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(54) Natural sound playback apparatus.

(57) A natural sound playback apparatus comprises a sound material memory (1) for storing a plurality of natural sounds, a plurality of fluctuation timing simulators (2) for creating playback timings of natural sounds, at least two data readers (3) for reading natural sounds stored in the sound material data, at least two natural sound playback sections (4) for playing back natural sounds, a priority memory (6) for storing the priority order among natural sounds and an output channel controller (7) for outputting natural sounds responsive to their playback timings and their priority data. Preferably the natural sound playback apparatus has Lch and Rch speakers (18) controlled by LR volume controller (17) for controlling the left and right volumes upon playing back the natural sounds to give the perception that the natural sounds come from different directions (Figure 4).

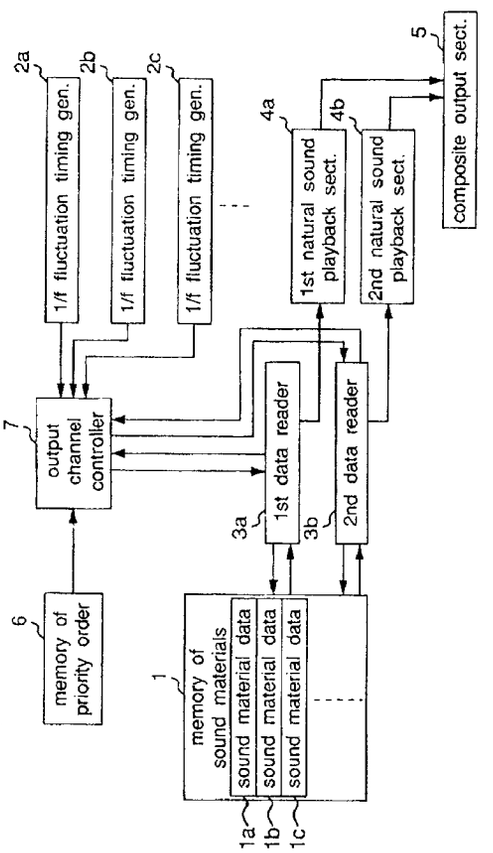

Fig. 1

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The present invention relates to a natural sound playback apparatus that is suitable for creating relaxation space in an office or residence.

Among various sounds in our life space are human voices, the rings of telephone bells, sounds generated by cars or trucks, and sounds from neighbor residences, which usually give us mental stresses and distract our concentration. In order to prevent damages caused by the noise, there have been methods of insulating the noise and methods of masking uncomfortable sounds by other sounds. A typical example of the latter method is so called Background music (BGM). However, BGM has an individual melody, and we have different likes and dislikes, so that it is difficult to please everyone. As a result, natural sounds such as the murmur of a brook and a song of a bird have been recently widely used. These natural sounds have natural fluctuation characteristics, for example the ones generally called 1/f fluctuation characteristics. The characteristics are known to have effects of relaxing people. However, it is said that if recorded natural sounds are repeatedly played back, human senses can perceive a periodicity. Therefore, we feel soon uncomfortable caused by the perception of the periodicity. In order to eliminate the feeling of repetition, a method of artificially creating 1/f characteristics and generating intermittent natural sounds like a song of a bird by controlling playback timing has been used to arouse naturalness. Further, a plurality of natural sounds are sometimes combined for playback to augment naturalness.

In the following is described an example of a prior natural sound playback apparatus. Fig. 7 is a block diagram showing the construction of a prior natural sound playback apparatus. In Fig. 7, a plurality of intermittent natural sounds having inherent unit lengths such as notes of a cuckoo or a warbler and the sound of waves are stored as sound material data pieces 1a, 1b, 1c, ··· in a sound material data memory 1. Here, each natural sound has its inherent 1/f fluctuation characteristic. A 1/f fluctuation timing generator 2a simulates the inherent 1/f characteristic of the sound material data piece 1a to create its playback timing. 1/f fluctuation timing generators 2b, 2c, ··· similarly simulate the inherent 1/f characteristics of the sound material data pieces 1b, 1c, ··· to create their playback timing. In this way, each 1/f fluctuation timing generator one-to-one corresponds to each sound material data piece stored in sound material memory 1. A data reader 13a reads the sound material data piece 1a from sound material memory 1, when playback timing generated by 1/f fluctuation timing generator 2a occurs. Data readers 13b, 13c, ··· similarly correspond to 1/f fluctuation timing generators 2b, 2c, ··· , so that the number of data readers is the same as the number of sound material data pieces stored in sound material memory 1. A natural sound playback section 14a plays back a signal read by data reader 13a. Natural sound playback sections 14b, 14c, ··· similarly correspond to data readers 13b, 13c, ···, so that the number of natural sound playback sections is the same as the number of sound material data pieces stored in sound material memory 1. The outputs from the plurality of natural sound playback sections are combined to output a composite signal from a composite output device 5.

