

[54] **ELECTRONIC TREMOLO EFFECT PRODUCING DEVICE**

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[63] Continuation of Ser. No. 111,449, Feb. 1, 1971, abandoned.

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Feb. 5, 1970 Japan..... 45-11739

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[51] Int. Cl. G10h 1/04

[58] Field of Search 84/1.01, 1.11, 1.19, 1.22, 84/1.24, 1.25, DIG. 4; 331/106

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[57] **ABSTRACT**

A tremolo effect producing device, wherein a frequency deviated musical sound signal the frequency of which is shifted higher or lower by as much as an extremely low frequency signal, is tone-colored differently from the tone color of the original signal, and the frequency deviated musical sound signal thus tone-colored and an original musical sound signal are mixed at a predetermined level. The resultant mixed signal presents a repeated change in tone color, which results in a so-called tone color tremolo. A tone coloring circuit for the frequency deviated musical sound signal expediently comprises a filter circuit acting as a filter the value of which changes in response to the level of an extremely low frequency signal applied at a control terminal of the filter circuit.

1 Claim, 10 Drawing Figures

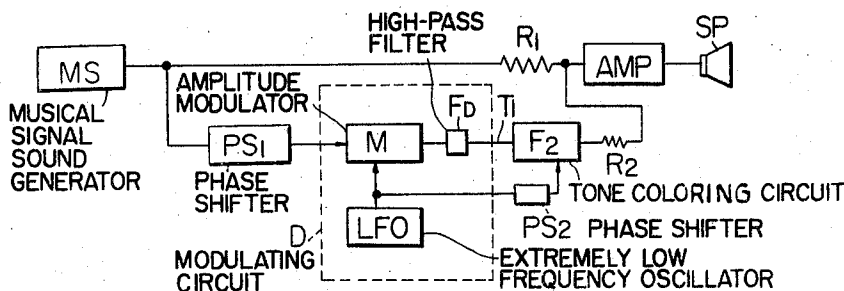


FIG. 1

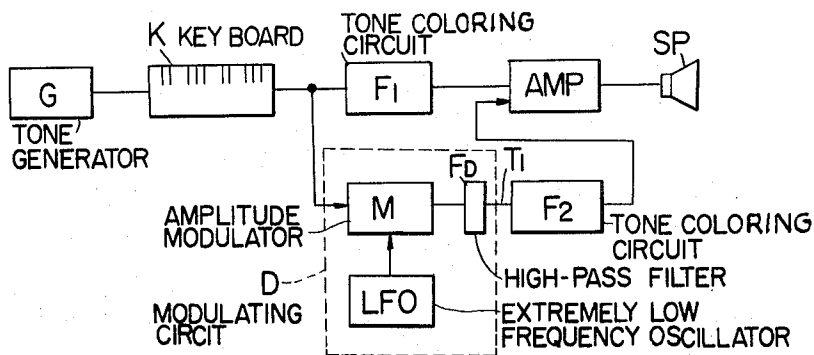


FIG. 2

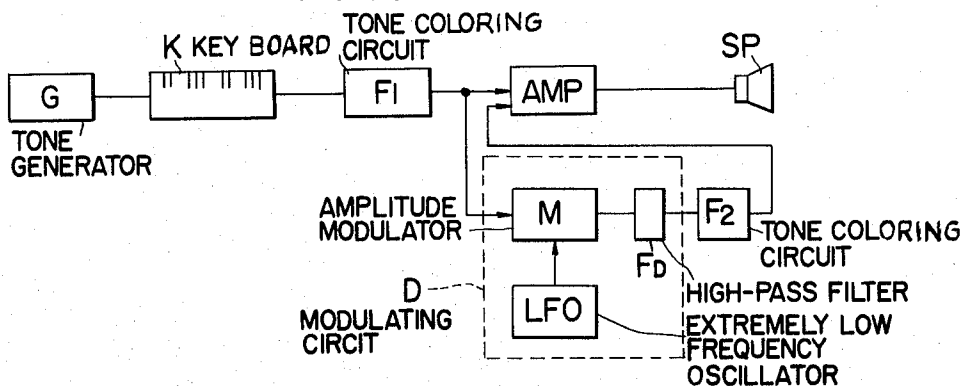


FIG. 3

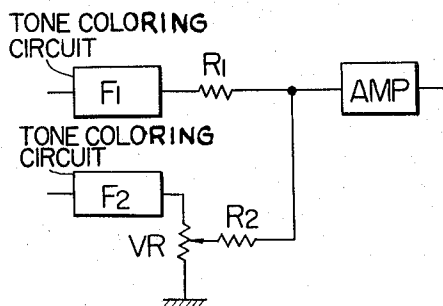


FIG. 4

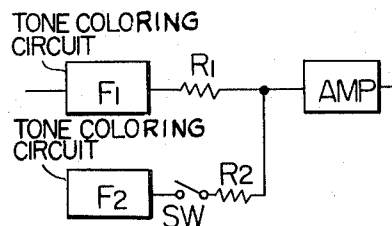


FIG. 5

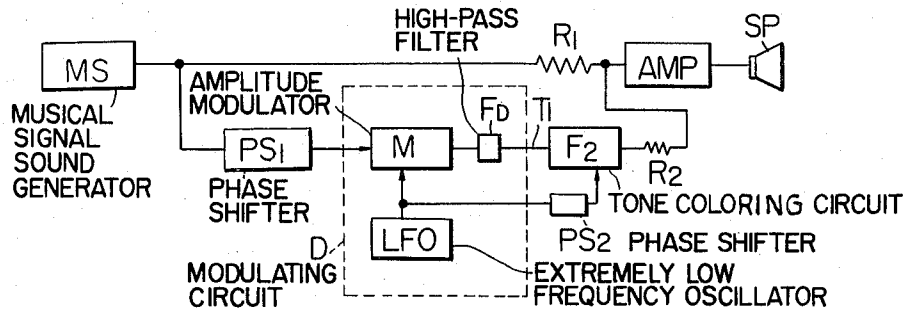


FIG. 6

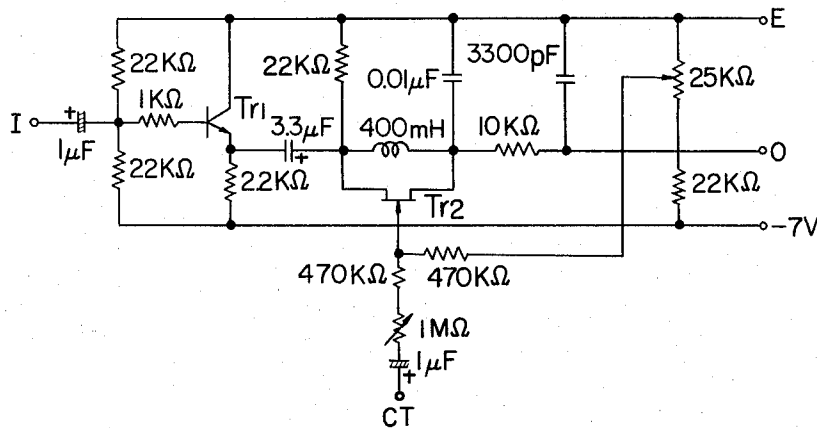


FIG. 7

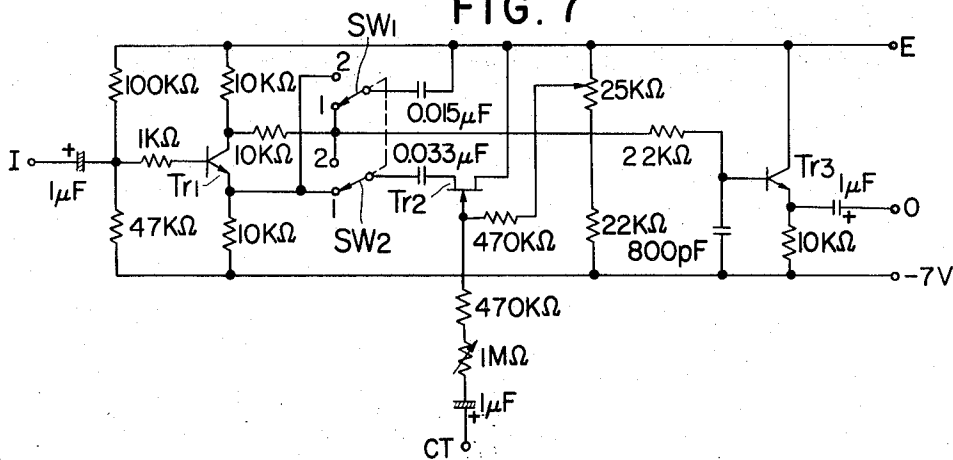


FIG. 8

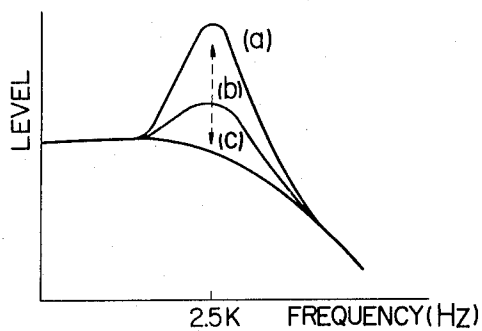


FIG. 9

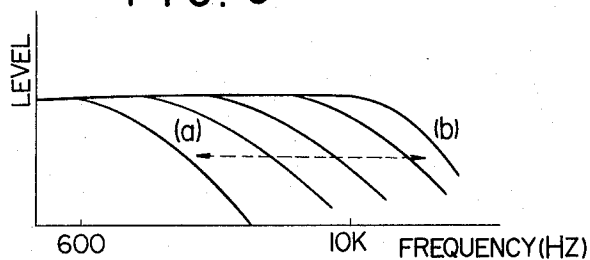
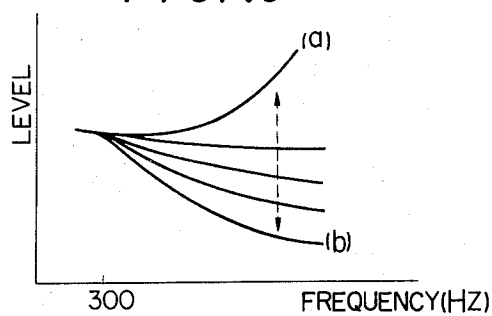


FIG. 10



ELECTRONIC TREMOLO EFFECT PRODUCING DEVICE

