United States Patent

[11] **3,569,605**

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[21] Appl. No. **791,088**
[22] Filed **Jan. 14, 1969**
[45] Patented **Mar. 9, 1971**

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[32] Priority **Jan. 18, 1968**
[33] **Japan**
[31] **2793**

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[54] **PLURAL CHANNEL TONE COLORING SYSTEM WITH COMMON MIXER FOR ELECTRONIC MUSICAL INSTRUMENT**
6 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **84/1.22**
[51] **Int. Cl.** **G10h 106**
[50] **Field of Search** ..... 84/1.11, 1.12, 1.19—1.24, (B,F)

[56] **References Cited**
UNITED STATES PATENTS

1,823,724	9/1931	Carlson	84/1.24X
2,755,695	7/1956	Krauss et al.	84/1.2
2,906,157	9/1959	Peterson	84/1.19
3,215,767	11/1965	Martin	84/1.24
3,443,463	5/1969	Campbell	84/1.01

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ABSTRACT: A tone coloring system for an electronic musical instrument simulates an accordion or harmonica sound, which consists in mixing a fundamental tone signal emitted from an accurately tuned first tone generating circuit and having the tone colors of string voice or reed voice with a signal obtained from a second tone generating circuit which has a frequency difference of 3 to 10 Hz. as compared with the fundamental tone signal, a voltage corresponding to 3 to 6db. lower than that of said fundamental signal and is capable of producing the tone color of the like voice as represented by said fundamental tone signal and using these mixed signals as the musical tone signals of an electronic musical instrument to be played.