The control shown by a flowchart of Fig. 8 is performed with the above construction. For simplicity, an example of control for the sound material data piece 1a is described in the following. First, in Step 21, 1/f fluctuation timing generator 2a judges if a natural sound playback switch, which is not shown in Fig. 7, has been turned on by a user. If the switch is on, the control proceeds with Step 22, and if not, the control is on stand-by. In Step 22, 1/f fluctuation timing generator 2a starts the generation of playback timing for the sound material data piece 1a. In Step 23, 1/f fluctuation timing generator 2a counts time. In Step 24, 1/f fluctuation timing generator 2a tests whether the counted time becomes the time when the sound material data piece 1a is played back. If the counted time is the time when the sound material data piece 1a is played back, then the control proceeds with Step 25, and if it is not, the control returns to Step 23 to continue the counting. In Step 25, data reader 13a reads the sound material data piece 1a from sound material memory 1 to send the read signal data to natural sound playback section 14a. In Step 26, natural sound playback section 14a plays back the signal data sent from data reader 13a to form a played-back signal for composite output device 5. In Step 27, 1/f fluctuation timing generator 2a judges if the natural sound playback switch has been turned off by a user. If the switch is off, the control is terminated, and if not, the control proceeds with Step 22 to start the generation of the timing for the next playback. Control similar to the one shown in Fig. 8 is performed in parallel for other sound material data pieces stored in sound material memory 1, and composite output device 5 combines the played-back signals to output a composite signal.

Fig. 9 shows an example of a plurality of natural sound played-back signals. If the sound material data pieces 1a, 1b, and 1c shown in (a) of Fig. 9 are stored in sound material memory 1, then 1/f fluctuation timing generator 2a generates 1/f fluctuation timing as shown in (b) of Fig. 9 based on a 1/f fluctuation characteristic set for the sound material data piece 1a, and natural sound playback section 14a obtains a natural sound shown in (c) of Fig. 9. Similarly, as shown in (d), (e), (f) and (g) of Fig. 9, natural sound playback sections 14b and 14c obtain natural sounds respectively corresponding to the sound material data pieces 1b and 1c. Therefore, in the composite output of these three played-back natural sounds, the outputs from natural sound playback sections 14a and

14b are simultaneously played back to be heard at the timing point (1) for the sound material data pieces 1a and 1b. Similarly, the outputs from natural sound playback sections 14a, 14b, and 14c are simultaneously played back to be heard at the timing point (3) for the sound material data pieces 1a, 1b, and 1c.

In the above prior construction, a plurality of natural sounds are generated in various combinations, so that sound of great naturalness is certainly created. However, playback channels as many as the number of natural sounds to be combined are necessary, so that the construction becomes complex and expensive.

Further, played-back natural sounds are monophonic in the above prior construction, so that the distance of a sound source can be represented by loudness, but the direction of a sound source can not be represented. In order to solve this problem, we can consider a method of adding a plurality of output sections to the above construction and horizontally arranging a plurality of speakers to output through different speakers by selecting an output section at each playback timing point for each natural sound. However, the construction becomes complex and large-scaled, and the locations from which natural sounds are heard are limited by the number of speakers.

According to a first aspect of this invention, a natural sound playback apparatus comprises a sound material memory that stores m kinds of natural sounds as m sound material data pieces, m fluctuation simulators that create playback timing for natural sounds by simulating fluctuation in nature depending on each sound material piece, n data readers that read a specified sound material data piece from the sound material memory with specified timing, where m > n are positive integers, n natural sound playback sections that play back each signal read by each data reader, a priority memory that stores the priority order of sound material pieces, and an output channel controller that monitors playback timings generated by m fluctuation simulators and, if some playback timing occurs, judges the operational states of the n data readers to assign the playback timing and corresponding sound material data pieces to idle data readers. Further, if playback timing for more than n sound material data pieces simultaneously occurs, then the output channel controller selects n sound material data pieces of higher priorities based on the priority order stored in the priority order memory.

According to a second aspect of the invention, a natural sound playback apparatus comprises a sound material memory that stores a plurality of natural sounds as sound material data pieces, a 1/f fluctuation timing generator that creates playback timing for natural sounds depending on 1/f fluctuation inherent in each sound material piece, a data reader that reads a specified sound material data piece from the sound material memory with specified timing, a natural sound playback section that plays back the signal data read by the data reader, a 1/f fluctuation volume level generator that obtains output volume at each playback timing point based on 1/f fluctuation inherent in the sound material, a volume controller that controls the magnitude of the signal played back by the natural sound playback section based on a value obtained by the 1/f fluctuation level generator, an LR volume generator that obtains the balance of volume between left and right to output natural sound through two left and right speakers, an LR (left and right) volume controller that creates, from the signal output from the volume controller, a signal output through a left speaker and a signal output through a right speaker, based on the balance of volume between left and right obtained by the LR volume generator, and Lch (left channel) output devices and Rch (right channel) output devices that output played-back sounds for left and right.

Further, in another natural sound playback apparatus in accordance with the present invention, the above 1/f fluctuation volume level generator and LR volume generator are combined into one unit, and the LR volume controller additionally performs the function of the volume controller.

Preferably, an output channel controller monitors playback timings generated by m fluctuation simulators to assign specific sound material data pieces to be played back to idle data readers by judging the operational states of n data readers and to assign n sound material pieces of higher priorities if playback timing points for more than n sound material data pieces coincide. Consequently, more than n kinds of natural sound can be combined using n playback channels to output composite sounds of great naturalness.

