

[54] **MULTI-CHANNEL STEREOPHONIC SOUND REPRODUCING SYSTEM FOR ELECTRONIC MUSICAL INSTRUMENTS**

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[51] Int. Cl. **G10h 1/00**

[58] Field of Search **84/1.01, 1.04, 1.11, 1.19, 84/1.22, 1.24, DIG. 1, DIG.27, 1.09, 1.1, 1.27; 179/1 G, 1 GA, 1 GP, 100.3 T, 100.4 ST**

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[57]

ABSTRACT

The multi-channel stereophonic sound reproducing system includes tone generators for generating tone signals each having a predetermined pitch and keyers each arranged to derive from the tone generators a tone signal having a pitch corresponding to the depressed one of a plurality of keys juxtaposed in the order of musical notes. Each of the tone signals derived through the keyers is applied to the preselected one of a plurality of tone coloring filters having frequency characteristics different from each other.

Output signals from the tone coloring filters are supplied via individual resistors to a plurality of points in the longitudinal direction of an elongated resistor body to form a composite signal. The composite signal is separated into a plurality of components at other points each arranged between the adjacent ones of the first-mentioned points. All the signal components are supplied via the corresponding sections each including a volume controlled and an amplifier to a plurality of loudspeakers disposed in a spacious hall or room at a substantially equal interval to reproduce therefrom desired stereophonic musical sounds.

14 Claims, 8 Drawing Figures

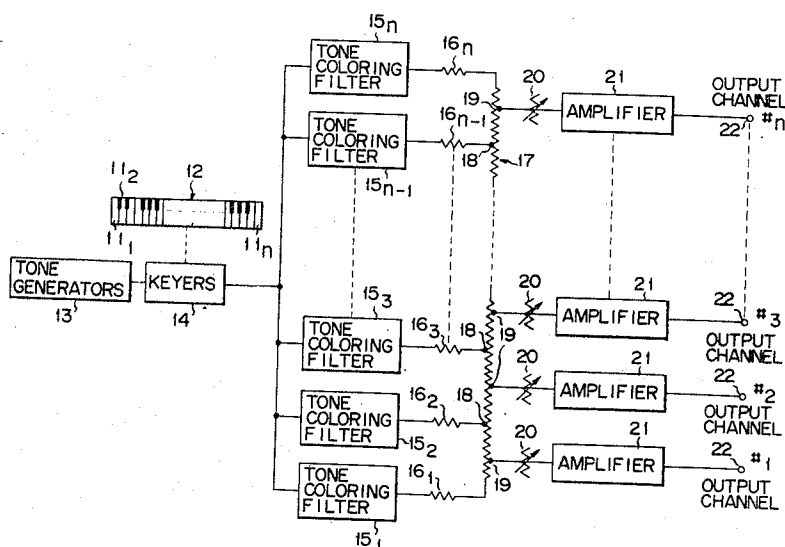


FIG. 2

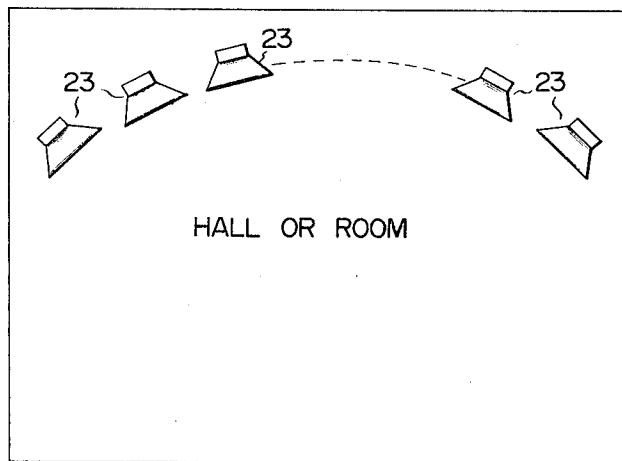
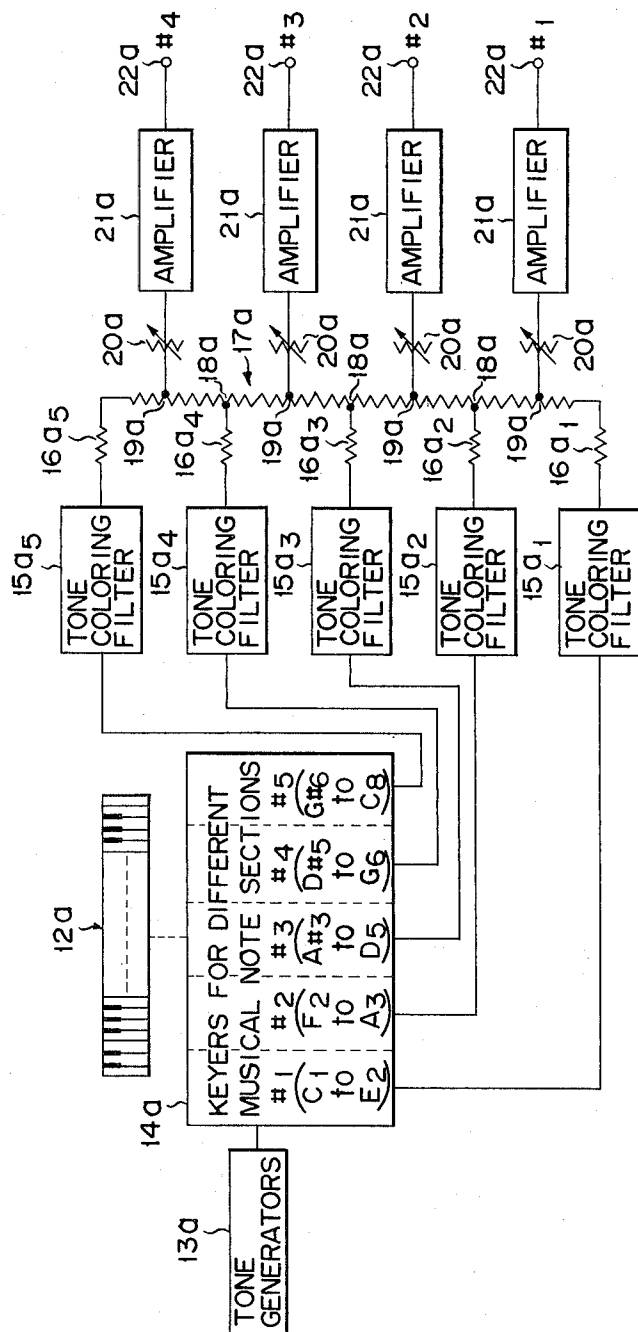


