

- [54] **AUDIO SIGNAL TRANSMITTING SYSTEM**
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 [73] Assignee: **Sony Corporation**, Tokyo, Japan
 [22] Filed: **Dec. 3, 1973**
 [21] Appl. No.: **421,215**

- [30] **Foreign Application Priority Data**
 Dec. 11, 1972 Japan..... 47-142222[U]

- [52] **U.S. Cl.**..... 330/124 R; 84/1.25; 84/DIG. 26;
 84/DIG. 27; 179/1 G; 179/1 J; 328/56
 [51] **Int. Cl.**..... **H03f 3/68**
 [58] **Field of Search**..... 330/124 R; 179/1 G, 1 J,
 179/100.1 TD, 100.4 ST; 84/1.25, DIG. 1,
 DIG. 26, DIG. 27; 328/56, 155; 333/18

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[57] **ABSTRACT**

In an audio signal transmitting system having an audio signal transferring device and a loudspeaker to reproduce audio signals, the system includes a vibrato device consisting of a charge transfer device (CTD) connected to the transferring device, a clock pulse oscillator to produce clock pulses and supply the clock pulses to the CTD, and an oscillator to supply low frequency signals. The clock pulse oscillator is controlled in its frequency in response to the low frequency signals, so that delayed and frequency-modulated audio signals are reproduced by the loudspeaker.

