

# United States Patent

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[72] Inventor **Yasuji Uchiyama**  
**Hamakita, Japan**  
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 [73] Assignee **Nippon Gakki Seizo Kabushiki Kaisha**  
**Hamamatsu-shi, Japan**  
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 [33] **Japan**  
 [31] **44/50,881**

[56]

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Primary Examiner—D. F. Duggan

Assistant Examiner—Ulysses Weldon

Attorney—Holman & Stern

## [54] TREMOLO EFFECT PRODUCING DEVICE 2 Claims, 12 Drawing Figs.

[52] U.S. Cl. .... 84/1.25,  
 84/1.24  
 [51] Int. Cl. .... G10h 1/04  
 [50] Field of Search ..... 84/1.01,  
 1.24, 1.25, 1.26

**ABSTRACT:** A tremolo or chorus effect can be obtained by a tremolo effect producing device which comprises a balanced modulator for modulating a signal having a specific frequency with a musical sound signal, a band-pass filter for obtaining a single-band signal of the output of the balanced modulator, a demodulating circuit for demodulating the single sideband signal employing a signal the frequency of which is shifted from the above-mentioned specific frequency by a predetermined quantity and a buffer amplifier which amplifies the above-mentioned sound signal in a buffering manner, output signal from the demodulating circuit and the output signal from the buffer amplifier being thereafter mixed together.

