United States Patent

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[33] **Japan**
[31] **43/43,743**

[54] **MUSICAL TONE-FORMING CIRCUITRY INCLUDING FILTER AND RANDOM NOISE MODULATION**
6 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **84/1.24,** 84/DIG. 9
[51] **Int. Cl.** **G10h 1/04**
[50] **Field of Search** ..... 84/1.01, 1.04, 1.11, 1.19, 1.12, 1.22, 1.24, 1.25, DIG. 9

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ABSTRACT: A whistle or grass reed sound is simulated by an electronic musical circuitry comprising a portamento-type oscillator, a tone coloring filter for providing a tone signal having predetermined harmonics as well as a fundamental, a noise generator, a low-pass filter for deriving frequency components below 30 Hz from a noise signal output of the noise generator, and a modulator for amplitude modulating the tone signal from the tone coloring filter with the noise signal components of less than 30 Hz from the low-pass filter.

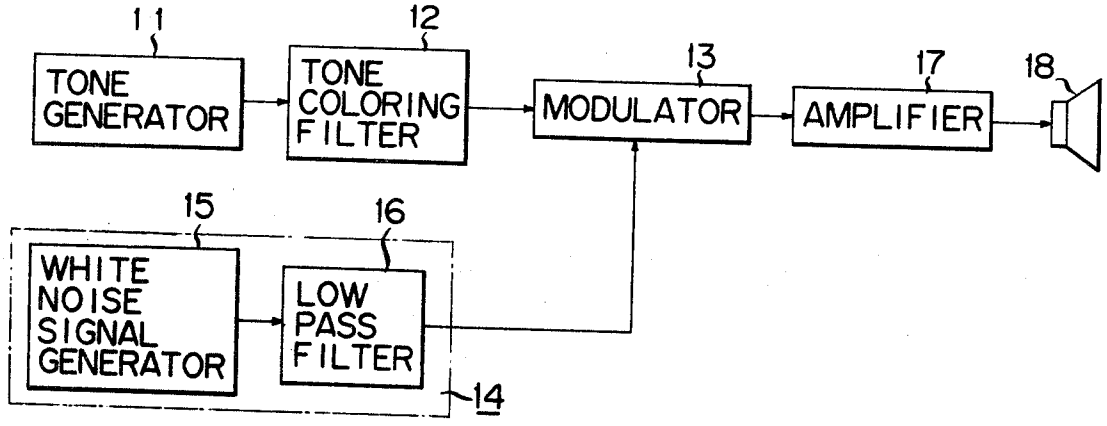


FIG. 1

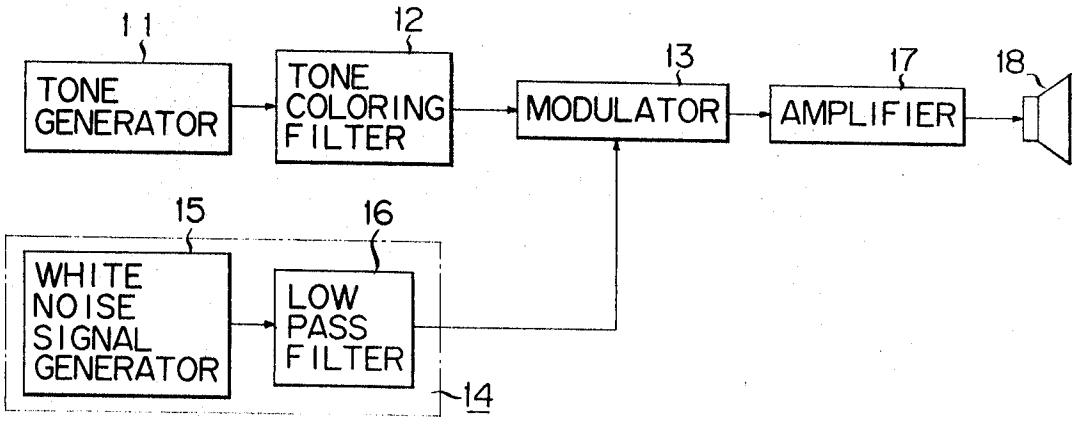


FIG. 3A

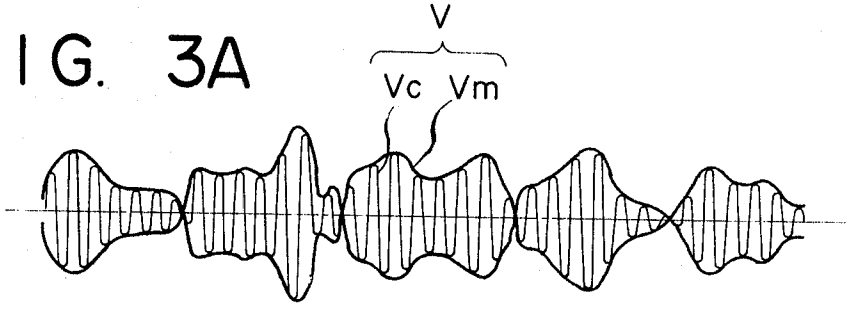


FIG. 3B

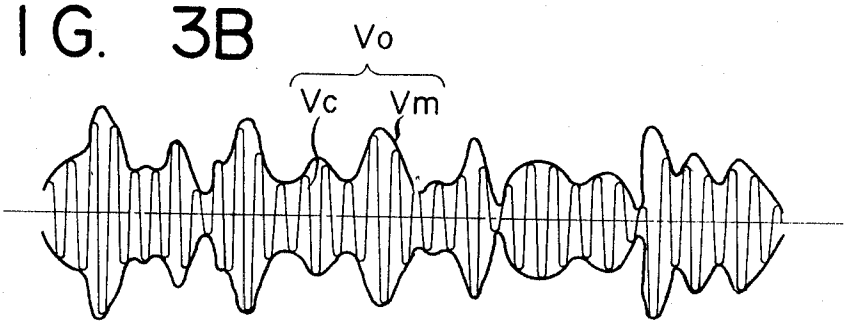
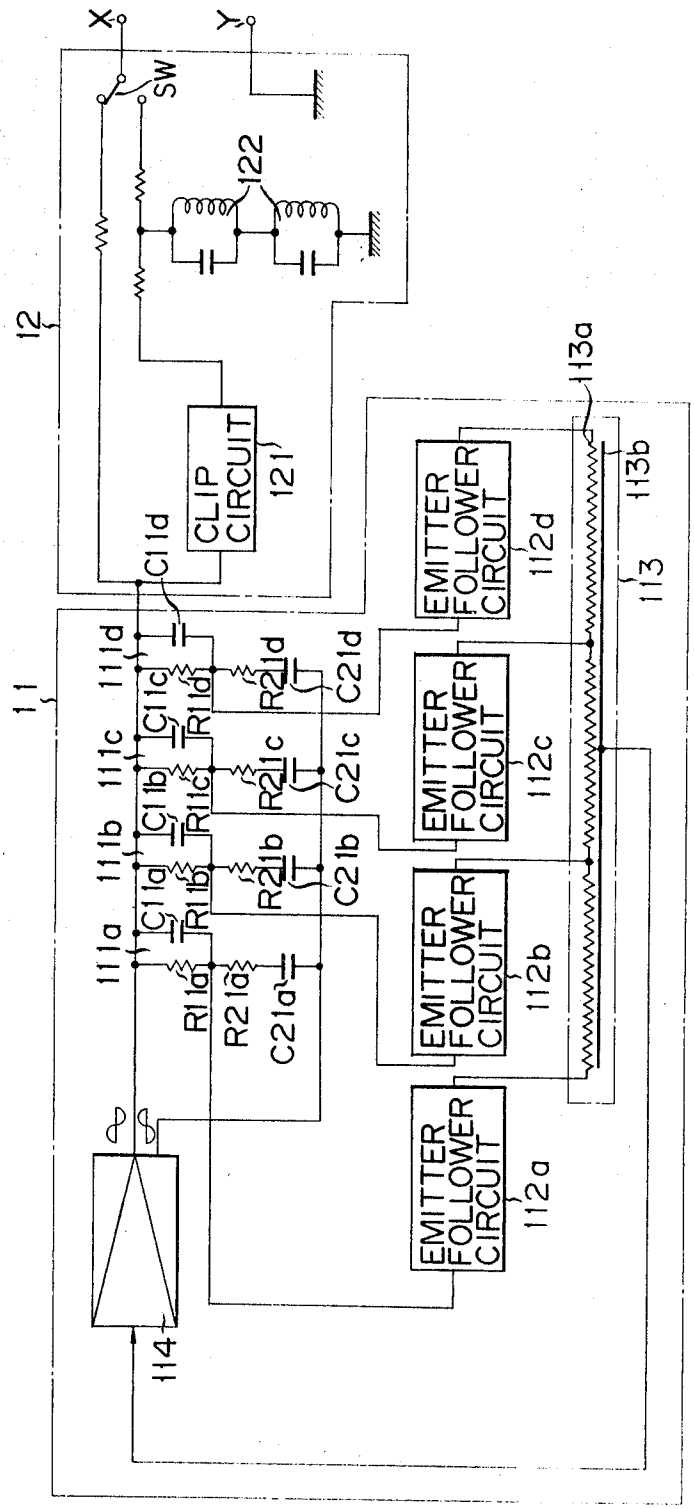