Preferably, a 1/f fluctuation controller controls the balance of volume between left and right, in processing playback timing and sound volume to play back natural sounds, based on 1/f fluctuation. Consequently, natural sounds of great naturalness can be played back by letting natural sounds such as notes of birds and insects be heard from various locations at left and right using only two left and right speakers.

Preferred embodiments of the present invention will now be described with reference to the accompanying drawings throughout which like parts are designated by like reference numerals, and in which:

Fig. 1 is a block diagram of an natural sound playback apparatus of a first embodiment in accordance with the present invention.

Fig. 2 is a flowchart showing the operation of the first embodiment.

Fig. 3 is a timing chart showing an example of operational signals and a played-back signal in the first embodiment.

Fig. 4 is a block diagram of an natural sound play-

back apparatus of a second embodiment in accordance with the present invention.

Fig. 5 is a flowchart showing the operation of the second embodiment.

Fig. 6 shows waveforms of an exemplary played-back signal in the second embodiment.

Fig. 7 is a block diagram of an natural sound playback apparatus of a prior art.

Fig. 8 is a flowchart showing the operation of the playback apparatus of the prior art.

Fig. 9 is a timing chart showing an example of operational signals and a played-back signal in the playback apparatus of the prior art.

The preferred embodiments according to the present invention will be described below with reference to the attached drawings.

A first embodiment in accordance with the present invention is described in the following with reference to Figs. 1 to 3. In Fig. 1, which is a block diagram showing the construction of a natural sound playback apparatus of the first embodiment, components having the same functions as the prior apparatus shown in Fig. 7 are denoted by the same symbols and their descriptions are simplified. In particular, a sound material memory 1, which functions as the same as the prior apparatus, stores similar sound material data pieces 1a, 1b, ··· . Fluctuation simulators that simulate fluctuation in nature, that is, 1/f fluctuation timing generators 2a, 2b, ··· one-to-one correspond to sound material data pieces 1a, 1b ··· .

The present embodiment has a first data reader 3a and second data reader 3b, which read sound material data pieces with timing determined by a means described later. The signal read by first data reader 3a is played back by a first natural sound playback section 4a, and the signal read by second data reader 3b is played back by a second natural sound playback section 4b. Then a composite output device 5 combines outputs of first and second natural sound playback sections 4a and 4b to output a composite signal. A priority order memory 6 stores the priority order of the sound material data pieces. An output channel controller 7 monitors playback timings generated by 1/f fluctuation timing generators 2a, 2b, ··· . When some playback timing occurs, output channel controller 7 judges the operational states of the two data readers 3a and 3b to assign the playback timing and corresponding sound material data pieces to idle data readers. Further, if playback timing for more than two sound material data pieces simultaneously occurs, then output channel controller 7 selects sound material data pieces of higher priorities based on the priority order stored in priority order memory 6.

The operation of the natural sound playback apparatus constructed as above is described in the following with reference to a flowchart shown in Fig. 2. In Step 1 of the flowchart, 1/f fluctuation timing generator 2a, 2b, ··· judges if a natural sound playback switch, which is not shown in Fig. 1, has been turned on by a user. If the switch is on, the control proceeds with Step 2, and if not, the control is on stand-by. In Step 2, 1/f fluctuation timing generators 2a 2b, ··· start the generation of playback timing for the sound material data pieces 1a, 1b, ··· . In step 3, 1/f fluctuation timing generators 2a, 2b ··· count time. In Step 4, 1/f fluctuation timing generators 2a, 2b, ··· test whether the counted time becomes the time when some sound material data piece is played back. If the counted time is the time when some sound material data piece is played back, then the control proceeds with Step 5, and if it is not, the control returns to Step 3 to continue the counting. In Step 5, output channel controller 7 judges if playback timing for more than one kind of sound material has simultaneously occurred. If playback timing for more than one kind of sound material has occurred, then the control proceeds with Step 6; otherwise the control proceeds with Step 7.

In Step 6, output channel controller 7 determines the priority order of sound material data pieces for which playback timing has occurred based on the priority order stored in priority order memory 16. In Step 7, output channel controller 7 judges if first data reader 3a is busy; if it is not, then the control proceeds with Step 8, and otherwise the control proceeds with Step 13. In Step 8, output channel controller 7 assigns a sound material data piece of the higher priority to first data reader 3a. In Step 9, first data reader 3a reads the selected sound material data piece from sound material memory 1 to send the read signal data to first natural sound playback section 4a. In Step 10, first natural sound playback section 4a plays back the signal data sent from first data reader 3a to send the played-back signal to composite output device 15.

In Step 11, output channel controller 7 monitors each 1/f fluctuation timing generator 2a, 2b, 2c, ··· to judge if there are sound material data pieces to be simultaneously played back. If there is no need for simultaneous playback, the control proceeds with Step 12; otherwise the control proceeds with Step 13. In Step 12, each 1/f fluctuation timing generator judges if the natural sound playback switch has been turned off. If the switch is off, then the control is terminated, and if the switch is not off, then the control returns to Step 2, and each timing generator starts the generation of the next playback timing for each sound material data piece. In Step 13, output channel controller 7 selects a sound material data piece for second data reader 3b. In Step 15, second data reader 3b reads the selected sound material data piece from sound material memory 1 to send the read signal data to second natural sound playback section 4b. In Step 16, second natural sound playback section 4b plays back the signal data sent from second data reader 3b to send the played-back signal to composite output device 15.