9 Claims, 9 Drawing Figures

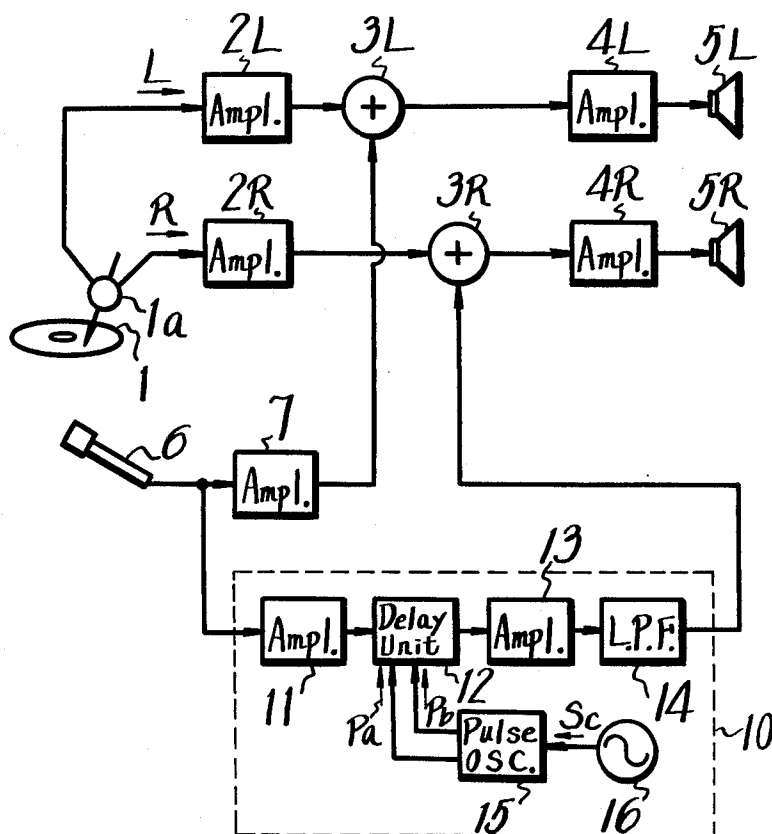


Fig. 1

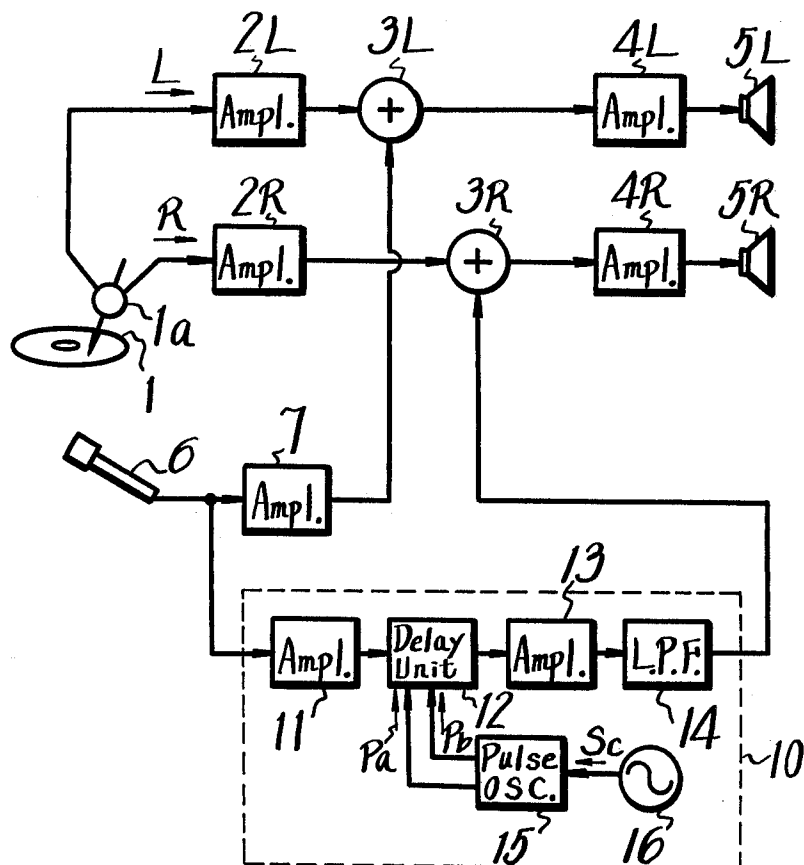


Fig. 2

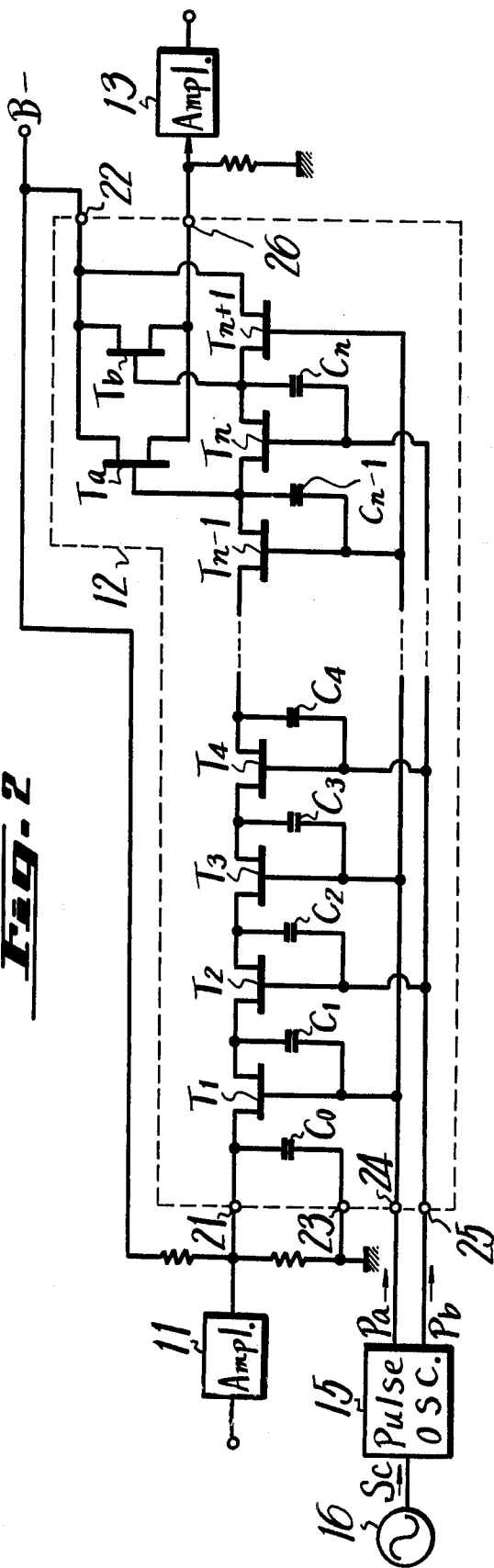


Fig. 4

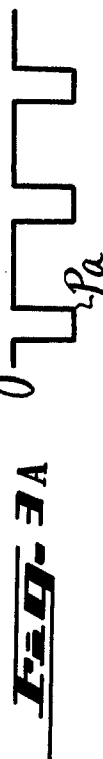
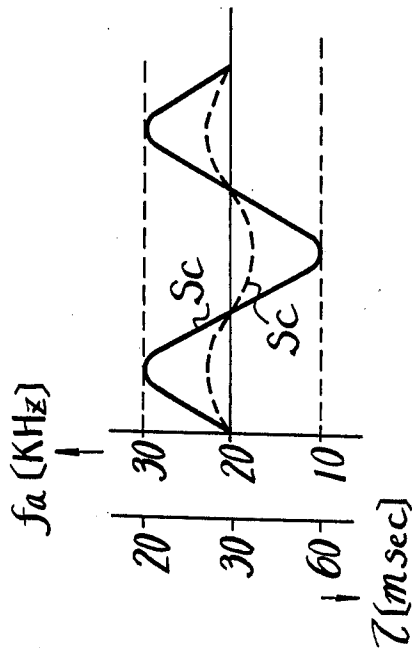