FIG. 2A


X
Y
SW
122
12
CLIP CIRCUIT
121
C11d
111d
111c
111b
111a
11
C11c
C11b
C11a
R11d
R11c
R11b
R11a
R21d
R21c
R21b
R21a
C21d
C21c
C21b
C21a
EMITTER FOLLOWER CIRCUIT
112d
112c
112b
112a
113a
113b
113
114

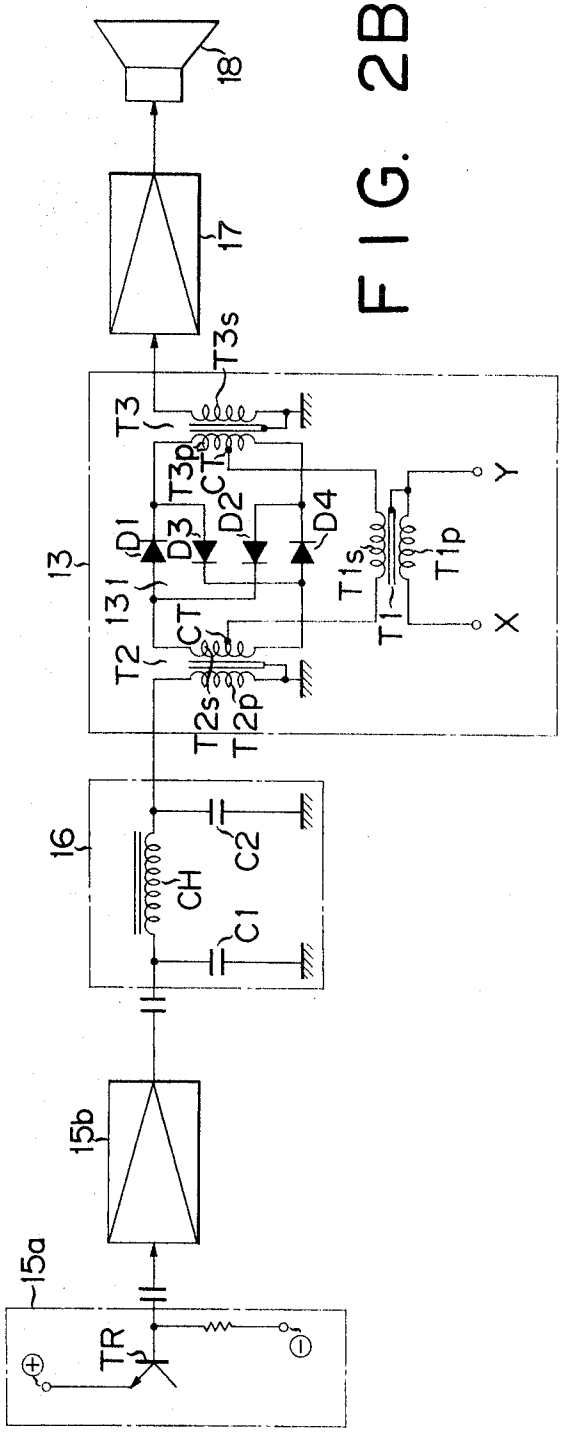

18
17
T3s
T3
T3p
CT
D1
D3
D2
D4
13
131
T1s
T1
T1p
Y
X
CT
T2
T2s
T2p
16
CH
C2
C1
15b
15a
TR

FIG. 2B

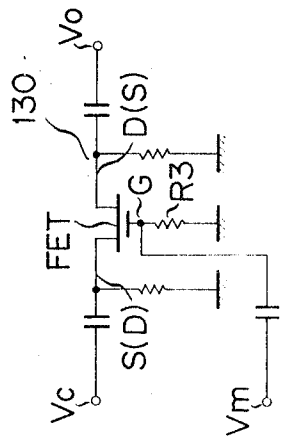

Vo
130
D(S)
G
R3
FET
S(D)
Vc
Vm

FIG. 4

MUSICAL TONE-FORMING CIRCUITRY INCLUDING FILTER AND RANDOM NOISE MODULATION

BACKGROUND OF THE INVENTION

This invention relates to a tone-forming device for electronic musical instruments, and more particularly to a device capable of readily producing musical tones of special timbers resembling those of whistles or grass reeds which are usually difficult to produce by the conventional electronic musical instruments.