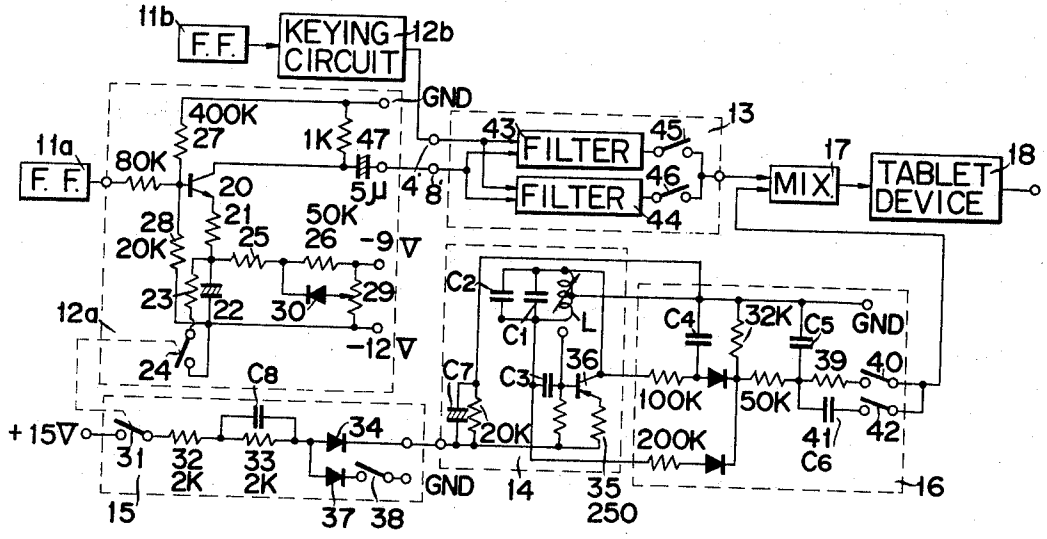


FIG. 1

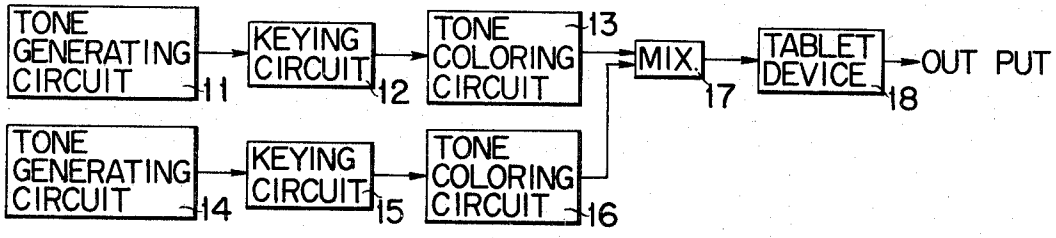


FIG. 2a

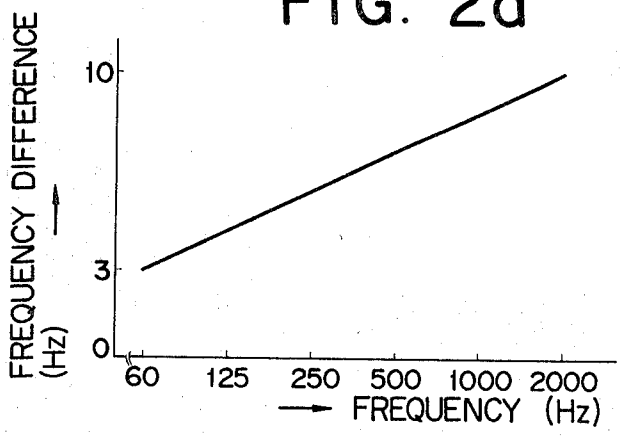
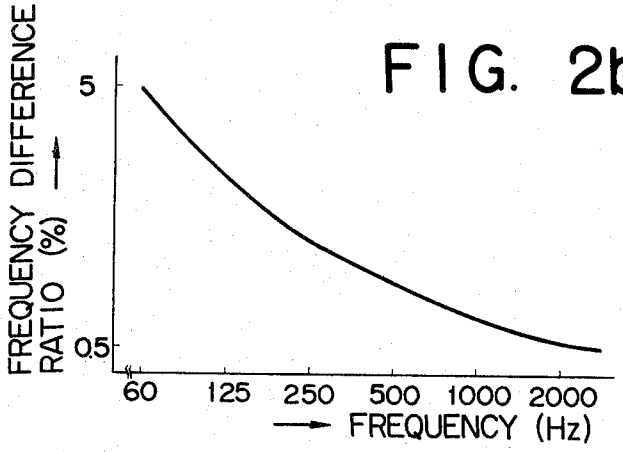


FIG. 2b



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FIG. 3

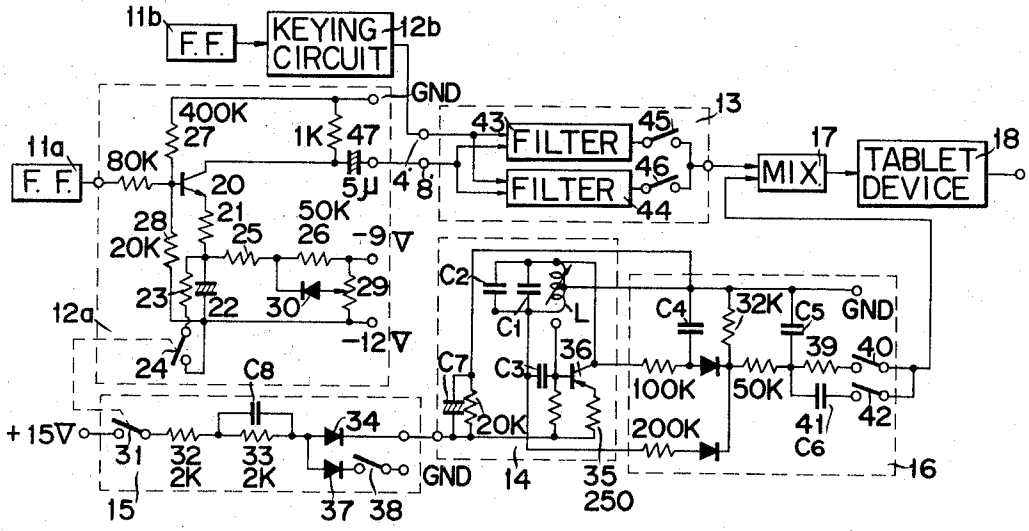
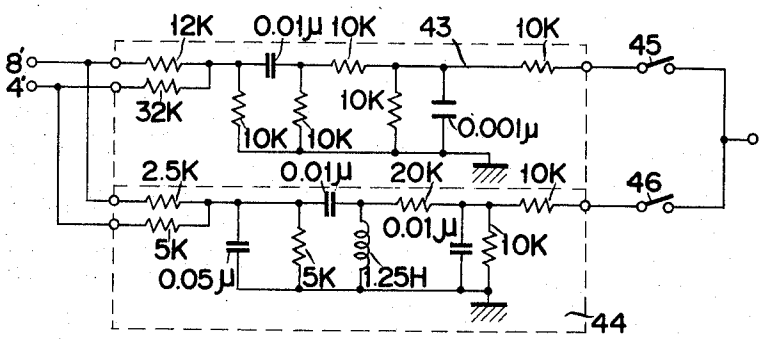