Fig. 3 shows an example of a played-back signal

of the present embodiment. If the sound material data pieces 1a, 1b, 1c shown in (a) of Fig. 3 are stored in sound material memory 1, and if the priority order is in the order of 1a, 1b, 1c, then as shown in (b), (c) and (d) of Fig. 3, playback timing is generated based on a predetermined 1/f fluctuation characteristics for each sound material data piece. Whenever a playback timing occurs, output channel controller 7 judges if each of first and second data readers 3a and 3b is busy to assign corresponding sound material data pieces to idle data readers. For example, the sound material data piece 1a is assigned to first data reader 3a at the timing point (1), and the sound material data piece 1b is assigned to second data reader 3b, since first data reader is busy.

At each of the timing points (3), (4), (5), a sound material data piece is assigned to first data reader 3a. At the timing points (7), (8), (9), playback timing for three sound material data pieces occur at the same time, so that the sound material data pieces of higher priorities 1a and 1b are respectively assigned to first data reader 3a and second data reader 3b. Therefore, at the timing point (9), the sound material data pieces 1c is not played back, unlike the prior example. However, if too many sounds are simultaneously heard, they may be hard to perceive. Therefore, even if the number of simultaneously played back sounds are limited to two, naturalness is not much damaged.

As described above, in combining more than three kinds of natural sounds, output channel controller 7 assigns sound material pieces to idle playback channels of two playback channels, and if more than two playback timing points occur at the same time, output channel controller 7 assigns sound material data pieces of higher priorities based on a predetermined priority order stored in priority order memory 6. In this way, composite sounds of great naturalness can be produced by means of only two playback channels.

In the present embodiment, the number of playback channels have been two, but the number of playback channels does not have to be limited to two and can be three or four. In general, if the number of playback channels is fewer than the number of sound material data pieces, then the effects of the present invention are obtained.

Further, the fluctuation rhythms are not limited to 1/f fluctuation. Greater naturalness may be obtained as a result of applying other fluctuation rhythms to the present embodiment by simulating nature through experiments. Only playback timing has been fluctuated in the present embodiment. However, fluctuation may also be generated for the volume and tone of sound. In this case, if data for level fluctuation and tone fluctuation are added to 1/f fluctuation timing generators besides timing data, and if natural sound playback sections are modified to be able to vary volume and tone, then the fluctuation of volume and tone can be realized.

As described above, a natural sound playback apparatus of the present invention comprises a sound material memory that stores m kinds of natural sounds as m sound material data pieces, m fluctuation simulators that create playback timing for natural sounds by simulating fluctuation in nature depending on each sound material piece, n data readers that read specified sound material data pieces from the sound material memory with specified timing, n natural sound playback sections that play back each signal read by each data reader, a priority memory that stores the priority order of sound material data pieces, and an output channel controller that monitors playback timing generated by m fluctuation simulators and, if some playback timing occurs, judges the operational states of the n data readers to assign the playback timing and corresponding sound material data pieces to idle data readers. Further, if playback timing for more than n sound material data pieces simultaneously occurs, then the output channel controller selects n sound material data pieces of higher priorities based on the priority order stored in the priority order memory.

By this construction, in case of combining more than two kinds of natural sounds, sound material data pieces to be played back are assigned to idle ones of two playback channels, and if playback timing for more than two sound material data pieces simultaneously occurs, sound material data pieces of higher priorities are assigned, so that composite sound of great naturalness can be produced, for example, by means of only two playback channels. Further, composite sound of greater naturalness can be produced without enlarging circuitry by using natural sounds of kinds more than the limited number of playback channels.

A second embodiment in accordance with the present invention is described in the following with reference to Figs. 4 to 6. In Fig. 4, which is a block diagram showing the construction of a natural sound playback apparatus of the second embodiment, components having the same functions as the prior apparatus shown in Fig. 7 are denoted by the same symbols and their descriptions are simplified. A 1/f fluctuation controller 13 has a timing generator 13a, a volume level generator 13b, and an LR volume generator 13c that obtains the balance of volume between left and right, based on 1/f fluctuation, to output natural sounds through two left and right speakers. The present embodiment has an LR volume controller 17 that creates, from a signal output from a volume controller 6, a signal to be output from the left speaker and a signal to be output from the right speaker based on the balance between left and right obtained by LR volume generator 13c. The present embodiment also has an Lch output device 18a and Rch output device 18b that respectively output two

played-back sounds for left and right.

The operation of the natural sound playback apparatus constructed as above is described in the following with reference to a flowchart shown in Fig. 5. In the figure, steps 1 through 7 are the same as Step 21 to Step 26 of the prior art, so that their descriptions are omitted. In Step 8, 1/f fluctuation controller 3 varies the magnitude of a played-back signal based on a value sent from volume level generator 13b and send the modified playback signal to LR volume controller 7. In Step 9, LR volume generator 13c obtains the balance of volume between left and right for the sound material data 2a to be currently played back and sends the balance to LR volume controller 17. In step 10, LR volume controller 17 creates two signals from the played-back signal depending on a value sent from LR volume generator 13c to send the signal to be output from left to Lch output device 18a and send the signal to be output from right to Rch output device 18b.

