United States Patent [19]

van der Kooij

[11] 3,833,752

[45] Sept. 3, 1974

[54] **ELECTRONIC MUSICAL INSTRUMENT WITH PLURAL CHANNELS PROVIDING DIFFERENT PHASE SHIFT**

[75] Inventor: **Tijmen van der Kooij,** Bodegraven, Netherlands

[73] Assignee: **N. V. Eminent,** Bodegraven, Netherlands

[22] Filed: **Feb. 26, 1973**

[21] Appl. No.: **335,496**

[30] **Foreign Application Priority Data**

Mar. 3, 1972 Netherlands 722834

[52] **U.S. Cl.** **84/1.24,** 84/1.25, 84/DIG. 4

[51] **Int. Cl.** **G10h 1/04**

[58] **Field of Search** ..... 84/1.01, 1.24, 1.25, DIG. 4, 84/DIG. 26

[56] **References Cited**

UNITED STATES PATENTS

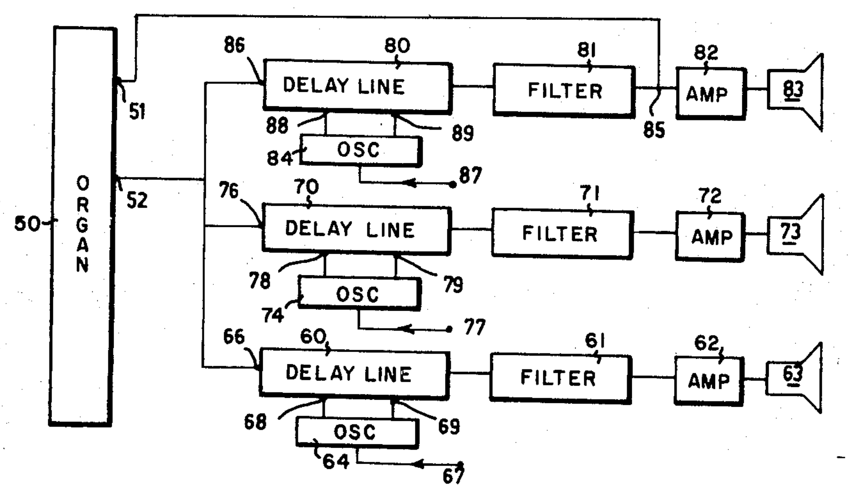
2,835,814	5/1958	Dorf	84/1.25 X
3,004,460	10/1961	Wayne	84/1.01
3,007,361	11/1961	Wayne	84/1.01
3,146,292	8/1964	Bonham	84/1.25
3,215,767	11/1965	Martin	84/1.24
3,257,495	6/1966	Williams	84/1.25
3,258,519	6/1966	Young	84/1.25
3,336,432	8/1967	Hurvitz	84/1.01
3,479,440	11/1969	Martin et al.	84/1.25
3,516,318	6/1970	Wayne	84/1.01
3,524,376	8/1970	Heytow	84/1.25
3,626,077	12/1971	Munch et al.	84/1.24
3,681,531	8/1972	Burkhard et al.	84/1.24 X

Primary Examiner—Richard B. Wilkinson
Assistant Examiner—Stanley J. Witkowski
Attorney, Agent, or Firm—Kurt Kelman

[57] **ABSTRACT**

The invention disclosed provides an electric musical instrument having an audio frequency signal source, an output from which the audio frequency signal passes to a plurality of parallel transmitting channels each of which comprises a delay line series circuit, a lowpass filter, an amplifier and loud speaker. Switching oscillators are disposed to provide 2 gate pulse trains, one running in opposite phase with regard the other, to the delay line series curcuit. Low frequency generators are disposed for generating a sine shaped sub-audio frequency signal to one of the switching oscillators while remaining units of the switching oscillators are connected to phase shifting networks. A second output from the audio frequency signal source connects to the amplifier of the last of the plurality of transmitting channels. The resultant combination of elements produces an ensemble effect.