FIG. 3



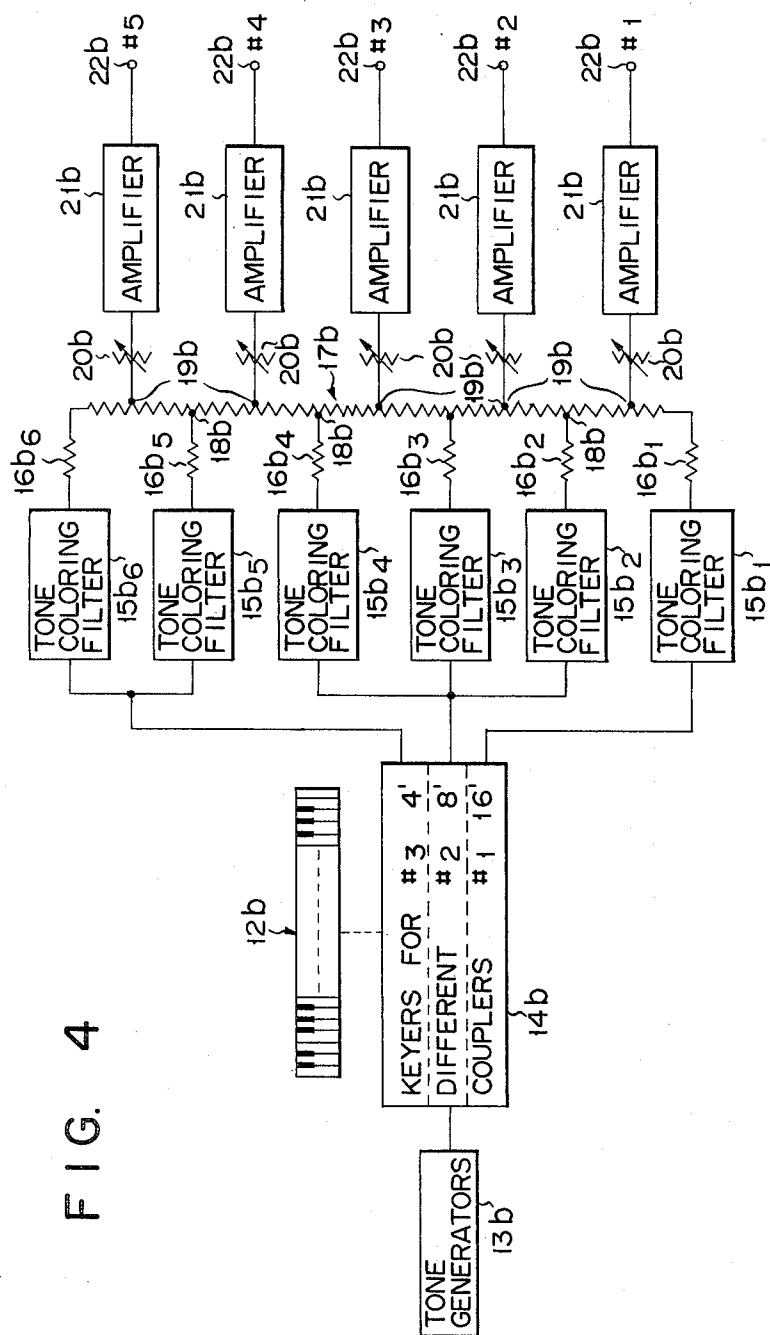


FIG. 4

FIG. 5

