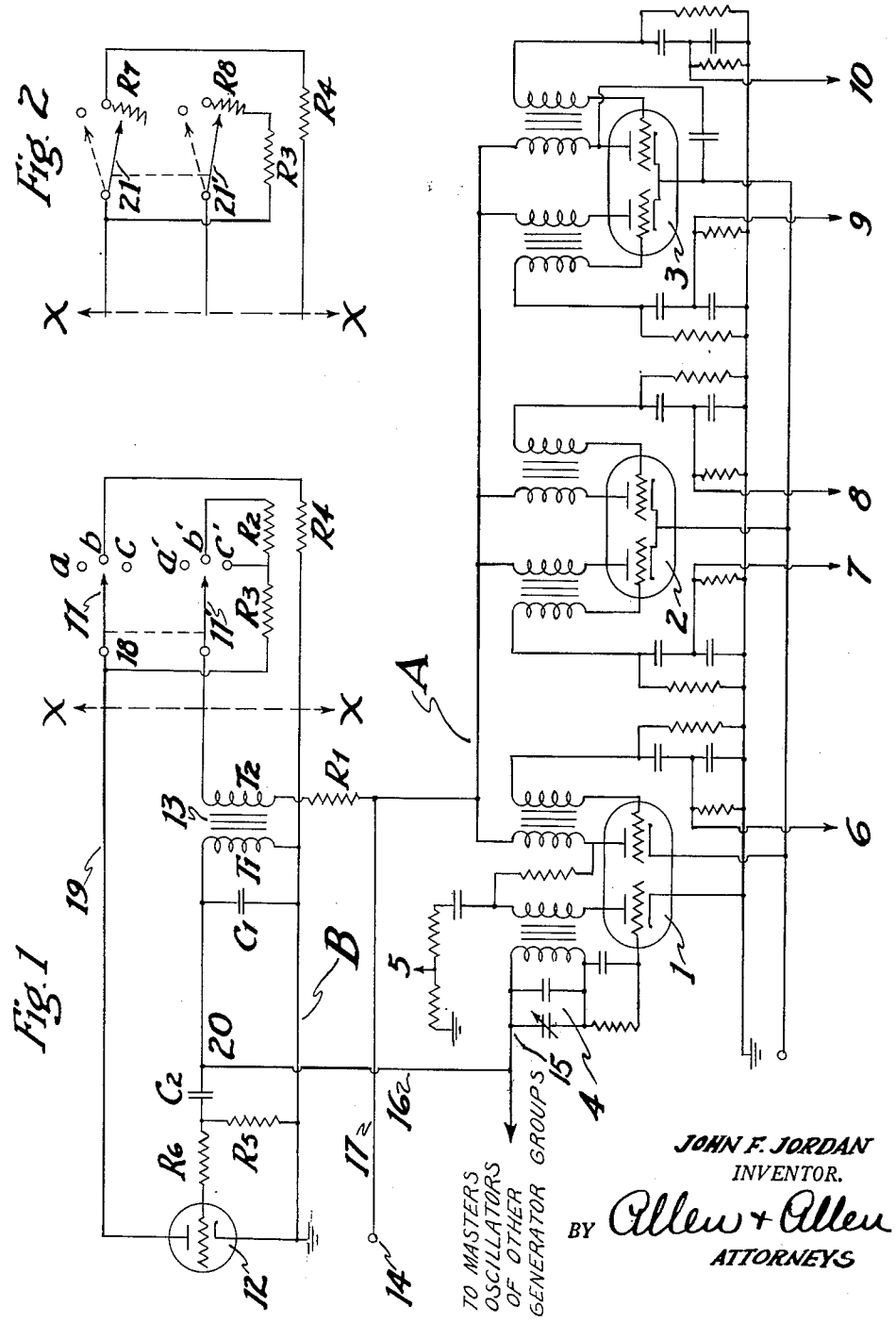
March 20, 1951 J. F. JORDAN 2,545,469

VIBRATO SYSTEM

Filed Oct. 29, 1947



Patented Mar. 20, 1951

2,545,469

UNITED STATES PATENT OFFICE

2,545,469

VIBRATO SYSTEM

John F. Jordan, Terrace Park, Ohio, assignor to The Baldwin Company, Cincinnati, Ohio, a corporation of Ohio

Application October 29, 1947, Serial No. 782,897

12 Claims. (Cl. 84—1.25)

1

This invention relates to electrical musical instruments, and in particular to a frequency tremolo or "vibrato" system for such instruments. By a vibrato, as distinguished from an amplitude tremolo, is meant an effect produced by periodically varying at a sub-audio rate, the frequencies of the electrical oscillations produced by the generating circuits of the instrument.