Fig. 5

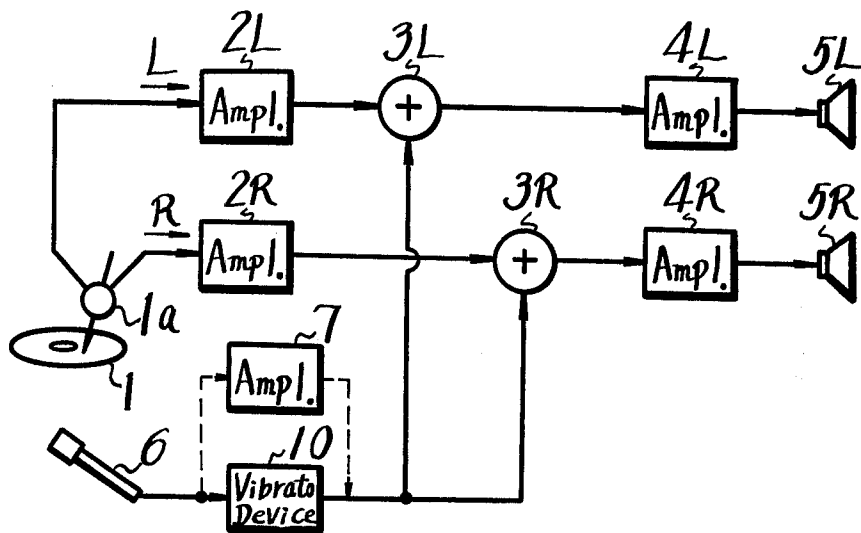


Fig. 6

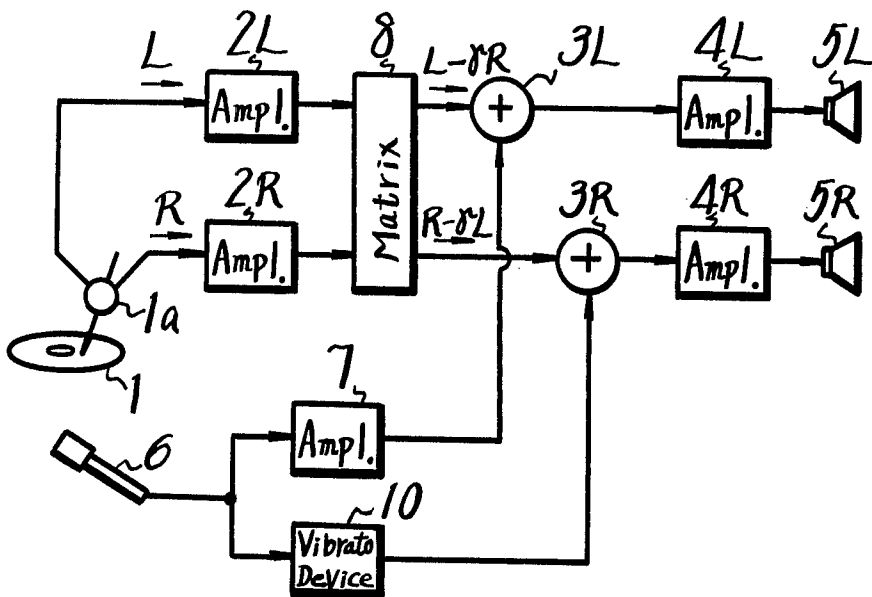


Fig. 7

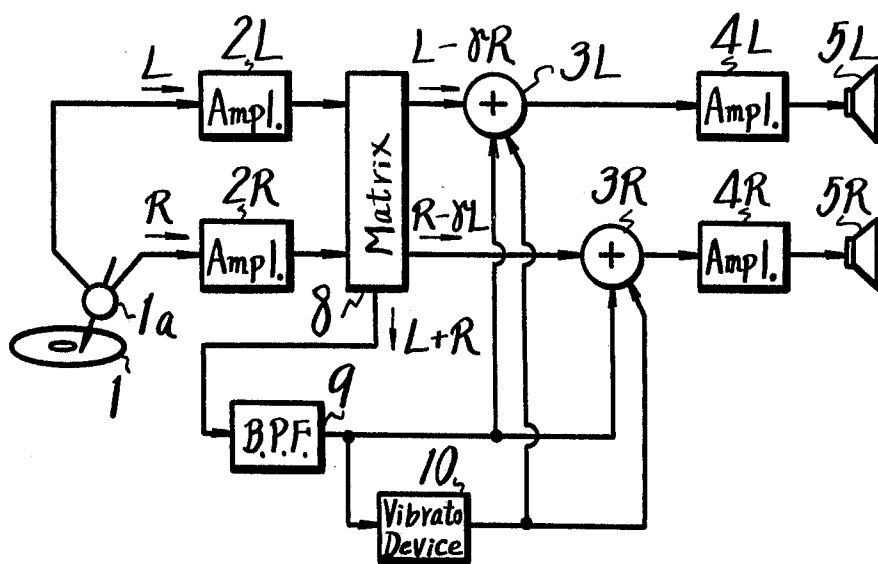
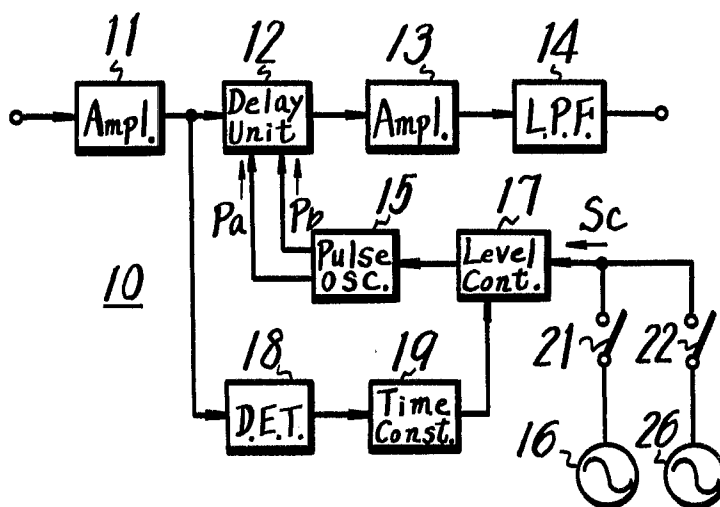


Fig. 8



AUDIO SIGNAL TRANSMITTING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to an audio signal transmitting system, and more particularly to an audio signal transmitting system in which a vibrato is caused in a sound.

2. Description of the Prior Art

A microphone mixing circuit has been known as a circuit by which a user's voice is reproduced from a speaker with the background music of, for example, a phonograph record. However, with the microphone mixing circuit of the prior art, outputs from one or two microphones are added, as they are, to left and right channel signals of a stereo-phonograph as monoral or stereo, so that the voice reproduced from the speaker is poor as compared with that of the professional singer from the phonograph record.

In general, it is said one attribute of a good singer is that the good singer can apply a vibrato to his voice. However, it is generally difficult to artificially treat a voice, which is once emitted to a space, to obtain a specific effect. In order to produce, for example, an atmosphere like a concert hall, when an unskillful person sings in a room with a good residual sound effect, his singing voice can be heard by a listener as a superior voice due to the residual sound effect. However, it is, in general, almost impossible to prepare such a room as a concert hall in an ordinary house, from an economical point of view.

Such a method is also proposed wherein a voice signal of a person from a microphone is delayed through a delay device mechanically and then reproduced by a speaker, but in this case a sound peculiar to the mechanical delay device is produced by the speaker.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a novel audio signal transmitting system with a vibrato device.

Another object of the invention is to provide an audio signal transmitting system which has a device for delaying an audio signal and applying thereto a vibrato, so that a singer himself or a listener can enjoy a pleasing musical tone.

A further object of the invention is to provide an audio signal transmitting system with a device which can be applied to a so-called mixing apparatus and with which a person can mix his voice with music from a music source such as a phonograph record, a broadcasting or the like, which makes it possible for a vibrato to be applied to the person's voice or singer's voice of the music source.

A further object of the invention is to provide an audio signal transmitting system in which a voice emitted once to a space is picked up by a microphone and a vibrato is applied thereto by electrically treating the audio signal.

A yet further object of the invention is to provide an audio signal transmitting system with a novel vibrato device which can change its vibrato in response to the intensity of an audio signal.

A still further object of the invention is to provide an audio signal transmitting system in which, instead of the center vocal sound from a stereo source, a vocal

sound supplied with a vibrato from a microphone is inserted.