The conventional electronic musical instrument is usually so constructed as to produce various kinds of musical tones, e.g., musical tones similar to those of a flute containing a relatively small quantity of high frequency components and musical tones similar to those of a reed instrument containing a relatively large quantity of high frequency components, by passing signals from tone generators through various tone coloring filters, whereby the desired musical signals having the desired tone colors are formed by selectively combining a signal of the fundamental frequency with different types of overtones in various level ratios.

With an electronic musical instrument utilizing the above-described method of forming musical tones it is easy to produce musical tones similar to those of ordinary reed or wind instruments which have relatively stable tone feelings but very difficult to produce musical tones having relatively unstable tone feelings such as those of whistles and grass reeds. Thus, it is highly desirable to obtain electronic musical instruments that can produce musical tones having relatively unstable tone feelings.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a tone-forming device for electronic musical instruments capable of readily producing musical tones having relatively unstable tone feelings resembling those of whistles and grass reeds.

According to this invention, the tone source signals containing the fundamental frequency and various overtones are subjected to balance modulation or amplitude modulation by a random signal containing frequency components of less than about 30 Hz.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic block diagram of one embodiment of a tone-forming device for electronic musical instruments embodying this invention;

FIGS. 2A, and 2B show preferred circuit arrangements of various circuits components shown in FIG. 1;

FIGS. 3A and 3B show the waveforms of typical modulated outputs produced by the modulation circuit shown in FIG. 1; and

FIG. 4 shows an amplitude modulation circuit utilizing an FET that can be substituted for the balanced modulation circuit shown in FIG. 2B.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a schematic block diagram of one embodiment of this invention, wherein tone signals are derived from a tone generator **11**, which is used as the tone source of a conventional electronic musical instrument including a plurality of oscillators or preferably a portamento oscillator constructed in a manner to be described later. Tone signals from the tone generator **11** are passed through a tone coloring filter **12** to be converted into musical signals having desired tones similar to those of flute or reed instruments (oboe, bassoon, etc.), and the converted signals are supplied to a balanced modulator (or an amplitude modulator) **13** to be described hereinafter.

A random modulation signal is also supplied to the balanced modulator (or amplitude modulator) **13** from a source of random signal **14** comprising a white noise signal generator **15** (the construction thereof will be described latter in detail) and a low-pass filter **16** which passes only frequency components of less than, for example, 30 Hz. out of the white noise signals generated by the white noise signal generator **15**.

Thus, the balanced modulator (or amplitude modulator) **13** provides modulated musical signals resembling the musical signal of whistles or grass reeds having relatively unstable tone feelings which have been difficult to produce by conventional electronic musical instruments. The musical signals thus modulated are provided by suitable modulating musical signals obtained from the tone generator **11** through tone coloring filter **12** and having relatively stable tone feelings resembling those of flute or reed instruments with random modulation signals having frequency components of less than 30 Hz. which are generated by the white noise signal generator **15** and passed through low-pass pass filter **16**. Output musical signals from the balanced modulator (or amplitude modulator) **13** are amplified, if desired, by an amplifier **17** and are then transduced by a loudspeaker **18** into the desired musical sounds.

The musical sounds of whistles or grass reeds are characterized in that their fundamental frequency generally ranges from 500 Hz. to 4 kHz. their tone feelings are unstable, their musical pitch varies continuously and their amplitude varies irregularly with a maximum degree of modulation amounting to 30 to 50 percent. The waveform of the whistle is substantially of a sine wave type containing small quantity of higher harmonics and resembling that of flutes, whereas the waveform of the grass reed contains a relatively large quantity of higher harmonics and resembling that of reed instruments.