In Step 11, Lch output device 18a and Rch output device 18b respectively outputs signals sent from LR volume controller 17 to audio systems (not illustrated) such as speakers. In Step 12, 1/f fluctuation controller 13 judges if key switch for terminating the playback of natural sound has been turned on. If the key switch is turned on, the playback is terminated; otherwise the control returns to Step 2 and the next playback timing is generated.

Fig. 6 shows an example of played-back signal of natural sounds. Since the process until the playback level of natural sounds is controlled is the same as the prior art, the signal obtained after playback level is controlled is the same as the signal shown in (c) of Fig. 9 and now shown in (a) of Fig. 6. (c) of Fig. 6 shows the balance of volume between left and right generated by LR volume generator 13c. For example, if the central level is 1, at the timing point (1), both left and right levels are 1. At the timing point (2), the left level is 1.4 and the right level is 0.6. The Lch output signal shown in (c) of Fig. 6 is obtained by multiplying the signal obtained after playback level control by the Lch level shown in (b) of Fig. 6. For example, the level of the signal shown in (a) of Fig. 6 is multiplied by 1 at the timing point (1), and the level of the signal shown in (a) of Fig. 6 is multiplied by 1.4 at the timing point (2). Similarly the Rch output signal shown in (d) of Fig. 6 is obtained by multiplying the signal obtained after playback level control by the Rch level shown in (b) of Fig. 6. For example, the level of the signal shown in (A) of Fig. 6 is multiplied by 1 at the timing point (1), and the level of the signal shown in (a) of Fig. 6 is multiplied by 0.4 at the timing point (2).

Next, a variation of the second embodiment is described in the following. Volume level generator 13b and volume controller 6 in Fig. 4 are removed from the second embodiment for the variation. Further, the function of LR volume generator 13c is enhanced to generate data obtained by combining the data indicating the balance of volume between left and right and the data indicating the volume level generated by volume level generator 13b in the second embodiment. In the flowchart of Fig. 5, Steps 7 and 8 are removed, and In Step 9, volume level is also set as well as volume balance. By these modifications, functions similar to those in the second embodiment are implemented in a simpler construction.

As described above, the second embodiment and its variation can produce natural sound of great naturalness by letting notes of birds and insects be heard from various locations at right and left using only two left and right speakers.

One kind of sound material has been used in the above descriptions. However, several kinds of sound material can be used for similar processing.

Further, timing generator 13a, which functions the same as timing generator 13a of the prior apparatus, generates data counted in Step 3. However, timing generator can generates an instruction for calling the sound material data piece 2a at each playback timing point. In this case, Step 2 is an instruction of starting the generation of timing, Step 3 is skipped, and Step 4 tests if the call instruction has been issued.

Still further, in the present embodiment and its variation, an analog signal obtained by digital-to-analog conversion has been used for volume control and balance control. However, a digital signal before the conversion can be used for the control.

As described above, a natural sound playback apparatus of the present invention comprises a sound material memory that stores a plurality of natural sounds as sound material data pieces, a 1/f fluctuation timing generator that creates playback timing for natural sounds depending on 1/f fluctuation inherent in each sound material data piece, a data reader that reads a specified sound material data piece from the sound material memory with specified timing, a natural sound playback section that plays back the signal data read by the data reader, a 1/f fluctuation volume level generator that obtains output volume at each playback timing point based on 1/f fluctuation inherent in each sound material data piece, a volume controller that controls the magnitude of the signal played back by the natural sound playback section based on a value obtained by the 1/f fluctuation level generator, an LR volume generator that obtains the balance of volume between left and right to output natural sound through two left and right speakers, an LR volume controller that creates, from the signal output from the volume controller, a signal output through a left speaker and a signal output through a right speaker, based on the balance of volume between left and right obtained by the LR volume generator, and Lch output devices and Rch output devices that output played-back sounds for left and right.

Here some of the above components can be combined to simplify the construction. As a result, when each natural sound is played back, the volume balance of the sounds output from two left and right speakers is controlled based on 1/f fluctuation, so that natural sounds such as notes of birds and insects can be heard from various locations at left and right, and natural sound of great naturalness can be obtained by a simple construction.

Claims

1. A natural sound playback apparatus comprising:
   a sound material memory that stores m kinds of natural sounds as m sound material data pieces, where m is an integer larger than one;
   m fluctuation simulators that create playback timings for natural sounds by simulating fluctuation in nature depending on corresponding sound material data pieces;
   n data readers that read a specified sound material data piece from said sound material memory with specified timing, where n is a positive integer smaller than m;
   n natural sound playback sections that play back signal data read by each data reader;
   a priority memory that stores the priority order of said m sound material pieces; and
   an output channel controller that monitors playback timings generated by said m fluctuation simulators and, if some playback timing occurs, judges the operational states of said n data readers to assign said playback timing and corresponding sound material data pieces to idle data readers,
   said output channel controller selecting n sound material data pieces of higher priorities based on the priority order stored in said priority order memory, if playback timing for more than n sound material data pieces simultaneously occurs.

