

[72] Inventor **Solomon Heytow**  
**23351 Burton St., Canoga Park, California**  
**91304**  
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[56]

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Primary Examiner— Herman Karl Saalbach

Assistant Examiner— Saxfield Chatmon, Jr.

Attorney— Watts, Hoffman, Fisher & Heinke

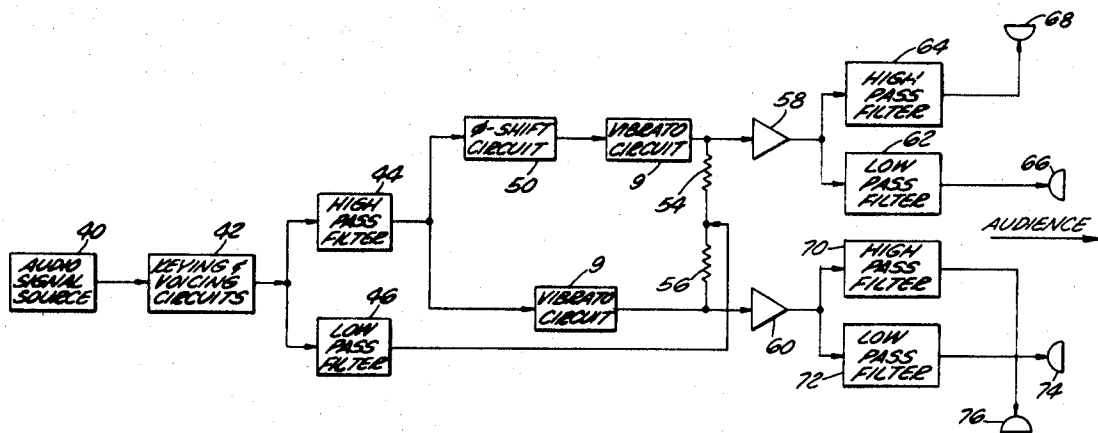
[54] **VIBRATO CIRCUIT UTILIZING LIGHT-SENSITIVE RESISTORS AND ORGAN EMBODYING SAME**  
**2 Claims, 2 Drawing Figs.**

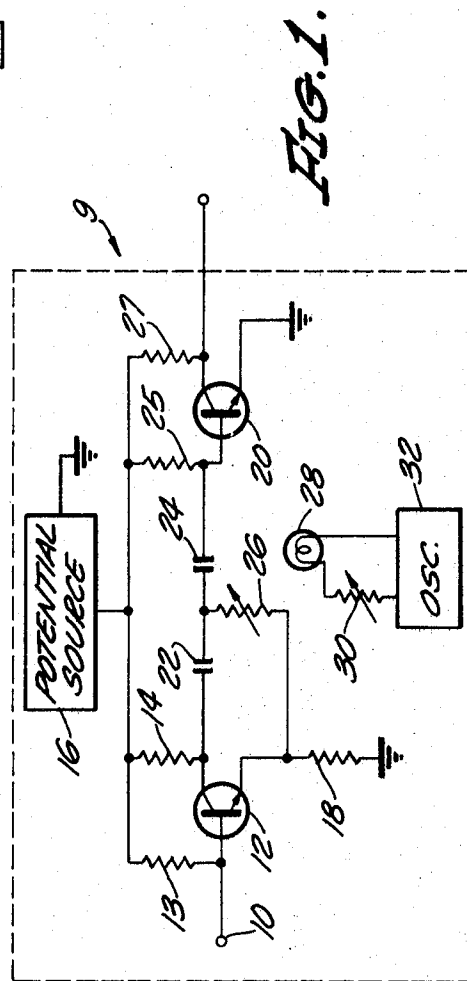
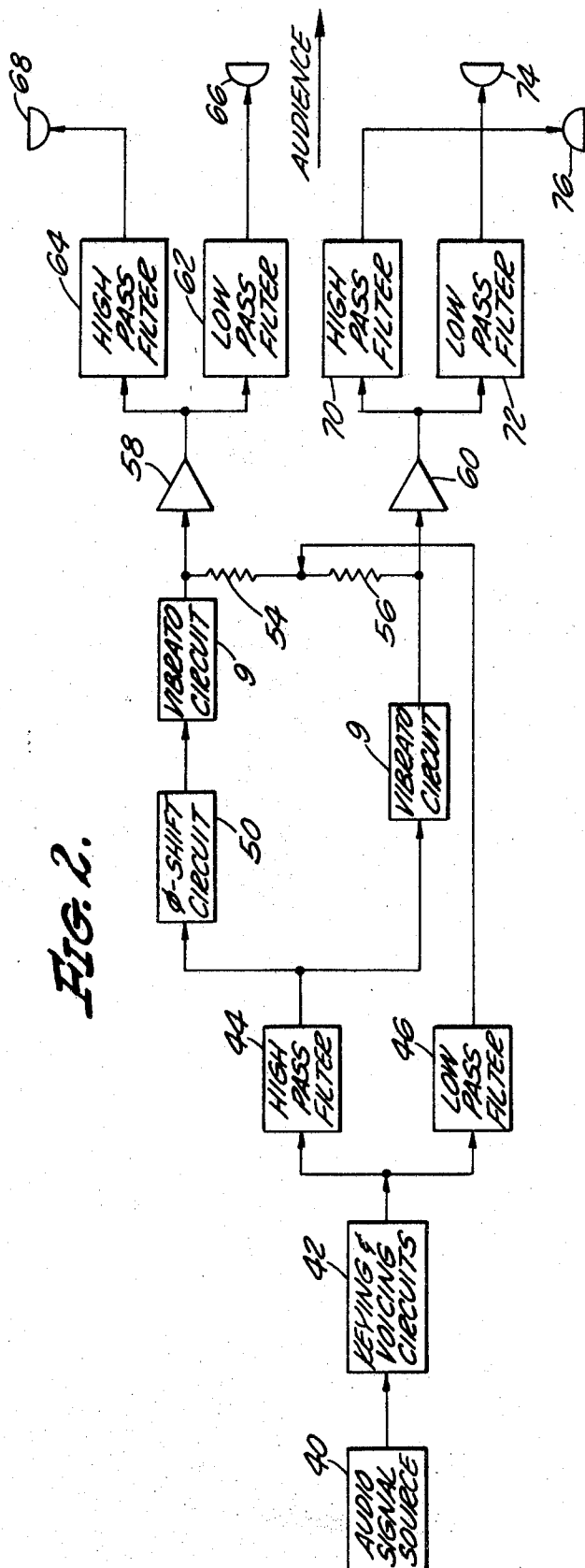
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**1.25, LSR, 1.01**