3 Claims, 4 Drawing Figures



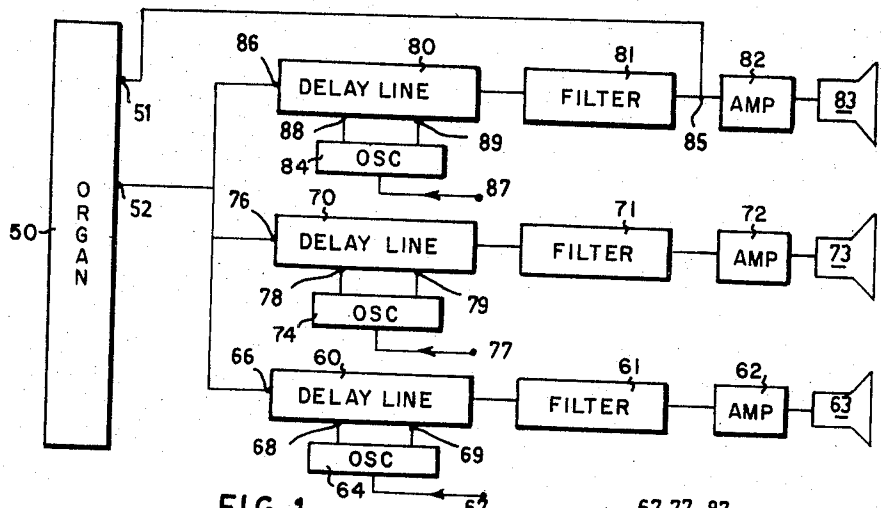


FIG. 1

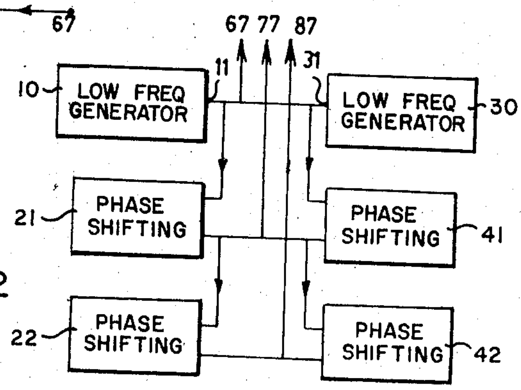


FIG. 2

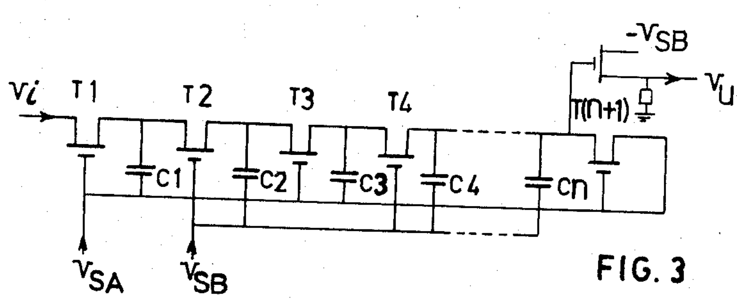


FIG. 3

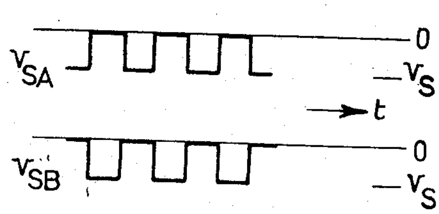


FIG. 4

ELECTRONIC MUSICAL INSTRUMENT WITH PLURAL CHANNELS PROVIDING DIFFERENT PHASE SHIFT

The present invention relates to an electronic musical instrument comprising a plurality of parallel transmitting channels for an audio frequency signal appearing via one output terminal only, a phase modulating device in at least two of the channels, means for directly connecting the output terminal to an input of each of said phase modulating devices, a generator means for generating a sine shaped sub-audio frequency signal and means for presenting modulating signals to the respective modulating devices having a predetermined fixed mutual phase shift relation, said sub-audio frequency signal being presented to a modulation input of each of said phase modulating devices.