2. The natural sound playback apparatus defined in claim 1 wherein each of said sound material data pieces represents an intermittent natural sound having a definite length.

3. The natural playback apparatus defined in claim 1 wherein each of said fluctuation simulators is a 1/f fluctuation timing generator that creates playback timing for natural sounds based on 1/f fluctuation inherent in the corresponding one of said sound material pieces.

4. A natural sound playback apparatus comprising:
   a sound material memory that stores a plurality of unit natural sounds as sound material data pieces,
   a 1/f fluctuation timing generator that creates playback timing for natural sounds depending on 1/f fluctuation inherent in each of said sound material data pieces,
   a data reader that reads a specified sound material data piece from said sound material memory with specified timing,
   a natural sound playback section that plays back the signal data read by said data reader,
   a 1/f fluctuation volume level generator that obtains output volume at each playback timing point based on 1/f fluctuation inherent in each of said sound material pieces,
   a volume controller that controls the magnitude of the signal played back by said natural sound playback section, based on a value obtained by said l/f fluctuation level generator,
   an LR volume generator that obtains the balance of volume between left and right to output natural sound through two left and right speakers,
   an LR volume controller that creates, from the signal output from said volume controller, a signal output through a left speaker and a signal output through a right speaker, based on the balance of volume between left and right obtained by said LR volume generator,
   and an Lch output device and Rch output device that output played-back sounds for left and right.

5. A natural sound playback apparatus selected from the natural playback apparatus defined in claim 4 wherein the digital data read from said sound material memory by said data reader is converted to analog data before being processed further.

6. A natural sound playback apparatus selected from the natural playback apparatus defined in claim 4 wherein the digital data read from said sound material memory by said data reader is processed further without being converted to analog data.

7. A natural sound playback apparatus comprising:
   a sound material memory that stores a plurality of unit natural sounds as sound material data pieces,
   a 1/f fluctuation timing generator that creates playback timing for natural sounds depending on 1/f fluctuation inherent in each of said sound material data pieces,
   a data reader that reads a specified sound material data piece from said sound material memory with specified timing,

a natural sound playback section that plays back the signal data read by said data reader,

an LR volume generator that obtains the balance of volume between left and right and output volume to output natural sound through two left and right speakers at each playback timing point,

an LR volume controller that creates, from the signal output from said volume controller, a signal output through a left speaker and a signal output through a right speaker, based on the balance of volume between left and right and output volume obtained by said LR volume generator,

and an Lch output device and Rch output device that output played-back sounds for left and right.

8. A natural sound playback apparatus selected from the natural playback apparatus defined in claim 7 wherein the digital data read from said sound material memory by said data reader is converted to analog data before being processed further.

9. A natural sound playback apparatus selected from the natural playback apparatus defined in claim 7 wherein the digital data read from said sound material memory by said data reader is processed further without being converted to analog data.

Fig. 1

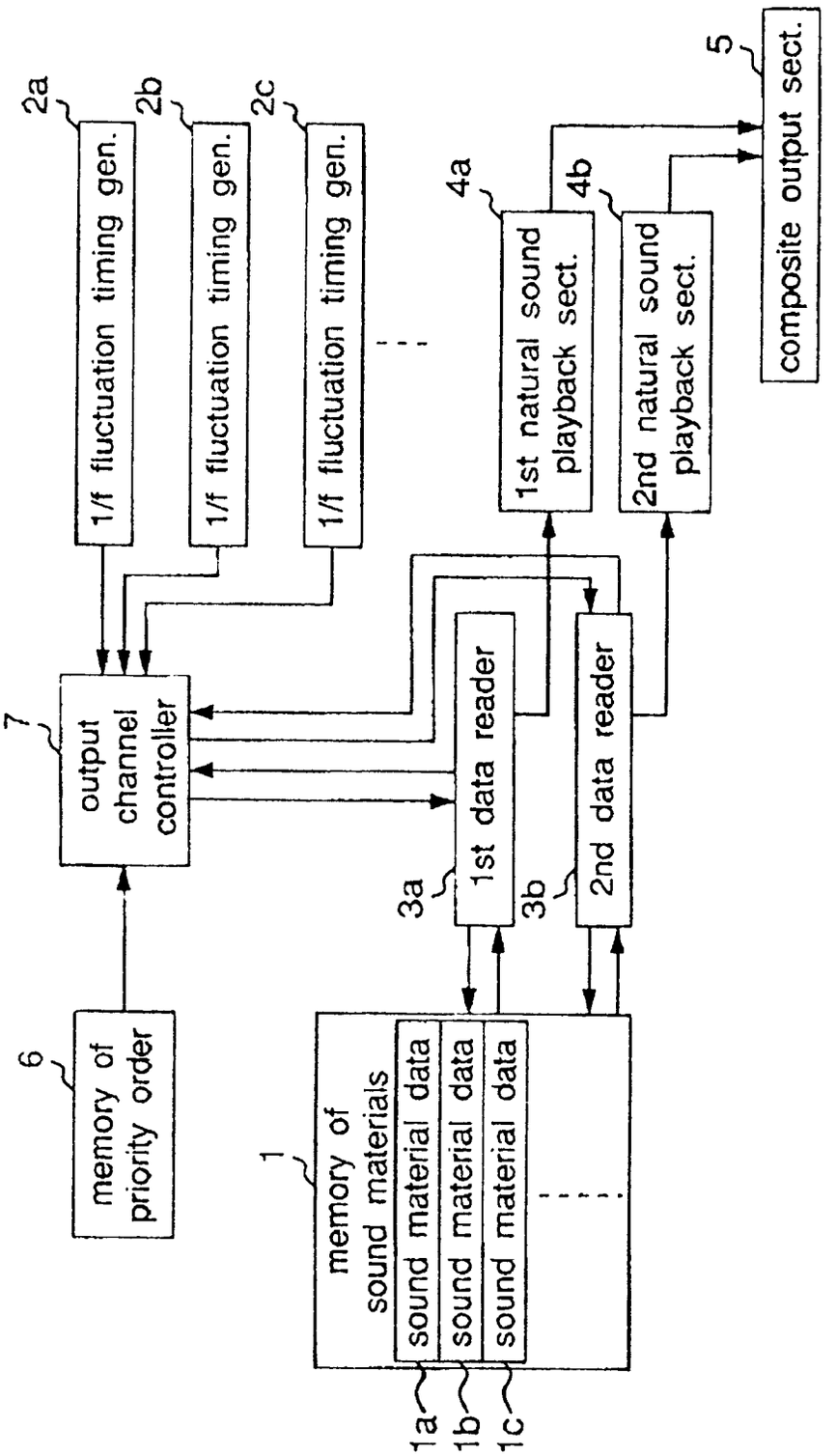
2a
1/f fluctuation timing gen.
2b
1/f fluctuation timing gen.
2c
1/f fluctuation timing gen.
4a
1st natural sound playback sect.
4b
2nd natural sound playback sect.
5
composite output sect.
7
output channel controller
3a
1st data reader
3b
2nd data reader
6
memory of priority order
1
memory of sound materials
sound material data
sound material data
sound material data
1a
1b
1c

