United States Patent

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[54] **ELECTRONIC MUSICAL INSTRUMENT WITH DUAL CHANNELS FOR REVERBERATION AND PULSATO**
11 Claims, 1 Drawing Fig.

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[51] **Int. Cl.** **G10h 1/04**
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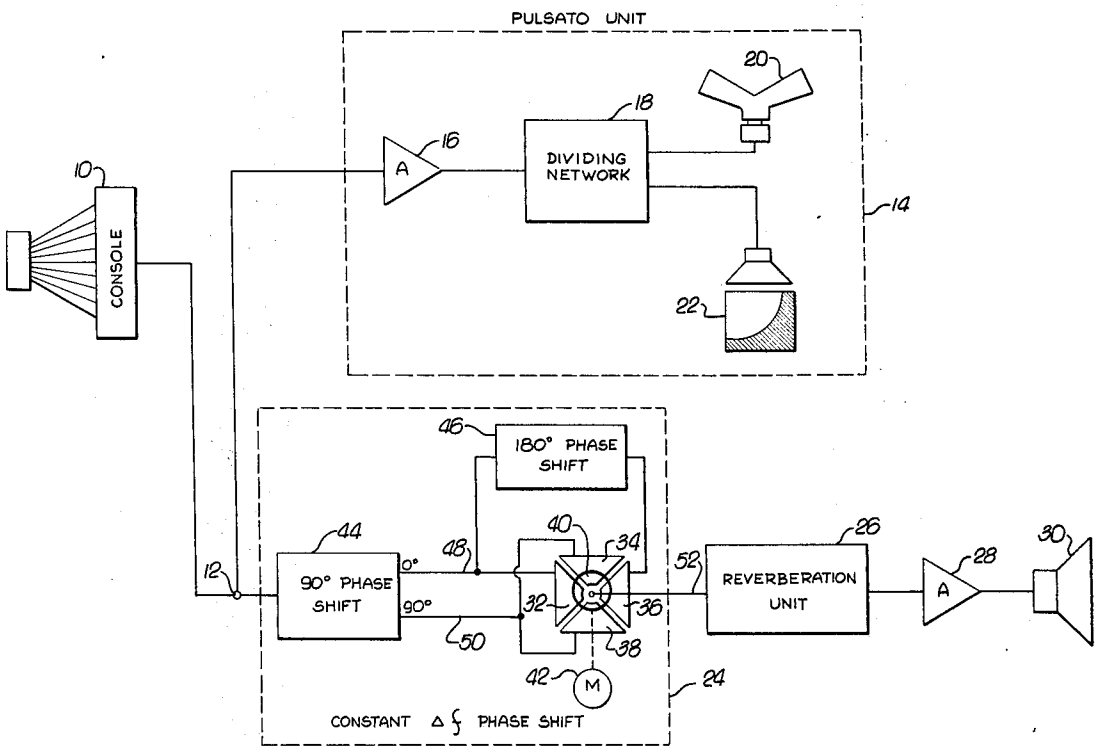
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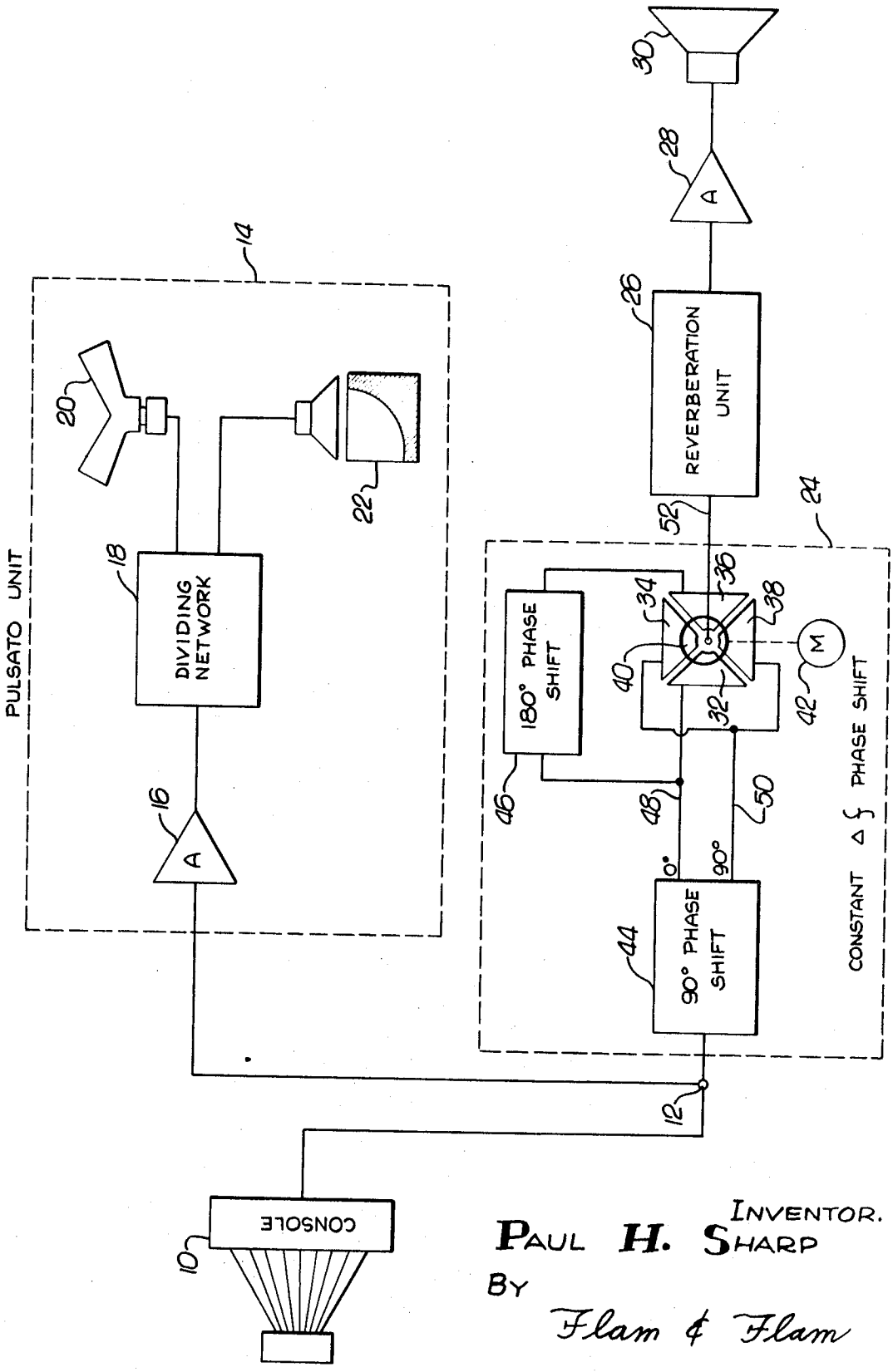
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ABSTRACT: A reverberation unit derives an instrument signal through an electrical phase shift vibrato device that imposes a maximum frequency deviation that is substantially constant for all notes in the musical range. The inherent comb-shaped frequency response of the reverberation device relatively attenuates certain notes. A second channel that includes acoustic pulsato apparatus derives instrument signal independently of the electrical vibrato device and provides with the first channel a distinct component to the total pulsato effect by virtue of the independency. Cessation of primary instrument signal provides a nonpulsato decaying reverberation the frequency response characteristic of which is substantially uniform due to the constant maximum frequency deviation pattern imposed prior to the cessation of signal.