This is a continuation, of application Ser. No. 111,449, filed Feb. 1, 1971, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to an electronic tremolo effect producing device, and more particularly to a type of device in which a tremolo effect accompanied by a tone color modulation is obtained.

Heretofore, there have been used tremolo or chorus producing devices wherein an electrical musical sound signal (as a carrier wave) is amplitude modulated with a signal (as a modulating wave) having a desired frequency and waveform, or alternatively, in a second method the electrical signal is converted into a sound signal through a loudspeaker rotating at a desired speed. (Hereinafter, as far as the electronic musical instrument of the invention is concerned, a tremolo effect represents a modulation by a frequency ranging from 5 Hz to 10 Hz, while a chorus effect represents a modulation by a frequency ranging from 0.5 Hz to 2 Hz.) However, in the first mentioned system, since only amplitude modulation is employed, the frequency of the musical sound signal remains unchanged, and therefore the resultant sound is rather monotonous and the sound effect is very poor. On the other hand, in the second system, a loudspeaker having a directional characteristic is rotated. Therefore, when a sound produced therefrom is listened to at a certain position, different frequency characteristics are found at every rotating position of the loudspeaker. In other words, the tone color is modulated and further the phase and directivity of the musical sound signal are varied. In addition, a variation (amplitude modulation) of the signal level results whereby a wide spread sensation can be obtained. Therefore, the second system is very effective, but it involves disadvantages such as an excessively complicated rotating mechanism and a driving mechanism of the loudspeaker, and high production cost thereof. Furthermore, there are possibilities of various undesirable noises occurring, such as wind noise and other mechanical noises being introduced at the time of rotation of the loudspeaker.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a novel organization of a tremolo or chorus effect producing device wherein all of the above-described drawbacks of the conventional devices can be eliminated.