**ABSTRACT:** The vibrato circuit includes a phase-splitting amplifier followed by a phase-shifting network, wherein the phase of one of the two out-of-phase signals may be varied relative to the other signal. The phase-shifting network includes a light-sensitive resistor (LSR), whose resistivity is varied at a suitable vibrato rate. The modulated signal appearing across the LSR is combined with the other (unmodulated) signal to produce a vibrato effect.





SOLOMON HEYTOW  
INVENTOR  
BY Allen W. Sutton  
ATTORNEY

## VIBRATO CIRCUIT UTILIZING LIGHT-SENSITIVE RESISTORS AND ORGAN EMBODYING SAME

This invention relates to electrical circuits of the type that are employed in electrical musical instruments and, more particularly, to an improved vibrato circuit for an electronic organ.

The vibrato effect is one which is desirable in electrical musical instruments for producing an effect pleasing to the ear, which simulates the effect obtained by vibrating the hand rapidly on a string when playing a stringed instrument such as a violin. In the case of an electronic organ, a number of different circuits have been developed for effectuating the vibrato effect. Many of these have employed a circuit arrangement such as a bridge to develop two signal voltages which are substantially  $180^\circ$  out of phase. The amplitudes of these out-of-phase voltages are varied at a frequency of anywhere from one to eight cycles per second, and then the two out-of-phase voltages are combined, amplified, and utilized to energize one or more loudspeakers.

An object of this invention is to provide a novel, improved and simple vibrato circuit.

Still another object of the present invention is to provide an arrangement employing a vibrato circuit in an electronic organ whereby improved performance of the organ is achieved.

These and other objects of the invention are achieved in a vibrato circuit comprising a phase-splitting amplifier followed by a phase-shifting network, wherein the phase of one of the two out-of-phase signals may be varied relative to the other. The phase-shift network includes first and second serially connected capacitors and a shunt-connected variable resistor which is connected between the two serially connected capacitors. The shunt-connected variable resistor is actually a light-sensitive resistor such as a cadmium sulfide cell, the resistance of which is determined by the intensity of light shining thereon. By varying the intensity of the light permitted to fall upon the light-sensitive resistor at a suitable rate, such as of the order of from three to ten cycles per second, and by combining the resulting signals, the output provides a typical vibrato sound.