11b
F.F.
KEYING CIRCUIT
12b
GND
400K
27
1K
47
43
FILTER
45
13
11a
F. F.
80K
20
5μ
4
8
FILTER
46
44
17
MIX
TABLET DEVICE
18
28
20K
21
25
50K
26
-9V
23
22
30
29
C2
C1
L
C4
32K
C5
GND
12a
-12V
24
C8
C7
C3
36
39
40
100K
50K
+15V
31
32
2K
33
2K
34
20K
200K
41
C6
42
15
37
38
GND
14
35
250
16

FIG. 4


12K
0.01μ
10K
43
10K
45
8'
4'
32K
10K
10K
10K
0.001μ
2.5K
0.01μ
20K
10K
46
0.01μ
5K
10K
0.05μ
5K
1.25H
44

PLURAL CHANNEL TONE COLORING SYSTEM WITH COMMON MIXER FOR ELECTRONIC MUSICAL INSTRUMENT

BACKGROUND OF THE INVENTION

The present invention relates to the tone coloring system of an electronic musical instrument and more particularly to the tone coloring system of an electronic musical instrument which is capable of producing by key operation the tone colors of multiple reeds such as those derived from an accordion or harmonica.

An electronic musical instrument can give forth not only the tones of an ordinary organ but also a variety of tone colors resembling those of other musical instruments. To date, however, conventional electronic musical instruments have been unable to produce such tone colors as will give the same impression as those of multiple reeds derived from, for example, an accordion or harmonica.

It is accordingly the object of the present invention to provide a tone coloring system of an electronic musical instrument which is capable of giving forth such musical tone colors as will have the same effect as those of multiple reeds obtained from, for example, an accordion or harmonica.

SUMMARY OF THE INVENTION

The present invention is characterized by mixing a fundamental tone signal emitted from a properly tuned first tone generating circuit having the tone colors derived from string voice or reed voice with a signal issued from a second tone generating circuit which has a frequency difference of 3 to 10 Hz. as compared with the fundamental tone signal, a voltage corresponding to 3 to 6db. lower than those of said fundamental signal and is capable of producing the tone color of the like voice as represented by said fundamental tone signal, and using these mixed signals as the musical tone signals of an electronic musical instrument thereby easily to give forth by key operation musical tones having the desired types of tone colors. BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a circuit diagram illustrating the principle of a tone coloring system according to the present invention;

FIGS. 2*a* and 2*b* represent the frequency relationship of two signals mixed by a circuit arranged as shown in FIG. 1;

FIG. 3 is a diagram of the circuit connection associated with a tone coloring system according to an embodiment of the invention; and