In electrical musical instruments in which oscillations for notes of the same nomenclature are produced in cascade systems each having a master oscillator of high audio frequency and a plurality of controlled generators for harmonically related lower frequencies, it has been proposed to provide an oscillator operating at a sub-audio frequency appropriate for vibrato purposes, and so to couple this sub-audio oscillator with the master oscillators of the several cascade systems as to cause their oscillations to fluctuate at the sub-audio rate to either side of normal frequency. Similar frequency fluctuations occur in the outputs of the controlled generators.

In the electrical organ it is not sufficient simply to provide for the presence or absence of a fixed vibrato in the output of the instrument. Musical expression requires at different times different degrees of audible vibrato. This can be obtained by varying the voltage applied to the master oscillators by the vibrato oscillator so as to change the extent of the fluctuations of the oscillations of the master oscillator to either side of the frequency norm.

It has been ascertained, however, that a much superior effect can be obtained if the rate of vibrato fluctuations can be varied concurrently with the extent of the frequency variations. The principal object of my invention is the provision of means and a method of accomplishing this.

It is an object of my invention to provide a system for varying concurrently and commensurately the rate and the extent of vibrato in the tones produced by electrical musical instruments.

Another object of my invention is to provide a simple, inexpensive and trouble-free electrical circuit for accomplishing the above object.

These and other objects of the invention which will be set forth hereinafter or will be apparent to one skilled in the art from the following teachings, I attain by that circuit arrangement and in that mode of operation of which I shall now describe an exemplary embodiment. Reference is made to the accompanying drawings, wherein:

Figure 1 shows a circuit diagram of my invention as applied to a cascaded group of oscillation generators together with control means for supplying fixed amounts of vibrato.

Figure 2 shows a continuously variable vibrato control which may be used in place of the control shown in Figure 1.

The lower portion A of Figure 1 is the circuit diagram of one of a series of generator groups

2

or cascades, each group producing all the octavely-related electrical oscillations corresponding to one note of the musical scale. Such a generator group and its mode of operation is fully described and claimed as to certain features in United States Patent application, Serial No. 714,601, filed Dec. 6, 1946, and entitled Interlocked Generator Circuits, in the name of Edward M. Jones. My invention is not limited to the employment of this particular cascade system, since others will serve.

It will be sufficient for the purposes of this description to point out that in the exemplary cascade system the left hand set of triode elements of the thermionic tube 1 is used in conjunction with the master oscillator circuit designated generally at 4, which determines by means of an interlocking system the frequencies of the remaining five oscillation-generating circuits which employ, respectively, the right-hand set of triode elements of tube 1 and both sets of triode elements in the tubes 2 and 3. The six octavely related electrical oscillations generated in any of the above mentioned generator groups are available at points 5 through 10 for subsequent keying, modification and translation into sound in an instrument such as that described in detail in U. S. Patent application Serial No. 756,126 filed June 21, 1947, and entitled An Electric Organ, in the name of John F. Jordan.

The upper portion B of Fig. 1 comprises a double-pole vibrato control switch 11, 11' and a vibrato oscillator circuit employing the thermionic tube 12, the transformer 13 and various capacitors and resistors which will hereinafter be described. A source of plate potential for all the thermionic tube circuits may be connected at the point 14 to lead 17. The output potential from the vibrator oscillator circuit may be supplied to the master oscillator circuit 4 at point 15 through the connecting lead 16. The voltage so supplied has the effect of varying at a vibrato rate the bias on the master oscillator grid circuit. The coil T1 of the transformer 13 provides a path to ground for the grid currents of the master oscillator triode, the first section of tube 1, and of the corresponding tube of the other cascade generator groups (not shown) in the complete instrument.

The operation of my vibrato system is as follows:

1. *No vibrato*

With the ganged switch arms 11, 11' in the upper position and contacting switch points *a* and *a'* respectively, the plate circuit of the tube 12 is open, the vibrato circuit is thus inoperative, and constant frequency oscillations are available at points 5 through 10 of the cascaded oscillation-producing circuits of each cascade generator group of the instrument.