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ELECTRONIC MUSICAL INSTRUMENT WITH DUAL CHANNELS FOR REVERBERATION AND PULSATO

BACKGROUND OF THE INVENTION

This invention relates to electrical musical instruments and particularly to systems utilizing mechanical time delay reverberation devices. One type of such reverberation device is shown in Hammond U.S. Pat. No. 2,230,836. This patent discloses a system in which springs are the operative elements. The electrical signal from the organ reproducer or other musical instrument is applied to the input end of the springs through a suitable electromechanical transducer. A signal is derived from the output end of the springs by a mechanicoelectrical transducer and applied to the speaker system. Signals at the output end of the springs are repeatedly reflected or fed back to the input end; consequently, reverberations are produced. Equivalent feedback arrangements are provided in tape loop and other reverberation devices.

Reverberation units of this kind may be used in at least two ways: one, during the course of play to simulate certain instruments, and two, to simulate the reverberant decay characteristics of the space in which sound is radiated. The use of such devices presents certain difficulties due to the fact that the time constant(s) of the mechanical-reverberation system is fixed. If an electrical signal is continually applied to the input, as, for example, when a key for an electrical organ is held down, the reflected signals may arrive at the output end of the mechanical reverberation unit in phase, out of phase, or partially in phase, or partially out of phase with the main signal, all depending upon the frequency or time period of the signal in question as it relates to the time period(s) of the mechanical reverberation unit. The result is that certain frequencies are attenuated; others are boosted. The frequency response at the output end of the mechanical reverberation unit has the appearance of spaced teeth of a comb. This is commonly referred to as the "comb effect." It is, of course, possible to provide separately tuned reverberation unit for each note for purposes of leveling the output characteristic, but this is highly impractical.

The use of acoustic pulsato units, such as shown in Leslie reissue U.S. Pat. No. Re. 24,566, is fairly widespread in order to add lively characteristics to the radiated sound. It has been common practice to pass all of the sound through the reverberation unit and then through the acoustic pulsato apparatus. The effect of the pulsato unit can be no better than the nonlinear frequency response resulting from the comb effect.