FIG. 4 is a concrete example of a connection used in a tone coloring circuit according to said embodiment.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, there is selectively derived an accurately tuned fundamental tone signal from the first tone generating circuit **11** through a keying circuit **12** which is actuated in accordance with the operation of the keys of an electronic musical instrument (not shown). The signal thus derived is supplied to a tone coloring circuit **13** used, if required. There is also provided a second tone generating circuit **14** to obtain a second signal having a frequency difference of 3 to 10 Hz. from the fundamental tone signal. A signal from this second tone generating circuit **14** is selectively derived out through a second keying circuit **15** controlled in interlocking relationship with the first keying circuit **12**, and supplied to a second tone coloring circuit **16** used when necessary.

In this case, the two signals from the two tone generating circuits **11** and **14** are only required to have a frequency difference of 3 to 10 Hz. therebetween. Thus, the signal from either of said circuits **11** and **14** may have a higher frequency than the other. The aforementioned frequency difference varies with the frequency of signals from the tone generating circuits **11** and **14**.

The tone coloring system of the present invention is so arranged to display as shown in FIG. 2*a*, a frequency difference of 3 Hz. in the neighborhood of the tone height of C_2: 65.4 and 10 Hz. in the vicinity of C_7: 2,093 Hz. FIG. 2*b* represents in

percentage the relationship between the signal frequencies and differences therebetween.

The tone coloring circuits **13** and **16** which are supplied with signals from the keying circuits **12** and **15**, respectively, each consist of, for example, an electric filter. The first tone coloring circuit **13** produces signals corresponding to a string voice or reed voice which are relatively rich with harmonics of odd and even order with respect to the fundamental tone signal, and the second tone coloring circuit **16** converts signals from the second tone generating circuit **14** to those having the like tone colors corresponding to a string or reed voice. In this case, the voltage of signals from the second tone coloring circuit **16** is set at a value corresponding to 3 to 6db. lower than that of signals from the first tone coloring circuit **13**. Two signals having such characteristics are mixed in the mixing circuit **17** to obtain musical tones having the desired tone colors which will give the same impression as those of multiple reeds derived from, for example, an accordion or harmonica. The mixed tone signals are supplied to a speaker-operating circuit through an amplifier device **18**, causing musical tones approximately corresponding to those of an accordion or harmonica to be sounded.

There will now be described the present invention by reference to FIGS. **3** and **4**. The tone generating circuit consists of a flip-flop circuit **11***a* generating 8-foot-tone output signals of, for example, 440 Hz. Output signals from this circuit **11***a* are conducted to the base region of a switching transistor **20** disposed in the keying circuit **12***a*. The emitter region of the transistor **20** is connected to a source of −12 volts through a resistor **21** having a relatively low value (3.2 kilohms) and condenser **22** connected in series. The junction between the resistor **21** and condenser **22** is connected to a source terminal of −9 volts through a resistor **25** of 630 ohms and a resistor **26** of 50 kilohms connected in series. The base region of the transistor **20** is supplied with a bias voltage divided by a resistor **27** of 400 kilohms and a resistor **28** of 20 kilohms connected between the ground terminal and the −12-volt source. A diode **30** whose cathode is connected to the junction between the resistors **25** and **26** and whose anode is connected to the variable terminal of the variable resistors **29** connected between the −9-volt source and the −12-volt source is used, as later described, as a circuit for charging a condenser **22** when the switch **24** is turned off.

Eight-foot tone generating signals from the keying circuit **12***a* are supplied to a first filter **43** included in the tone coloring circuit **13** to give forth the tone color of a string voice and a second filter **44** also enclosed therein to generate the tone color of a reed voice.