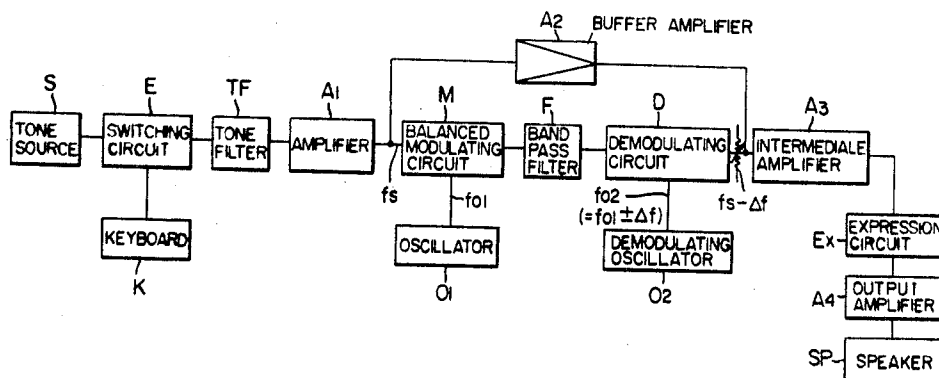


FIG. 1

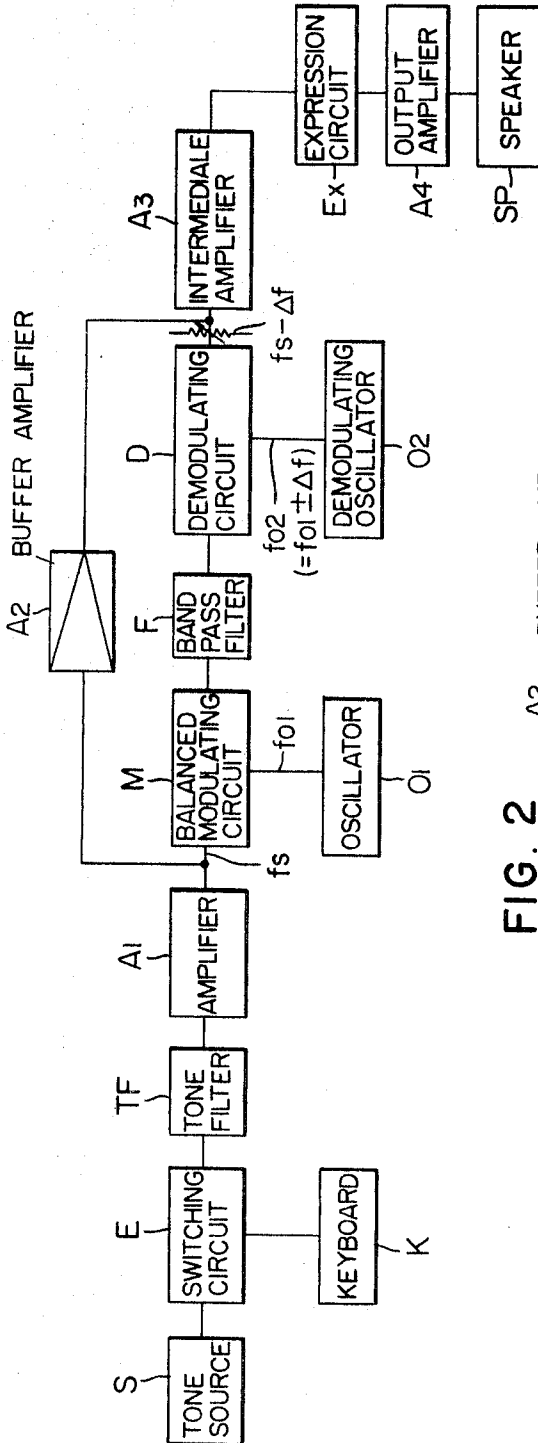
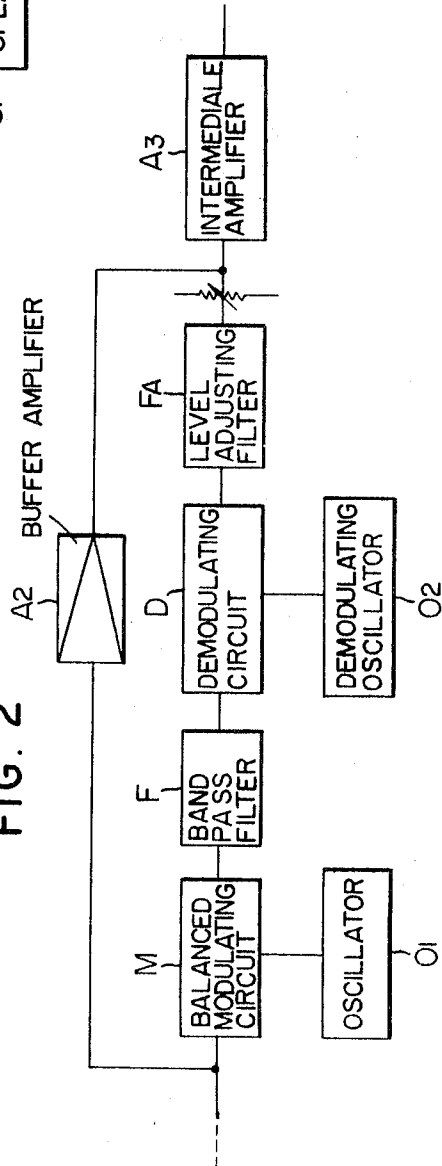


FIG. 2



INVENTOR

*Yasuji Uchiyama*

BY *Holman, Glascock, Downing & Seibold*  
ATTORNEYS

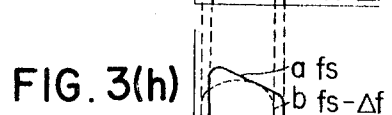
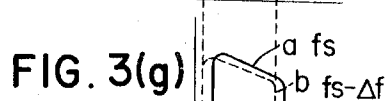
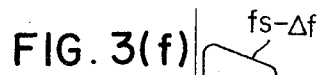
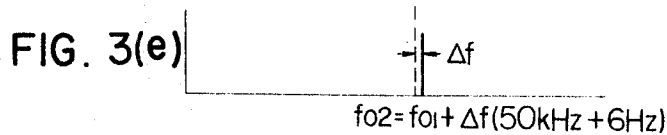
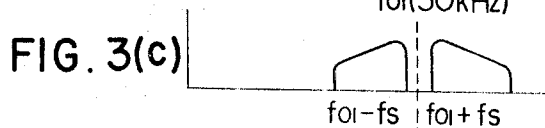
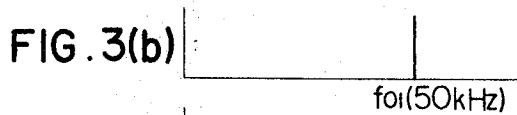
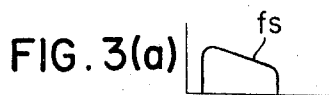