When the tone generator **11** is so constructed as to selectively produce tone signals having a fundamental frequency ranging from 500 Hz. to 4 Hz., and when the tone coloring filter **12** is so designed as to suitably select the desired percentage of the high frequency contents of the tone signal, it is possible to produce tone signals resembling those of flute and reed instruments. It is also preferable to set the degree of modulation by the balanced modulator (or amplitude modulator) **13** at a range of from 30 to 50 percent. Further, it is preferably to form the tone generator **11** from a portamento oscillator, as the musical pitch of the tones selectively generated thereby can vary continuously. The tone signals produced through the tone coloring filter **12** and resembling those of flute or reed instruments are subjected to balanced modulation (or amplitude modulation) **13** and are modulated with random modulation signals generated by the white noise signal generator **15** and passed through the low-pass filter **16** which acts to selectively pass only frequency components of less than about 30 Hz., with the result that the amplitude of the modulated musical signal outputs varies irregularly.

Thus the tone-forming device for electronic musical instruments can readily produce tone signals resembling those of whistles and grass reeds having relatively unstable tone feelings which heretofore have been difficult to produce by conventional electrical instruments, so that said device has a broader field of application.

Turning now to FIGS. 2A and 2B illustrating the detailed construction of the circuit shown in FIG. **1**, the portamento oscillator serving as a tone generator **11** is a modified from of a Wien's bridge oscillator which comprises a plurality of oscillation frequency determining circuits **111***a*, **111***b*, **111***c* and **111***d* including parallel circuits of resistors R**11***a*, R**11***b*, R**11***c*, R**11***d* and capacitors C**11***a*, **11***b*, C**11***c*, C**11***d* and serial circuits connected therewith and including resistors R**21***a*, R**21***b*, R**21***c*, R**21***d* and capacitors C**21***a*, C**21***b*, C**21***c* and C**21***d*. Junctures between said parallel circuits and serial circuits involved in the respective oscillation frequency determining circuits are connected to the corresponding taps of an elongated bar resistor **113***a* respectively through emitter follower circuits **112***a*, **112***b*, **112***c* and **112***d*. The resistor **113***a* is associated with the opposite electrically conductive flexible contact **113***b*. These elements are normally set apart from each other and constitute a kind of potentiometer serving as a fingerboard to be manipulated in playing music. With this finger-

board, the oscillation frequency is determined by the position at which the contact **113***b* is depressed for contact with the resistor **113***a* The signal having an oscillation frequency determined by the manner in which the fingerboard is operated is supplied to a phase dividing amplifier **114** which produces two outputs in the opposite phases. The two outputs are supplied across the aforementioned frequency determining circuits. Thus is formed an oscillation loop which includes the oscillation frequency determining circuits **111***a* to **111***d*, the emitter follower circuits **112***a* to **112***d*, the fingerboard **113**, and the amplifier **114**. This oscillation loop is normally open but is closed by the selective operation of any point of the fingerboard **113** to produce a tone signal having the frequency determined by the position of the particular point depressed. Oscillation frequencies *fa*, *fb*, *fc* and *fd* of the oscillation frequency determining circuits **111***a* to **111***d* are given by

$$fa = \frac{1}{2\pi\sqrt{C11a \cdot C21a \cdot R11 \cdot R21a}}$$

$$fb = \frac{1}{2\pi\sqrt{C11b \cdot C21b \cdot R11b \cdot R21b}}$$

$$fc = \frac{1}{2\pi\sqrt{C11c \cdot C21c \cdot R11c \cdot R21c}}$$

and

$$fd = \frac{1}{C11d \cdot C21d \cdot R11d \cdot R21d}$$

With this arrangement, it is possible to easily provide the portamento effect by continuously sliding the finger tip over the fingerboard. The tone signals produced by the portamento oscillator **11** substantially has a sine waveform containing a relatively small quantity of higher harmonics, and resembling the waveform of musical signals produced by flutes. Accordingly, in this case, the tone coloring filter **12** includes a clip circuit **121** and a tone coloring filter circuit **122** for obtaining the tones of a reed instrument. Either of the whistle and grass reed tones is selectively produced by means of a switch SW.

Since the signals produced by the portamento oscillator **11** substantially have a since wave containing relatively small quantity of high harmonics, it is only required to cause these signals to pass directly to terminal X in order to form tone signals resembling the tones of flutes, whereas, to form tone signals resembling those of reed instruments, it is necessary to cause the signals to pass first through the clip circuit **121** so as to increase its percentage of higher harmonic content and then through the tone coloring filter circuit **122**.

The white noise signal generator **15** in the random signal source **14** comprises a noise source **15***a* consisting of a transistor TR with a negative bias applied across its base and emitter electrodes (or a conventional diode may be used) to utilize the breakdown characteristic of the transistor and an amplifier **15***b* for amplifying the noise signal. The white noise signal thus produced is passed through a π type low-pass filter **16** comprising a choke coil CH and two capacitors C1 and C2 so designed as to allow only frequency components of less than about 30 Hz. to pass therethrough.