The additional and other objects, features and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 diagrammatically illustrates a preferred embodiment of an audio signal transmitting system according to the present invention;

FIG. 2 is a circuit diagram showing the delay unit of the example shown in FIG. 1;

FIG. 3A and 3B are waveform diagrams for illustrating clock pulses supplied to the delay unit shown in FIG. 2;

FIG. 4 is a graph illustrating the relationship of a low frequency signal, the frequency of the clock pulses and the delay time of an audio signal;

FIG. 5 diagrammatically illustrates a second embodiment of the invention in which the output signal from a microphone is delayed and supplied with a vibrato, and thereafter mixed with a stereophonic signal;

FIG. 6 diagrammatically illustrates a third embodiment of the invention in which one of two signals combined with stereophonic signals is directly mixed with an output signal from a microphone and in which the other signal is mixed with an output signal from the microphone which is delayed and subjected to a vibrato;

FIG. 7 diagrammatically illustrates a fourth embodiment of the invention in which the center vocal of a stereophonic signal is supplied with a vibrato; and

FIG. 8 diagrammatically illustrates a device used in the fourth embodiment by which a vibrato is varied in response to the magnitude of an audio signal.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invention will now be described with reference to FIG. 1. In the embodiment of FIG. 1, left and right stereophonic signals are reproduced from a stereophonic signal source such as a phonographic record 1 by a cartridge 1a. The left channel signal L is applied to an equalizer amplifier 2L, amplified therein in equalizing manner, applied to a mixer circuit 3L and then applied to a main amplifier 4L. The output signal from the main amplifier 4L is fed to a left speaker 5L to be reproduced. While, the right channel signal R is applied to an equalizer amplifier 2R to be amplified in equalizing manner, to mixer circuit 3R, to a main amplifier 4R to be amplified in power, and then to a right speaker 5R to be reproduced. The output signal from a microphone 6 is fed through a microphone amplifier 7 to the mixer circuit 3L to be combined with the left channel signal L, and is also applied to a vibrato device 10 directly. In this case, the output signal from the microphone 6 is fed to a variable delay unit to be delayed, and the delay time thereof is varied periodically to achieve a so-called frequency modulation. Thus, a vibrato is applied to the output signal from the microphone 6.

This will now be described in detail. The vibrato device 10 includes a microphone amplifier 11 to which the output signal from the microphone 6 is applied. The amplified output signal from the amplifier 11 is then fed to a variable delay unit 12 to be delayed and frequency-modulated. The output signal from the delay

unit 12 is fed through a buffer amplifier 13 and a low-pass filter 14 to the mixer circuit 3R to be mixed with the right channel signal R.

As seen in FIG. 2, the variable delay unit 12 is provided by a bucket-brigade device, which will be hereinafter referred to as BBD. The BBD 12 as shown in FIG. 2, employs n FETs, T_1 to T_{n+1} , which are connected so that their drain and source electrodes are connected with one another in series. The drain electrode of the FET T_1 is connected to an input terminal 21 of the BBD 12 and the source electrode of the FET T_{n+1} is connected to a power source terminal 22 of the BBD 12 to which a power source of -B potential is connected. Between the input terminal 21 and a ground terminal 23 of the BBD 12, there is inserted a capacitor C_0 . Capacitors C_1 to C_n are connected between the source and gate electrodes of the FETs T_1 to T_n , respectively, and the gate electrodes of the odd numbers FETs $T_1, T_3, \dots$ are connected to a first clock pulse input terminal 24 of the BBD 12, while the gate electrodes of the even number's FETs $T_2, T_4, \dots$ are connected to a second clock pulse input terminal 25 of the BBD 12. The source electrodes of the FETs T_{n-1} and T_n are connected through source-follower FETs T_a and T_b to an output terminal 26 to the BBD 12. The part of the BBD 12 just mentioned above or the part shown by a dotted line block in FIG. 2 is made as an integrated circuit.

A clock pulse oscillator 15 of the BBD 12 produces first and second clock pulses (synchronizing pulses) P_a and P_b which are shifted in phase by 180° as shown in FIGS. 3A and 3B with each other, and are fed to the terminals 24 and 25, respectively. The terminal voltage across the capacitor C_0 is varied in accordance with the signal from the amplifier 11. When the pulse P_a is applied to the terminal 24, the FET T_1 is turned ON. Accordingly, the charge stored in the capacitor C_0 is shifted or transferred to the next capacitor C_1 through the FET T_1 . Thereafter, when the pulse P_b is applied to the terminal 25, the FET T_2 is turned ON. Thus, the charge stored in the capacitor C_1 is transferred to the following capacitor C_2 through the FET T_2 . When the pulse P_a is next applied, the FET T_3 is turned ON to transfer therethrough the charge stored in the capacitor C_2 to the capacitor C_3 . At this time, since the FET T_1 is turned ON also, the charge newly stored in the capacitor C_0 in response to the input signal is transferred to the capacitor C_1 through the FET T_1 . The above operation is carried out repeatedly in response to the pulses P_a and P_b , so that delayed signals can be delivered to the output terminal 26.