FIG. 4(a)

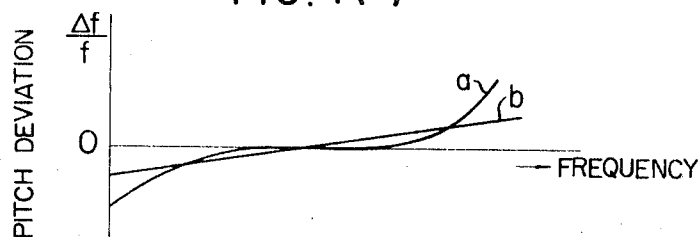
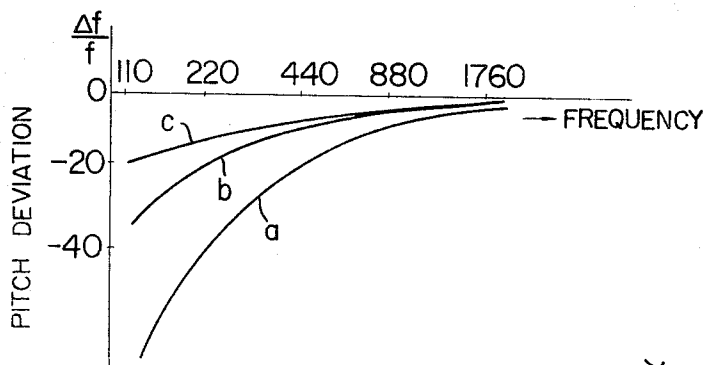


FIG. 4(b)



INVENTOR  
*Yasuji Uchiyama*

BY *Holman, Glascock, Downing / Seibold*  
ATTORNEYS

## TREMOLO EFFECT PRODUCING DEVICE

## BACKGROUND OF THE INVENTION

This invention relates generally to a tremolo effect (inclusive of chorus effect) producing device, and more particularly to a type of device for creating tremolo effect sounds, by varying not only the amplitude but also the frequency thereof, in a purely electrical manner.

Heretofore, tremolo or chorus effect producing device wherein a sound signal is simply amplitude modulated with a signal having a desired waveform and frequency, or the sound signal is converted into sound by means of a loudspeaker rotatable at a desired speed have been proposed. (Hereinafter, a sound modulated with a frequency of from 5 to 7 Hz. is referred to as "tremolo effect sound" and that modulated with a frequency of from 0.5 to 2 Hz. is referred to as "chorus effect sound.")

However, in the first mentioned type of device, since the sound signal is merely amplitude modulated with a desired signal with the frequency thereof being left unchanged, the resultant sound is rather monotonous and no satisfactory tremolo or chorus effect can be obtained. The second type of device, on the other hand, is accompanied by the Doppler effect in its operation, and the frequency, phase relation, and the radiation direction of the output musical sound can be varied. In addition, the amplitude of the output musical sound transmitted in one direction is varied in the second type of device, can a wide spread sensation of the sound can also be obtained.

However, the mechanism and the driving system of the rotatable loudspeaker in the second device are excessively complicated, and the production cost thereof is much too high. Furthermore, there are much possibilities for introducing various noises such as windbreaking noise, and many other mechanical noises at the time of the rotation.

## SUMMARY OF THE INVENTION

Therefore, the primary object of the present invention is 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 a novel tremolo or chorus effect producing device which can produce a sound signal which is not only amplitude modulated but also frequency modulated.

Still another object of the present invention is to provide a novel tremolo or chorus effect producing device which can operate in a purely electrical manner and is simple in organization and economical in production.

These and other objects of the present invention can be achieved by a novel organization of a tremolo or chorus effect producing device which comprises a balanced modulator for modulating a signal of specific frequency with a musical signal, a band-pass filter for passing a single sideband of the output signal from the balanced modulator, a demodulating circuit which demodulates the single sideband signal employing a signal the frequency of which is shifted from the above-mentioned specific frequency by a predetermined value, and a buffer amplifier which amplifies the above-mentioned musical sound signal for isolating the preceding circuit from the subsequent circuit, whereby the output signal from the demodulating circuit and the output signal from the buffer amplifier can be mixed together for obtaining the tremolo or chorus effect on the musical sound.