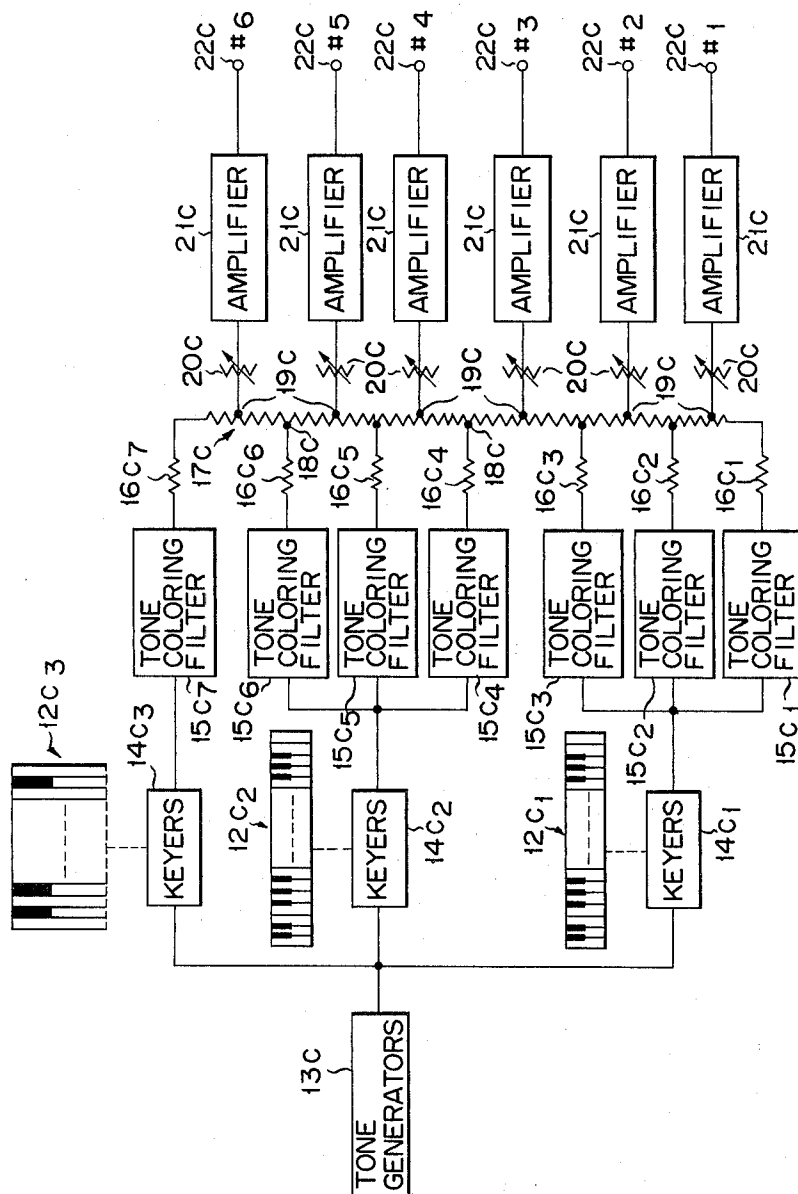


FIG. 6

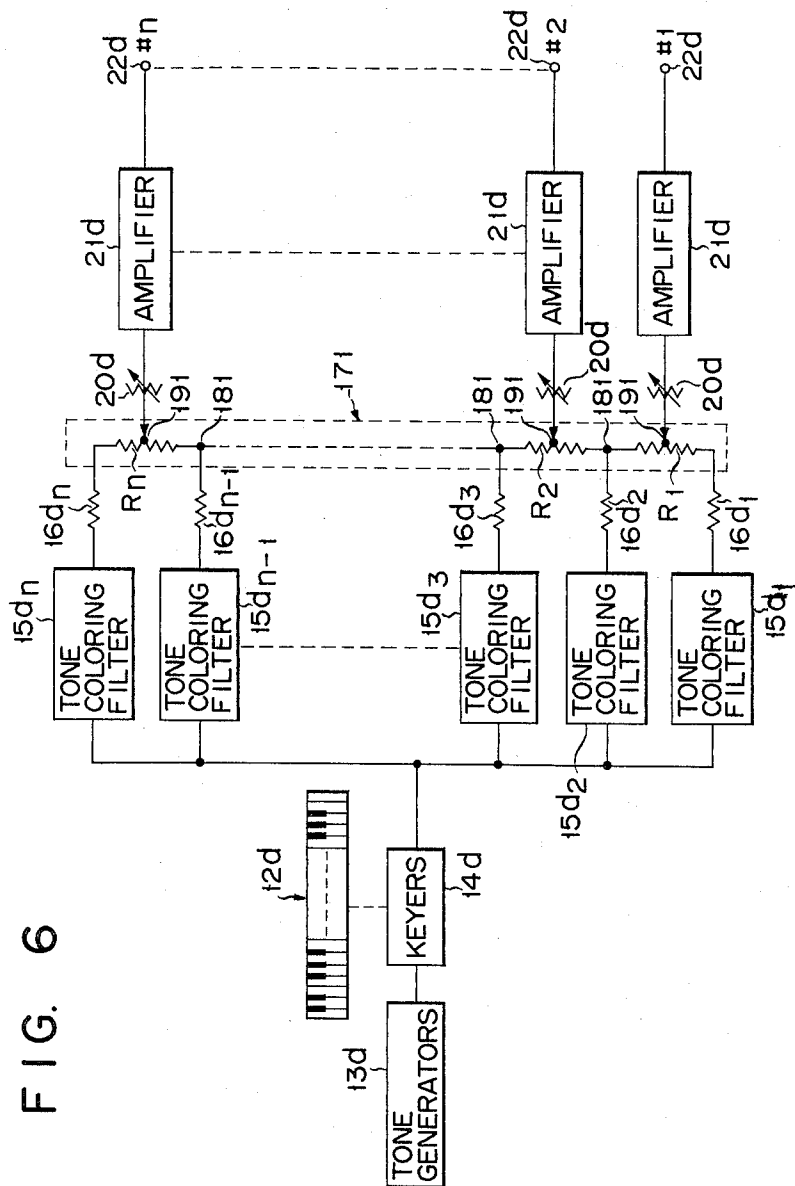


FIG. 7