2. *Medium vibrato*

With the switch arms 11, 11' in the central position, and contacting switch points *b* and *b'*, the plate circuit of the tube 12 is closed and current flows from the plate supply source connected at 14 through the lead 17, the dropping resistor R1, the plate coil T2 of the transformer 13, the switch arm 11', the fixed contact *b'*, the dropping resistor R2, the dropping resistor R3, to the junction 16, from which a portion of the current from the plate supply is by-passed by way of the switch arm 11, the fixed contact *b*, the by-pass resistor R4 to ground; the other portion of the current from the plate supply flows through the lead 19 to the plate of the tube 12. In a manner well known in the art, an oscillatory current is generated in the closed circuit comprising the grid coil T1 of the transformer 13 and the condenser C1. The oscillating potential thus produced at 20 is applied through the lead 18 to point 15 of the master oscillator circuit 4.

The result is a vibrato variation in the frequency of the oscillations generated in all master oscillators at a rate dependent upon the oscillatory rate of the circuit C1T1 and of an extent dependent upon the potential at the point 20. Since the cascaded oscillation-generating circuits in each generator group are locked to the master oscillator, vibrato variations will be present in the signals at points 6 through 10 as well as at 5, which is the signal take-off point in a master oscillator circuit.

The condenser C2 is a grid-blocking condenser. The resistor R5 is for the self-biasing of the grid of the tube 12. The resistor R6 is for the suppressing of parasitic oscillations in the grid circuit of the tube 12.

The values of the various circuit elements have been determined experimentally and a typical but non-limiting set is as follows:

R1=2000 ohms; R4=56,000 ohms; C1=2.25 mfd.
R2=10,000 ohms; R5=270,000 ohms; C2=.2 mfd.
R3=5600 ohms; R6=1000 ohms;

The tube 12 may be half of a 6SN7 twin triode.

The transformer 13 may be specified as follows:

Ratio of turns in T1 to T2—1.82 to 1
D. C. resistance of T1—1750 ohms (max.)
D. C. resistance of T2—1100 ohms (max.)

The purpose of the by-pass resistor R4 is to bring the current through the coil T2 of the transformer 13 to a value such that the magnetizing force of the coil T2 is approximately equal and opposite to that of the coil T1 which carries the sum of the grid currents of all the master oscillator tubes.

3. *Full vibrato*

With the switch arms 11, 11' in the lower position and contacting switch points C and C', the resistors R2 and R4 are removed from the active part of the circuit as will be evident. The removal of R4 has the effect of reducing the potential drop in R1, and R3, because the current which formerly flowed through R4 necessarily flows through R1 and R3. The removal of R2 further reduces the potential drop in the circuit between the points 14 and 16. Since the plate of the tube 12 is at the same potential as the point 16, the overall effect of this removal of R2 (and R4) from the circuit is a rise in the potential at the plate of the tube 12. Therefore the potential across the oscillating circuit C1T1 rises

causing a higher oscillating potential at the point 15, and hence the extent of the vibrato of the signals at 5 through 10 is increased. Due partly to the increased potential on the plate of the tube 12 but mostly to the reduced magnitude of the direct current flowing through the winding T2, caused by removal of R4, the effective inductance of the coil T1 is reduced, and the frequency of the oscillations in the circuit C1T1 is thereby increased; hence the vibrato rate of the signals at the points 5 through 10 is increased.

Although I may prefer fixed steps of vibrato for economy, a gradual change in the rate and the extent of the vibrato may be accomplished by the modified control means shown in Fig. 2. This control means may be substituted for that shown to the right of the line X—X in Figure 1. Identical parts have been given the same index numerals.

R7 and R8 are variable resistors in which the contact arms have also an open position as shown. As the contact arms 21 and 21' are moved from the median (central) position to the full lower position, the value in the circuit of the resistance R7 is increased and the current through T1, R1, R3 and R4 is reduced, while the value of R8 in the circuit is decreased and the circuit resistance which corresponds to R2 in Fig. 1 is reduced. The resultant effects upon the vibrato rate and extent are the same as in Fig. 1, except that a gradual, rather than abrupt, transition is made from the medium to full vibrato.

Other modifications can be made in my invention without departing from the spirit of it.