Fig.2

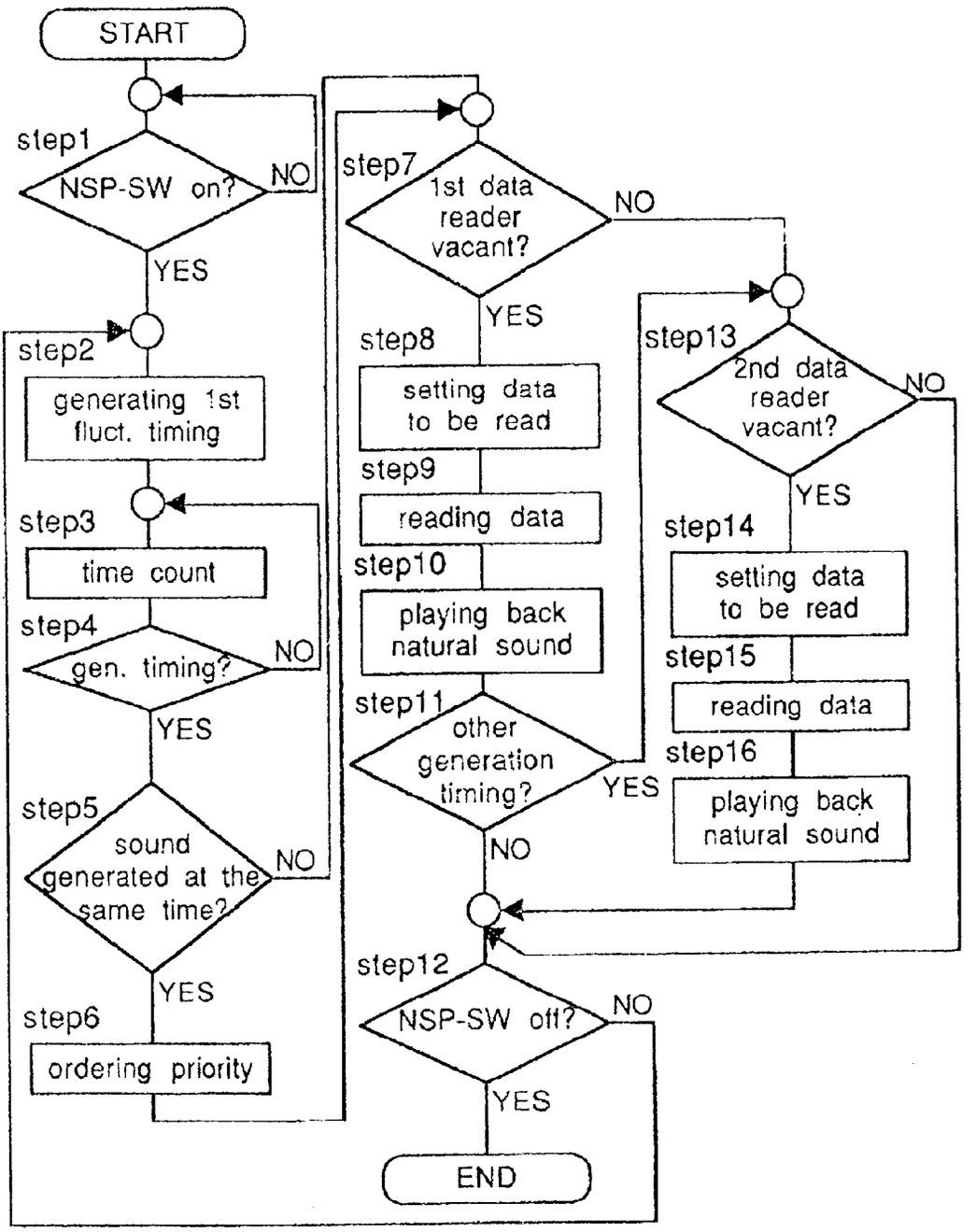
START
step1
NSP-SW on?
NO
YES
step2
generating 1st fluct. timing
step3
time count
step4
gen. timing?
NO
YES
step5
sound generated at the same time?
NO
YES
step6
ordering priority
step7
1st data reader vacant?
NO
YES
step8
setting data to be read
step9
reading data
step10
playing back natural sound
step11
other generation timing?
YES
NO
step13
2nd data reader vacant?
NO
YES
step14
setting data to be read
step15
reading data
step16
playing back natural sound
step12
NSP-SW off?
NO
YES
END