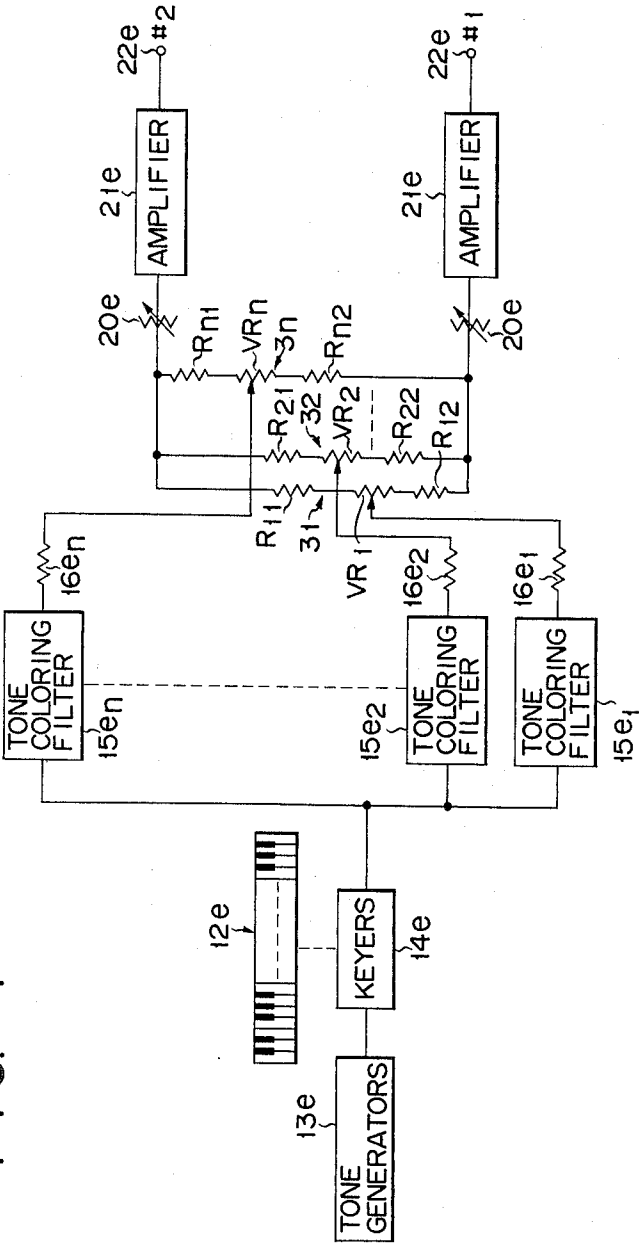
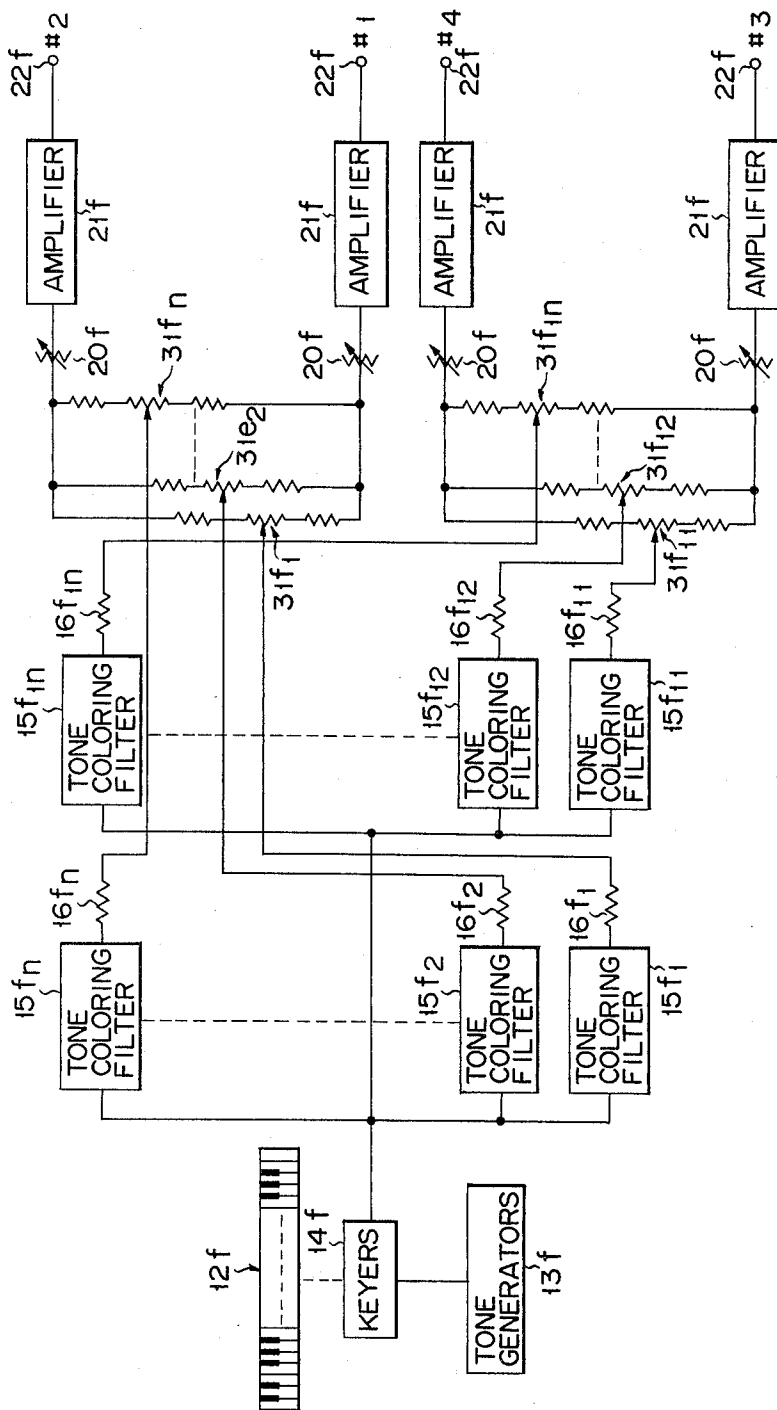