Having thus described my invention in an exemplary embodiment, what I claim as new and desire to secure by Letters Patent is:

1. In an electrical musical instrument, the combination of a plurality of generators of electric oscillations corresponding to the notes of a musical scale, a sub-audio frequency source in connection with said generators operative to modulate the frequency of said electric oscillations at a sub-audio rate, and control means associated with said sub-audio source whereby the rate and the magnitude of the frequency modulation can be varied commensurately.

2. The combination as set forth in claim 1 in which said control means includes switch means whereby said rate and said magnitude can be varied in definite steps.

3. The combination as set forth in claim 1 wherein said control means includes variable electric impedance means whereby said rate and said magnitude can be varied gradually.

4. The combination as set forth in claim 1 in which said generators include an electron discharge tube, and in which said sub-audio frequency source includes a connection to said generators whereby the oscillating sub-audio potential generated in said source is effective to vary the bias on the grid of said electron discharge tube in said generators.

5. The combination as set forth in claim 4, said connection also providing a return path for the grid current passing through said electron discharge means in said generators.

6. The combination as set forth in claim 5, said sub-audio frequency source also including said control means, an electron discharge tube, a transformer, a plate supply circuit, and electrical impedances, said transformer including a first winding for said grid current and a second winding for the current in said plate supply cir-

cuit, said control means and said electric impedances being effective to vary the value of said plate supply current flowing through said second winding.

7. In combination a generator for oscillations of audio frequency corresponding to notes of a musical scale, said generator comprising a thermionic tube having coupled grid and plate circuits, and resonant means in said grid circuit for controlling the frequency of oscillation of said generator, a sub-audio oscillator comprising a thermionic tube having coupled grid and plate circuits, and resonant means in said grid circuit for controlling the frequency of oscillation of said oscillator, a connection between said oscillator and said generator for impressing oscillations from said oscillator on the resonant means of said generator, impedance means for varying the strength of said oscillations, impedance means for varying the frequency of said oscillations, and a connection between said last mentioned means enforcing concurrent variation thereof.

8. In combination a generator of audio-frequency oscillations corresponding to notes of a musical scale, an external source of sub-audio frequency oscillations, a connection between said generator and said source, a circuit in connection with said source for varying the frequency of oscillations therefrom, a circuit for varying the amplitude of said oscillations, and means in connection with both circuits for controlling concurrently the frequency and amplitude of the oscillations from said source.

9. In combination a generator for oscillations of audio frequency corresponding to notes of a musical scale, said generator comprising a thermionic tube having coupled grid and plate circuits, said grid circuit containing resonant frequency-controlling means, a generator for oscillations of sub-audio frequency comprising a thermionic tube having coupled grid and plate circuits, said grid circuit containing resonant frequency-controlling means, a connection between the grid circuits of said generators such that the said resonant means are in series, controllable impedance means in connection with the plate circuit of said sub-audio generator for varying the frequency of the sub-audio oscillations, additional controllable impedance means in the plate circuit of said sub-audio generator for

varying the amplitude of the sub-audio oscillations, and an operative connection between said controllable impedance means.

10. The structure claimed in claim 9 in which said audio frequency generator is coupled to a plurality of controlled generators of harmonically related frequencies forming a cascade series, and in which a plurality of said cascade series is similarly connected to said sub-audio generator.

11. A process of producing a variable frequency tremolo in an electrical musical instrument having a series of generators of audio frequency for the notes of a musical scale, a generator of sub-audio frequency, and a connection between said last mentioned generator and said first mentioned generators effective to transfer oscillations from said sub-audio generator to said first mentioned generators to cause cyclical fluctuations of the frequencies thereof, which process comprises varying the voltage of the oscillations so transferred to vary the extent of said frequency fluctuations, and concurrently varying the frequency of said sub-audio generator to vary the frequency of said cyclical fluctuations.

12. In combination a generator of audio frequency oscillations corresponding to notes of a musical scale, an external source of sub-audio frequency oscillations coupled to said generator for modulation of the frequency of said audio frequency oscillations, circuit means coupled to said source for varying the frequency and amplitude of the oscillations from said source whereby the rate and magnitude respectively of the frequency of the oscillations from said generator are varied, and means in said circuit means for effecting concurrent variation of the frequency and amplitude of the oscillations from said source whereby said rate is varied in direct proportion to said magnitude.

JOHN F. JORDAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,274,370	Kent	Feb. 24, 1942
2,328,282	Kock	Aug. 31, 1943
2,340,001	McKellip	Jan. 25, 1944