In an attempt somewhat to level the frequency response, it has been proposed to provide a second electrical acoustic channel that bypasses the reverberation device, the acoustic pulsato unit being incorporated in the bypass channel. In this arrangement, however, the sound from the reverberation channel has no acoustic pulsato; its sterile quality tends to dilute or detract from the lively effect produced in the bypass channel. A second pulsato unit is an obvious and expensive solution; but in this case pulsato is applied to the reverberated signal at all times, which is not always desirable.

In a further attempt to remedy this deficiency with a single pulsato unit, it has been proposed to provide an electronic phase shift mechanism at the main output of the organ instrument, with the acoustic pulsato channel and the reverberation channel both deriving signals therefrom. While a vibrant and more lively sound is produced in this arrangement, an unusual, unpleasant effect results in the reverberation channel when the main signals cease: the superimposed phase shift causes the high frequency impulses to sweep through a fair number of peaks of the comb characteristic, whereas the low-frequency notes sweep perhaps through only one. The high-frequency sounds reverberate noticeably off tune, whereas the low frequency sounds reverberate close to nominal pitch. In addition, the combination of acoustic pulsato and electronic phase shift vibrato produces undesirable beat effects.

SUMMARY OF THE INVENTION

The primary object of this invention is to provide a system for effective use of a reverberation unit free of the foregoing disadvantages. For this purpose, I provide an arrangement in which the bypass channel with the acoustic pulsato apparatus also bypasses the electronic phase shift unit. The full, vibrant, lively sound is achieved during the normal progress of music by virtue of a certain interplay of unlike sounds from the respective channels.

The electronic phase shift unit is selected to be of the type in which a constant frequency deviation is produced throughout the frequency range. A phase shift unit of this type is shown, for example, in U.S. Pat. No. 2,988,706 and U.S. Pat. No. 3,146,292. By using an electronic phase shift unit of this type, the frequency swing at the high end of the band as well as at the low end traverses a small number of peaks of the comb characteristic. When the instrument signal is discontinued, only a slight, barely perceptible detuning effect results; the source of widely detuned reverberation effects is eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of the invention will be made with reference to the accompanying drawing. The description of the invention is of the best presently contemplated mode of carrying out the invention. This description is not to be taken in a limiting sense but is made merely for the purpose of illustrating the general principles of the invention.

The single FIGURE is a schematic diagram of a system incorporating the present invention.

DETAILED DESCRIPTION

The invention will be described with respect to a single-wire diagram of an electronic organ. However, the invention is equally applicable to a wide variety of other musical instruments.

The organ console **10** is shown connected to an output terminal **12**. One output channel derived from the terminal **12** is a pulsato unit **14** that includes an amplifier **16**, a frequency-dividing network **18**, and rotary sound channels **20** and **22**. In place of the rotary pulsato unit, an electronic pulsato unit could be provided. A second output channel derived from the terminal **12** includes, in series, a constant phase shift unit **24**, a reverberation unit **26**, for example of the type shown in said Hammond U.S. Pat. No. 2,230,836, an amplifier **28**, and a speaker **30**. The components **24**, **26**, **28** and **30** in practice may be incorporated in the console **10**.

The constant phase shift unit **24** may be of any suitable type, providing it produces a constant cyclic frequency shift or deviation throughout the musical range. In the present instance, the phase shift unit **24** includes a rotary capacitor unit having four generally triangular stator plates **32**, **34**, **36** and **38** equiangularly arrayed closely about a common center, with the plates oriented in a common plane. An eccentric pickup disc **40** is supported for rotation about the common center in close opposition to the plates, whereby the disc sweeps past the plates in succession. The pickup disc **40** is rotated at a selected rate by a motor **42**.

The signal from the terminal **12** is applied to the plates **32**, **34**, **36** and **38** in the phase relationships of 0°, 90°, 180° and 90°, respectively. This is achieved by the aid of two phase shift devices **44** and **46**. The device **44** produces two outputs displaced 90° in phase for all of the frequency components of the input. The input of the phase shift device **44** is connected to the terminal **12** and has two outputs at leads **48** and **50**. The output lead **48** is connected to the first plate **32** in 0°-phase relationship; the output lead **50** is connected to the second and fourth plates **34** and **38**. The phase shift device **46** produces a 180°-phase displacement for all frequencies and connects the output lead **48** to the plate **36**. An output lead **52** is connected by a suitable brush to the rotary capacitor disc **40**.

The signal at the output lead **52** is, accordingly, phase modulated, all frequency components undergoing the same frequency shift.

As the impulses cyclically shift in frequency due to the device **24**, slightly different portions of the frequency response characteristic curve of the reverberation unit **26** are traversed. The overall effect is a reasonably flat response at least over a time period corresponding to the time period of the rotation of pickup disc **40**.