FIG. 8



MULTI-CHANNEL STEREOPHONIC SOUND REPRODUCING SYSTEM FOR ELECTRONIC MUSICAL INSTRUMENTS

BACKGROUND OF THE INVENTION

This invention relates to a multi-channel stereophonic sound reproducing system for a keyboard electronic musical instrument and more particularly to a multi-channel stereophonic sound reproducing system in which there are reproduced from a plurality of loudspeakers a series of musical sounds which differ successively from each other at least in frequency characteristics.

Prior art electronic musical instruments such as electronic organs in which there are installed a plurality of loudspeakers are mostly so arranged as to reproduce a single musical sound or tone from all the loudspeakers.

However, electronic musical instruments constructed as described above have the drawback that they can not realize a stereophonic sound effect substantially true to that of an orchestral performance, although they can attain a pseudostereophonic sound effect by expanding an audible region defined by a sonic energy emanated from all the loudspeakers.

As the result of noticeable development of the technique of reproducing stereophonic sounds there has recently grown a strong demand for the realization of an electronic musical instrument capable of attaining an excellent stereophonic sound effect.

It is therefore the object of this invention to provide a multi-channel stereophonic sound reproducing system for an electronic musical instrument capable of attaining a stereophonic sound effect substantially true to that of an orchestral performance.

SUMMARY OF THE INVENTION

According to the multi-channel stereophonic sound reproducing system of this invention, tone signals which have predetermined pitches and are derived from tone generators through keyers actuated by the selective depression of a plurality of manual and/or pedal keys of an electronic musical instrument arranged in the order of musical notes are coupled to a resistor network through respective tone coloring filters each having different frequency characteristics, thereby to form a composite signal. The composite signal is separated into a plurality of components from different points on the resistor network. Each of the signal components thus obtained is supplied through the corresponding section including a volume controller and an amplifier to the predetermined one of a plurality of loudspeakers.