In another aspect of the invention, a level-adjusting filter for lowering the level of a signal in the low frequency region is provided at the output side of the demodulator circuit in the above-mentioned tremolo effect producing device, whereby the output of the level-adjusting filter is mixed with the output signal from the buffer amplifier.

The nature, utility, and the principle of the invention will be more clearly understood from the following detailed descrip-

tion with reference to the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

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

FIG. 2 is a block diagram showing another example of the device according to the invention;

FIG. 3(a) through 3(h) are graphical representations respectively indicating frequency spectra of signals obtained from various parts of the devices shown in FIGS. 1 and 2; and

FIG. 4(a) and 4(b) are graphical representations of tunings, based on the equal temperament, of an ordinal musical instrument and of an electronic musical instrument embodying the present invention.

## DETAILED DESCRIPTION OF INVENTION

Referring now to FIG. 1 showing an example of the tremolo or chorus effect producing device according to the present invention, when one of the keys in the keyboard K is depressed, a signal having a frequency  $f_s$  (the signal comprises not only a fundamental frequency but also harmonic components, thus constituting a frequency band, but for convenience in explanation in this specification, the band is referred to as  $f_s$  only) generated in a tone source circuit S is passed through a switching circuit E to a tone filter circuit TF, so that the tone color thereof is adjusted therein. The signal is then amplified in an amplifier circuit A1. It should be noticed that the output signal  $f_s$  from the amplifier A1 has a certain band width as shown in FIG. 3(a). The signal  $f_s$  is then passed to a balanced modulator M wherein a frequency  $f_{o1}$  (see FIG. 3(b)) from an oscillator  $O_1$ , which is oscillating at a frequency of, for instance, 50 kHz., is balance modulated so that frequencies  $f_{o1} + f_s$  and  $f_{o1} - f_s$  are included in the output signal (see FIG. 3(c)).

Of these two signals, the upper sideband  $f_{o1} + f_s$  only is taken out through a band-pass filter F (see FIG. 3(d)) and is supplied to a demodulating circuit D. At the demodulating circuit D, the signal of frequencies corresponding to the upper sideband is demodulated employing a frequency  $f_{o2}$  which is generated from a demodulating oscillator  $O_2$  and the value thereof is selected to be higher than the above mentioned  $f_{o1}$  (of 50 kHz.) by a frequency  $\Delta f$  of, for instance, 6 Hz. so that more specifically the frequency  $f_{o2} = f_{o1} + \Delta f = 50 \text{ kHz} + 6 \text{ Hz}$ . (as indicated in FIG. 3(e)). Thus, a demodulated signal will have a frequency  $f_s - \Delta f$  (as indicated in FIG. 3(f)).

When the signal having a frequency of  $f_s - \Delta f$  is mixed with original signal  $f_s$  from an amplifier A1 and through a buffer amplifier A2, the mixed signal will be a signal having the spectra of  $f_s$  (a full line a) plus  $f_s - \Delta f$  (a dotted line b) as shown in FIG. 3(g), wherein the signal  $f_s$  and the signal  $f_s - \Delta f$  interfere each other to produce phase change resulting in the amplitude modulation and with the frequency modulation at a frequency  $\Delta f$ . The mixed signal is then amplified in an amplifier A3 and passed, through an expression circuit EX and another amplifier A4, to a loudspeaker SP. In this manner, the sound varied in both the amplitude and frequency can be obtained from the loudspeaker SP.

In the above description, the frequency difference  $\Delta f$  is selected to be in a range from 5 to 7 Hz. for obtaining a tremolo effect and is selected to be in a range from 0.5 to 2 Hz. for obtaining a chorus effect sound. The signals  $f_s$  and  $f_s - \Delta f$  from the modulating circuit D are mixed in a condition wherein both of the signals are at the same level or either one of the signals is slightly lower than the other.