There are obtained four foot signals of 880 Hz. from a tone generating circuit **11***b* consisting of a flip-flop circuit in addition to similar signals from the tone generating circuit **11***a*. The signals from the circuit **11***b* are supplied to the filters **43** and **44** through the keying circuit **12***b* having the same arrangement as the keying circuit **12***a*. A switch included in the circuit **12***b* is, of course, interlocked with the switch **24**. The filters **43** and **44** have a circuit arrangement as shown in FIG. **4** and shape rectangular input signals into the waveforms adapted to produce the tone color of string and reed voices respectively. These filters **43** and **44** may consist of those generally used in the art, and a detailed description thereof is omitted.

The switch **24** is so arranged to operate in interlocking relationship with a switch **31** included in the keying circuit **15** provided in connection with the second tone generating circuit **14**. One end of the switch **31** is connected to a source of +15 volts and the other end to the emitter region of a transistor **36** involved in the second tone generating circuit **14** through resistors **32** and **33**, diode **34** and resistor **35**. The tone generating circuit **14** constitutes a sine wave generator using the transistor **36** as an active element. The junction point between the resistor **33** and diode **34** is grounded through a diode **37** and switch **38**. When the switch **38** is opened, the transistor **36** is supplied with a voltage for oscillation. When the switch **38** is

closed, the source voltage of +15 volts is grounded through the diode **37** to stop the oscillation. Said generator is provided with a circuit for generating a sine wave signal having an oscillating frequency of 446.8 Hz. which is 6.8 Hz. higher than the 440 Hz. frequency of signals from the first tone generating circuit **11***a*.

The fundamental tone generator is comprised of a frequency dividing system using flip-flop circuits to cause all tone signals to be tuned to an exactly equal interval scale, so that said generator is incapable of adjusting individual tone signals separately.

On the other hand, the sine wave generator is an independent oscillator and well adapted to tune individual tone signals. Tuning is carried out by changing the value of elements involved in the tank circuit, for example, the inductance *L* as shown in FIG. **3**.

Outputs of sine wave signals from the second tone generating circuit **14** are supplied to the succeeding tone coloring circuit **16**, and are so shaped as to assume a waveform corresponding to the tone color of a string or reed voice. The tone coloring or shaping circuit **16** may consist of rectifiers and filters. Output signals from the tone coloring circuit **16** which give forth the tone color of a reed voice are conducted through a resistor **39** to one end of a switch **40**, and those producing the tone color of a string voice are conducted through a condenser **41** to one end of a switch **42**. The other end of each of the two switches **40** and **42** is connected to one end of the mixing circuit **17**.

Outputs from the filters **43** and **44** are jointly supplied to the mixing circuit **17** through switches **45** and **46** to be mixed with outputs from the tone coloring circuit **16**. In this case, outputs from the switches **45** and **46** are so arranged to have a voltage corresponding to 3 to 6db. higher than those from the tone coloring circuit **16**. Needless to say, the signals supplied to the mixing circuit **17** should be so adjusted as to give the like tone color as that of a string or reed voice. For instance, when the switches **42** and **45** are closed, the signals are so mixed as to produce the tone color of a string voice, and when the switches **40** and **46** are closed they are so mixed to obtain the tone color of a reed voice. In either case, the musical tone signals fed out from the amplifier device **18** have tone colors approximating those of multiple reeds such as those derived from an accordion or harmonica.

The foregoing description relates to the case where tone signals having a pitch of 440 Hz. are treated. With respect to tone signals of other pitches, the frequency of the sine wave generator is so set as to conform to the relationship shown in FIGS. **2***a* and **2***b*. (The frequency deviation appears more prominent in the high frequency range than in the low frequency range, whereas the percentage deviation is larger in the low frequency range than in the high frequency range). The inventor's experiments show that such a relationship proved to be the best condition for adjustment.