The balanced modulator **13** comprises a signal input transformer T1 connected to receive tone signals resembling those of flute or reed instruments and supplied through the tone coloring filter **12**, an input transformer T2 connected to receive random signals supplied from the random signal generator **14** and having frequency components of less than 30 Hz and an output transformer T3 for deriving modulated signals, said transformers T1, T2 and T3 including magnetically coupled primary windings $T1_p$, $T2_p$ and $T3_p$ and secondary windings $T1_s$, $T2_s$ and $T3_s$, respectively.

Between the secondary winding $T2_s$ of the modulating signal input transformer T2 and the primary winding $T3_p$ of the output transformer T3 is connected a diode rectifier bridge circuit **131** including four diodes D1, D2, D3 and D4 which are connected to each other with the indicated polarities. The opposite terminals of the secondary winding $T1_s$ of the signal input transformer T1 are connected to the intermediate terminal CT on the secondary winding $T2_s$ of the modulating signal input transformer T2 and the intermediate terminal CT' on the primary winding $T3_p$ of the output transformer T3, respectively. Thus, the output transformer T3 of the balanced modulator **13** provides a modulated musical signal V having relatively unstable tone feelings like the sounds of whistles or grass reeds, said modulated musical signal being obtained by subjecting the source signal Vc produced by the portamento oscillator **11** and passed through the tone coloring filter **12** and having tones resembling those of flutes or reeds to balanced modulation by a random modulation signal Vm produced by the white noise signal generator **15** and passed through the low-pass filter **16** and having frequency components of less than about 30 Hz., as shown in FIG. 3A. The resultant output is reproduced by a loudspeaker **18** after being amplified by the amplifier **17**, if desired.

FIG. 4 shows the circuit arrangement of an amplitude modulator **130** having equivalent sound effects to those offered by the balanced modulator **13** and may be substituted therefor. As shown, a field effect transistor (FET) is used with its gate terminal G grounded through a resistor R3. The source signal Vc from the tone coloring filter **12** is supplied to the source terminal S (or drain terminal D instead) of the FET, whereas the random modulating signal Vm having frequency components of less than about 30 Hz. is conducted to the gate terminal G through the low-pass filter **16**, whereby an amplitude modulated musical signal Vo, (see FIG. 3B), having relatively unstable tone feelings like the tones of a whistle or grass reed is drawn out through the other drain terminal D (or source terminal S instead).

As described hereinabove, the invention provides a tone-forming device for electronic musical instruments wherein the selective operation of the fingerboard of the electronic musical instruments enables musical signals of relatively unstable tone feelings similar to those of whistles and grass reeds, to be readily produced though the conventional musical instruments failed to generate such musical tone signals. Accordingly, the invention has a broader field of application.

I claim:

1. A musical tone forming circuit comprising:
- a tone generator including portamento-type oscillator means for producing a tone signal having gradually variable frequency:
- a tone coloring filter coupled to the output of said tone generator for producing a tone signal having a predetermined harmonics and a fundamental frequency:
- a white noise signal generator;
- a low-pass filter for deriving frequency components below 30 Hz. out of a noise signal from said white noise signal generator; and
- an amplitude modulator for amplitude modulating a tone signal from said tone coloring filter with a noise signal from said low-pass filter.

2. The tone-forming circuit according to claim 1 wherein said white noise signal generator comprises a negatively biased transistor circuit, the breakdown characteristic of said transistor being utilized in generating said white noise signals.

3. The tone-forming circuit according to claim 1 where said amplitude modulator comprising a balanced modulation circuit including an input transformer for supplying tone signals obtained from said tone coloring filter, an input transformer for supplying the modulating signals obtained from said low-pass filter and an output transformer for taking out output signals obtained by modulating said tone signals with said modulating signals.

4. The tone-forming circuit according to claim 1 wherein said amplitude modulator comprises a field effect transistor having its gate terminal grounded through a resistor, one of its source and drain terminals being connected to receive said tone signals from said tone coloring filter, said gate terminal being connected to receive the modulating signal from said low-pass filter and the other source of drain terminal being

connected to couple the modulated signals to an output.

5. The tone-forming circuit according to claim 1 wherein the tone signal from said tone coloring filter has a flute voice tone color.

6. The tone-forming circuit according to claim 1 wherein the tone signal from said tone coloring filter has a reed voice tone color.