Also, in accordance with this invention, an arrangement is provided whereby the sound of a large organ in a large room, such as in an auditorium, may be simulated by a small electronic organ. This is accomplished by separating low from high frequencies in signals desired to be converted into audible sound. The high frequencies are then split into two out-of-phase signals, which are then applied to two vibrato circuits embodying the invention. These high-frequency signals are maintained in two separate channels and are combined in these two separate channels with the low frequency signals and are amplified. The output of each of the latter channels is again split into low-frequency and high-frequency signals. The low-frequency signals are reproduced by loudspeakers which are mounted to face in the direction of the audience. The high-frequency signals in each channel are applied to high-frequency loudspeakers which are mounted to face respectively  $180^\circ$  relative to one another and at  $90^\circ$  relative to the position of the listener. The realism of the resultant effect is startling.

Further advantages and features of the invention will become apparent from the following description of several embodiments thereof, taken in conjunction with the accompanying drawings, in which:

**FIGURE 1** is a circuit diagram of a vibrato circuit embodying this invention; and

**FIGURE 2** is a block diagram showing an arrangement for employing the vibrato circuit embodying the invention to simulate the sound of a large organ in an auditorium.

Reference is now made to **FIG. 1**, which is a circuit diagram of a vibrato circuit embodying the invention. Basically, this circuit comprises a phase-splitting arrangement for a signal which is to be reproduced in vibrato form. This includes an input terminal 10, which is connected to the base of an NPN

transistor 12. The base of the transistor 12 is connected through a resistor 13 to a source of operating potential 16, and the collector is similarly connected through a resistor 14. The emitter of the transistor 12 is also connected through a resistor 18 to ground. Resistors 14 and 18 are made substantially equal. As a result, any signal which is applied to the input terminal 10 will appear as two  $180^\circ$  out-of-phase components at the collector and emitter, respectively, of the transistor 12. These out-of-phase signal components have their phases shifted relative to one another at a suitable rate by a variable phase-shift network and then are combined and applied to the base of a succeeding transistor 20. The network coupling the collector of the transistor 12 to the base of the transistor 20 includes a first capacitor 22 and a second capacitor 24 connected in series between the collector of transistor 12 and the base of transistor 20. A variable resistor 26 is connected between the emitter of the transistor 12 and the junction of the two serially-connected capacitors 22 and 24. The base and collector of the transistor 20 are connected to the potential source 16 through resistors 25 and 27, respectively, and the emitter of the transistor 20 is grounded.

The resistor 26 is of a type whose resistance value is dependent upon the intensity of the light which is permitted to shine thereon. Such a resistor may be a cadmium sulfide cell, for example. The resistance of the light-sensitive resistor in the circuit shown is determined by the intensity of the light from a lamp 28. The lamp 28 may be a Tungsten filament lamp, whose average intensity is controlled by a variable resistor 30 or potentiometer. Power for causing illumination of the lamp 28 is derived from an oscillator 32 which provides oscillations at a frequency anywhere from one to eight cycles per second, as desired, in accordance with the vibrato effect desired. The amplitude of the current supplied to the lamp 28, which effectively determines the depth of modulation of the vibrato signal on the signal being applied to the input terminal 10, is controlled by the variable resistor 30. The rapidity of such modulation is a function of the output frequency of the oscillator 32.

The output from the vibrato circuit may be taken from either the collector or emitter of the transistor 20, but is shown as taken from the collector. The transistor 20 is connected to the source of operating potential 16 through resistors 25 and 27 in conventional fashion since it functions only to serve as an amplifier.

The vibrato circuit just described may be embodied in any circuit employed in an electrical instrument, where the vibrato effect is desired. Of course, the NPN transistors 12, 20 may be replaced by PNP transistors or by vacuum tubes connected to provide the same functions as the transistors. The intensity of illumination at which the lamp 28 is operated is of a rather low level when compared to its full intensity, therefore this lamp will operate for an extremely long interval of time. The light sensitive resistor 26 also is relatively time insensitive. Thus the circuit shown is substantially free of maintenance problems.

**FIGURE 2** shows an arrangement employing the vibrato circuit shown in **FIG. 1** in an electronic organ, whereby an effect may be obtained of a large organ played in an auditorium from a small electronic organ. Heretofore, to achieve this effect with a small electronic organ, a pair of loudspeakers were mounted back-to-back on a turntable. The loudspeakers were supplied with signals to be reproduced, and the turntable rotated at a suitable rate. The resultant sound would simulate the reverberations achieved by a large organ in a large auditorium. In accordance with this invention, such an arrangement with its mechanical problems of rotating two loudspeakers, which have a considerable weight, and also the electrical problem of commutating the audio signals of these loudspeakers while they are being rotated, is obviated.

In the usual organ, signals from a suitable audio signal source 40 are applied to keying and voicing circuits 42. The keying and voicing circuits 42 represent the keys on an organ, whereby desired audio signals are selected and the voicing circuits represent also the circuits in the organ which are selected

by suitable keys for shaping the audio signals to reproduce the sound desired.