A device is known such as that disclosed in Dutch patent application 6907873, laid open to public inspection, in which means are described (particularly FIGS. 6 and 13) which lead to a certain vibration-effect on an audio frequency signal to be transmitted.

An object of the present invention is to provide a vibration-effect to be carried out in a special way, in that a new imitative effect is provided. The components of the audio frequency signal, while harmonizing at the output of the respective transmission channels, will produce the illusion of originating from an array of substantially identically played instruments, such as a group of strings in a string orchestra, or the like.

According to the present invention the object is achieved by a second generator means for generating a second sine shaped sub-audio frequency signal having a frequency different from the frequency of the first signal, the signal being presented to each of the modulation inputs comprising both the first and the second sub-audio frequency signals.

The effect of the present device is most apparent when the frequency of the signal generated by the first generator means is at most 1 Hz and that of the second signal is in the range from 5 to 6 Hz, the fixed mutual phase shift amounting to 360° divided by the number of transmission channels.

For an appropriate construction of the present device, the phase modulating devices preferably each comprise a controllable shift register being connected for operation with two oppositely running gate pulse trains. The gate pulses in a train succeed each other with a repetition time that is sufficiently short, i.e., not to exceed the inverse value of twice the bandwidth of the sound signal and that is otherwise modulated with the signal being obtained by summing in the phase shift means.

An advantage of the present device is that a prolonged delay required for the achievement of the effect can be obtained by a singular delay line, said delay having to last more than 1 millisecond.

A further advantage of the present invention is that the wave shape of the audio frequency signal will not be deformed by the delay line.

The present invention will now be illustrated in its preferred embodiment by a description of an example with reference to drawing wherein:

FIG. 1 represents a block diagram of an electronic musical instrument having a construction according to the present invention.

FIG. 2 shows in block diagram a circuit for generating a modulation signal.

FIG. 3 shows schematically the structure of a delay line as used according to the present invention.

FIG. 4 shows a time sequence diagram for two gate pulse trains.

In FIG. 1 is an output **52** of an electronic organ **50** directly connected with inputs **66,76,86** of three transmission channels which respectively comprise a series circuit of a delay line **60,70,80**, a low pass filter **61,71,81**, an amplifier **62,72,82** and a loud-speaker **63,73,83**. An output **51** of organ **50** is directly connected with the input **85** of amplifier **82** for the signal from filter **81**.

Each of the delay lines **60,70,80** is provided with an input **67,77,87**, respectively, for a modulation signal said, the input in the example actually being a control input of a switching oscillator **64,74,84**, respectively. The switching oscillator produces two gate pulse trains, the gate pulses in one train running in opposite phase with regard to the gate pulses in the other train. The gate pulse trains are connected respectively through inputs **68** and **69**, **78** and **79**, and **88** and **89** with the corresponding delay lines, in succession **60,70** and **80.**

In FIG. **2**, a circuit for generating a modulation signal is shown in the form of a block diagram.

A sine shaped signal transmitted from a low frequency signal generator **10** via an output **11** and a second sine shaped signal transmitted from a low frequency signal generator **30** via an output **31** are summed in three ways. The sine shaped signal generated in the generator **10** has a frequency that is not higher as 1 Hz and the sine shaped signal generated in the generator **30** preferably has a frequency in range from 5 Hz to 6 Hz. It is not necessary that a simple relation exists between the sine shaped signals originating from the generator **10** and the generator **30** with respect to phase or frequency. Indeed, it appears to be important that the amplitudes of the two signals are of about the same magnitude. A sub-audio frequency signal obtained by direct summation is transmitted to input **67** as a modulating signal.

The outputs **11** and **31** are each connected with an input of a phase shifting network **21** and **41** respectively. The phase shifting networks effect a phase shift as a result of which the sum of the output signals of the networks transmitted to input **77** which has a fixed phase shift with regard to the modulation signal transmitted to input **67**.

In an similar way, portions of the output signals from the networks **21** and **41**, are once again subjected to a phase shift in networks **22** and **42**, and successively transmitted in summed form to input **87**.