Since they have frequency characteristics differing successively one from the other, musical sounds reproduced from a combination of such loudspeakers can cause listeners present in a listening area in which the instrument is disposed to enjoy a stereophonic sound effect substantially true to that of an orchestral performance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic block circuit diagram of a stereophonic sound reproducing system for an electronic musical instrument according to an embodiment of this invention;

FIG. 2 is a schematic plan view of a combination of a plurality of loudspeakers which are disposed in a spacious hall or room and are connected to the individual output channels of FIG. 1;

FIGS. 3 to 5 show schematic block circuit diagrams of a stereophonic sound reproducing system suitable for practical use which is arranged in accordance with the embodiment of FIG. 1;

FIG. 6 indicates a similar block circuit diagram of a stereophonic sound reproducing system prepared by replacing the elongated resistor body of FIG. 1 with a series combination of a plurality of resistors;

FIG. 7 is a schematic block circuit diagram of a stereophonic sound reproducing system according to another embodiment of this invention; and

FIG. 8 is a similar block circuit diagram showing one modification of a stereophonic sound reproducing system used when it is in a multi-channel form in accordance with the embodiment of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A stereophonic sound reproducing system according to the preferred embodiments of this invention will now be described by reference to the appended drawings.

FIG. 1 is a schematic block circuit diagram of a stereophonic sound reproducing system according to an embodiment of the invention.

There are provided a keyboard 12 comprised of a plurality of manual and/or pedal keys $11_1, 11_2, \dots, 11_n$ arranged in the order of musical notes; tone generators 13 which generate tone signals each of a predetermined pitch or frequency corresponding to the preset one of musical notes allotted to the respective keys 11_1 to 11_n on the keyboard 12; keyers 14 each arranged to be actuated upon the selective depression of the keys 11_1 to 11_n on the keyboard 12 so as to produce therethrough a tone signal of a pitch corresponding to the depressed key; and a plurality of tone coloring filters $15_1, 15_2, 15_3, \dots, 15_{n-1}, 15_n$ of the undermentioned construction each receiving the predetermined ones of the tone signals obtained through the keyers 14.

The respective tone coloring filters 15_1 to 15_n are comprised of, as it is well known to those skilled in the art, a differentiator, an integrator, a series resonance or a parallel resonance type circuit or combinations thereof and have frequency characteristics different from each other. For example, the first tone coloring filter 15_1 is so designed to form a musical tone having a color substantially true to that of a flute, and the remaining tone coloring filters 15_2 to 15_n are so designed as to give forth musical tones having colors practically resembling those of other natural musical instruments such as a diapason, a brass instrument, a clarinet, an oboe and a string instrument.

Output signals obtained at the coloring filters 15_1 to 15_n are transmitted to their respective resistors $16_1, 16_2, 16_3, \dots, 16_{n-1}, 16_n$ each having a proper value and then are supplied together to an elongated resistor body 17 of such a construction as will be described hereinafter. The elongated resistor body 17 has opposite ends respectively supplied with output signals from the first and last tone coloring filters 15_1 and 15_n and has a plurality of first taps 18 which are arranged in the longitudinal direction thereof at substantially equal intervals and are supplied respectively with separate output signals from the remaining tone coloring filters 15_2

to 15_{n-1} . The elongated resistor body 17 has also other taps 19 which are arranged between any adjacent two first-mentioned taps 18 and between the first tap 18 and the one end of the elongated resistor body 17 as well as the last tap 18 and the other end thereof. Therefore, there are derived from the second-mentioned taps 19 of the elongated resistor body 17 signal components into which the composite signal has been split. The individual signal components thus obtained are supplied to the corresponding output channels 22 through the corresponding volume controllers 20 and amplifiers 21. Each of the output channels 22 is connected to the pre-selected one of a plurality of loudspeakers 23 which are disposed in a spacious hall or room at substantially equal intervals, for example, as shown in FIG. 2.

In the stereophonic sound reproducing system so constructed as described above, there are reproduced from the respective loudspeakers 23 musical sounds each having such a tone color that output signal components from the tone coloring filters 15_1 to 15_n are mixed in a ratio defined by the position of the corresponding tap 19 relative to the elongated resistor body 17.

For example, musical sounds from the loudspeaker 23 of the first channel have a greater part occupied by the mixture of output signal components from the first and second tone coloring filters 15_1 and 15_2 and have the remaining parts occupied by the output signal components from the remaining tone coloring filters 15_3 to 15_n . Similarly, the greater part of musical sounds from the second-channel loudspeaker 23 is occupied by the blend of output signal components from the second and third tone coloring filters 15_2 and 15_3 and the remaining parts are occupied by output signal components from the remaining tone coloring filters.

As a result, the stereophonic sound reproducing system of this invention has the advantage that it can attain a stereophonic sound effect practically resembling that of an orchestral performance, since there are reproduced from the loudspeakers 23 musical tones whose colors vary successively from the left to the right or vice versa and whose volumes regularly differ from each other in response to the momentarily changing performance of the instrument.