Another object of the present invention is to provide an electronic tremolo effect producing device which produces a tremolo effect or a chorus effect accompanied by amplitude modulation and frequency modulation, and further effected by a tone color modulation.

A further object of the present invention is to provide a tremolo effect producing device which can be freely incorporated in a desired tone color of an electronic musical instrument, and where many stages of key boards in the musical instrument are provided, in only one stage of the stages.

A still further object of the present invention is to provide a novel tremolo or chorus effect producing device which can operate in purely electronic manner and is simple and small in organization and economical in production.

The nature, utility and the principle of the present invention will be more clearly understood from the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawings:

FIG. 1 is a block diagram illustrating an embodiment of the tremolo effect producing device according to the present invention;

FIG. 2 is a block diagram showing another embodiment of the present invention;

FIG. 3 is a block diagram illustrating an embodiment of the mixing circuit included in FIG. 1;

FIG. 4 is a block diagram exhibiting an example of the mixing circuit included in FIG. 2;

FIG. 5 is a block diagram illustrating a further embodiment of the present invention;

FIGS. 6 and 7 are circuit diagrams showing concrete examples of the filter included in a tone coloring circuit of FIG. 5; and

FIGS. 8, 9 and 10 are graphic diagrams exhibiting the characteristics of the filter included in the tone coloring circuit.