The amount of the fixed phase shift in all networks **21, 22, 41, 42** respectively can simply be determined to be 360° divided by the number of transmission channels, but with different values good results are also achieved. As the frequencies of the sine shaped signals differ considerably, the networks although effecting one and the same phase shift, are structured differently in an otherwise wellknown way, measures being taken at the same time to provide for equality in amplitude of the signals respectively transmitted to inputs **67,77** and **87.**

The operation as a delay line of a shift register is generally known. The shift register shown in FIG. **3** comprises MOSFET-transistors **T1,T2,...T**(n + 1). By switching the transistors from the conductive state to the blocking state, a signal V_i is sampled with the frequency of the gate pulses in a gate pulse train V_{SA} and is transmitted via capacitors **C1, C2,...C**n, by means of an additional gate pulse train V_{SB} thereby switching the even numbered transistors.

The sample of the signal V_i reaches the output of the shift register which is referred to by V_u, after n/**2** times the repetition time of the pulses in a pulse train. Such a delay line presents the capability to attain a relatively long delay time and moreover to modulate said delay time in a simple way.

To effect such modulation, only the common source of the two pulse trains need to be modulated.

The delay line just described is commercially obtainable in the form of an integrated circuit, there being **185** shift register sections realized in the integrated circuit. In applying said delay line in the audio frequency range, in this case the upper limit of said frequency range being fixed at 15 kHz, the sampling frequency should amount to at least 30 kHz. A mean sampling frequency, that is a frequency for the pulse trains, of 45 kHz effects a delay time of somewhat more than 2 msec and permits a modulation of 30 to 60 kHz, for example the travelling time varying from about 3 to about 15 msec.

As is known, travelling time modulation has as a consequence a relative frequency variation this is independent from frequency.

With the relatively long delay time, a substantial modulation depth in phase modulation is achieved in a simple way. It has been found that a modulation depth to be achieved in phase modulation with the delay line as described above, is necessary for the contemplated effect.

The low pass filters **61,71,81** shown in FIG. **1,** return the delayed sampled signal to its original shape. The filters have a cut-off frequency of about 20kHz. In this way, the wave shape of the audio-frequency signal remains maintained and thus its sound.

Furthermore, travelling time modulation does not give rise to any amplitude modulation, i.e., the amplitude of the audio-frequency signal in the various transmission channels does not change relatively. For the construction of the circuit, this means a considerable simplification.

What is claimed is:

1. An electric musical instrument which comprises in combination, an audio frequency signal source; an output terminal for the audio frequency source; a plurality of parallel transmitting channels each of which comprises a delay line series circuit, a low pass filter, an amplifier and loud speaker all interconnected; said delay line series circuit connected to receive the audio frequency signal from said output terminal; a switching oscillator disposed to provide two gate pulse trains, one running in opposite phase with regard the other to the delay line series circuit; a first and a second sine shaped signal low frequency generator disposed for generating a sine shaped sub-audio frequency signal to one of said switching oscillators; at least a first and a second phase shifting network each disposed to receive signals respectively from said first and second sine shaped signal low frequency generators, said first and second phase shifting networks disposed to provide a sum output signal to a second delay line series circuit; each of the further plurality of parallel transmitting channels having receiving imputs for switching oscillators from further first and second phase shifting networks each disposed to receive signals respectively from prior disposed phase shifting networks; and a second output from the audio frequency signal source, said second output connected to the amplifier of the last of said plurality of transmitting channels.

2. The electronic musical instrument of claim **1** wherein the frequency of the signal generated by the first generator is less than 1 Hz and that of the second signal is in the range from 5 to 6 Hz, the fixed mutual phase shift amounting to 360° divided by the number of transmission channels.

3. The electronic musical instrument of claim **1** wherein the phase shifting networks each comprise a controllable shift register connected for operation with said two gate pulse trains running in opposition, said gate pulses in a train succeeding each other with a repetition time that is sufficiently short not to exceed the inverse value of twice the bandwidth of the audio frequency signal, and which is modulated with the signal being obtained by summing in the phase shifting network.

* * * * *