FIG. 3 shows a practical construction of a stereophonic sound reproducing system according to the embodiment of FIG. 1. In this construction, the entire scale of musical notes (C_1 to C_8 , for example) of an electronic musical instrument are separated into a plurality of groups (five groups of C_1 to E_2 , F_2 to A_3 , A_3 to D_5 , D_5 to G_6 and G_6 to C_8 in this case) and consequently keys 14a are grouped for each of the musical note sections.

Thus, tone signals obtained from tone generators 13a through the different groups of keys 14a upon the selective depression of keys on a keyboard 12a are devised to be supplied to corresponding tone coloring filters $15a_1$, $15a_2$, $15a_3$, $15a_4$ and $15a_5$.

FIG. 4 is another practical construction of a stereophonic sound reproducing system according to the embodiment of FIG. 1. In the construction, keys 14b for an electronic musical instrument are grouped for each of a plurality of coupler registers (three 16 feet, 8 feet and 4 feet couplers in this case). Tone signals derived through the first keyer portion corresponding to the 16 feet coupler are supplied to a single tone coloring filter $15b_1$ which is designed to form a color similar to that

of, for example, a bourdon; those obtained through the second keyer portion corresponding to the 8 feet coupler are supplied in a predetermined relationship to three tone coloring filters $15b_2$, $15b_3$ and $15b_4$ which are designed to present colors very similar to those of e.g., a flute, a trumpet and an oboe; and those drawn out through the third keyer portion corresponding to the 4 feet coupler are supplied in a prescribed relationship to two tone coloring filters $15b_5$ and $15b_6$ which are so devised as to form colors similar to those of, e.g., a flute and a string instrument.

FIG. 5 shows still another practical construction of a stereophonic sound reproducing system according to the embodiment of FIG. 1.

In this construction, three keys $14c_1$, $14c_2$ and $14c_3$ are provided for an upper or great manual keyboard $12c_1$, a lower or swell keyboard $12c_2$ and a pedal keyboard $12c_3$, respectively. Thus, tone signals derived through the keys $14c_1$ corresponding to the upper manual keyboard $12c_1$, are supplied in a predetermined relationship to three tone coloring filters $15c_1$, $15c_2$ and $15c_3$ which are so designed as to form colors closely resembling those of, e.g., a diapason, a flute and a clarinet; those drawn out through the keys $14c_2$ corresponding to the lower manual keyboard $12c_2$ are supplied in a predetermined relationship to three tone coloring filters $15c_4$, $15c_5$ and $15c_6$ which are so made as to attain colors similar to those of, for example, a melodia, a trumpet and an oboe; and those obtained through the keys $14c_3$ corresponding to the pedal keyboard $12c_3$ are supplied to a single tone coloring filter $15c_7$ which is devised to produce a color similar to that of, e.g., a sub bass.

With the stereophonic sound reproducing systems constructed as shown in FIGS. 3 to 5, it will be apparent to those skilled in the art how to attain substantially the same effect as the embodiment of FIG. 1.

FIG. 6 shows a schematic block circuit diagram of one modification prepared by replacing the elongated resistor body 17 with a series combination 171 of a plurality of resistors (or variable resistors) R_1 , R_2 , R_3 , ..., R_{n-1} , R_n each having a pair of common connections 181 to the adjacent ones of the resistors R_1 to R_n which are supplied with individual output signals from prescribed tone coloring filters $15d_2$, $15d_3$, ..., $15d_{n-1}$, output signals from the first and last tone coloring filters $15d_1$ and $15d_n$ being supplied to the opposite ends of the series resistor combination 171, and having a top (or a movable contact) 191 which is connected to a corresponding output channel 22d via volume controller 20d and an amplifier 21d.

FIG. 7 is a block circuit diagram of a stereophonic sound reproducing system according to another embodiment of this invention. In this embodiment, there is so arranged as to replace the elongated resistor body 17 having two sets of taps 18 and 19 in the embodiment of FIG. 1 with a plurality of resistor networks 31, 32, ..., 3n comprising variable resistors VR_1 , VR_2 , ..., VR_n which have a movable contact connected to the pre-selected one of tone coloring filters $15e_1$, $15e_2$, ..., $15e_n$ and respective two resistors R_{11} - R_{12} , R_{21} - R_{22} , ..., R_{n1} - R_{n2} , provided if required, which have one end connected to the corresponding one of the variable resistors VR_1 to VR_n and have the other end connected in common to the corresponding one of two output channels 22e via individual amplifiers 21 and volume controllers 20. In this construction, there are respectively supplied with

musical sounds each consisting of a plurality of mixed components which have split tone signals from the tone coloring filters $15e_1$ to $15e_n$ in a ratio determined by the respective positions of movable contacts on the variable resistors VR_1 to VR_n included in the resistor networks 31 to $3n$ to the two output channels $22e$.