The sounds issuing from the speaker **30** for the reverberation channel constantly change in phase. These sounds interplay with sounds issuing from the speakers of the pulsato channel. The combined effect is highly lively and vibrant, more so than can be attributed to the individual effects of the channels.

I claim:

1. In an electrical musical instrument having a pair of speaker means defining separate output channels:

a. means generating a signal corresponding to musical sounds in a musical frequency range;

b. means superimposing upon said signal, first, a cyclic frequency shift that is substantially constant throughout said frequency range;

c. means superimposing upon said signal, second, a reverberation characteristic in which the frequency response is characterized by peaks spaced throughout the musical range;

d. means applying said signal with superimposed frequency shift and reverberation to the input of one of said speaker means;

e. means generating at the input to the other of the speaker means a signal corresponding to said musical sounds free of said superimposed frequency shift and free of said superimposed reverberations; and

f. pulsato means operating in conjunction with the channel defined by said other of said speaker means.

2. The combination as set forth in claim **1** in which said pulsato means includes rotary apparatus for superimposing pulsato by acoustic effects on the sound issuing from said other speaker means.

3. The combination as set forth in claim **2** in which the channel for said one of said speaker means is devoid of pulsato other than said constant frequency shift.

4. In an electrical musical instrument having an instrument output at which there exist impulses corresponding to musical sounds in a musical frequency range:

a. means forming a first electrical acoustic channel derived from said instrument output;

b. means forming a second electrical acoustic channel derived from said instrument output independently of said first electrical acoustic channel;

c. speaker and acoustic pulsato means in said first electrical acoustic channel;

d. said second electrical channel including in series,

i. a cyclic phase shift unit that produces a cyclic frequency deviation throughout said musical frequency range that is substantially constant;

ii. a mechanical reverberation unit having a frequency response characterized by a series of peaks distributed throughout the said musical frequency range; and

iii. speaker means.

5. The combination as set forth in claim **4** together with circuit means for determining a mode of operation of said channels in which said channels are simultaneously operable during the course of playing of the instrument whereby the interplay of out-of-phase sounds from both channels produces a vibrant effect; whereby the reverberations upon cessation of instrument output are substantially in tune; and whereby the average frequency response is substantially flat despite the frequency response characteristic of said reverberation unit.

6. The combination as set forth in claim **4** in which said acoustic pulsato means is included only in said first electrical acoustic channel.

7. A process of producing music which comprises:

a. generating an output corresponding to musical sounds in a frequency range;

b. modifying said output in one electrical acoustic channel by cyclically shifting the phase of said output to impart a frequency deviation that is substantially constant throughout the musical range;

c. imposing a reverberation on the phase shifted output by a device having a comb characteristic;

d. modifying said output in a second parallel electrical acoustic channel by superimposing a substantial pulsato effect.

8. The process as set forth in claim **7** in which the pulsato effect is added acoustically.

9. For use with an electrical musical instrument having means generating an electrical signal corresponding to musical sounds in a frequency range:

a. a speaker system for converting electrical signals into sound;

b. first and second electrical signal modifying means together serially interposed between said generating means and said speaker system with the first modifying means located ahead of the second modifying means;

c. said first modifying means superimposing upon said electrical signal, cyclic frequency shift that is substantially constant throughout said frequency range;

d. said second modifying means additionally superimposing upon the electrical signal a reverberation characteristic in which the frequency response is characterized by peaks spaced throughout the musical range;

e. the constant frequency shift means causing all electrical signals to sweep through substantially the same number of peaks whereby no part of the frequency range is more noticeably off tune than any other part of the frequency range upon cessation of signal.

10. For use with an electrical musical instrument having a pair of speaker means defining separate output channels, and means generating an electrical signal corresponding to sounds in a frequency range:

a. first and second electrical signal modifying means together serially interposed between said generating means and one of said speaker systems with the first modifying means located ahead of the second modifying means;

b. said first modifying means superimposing upon said electrical signal, cyclic frequency shift that is substantially constant throughout said frequency range;

c. said second modifying means additionally superimposing upon the electrical signal a reverberation characteristic in which the frequency response is characterized by peaks spaced throughout the musical range;

d. the constant frequency shift means causing all electrical signals in the corresponding output channel to sweep through substantially the same number of peaks whereby no part of the frequency range is more noticeably off tune than any other part of the frequency range upon cessation of signal;

e. means connecting the other of said speaker systems to said generating means;

f. and pulsato means operating in conjunction with the output channel defined by said other of said speaker means so that the unlike sounds issuing from both channels interplay to produce a full, vibrant lively musical effect.

11. The combination as set forth in claim **10** in which said pulsato means includes rotary apparatus for rotating the sound radiation pattern produced by said speaker system.

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