DETAILED DESCRIPTION OF THE INVENTION

With reference now to the accompanying drawings and more particularly to FIG. 1, reference symbol G represents a tone generator and K represents a keyboard including key switches. A musical sound signal selectively derived from the keyboard K is properly tone-colored by a tone-coloring circuit F_1 and is then fed to an amplifier AMP. At the same time, the musical sound signal (the signal usually comprises a plurality of frequency components thus constituting a frequency spectrum band and the frequency thereof is varied in accordance with the progression of the musical performance, but for convenience in explanation in this specification, the musical signal is represented by only a single frequency of f Hz) is applied to a modulating circuit D. The modulating circuit D comprises an oscillator LFO oscillating a signal having a frequency (0.5 to 10 Hz) which is substantially lower than that of the musical sound signal, an amplitude modulator M, and a high-pass filter F_D . The modulating circuit D serves to amplitude modulate an extremely low frequency signal (as a carrier wave) furnished from the extremely low frequency oscillator LFO with the musical sound signal (as a modulating wave). In this case, either a single side band modulation method or a two side band modulation method may be utilized for the amplitude modulation.

Hereinafter, the modulation method of two side band modulation is described.

Now it is assumed that a signal (carrier) to be modulated furnished from the extremely low frequency oscillator LFO is represented by $A \cos \Delta \omega t$ (where $\Delta \omega = 2\pi \Delta f$) and the musical sound signal (modulating wave) is represented by $\cos \omega t$ (where $\omega = 2\pi f$), an amplitude-modulated output signal which is obtained on the output side of the amplitude modulator M is represented by the following formula:

$$= A \cos \Delta w t (1 + m \cos w t) \\ = A \cos \Delta t + (mA/2) [\cos (w + \Delta w)t + \cos (w - \Delta w)t]$$

where $m = ka$ and m means the amplitude modulation factor (k is the modulation sensitivity).

Then, when an extremely low frequency component of the thus obtained output signal is eliminated by means of the high-pass filter F_D , a signal represented by the following formula is obtained at an output terminal T_1 of the high-pass filter F_D :

$$(mA/2) [\cos (w + \Delta w)t + \cos (w - \Delta w)t]$$

This signal is shifted in frequency by as much as Δf to both sides of the original frequency (f) of the musical sound signal. Furthermore, this signal is properly tone-colored through a tone coloring circuit F_2 which gives a tone color different from the tone color given by the circuit F_1 and is then fed to the amplifier AMP thereby to be mixed with an original musical sound signal. The thus mixed signal is passed through the amplifier AMP and converted into sound in a loudspeaker SP.

A tremolo effect or a chorus effect can be recognized as marked or less marked depending on the tone-color or the musical signal. Therefore, when the tone-coloring circuit F_2 has a proper formant, the mixed signal represents a kind of tone-color modulation due to the beat phenomenon between f and $f \pm \Delta f$ thereby to make the tremolo-effect more pronounced. In addition, it is not always required to insert the tone coloring circuit F_1 into the circuit after the branch to the modulator M as shown in FIG. 1, and it may be inserted before the branching point so that the musical sound signal commonly tone-colored is fed to the modulation circuit D.

Mixing of the frequency deviated musical sound signal furnished from the tone coloring circuit F_2 and the original musical sound signal may be accomplished by various ways. For instance, the mixing may be effected in such a manner that the relative rate of these signals is variable by a variable resistor VR and a resistor R_2 provided in the frequency deviated musical sound signal path and by providing a resistor R_1 in the original musical sound signal path as shown in FIG. 3, or that the musical sound signal alone and that accompanied with the tone color modulation can be selectively switched over by a switch provided on the output side of the filter F_2 as shown in FIG. 4.

Now, shown in FIG. 5 is an electronic musical instrument which comprises a musical sound signal generator MS, a phase shifter PS_1 adapted to cause a phase shift proportional to the frequency of a musical sound signal, an amplitude modulating circuit D, a filter F_2 of a tone coloring circuit, a phase shifter PS_2 , resistors R_1 and R_2 , an amplifier AMP, and a loudspeaker SP. In FIG. 5, a case of two side band modulation is shown as one example of the amplitude modulating circuit D which comprises an amplitude modulator M, an extremely low frequency oscillator LFO oscillating a frequency (for instance 0.5 to 10 Hz) which is substantially lower than that of the musical sound signal, and a high-pass filter F_D used to eliminate the extremely low frequency signal.