There will now be described the operation of the aforementioned embodiment. When the switch **24**, and consequently a switch **31** and another switch (not shown) included in the keying circuit **12***b*, are closed in interlocking relationship with the keys of an electronic musical instrument, the charge stored in the condenser **22** of the keying circuit **12***a* is discharged through the resistor **23** with a prescribed time constant. This discharge causes the emitter potential of the transistor **20** to be decreased with respect to the base potential thereof and the transistor **20** to be conducting. Thus rectangular 8-foot signals of 440 Hz. from the tone generating circuit **11***a* are supplied to the filters **43** and **44** of the tone coloring circuit **13** through the collector region of the transistor **20** and a condenser **47**. Also rectangular 4-foot signals of 880 Hz. from the tone generating flip-flop circuit **11***b* having the same arrangement as the tone generating circuit **11***a* are supplied to the filters **43** and **44** through the keying circuit **12***b*. At this time, the sine wave generator **14** is put into operation to generate a sine wave signal of 446.8 Hz. and supply it to the tone coloring circuit **16**. Signals to give forth the tone color of a string or reed voice are selectively supplied from the switch **40** or **42** to the mixing circuit **17** so as to be mixed with the signals selectively derived out from the switch **45** or **46** which are intended to produce the tone color of the like voice. When the keys of an electronic musical instrument are brought back to the original positions, the switch **24** is opened and the condenser **22** is charged through a charging circuit consisting of the resistor **25**, diode **30** and variable resistor **29**. As the condenser **22** is charged, the transistor **20** is progressively turned off with the increasing emitter region potential thereof. The speed at which the transistor **20** is turned off is proportional to that at which the emitter potential rises, so that said turnoff speed can be controlled by the time constant at which the charging circuit consisting of the resistor **25**, diode **30** and variable resistor **29** is operated, as well as by varying the resistance of the variable resistor **29**.

When the switch **38** is closed to make its contact, the sine wave oscillator **14** is rendered inoperable, causing no occurrence of ordinary humming, but giving forth musical tones corresponding to those derived from reed or string instruments.

According to the foregoing embodiment, tone generating signals having a rectangular or sine wave are converted by a tone coloring circuit to those capable of producing the tone color of a string or reed voice. It will be apparent that if signals capable of giving forth the tone color of a string or reed voice are initially used as tone generating signals then the tone coloring circuit will be unnecessary.

I claim:

1. A tone coloring system of an electronic musical instrument comprising:

a source of a fundamental tone signal having a tone color corresponding to that derived from a string voice or reed voice;

a source of a second signal having a frequency difference of 3 to 10 Hz. as compared with said fundamental tone signal, a voltage corresponding to 3 to 6db. lower than that of said fundamental tone signal and which is capable of producing the tone color of the like voice as represented by said fundamental tone signal; and

means for mixing said fundamental and second signals to obtain musical signals having tone colors approximately corresponding to those of multiple reeds.

2. A system according to claim **1** wherein said source of a fundamental tone signal includes an accurately tuned tone generating circuit.

3. A system according to claim **1** wherein said source of a fundamental tone signal includes flip-flop tone generating circuit providing rectangular wave signals; a keying circuit coupled to said tone generating circuit for selecting fundamental signals of desired frequencies; and a filter coupled to said keying circuit to filter said rectangular wave signals provided by said flip-flop tone generating and keying circuits.

4. A system according to claim **1** wherein said source of a second tone signal includes a sine wave generator and a tone coloring circuit coupled to the output of said sine wave generator.

5. A system according to claim **4** wherein said tone coloring circuit includes at least one rectifier coupled to a filter.

6. A method for generating musical signals having tone colors approximately corresponding to those of multiple reeds comprising the steps of:

generating a fundamental tone signal having a tone color corresponding to that derived from a string voice or reed voice;

generating a second signal having a frequency difference of 3 to 10 Hz. as compared with said fundamental tone signal, a voltage corresponding to 3 to 6db. lower than that of said fundamental tone signal and which is capable of producing the tone color of the like voice as represented by said fundamental tone signal; and

mixing said fundamental and second signals to obtain musical signals having tone colors approximately corresponding to those of multiple reeds.