In accordance with this invention the output of the keying and voicing circuits are applied to high-pass and low-pass filters 44 and 46, respectively. The output of the high-pass filter 44 is applied directly to a first vibrato circuit 9, which may be the circuit shown in FIG. 1, and through a 180° phase shift circuit 50 to a second vibrato circuit 9 which may also be the circuit shown in FIG. 1. The output signals from the vibrato circuits 9 have the low-frequency signals re-combined therewith. This is achieved by connecting the output of the low-pass filter 46 to the center tap of a voltage divider consisting of two resistors 54, 56, which are connected in series with one another and between the two vibrato circuit outputs. It will be appreciated that two sound channels have been established. In one sound channel, there are combined high-frequency vibrato-modulated signals and low-frequency signals, and in the other channel there are combined high-frequency vibrato modulated signals which are shifted 180° in phase from those in the other channel, plus the low-frequency signals. A first amplifier 58 is connected in the first sound channel and the second amplifier 60 is connected in the second sound channel.

The output of the first amplifier 58 is again split into low- and high-frequency components by the low- and high-frequency filters 62, 64. The output of the low-pass filter 62 is applied to a loudspeaker 66 which will reproduce the low frequencies. The output of the high-pass filter 64 is applied to another speaker 68 which will reproduce the high-frequency signals.

The output of the amplifier 60 is applied also to a high-pass filter and to a low-pass filter 70 and 72, respectively. The output of the low-pass filter 72 is applied to a loudspeaker 74 for reproduction and the output of the high-pass filter 70 is applied to a high-frequency reproducer 76.

In accordance with this invention, the low-pass filter outputs are applied to drive the speakers 66 and 74, which are physically positioned to emit sound directly at the audience. The high-frequency reproducers or speakers 68, 76, are physically located so that they are back-to-back with one another, and also are positioned at 90° with respect to the speakers 66 and 74. Thus, the speakers 66 and 74 emit sound in a direction along one coordinate and the speakers 68 and 76 emit sound 180° out of phase with one another along a second coordinate which is substantially 90° relative to the first coordinate. The positioning of the loudspeakers together with the effects of the phase-varying vibrato circuits cause reproduction having the startling realism of the sound of an organ played in a large auditorium. The result is a marked improvement over the commonly accepted arrangement for reproducing sound of this type by mounting the loudspeakers on a rotating turntable. The phase shifting effects of the vibrato circuits permit the loudspeakers 68 and 76 to simulate the effects provided by the rotating loudspeakers of the prior art. It has been determined that the low-frequency sound is non-directional, and, therefore, it need not be phase-shifted in order to assist in the illusion to be established.

There has been accordingly described herein a novel, useful and improved vibrato circuit and system, whereby the sound provided by electrical musical instruments is improved. It is

pointed out that the vibrato effect may be increased by operating the vibrato circuits 9 connected to the filter 44 180° out-of-phase with each other. The effect may be further increased by connecting two or more of the circuits shown in FIG. 1 in series.

It is apparent that many other modifications may be made by one skilled in the art without departing from the true scope and spirit of the invention.

I claim:

1. A system for simulating musical signals as they would be produced in a large auditorium, comprising:

- means for separating high-frequency components of said signals from low-frequency components of said signals; a first and a second vibrato circuit;
- means for applying said high-frequency signal components to said first and second vibrato circuits;
- means for adding said low-frequency signal components to the respective outputs of said first and second vibrato circuits;
- means for splitting the resultant combined output of said first vibrato circuit into respective first high-frequency components and first low-frequency components;
- means for splitting the combined output of said second vibrato circuit into respective second high-frequency components and second low-frequency components;
- first and second low-frequency signal reproducers;
- first and second high-frequency signal reproducers;
- said first and second low-frequency signal reproducers being positioned to direct their outputs along coordinate;
- said first and second high-frequency signal reproducers being positioned to direct their outputs substantially in opposite directions from one another and along a coordinate which is at substantially 90° relative to said one coordinate;
- means for applying said first and second low-frequency components to said first and second low-frequency signal reproducers; and
- means for applying said first and second high-frequency components to said first and second high-frequency signal reproducers.

2. A system as defined by Claim 1, wherein said first and second vibrato circuits each include:

- means for splitting said high-frequency signal components into two relatively 180° out-of-phase signal components;
- a first input terminal and a second input terminal;
- means for applying said two relatively 180° out-of-phase signal components to said respective first and second input terminals;
- an output terminal;
- a first and a second capacitor connected in series between said first input terminal and said output terminal;
- a light-sensitive resistor connected between said second input terminal and the connection between said two series-connected capacitors; and
- means for illuminating said light-sensitive resistor with light which has its intensity varied at a desired vibrato frequency.