In order to realize a further multi-channel form according to the embodiment of FIG. 7, tone coloring filters used in an electronic musical instrument have only to be so constructed that they can be separated into a plurality of groups, for example, as shown in FIG. 8 (two groups in FIG. 8).

In practice, as illustrated in FIGS. 3 to 5, the tone coloring filters are so separated into groups so that the filters of a group may be so devised as to correspond to the preselected one of all the musical notes, all the couplers or all the keyboards for the instrument.

It will be apparent to those skilled in the art how to attain substantially the same effect as those of FIGS. 1 and 3 to 6 in the stereophonic sound reproducing system constructed as described above.

In FIG. 1 and FIGS. 3 to 8, the loudspeakers may be installed in an electronic musical instrument as well as in a spacious hall or room as shown in FIG. 2.

The parts of FIGS. 3 to 8 corresponding to those of FIGS. 1 and 2 are respectively denoted by the corresponding numerals and description thereof is omitted.

What is claimed is:

1. In a keyboard electronic musical instrument having tone generators for generating a plurality of tone signals each having a predetermined pitch, keyers coupling out from the tone generators a tone signal having a pitch corresponding to the depressed one of a plurality of keys arranged in the order of musical notes, and a plurality of tone coloring filters each having different frequency characteristics and supplied with the preselected ones of the tone signals derived through the keyers;

a multi-channel stereophonic sound reproducing system comprising:

a resistor network including a plurality of variable resistance elements each of said tone coloring filters being coupled to a variable resistance element for adjustably combining collectively output signals from the respective tone coloring filters to form composite signals;

a signal separation means connected to said resistor network for separating a composite signal formed by the resistor network into a plurality of components, said separation means including a plurality of sections each including an amplifier; and

a plurality of loudspeakers each connected to a respective one of said sections and receiving the preselected one of the signal components obtained by the corresponding sections, whereby stereophonic musical sounds are reproduced from the combination of all the loudspeakers.

2. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said tone coloring filters are arranged to receive signals corresponding to preset ones of all the musical notes of the instrument.

3. A multi-channel stereophonic sound reproducing system according to claim 1 including a plurality of couplers connected to said keyers and wherein respec-

tive tone coloring filters are coupled to one of said couplers.

4. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said keys are arranged in a plurality of keyboards, and said tone coloring filters are respectively separately coupled to a preset one of the keyboards of the instrument.

5. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said resistor network comprises at least one elongated resistor body which has opposite ends connected with the first and last ones of a group of said tone coloring filters and has a plurality of adjustable taps spaced in the longitudinal direction of the elongated resistor body and connected with the remaining tone coloring filters of said group.

6. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said resistor network comprises a series combination of a plurality of variable resistance elements, said series combination having opposite free ends connected with the first and last ones of said tone coloring filters, a plurality of common connections to the respective adjacent ones of the resistance elements connected with the remaining tone coloring filters, and a plurality of contacts arranged on the individual resistance elements, said contacts being coupled to said signal separation means.

7. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said resistor network comprises a plurality of variable resistors having movable contacts each connected with the preselected one of said tone coloring filters and having opposite end terminals connected to respective ones of two loudspeakers via its respective section of said signal separation means.

8. A multi-channel stereophonic sound reproducing system according to claim 7 wherein said resistor network includes at least two groups of said variable resistors, each group being coupled to respective tone coloring filters for combining output signals therefrom, thereby attaining a further multi-channel form.

9. A multi-channel stereophonic sound reproducing system according to claim 7 further including a pair of resistors connected to both ends of each of said variable resistors.

10. A multi-channel stereophonic sound reproducing system according to claim 1 wherein each of said sections of said signal separation means include a volume controller coupled to said amplifier for controlling the output of the respective loudspeaker.

11. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said resistor network comprises an elongated resistor body which has opposite ends connected with the first and last ones of said tone coloring filters and has a plurality of taps spaced in the longitudinal direction of the elongated resistor body and connected with the remaining tone coloring filters, said elongated resistor body further comprising another group of adjustable taps each arranged between the adjacent ones of said first-mentioned plurality of taps, said another group of taps being coupled to said signal separation means.

12. A multi-channel stereophonic sound reproducing system according to claim 5 comprising another group of taps each of which are arranged between the adjacent ones of said first-mentioned plurality of taps, said

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another group of taps being adjustable and being coupled to said signal separation means.

13. A multi-channel stereophonic sound reproducing system according to claim 6 wherein said plurality of contacts are adjustably arranged on the individual resistance elements.

14. A multi-channel stereophonic sound reproducing system according to claim 1 wherein said resistor net-

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work includes a plurality of fixed resistance elements respectively coupled to the outputs of said tone coloring filters, said fixed and variable resistance elements being coupled together to combine said output signals from said tone coloring filters to form said composite signals.

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