In this case, the charges stored in the capacitors C_0 to C_n are transferred at every supply of the pulses P_a and P_b , so that the delay time becomes long as the frequency of the pulses P_a and P_b is low and the number of the capacitors C_0 to C_n is large. If $n = 256$ and the frequency of the pulses P_a and P_b is 10KHz, by way example, the delay time becomes to 12.8 milliseconds.

In order to vary the delay time of the BBD 12 periodically, a variable frequency oscillator formed, for example, of an astable multivibrator is used as the clock pulse oscillator 15, and in order to control the variable frequency oscillator 15 there is provided a low frequency oscillator 16 which produces, for example, a sine wave signal S_r (refer to FIG. 4) with a frequency of 7Hz. The sine wave signal S_r from the oscillator 16 is applied to the clock pulse oscillator 15 to control the oscillation frequency of the latter. Thus, as shown by a

solid line in FIG. 4, the frequency f_a of the pulses P_a and P_b from the oscillator 15 is periodically varied with the frequency 7Hz of the signal S_r as its frequency between 10KHz and 30 KHz in response the level of the signal S_r , or the pulses P_a and P_b are frequency-modulated with the signal S_r .

When the frequency of the clock pulses P_a and P_b are periodically varied with the signal S_r , the delay time τ of the BBD 12 is also periodically varied with the frequency 7Hz of the signal S_r as its frequency between, for example, 60 milliseconds and 20 milliseconds. Accordingly, the voice signal from the microphone 6 is delayed in delay time between 40 milliseconds and 0. That is, the voice signal from the microphone 6 is delayed and frequency-modulated in the BBD 12, so that the BBD 12 produces a second signal which is delayed and caused to be a vibrato.

As mentioned above, the output signal from the microphone 6 is delayed and caused to have a vibrato effect in the BBD 12 and thereafter mixed to the right channel signal R in the mixer circuit 3R. The low-pass filter 14 serves to eliminate the components of the pulses P_a and P_b contained in the output signal from the BBD 12 through the amplifier 13. In this case, the left channel signal L is mixed with the output signal from the microphone 6 without being delayed, so that the left speaker 5L produces the user's singing voice with the music from the phonographic record 1 as background, while the right speaker 5R produces the user's singing voice with the music from the record 1 as background, which voice is delayed and caused to have a vibrato effect.

When the singing voice which is not delayed and the voice which is slightly delayed and caused to have a vibrato effect are reproduced at the same time, a peculiar effect can be achieved, which is somewhat different from the effect achieved by applying an echo or reverberation to a professional singer in a popular song.

Further, since the singing voice without being delayed and the singing voice being delayed and caused to have a vibrato effect are separately reproduced from the left and right speakers 5L and 5R, the singing voice arriving at the left ear of the listener or user always differs from that arriving at the right ear, or if the user with the microphone 6 moves in his body when he sings, the reproduced voices arriving at high left and right ears become different further. Therefore, a sound effect which can not be attained by the prior art microphone mixing circuit is obtained by the present invention.

It is also possible that if a professional singer's voice exists in the left and right signals L and R reproduced from a record, a chorus of the user's voice with the singer's voice can be obtained.

A second embodiment of the invention will now be described with reference to FIG. 5 in which reference numerals the same as those of the foregoing figures indicate the same elements.

In the embodiment of FIG. 1, the voice signal which is not delayed is fed to the left channel signal L and the voice signal which is delayed and caused to have a vibrato effect is fed to the right channel signal R. However, in the embodiment of FIG. 5, a voice signal which is delayed and caused to have a vibrato effect by the same vibrato device 10, is fed to both of the left and right channel signals L and R, respectively. In this case,

it is also possible that, through the amplifier 7, a voice signal without being delayed can be applied to both the channel signals L and R, as shown by a dotted line in FIG. 5.

A third embodiment of the invention will now be described with reference to FIG. 6, in which the same reference numerals or characters as those of the above figures show the same elements.

