharge path and connect said condenser means to a tap on said second inductor means, said second resistor means having a value sufficiently large to prevent oscillations in said discharge path, so that oscillations are produced only when said switch means is operated and said condenser means is connected thereby one of said taps on said second inductor means, means connected to said first resistor means for deriving the voltage of pulse wave form developed thereacross, and means connected to a tap on said second inductor means for deriving a portion of the voltage of pulse wave form developed in said second inductor means.

8. An oscillator for producing a plurality of different frequencies corresponding to musical tones including in combination, tuned circuit means including a first variable inductor, a second inductor having an end terminal and taps thereon spaced from said end terminal, said first inductor being connected in parallel across at least a portion of said second inductor, condenser means having first and second leads with said first lead being connected to said end terminal, a plurality of key operated switches individually associated with the tones and operable to selectively connect said second lead of said condenser means to said taps on said second inductor to form a resonant circuit with said first and second inductors, a discharge device coupled to said tuned circuit means in oscillation sustaining relation therewith, and resistor means having first and second connectors with said first connector being connected to said tap on said second inductor remote from said end terminal, each of said switches including a contact connected to a tap on said second inductor and normally closed contacts establishing a circuit connecting said second connector of said resistor means to said second lead of said condenser means so that a discharge circuit is provided for said condenser means, said resistor means having a value such that oscillations are not produced through said discharge path, each of said switches being operable by the key thereof to break the connection from said second lead to said second connector and to make a connection from said second lead to the contact of said switch connected to a tap on said second inductor to render said tuned circuit means oscillating.

9. An oscillator for producing a plurality of different frequencies corresponding to musical tones including in combination, tuned circuit means including a first variable inductor, a second inductor having an end terminal and taps thereon spaced from said end terminal, said first inductor being connected in parallel across at least a portion of said second inductor, condenser means having first and second leads with said first lead being connected to said end terminal, a plurality of key operated switches individually associated with the tones and operable to selectively connect said second lead of said condenser means to said taps on said second inductor to form a resonant circuit with said first and second inductors; a discharge device coupled to said tuned circuit means in oscillation sustaining relation therewith, and resistor means having first and second connectors with said first connector being connected to said tap on said second inductor remote from said end terminal, each of said switches including first and second contacts normally in engagement and a third contact adapted to be moved by the associated key into engagement with said second contact and moving the same out of engagement with said first contact, said first and second contacts of said switches normally connecting said second connector of said resistor means to said second lead of said condenser means so that a discharge circuit is provided for said condenser means, said resistor means having a value such that oscillations are not produced through said discharge path, said third contact of each switch being connected to a tap on said second inductor, operation of each key switch being effective to break the connection from said second lead to said second connector and to connect said second lead to the tap on said second inductor connected to the third contact of said operated switch to render said tuned circuit means oscillating at the frequency corresponding to the operated key switch.



10. An oscillator for producing a plurality of different frequencies corresponding to musical tones including in combination; tuned circuit means including a first variable inductor a second inductor having an end terminal and taps thereon spaced from said end terminal, said first inductor being connected in parallel across at least a portion of said second inductor, condenser means having first and second leads with said first lead being connected to said end terminal, a plurality of key operated switches individually associated with the tones and operable to selectively connect said second lead of said condenser means to said taps on said second inductor to form a resonant circuit with said first and second inductors; a discharge device coupled to said tuned circuit means in oscillation sustaining relation therewith, and resistor means having first and second connectors with said first connector being connected to said tap on said second inductor remote from said end terminal, each of said switches including first and second contacts normally in engagement and a third contact adapted to be moved by the associated key into engagement with said second contact and moving the same out of engagement with said first contact, said first and second contacts of said switches being connected in series with said first contact of the switch at one end of said series being connected to said second connector of said resistor means and said second contact of the switch at the other end of the series being connected to said second lead of said condenser means so that a discharge circuit is established from said condenser means to said resistor means, said resistor means having a value such that oscillations are not produced through said discharge path, said third contact of each switch being connected to a tap on said second inductor, operation of each key switch being effective to break the connection between said first and second contacts thereof to break the discharge circuit from said condenser means to said resistor means, said operated key switch thereafter making a connection through said second and third contacts to connect said second lead of said condenser means to the tap on said second inductor connected to the third contact of said operated key switch to render said tuned circuit means oscillating at the frequency corresponding to the operated key switch.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,543,629 | Hanert | Feb. 27, 1951 |
| 2,672,068 | Hanert | Mar. 16, 1954 |