Furthermore, although it has been described above in the example of the tremolo effect producing device according to the present invention that an upper side band signal is taken out employing a band-pass filter F, and the demodulating frequency  $f_{o2}$  is determined higher than the modulation frequency  $f_{o1}$  by  $\Delta f$ , various combinations of frequencies as indicated in the following table can also be employed for the same purpose.

Input signal	$f_0$ kHz.	$\Delta f$ , Hz	Pass-range of filter F	Actual characteristics of filter F, kHz.	Output signal, Hz.
$f_s$	50	-6	$f_0 \pm f_s$	50-60	$f_s - 6$
$f_s$	50	-6	$f_0 - f_s$	40-50	$f_s + 6$
$f_s$	50	-6	$f_0 + f_s$	50-60	$f_s + 6$
$f_s$	50	-6	$f_0 - f_s$	40-50	$f_s - 6$

In FIG. 2, there is shown another example of the present invention wherein a level-adjusting filter  $F_4$  is further provided at the output side of the demodulator circuit D of FIG. 1, and the signal  $f_s$  from an amplifying circuit A1 and through a buffer amplifier A2 is applied to the output side of the filter  $F_4$ . The characteristic of the filter  $F_4$  is so selected that the level of the output signal from the demodulating circuit D (see FIG. 3(f)) is lowered at the low-tone portion of the signal. As a result, the spectrum of the output signal from the filter  $F_4$  will show a configuration as indicated by a dotted line  $b$  in FIG. 3(h).

It should be noted that an advantageous tuning can also be obtained at the time the tremolo effect sound is produced in accordance with this invention.

This feature will be more clearly apparent from FIGS. 4(a) and 4(b) showing various tunings based on the equal temperament. Curves  $a$  and  $b$  in FIG. 4(a) show pitch deviations in ordinary musical instruments such as a piano and a wind instrument, respectively. It is known that the tunings of the ordinary musical instruments will be felt natural to human ears when the tunings are done in such a way that the pitch is deviated higher in the treble range and lower in the bass range.

In FIG. 4(b), curve  $a$  shows the deviations of the output signals of the demodulating circuit D from the standard equal temperament, and curve  $b$  shows the deviations of the mixed signals, of the output signals from the demodulating circuit D and the output signals from the amplifier A1, from the standard equal temperament. However, these curves deviate excessively from the standard temperament pitch at the bass region, and this excessive deviation of the curve  $b$  can be compensated to a moderate curve  $c$  when the level-adjusting filter  $F_4$  is provided at the output side of the demodulating circuit

D. Thus, the tuning of the tremolo effect sound may be brought nearer to those of the ordinary musical instruments.

The entire tremolo effect producing device according to the present invention of the constitution as described above is composed purely of electrical components, whereby the device can easily be combined with a specific tone color lever in the musical instrument, and in a musical instrument of a type having multiple stages of keyboards, the device can also be combined with one of these keyboards. Furthermore, the device can be produced without requiring any high-precision mechanical technique, so that it has various advantageous features such as economy in production, compact size, a tuning to render natural sensations of instruments, and capability to produce tremolo or chorus effect accompanying amplitude and frequency variations in the output sounds.

I claim:

1. A tremolo effect producing device comprising a balanced modulator for modulating a signal having a first frequency with a musical tone signal, a filter for passing one of the sidebands of the output from said balanced modulator, a demodulating circuit which demodulates said single sideband signal employing a second frequency differing from said first frequency by a predetermined small quantity, and a buffer amplifier which amplifies said musical tone signal with a buffer action, whereby a desired musical tone accompanied with a tremolo effect is obtained when the output from said demodulating circuit is mixed with the output from said buffer amplifier.

2. A tremolo effect producing device comprising a balanced modulator for modulating a signal having a first frequency with a musical tone signal, a filter for passing one of the sidebands of the output signal obtained from said balanced modulator, a demodulator circuit which demodulates said single sideband signal employing a second frequency differing from said first frequency adjusting filter inserted at the output side of said demodulator circuit for reducing the signal level at a low-tone range thereof, and a buffer amplifier which amplifies said musical tone signal with a buffer action, whereby a desired musical tone accompanied with a tremolo effect is obtained when the output from said level-adjusting filter is mixed with the output from said buffer amplifier.

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