In the third embodiment of FIG. 6, if a professional singer's voice signal exists in the left and right channel signals L and R reproduced from the record 1, the voice signal is eliminated and in place thereof a user's voice signal which is subjected to vibrato is inserted. That is, a matrix circuit 8 is provided which is supplied with the signals L and R through the amplifiers 2L and 2R, respectively, and produces signals $L - \gamma R$ and $R - \gamma L$ where the condition $0 \leq |\gamma| \leq 1$ is satisfied. The mixer circuits 3L and 3R are supplied with the signals $L - \gamma R$ and $R - \gamma L$, respectively, and also with the output signal from the microphone 6 through the amplifier 7 and the vibrato device 10, respectively.

In this case, consideration is given to a signal component in a program source such as a record. A professional singer's voice (center vocal) is recorded with the same phase and level with respect to the left and right channels so as to be localized at the center of stereophonic apparatus, while a sound from a musical instrument is recorded in a different level with respect to the left and right channels so as to be localized in dispersed left and right directions. Accordingly, if the matrices of $L - \gamma R$ and $R - \gamma L$ are carried out in the matrix circuit 8, the signal from the musical instrument is almost kept at the same level as it is, but the professional singer's voice signal is cancelled if $|\gamma| = 1$ and hence the signal from the musical instrument is only contained in the signals $L - \gamma R$ and $R - \gamma L$. As a result, the user's voice is reproduced from the speakers 5L and 5R instead of the professional singer's voice. In this case, in addition thereto, the user's voice which is not delayed is reproduced from the speaker 5L and the user's voice which is delayed and caused to have a vibrato effect is reproduced from the speaker 5R, as described above, with the result that the microphone mixing effect is much enhanced.

Further, if the condition $1 > \gamma$ is satisfied, the singer's voice is reproduced lower in response to γ , a chorus of the user's voice with the singer's voice can be played.

FIG. 7 shows a fourth embodiment of the invention in which the parts corresponding to those of the above embodiments are shown with the corresponding references. With the embodiment of FIG. 7, the singing voice of a professional singer from the record 1 can be caused to have a vibrato effect. That is, the sum signal $L+R$ of the signals L and R is obtained from the matrix circuit 8 and then applied to an audio band-pass filter 9 from which the vocal signal of the singer is derived. The thus derived vocal signal from the bandpass filter 9 is directly fed to the mixer circuits 3L and 3R, respectively, and also to the vibrato device 10. The signal which is delayed and caused to have a vibrato effect from the vibrato device 10 is fed to the mixer circuits 3L and 3R, respectively. Accordingly, from the speakers 5L and 5R, there are reproduced both the original singing voice and that delayed and caused to vibrato of the singer with the music as its background.

In the above embodiments, the intensity or amount of vibrato is substantially constant, but it is possible to have the intensity or amount of vibrato changed in response to the magnitude of the audio (vocal) signal to enhance the vibrato effect. With reference to FIG. 8, in which the parts similar to those of FIG. 1 are shown with the similar reference numerals, such a vibrato device 10 will now be described.

In the vibrato device 10 shown in FIG. 8, there is provided a low frequency oscillator 26 with the frequency of, for example, 30 Hz in addition to the low frequency oscillator 16 of 7Hz. The output signals S_c from the oscillators 16 and 26 are applied through switches 21 and 22 to a level control circuit 17 as its input signal.

The output signal from the audio amplifier 11 is further applied to a detector circuit 18 the output signal from which is applied to a time constant circuit 19 to be made as a DC signal which changes its level in response to the level of the audio signal (average level thereof). The DC signal from the time constant circuit 19 is also fed to the level control circuit 17 as a control signal. Accordingly, the signal S_c passed through the level control circuit 17 from the oscillator 16 or 26 is varied in level in response to the level of the audio signal.

For example, as the level of the audio signal increases, that of the signal S_c increases correspondingly. The signal S_c which is controlled in level by the level control circuit 17 is applied to the pulse oscillator 15 as a control signal for controlling the oscillation frequency f_a of the latter. Accordingly, the frequency f_a of the pulses P_a and P_b from the oscillator 15 is changed between, for example, 10 KHz and 30 KHz with the period the same as that of the signal S_c as shown in FIG. 4 by the solid line if the signal is high in level, while changed within a band narrower than the former as shown in FIG. 4 by the dotted line with the same period if the signal S_c is low in level. As a result, since the changing range of the delay time τ of the BBD 12 becomes wide if the audio signal is high in level, but becomes narrow if the audio signal is low in level, vibrato is applied to the singing voice much as the singing voice is great in intensity. In this case, the period of vibrato can be varied by changing the switches 21 and 22. Accordingly, with the employment of the vibrato device 10 shown in FIG. 8, a further specific effect can be applied to the microphone mixing circuit.