In the same manner as in FIG. 1, a signal represented by the following formula is obtained at an output terminal T_1 of the filter F_D in FIG. 5 also:

$$(mA/2) [\cos (w + \Delta w)t + \cos (w - \Delta w)t]$$

This represents a signal which is shifted in frequency by as much as Δf to both sides of a frequency (f) of the musical sound signal.

Then, this signal is properly tone-colored through the filter F_2 of the tone coloring circuit, and is then mixed at a proper level through the resistor R_2 with original musical sound signal which is passed through the resistor R_1 .

The filter F_2 of the tone coloring circuit serves to vary its filtering characteristic by the extremely low frequency signal furnished from the low frequency oscillator LFO, and the tone color of an output signal of the amplitude modulating circuit D is varied in response to the extremely low frequency signal applied to a control terminal of the filter F_2 .

The filter F_2 of the tone coloring circuit may be composed as shown in FIG. 6 so that its filtering characteristic be changed by varying its quality factor (Q value) constructed as in FIG. 7, or the filter F_2 may be made so that its frequency characteristic be changed.

FIG. 8 illustrates one example of the characteristic of the filter shown in FIG. 6, and its level is changed in the vicinity of frequency 2.5 kHz as shown by (a) through (c) depending on the voltage value of the extremely low frequency signal applied to the control terminal CT. FIGS. 9 and 10 show characteristics of the filter circuit illustrated in FIG. 7. FIG. 9 shows a characteristic thereof when switches SW_1 and SW_2 of FIG. 7 are changed over to the side 1, while FIG. 10 shows a characteristic thereof when the switches SW_1 and SW_2 are changed over to the side 2, and the characteristics are as shown by (a) through (b) depending upon the voltage value of a signal applied to the control terminal CT.

A signal mixed through the resistors R_1 and R_2 is converted through the amplifier AMP into a sound which varies in amplitude, frequency and tone color, whereby a tremolo effect sound similar to that in a rotating loudspeaker can be obtained. In addition, Δf should be 5 Hz to 7 Hz to obtain the tremolo effect and 0.5 Hz to 2 Hz to obtain a chorus effect.

Moreover, if the phase shifter PS_1 is provided where shown by a dotted line in FIG. 5, a more intricate effect can be produced. In other words, phase-shifting by the phase shifter PS_1 increases with the increment of frequency.

Therefore, a phase difference is produced between the musical sound signal (modulating wave) and the extremely low frequency signal (carrier wave) in the amplitude modulator D. Consequently, frequency modulation and amplitude modulation are effected by the frequency of the musical sound signal thereby to produce intricate effects. Further, if the phase shifter PS_2 is inserted between the extremely low frequency oscillator LFO and the filter F_2 , the extremely low frequency signal applied to the amplitude modulator D becomes different in phase from the extremely low frequency signal applied to the control terminal of the filter F_2 , and as a result of which the frequency and phase variations of the sound produced from the loudspeaker differs from the tone color thereof thereby to produce intricate effects.

While a few embodiments of the present invention have been illustrated and described in detail, it is particularly understood that the present invention is not limited thereto or thereby.

I claim:

1. An electronic tremolo-effect producing device, producing a tremolo effect by mixing a musical sound signal with a frequency-deviated musical signal, comprising:

a tone generator to generate musical sound signals;
a first tone coloring circuit connected to said tone generator for effecting tone coloring of a selected musical sound signal from said tone generator;

a modulating circuit connected to receive the tone-colored selected signal from said first tone coloring circuit and comprising a low frequency oscillator generating a low frequency carrier signal and a modulator connected thereto and giving out a modulated signal;

a filter means connected to said modulator for eliminating said low frequency carrier signal from the

modulated signal and for giving an output which is selectively deviated on higher and lower sides of the selected signal frequency to the extent of the frequency of said low frequency oscillator;

a second tone coloring circuit connected to said modulating circuit to receive said output from said filter means, said second tone coloring circuit including a variable filter circuit having a control input receiving the low frequency signal, wherein the value of the variable filter circuit varies in response to variations of said low frequency signal; and

a signal mixing means connected to said first and second tone coloring circuits to mix at a predetermined level said frequency deviated signal which is tone-colored and said tone-colored selected musical sound signal, to obtain a tremolo effect.

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