As described above, with the present invention, a specific effect which can not be achieved by the prior art microphone mixing circuit can be applied to the singing voice, and a user can enjoy the atmosphere that a professional singer is singing. Further, the present invention for achieving such effects is simple in construction and inexpensive.

The above description is given on the case that the BBD 12 is used as the delay unit, but a CTD (charge transfer device) such as a CCD (charge coupled device) can be used.

Further, it may be understood that such a system, as a flip-flop or memory core may be used and that the delay time may be controlled by the clock pulse.

It may also be apparent that many modifications and variations could be effected by those skilled in the art without departing from the spirit and scope of the novel concepts of the invention, and hence the scope of the invention should be determined by the appended claims only.

I claim as my invention:

1. An audio signal transmitting system comprising:
 a. means for transferring audio signals;
 b. means connected to an output stage of said transferring means for reproducing said audio signals; and
 c. means connected to said transferring means and supplied with clock pulses for delaying and frequency modulating said audio signals in response to the frequency of said clock pulses thereby to cause vibrato in the reproduced audio signals, a clock pulse oscillator for supplying said clock pulses, a low frequency oscillator for applying a low frequency signal to said clock pulse oscillator, and a detector for detecting an audio signal in said transferring means, the output signal from said detector being used to vary the level of said low frequency signal and hence to control the oscillation of said clock pulses.

2. An audio signal transmitting system according to claim 1, which further includes a time constant circuit which is connected to the output stage of said detector.

3. An audio transmitting system comprising, a first source of audio signals, a vibrato device receiving the output of said source of audio signals, said vibrato device comprising a variable time delay device having an input terminal receiving said audio signals, an output terminal, and at least one time delay control terminal, a pulse oscillator connected to said time delay control terminal to vary the time delay of said variable time delay device, a low frequency oscillator connected to said pulse oscillator to vary the pulse frequency thereof, a second audio frequency source having left and right stereo components, a first mixer receiving one of said left and right stereo components of said second audio source and said first source of audio signals, a first audio producing means connected to said first mixer, a second mixer receiving the other one of said left and right stereo components of said second audio source and the output of said variable time delay device, and a second audio reproducing means connected to said second mixer.

4. An audio transmitting system according to claim 3 including a low pass filter in said vibrato device connected between and said mixer and the output terminal of said variable time delay device.

5. An audio transmitting system according to claim 3 including an matrix connected between said first and second mixers and receiving said left and right stereo components so as to vary their phases.

6. An audio transmitting system comprising, a first source of audio signals, a vibrato device receiving the output of said source of audio signals, said vibrato device comprising a variable time delay device having an input terminal receiving said audio signals, an output terminal, and at least one time delay control terminal,

a pulse oscillator connected to said time control terminal to vary the time delay of said variable time delay device, a low frequency oscillator connected to said pulse oscillator to vary the pulse frequency thereof, a second audio frequency source having left and right stereo components, a first mixer receiving one of said left and right stereo components of said second audio source and the output of said variable time delay device, a first audio reproducing means connected to said first mixer, a second mixer receiving the other one of said left and right stereo components of said second audio source and the output of said variable time delay device, and a second audio reproducing means connected to said second mixer.

7. An audio transmitting system comprising, a source of left and right stereo component signals, a matrix receiving said left and right stereo component signals and producing three output signals with one being a sum of the left and right stereo component signals, another being a phase shifted left stereo component signal and the third being a phase shifted right stereo component signal, a first mixer receiving said sum of the left and right stereo component signals and the phase shifted left stereo component signal from said matrix, a second mixer receiving said sum of the left and right stereo component signals and the phase shifted right stereo component signal from said matrix, a vibrato device receiving said sum of the left and right stereo component signals from said matrix, said vibrato device comprising a variable time delay device having an input terminal receiving said sum of the left and right stereo component signals, an output terminal and at least one time delay control terminal, a pulse oscillator connected to said time delay control terminal to vary the time delay of said variable time delay device, a low frequency oscillator connected to said pulse oscillator to vary the pulse frequency thereof, the output terminal of said variable time delay device supplying inputs to said first and second mixers, a first audio reproducing means connected to said first mixer, and a second audio reproducing means connected to said second mixer.

8. A vibrato device comprising a delay unit receiving an audio signal on its input terminal, said delay unit having an output terminal and at least one time delay control terminal, a pulse oscillator connected to said time delay control terminal, a level control connected to the input of said pulse oscillator to control its frequency, a detector receiving said audio signal, a time constant circuit receiving the output of said detector and supplying an input to said level control, and a first low frequency oscillator supplying an input to said level control.

9. A vibrato device according to claim 8 further including a second low frequency oscillator connected to said level control.

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