Fig.3

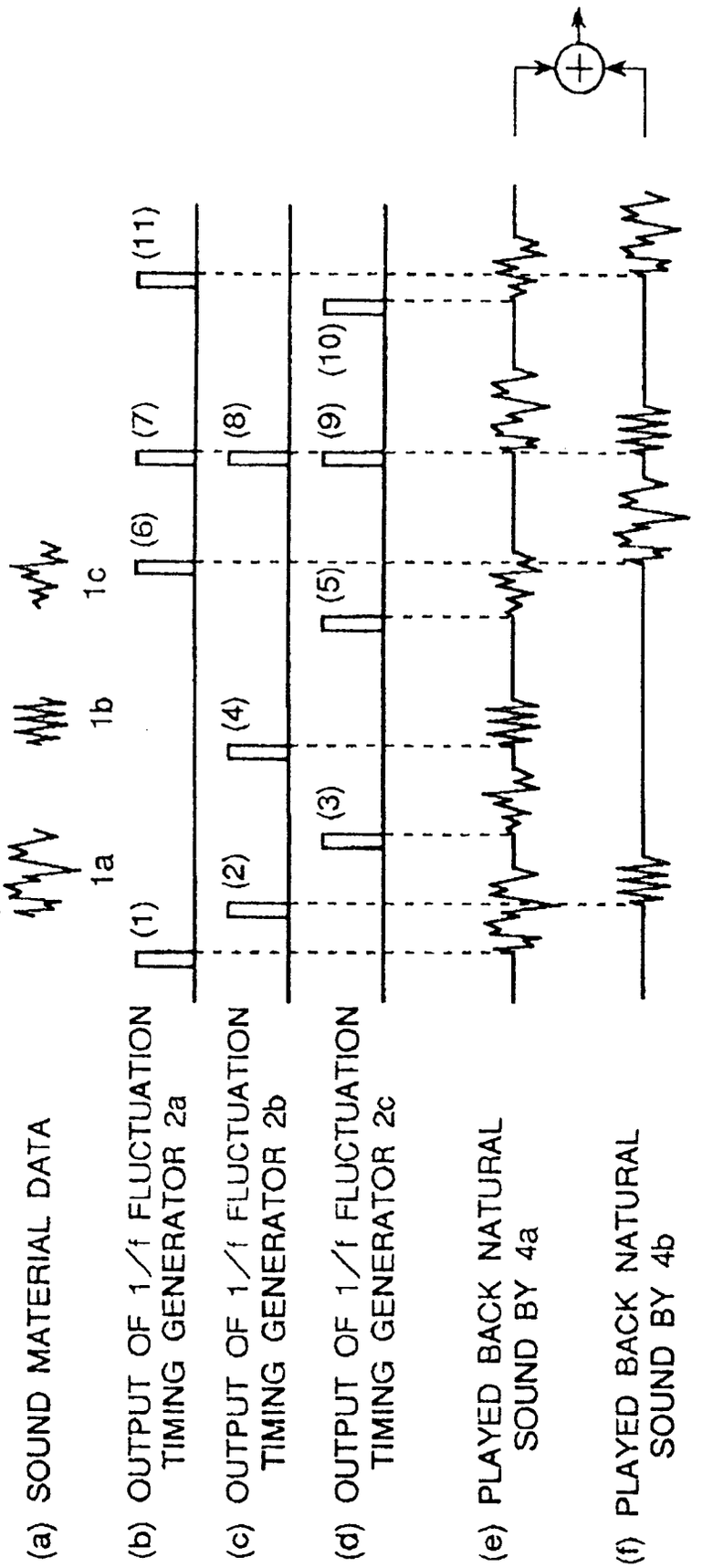
(a) SOUND MATERIAL DATA
1a
1b
1c
(b) OUTPUT OF 1/f FLUCTUATION TIMING GENERATOR 2a
(1)
(6)
(7)
(11)
(c) OUTPUT OF 1/f FLUCTUATION TIMING GENERATOR 2b
(2)
(4)
(8)
(d) OUTPUT OF 1/f FLUCTUATION TIMING GENERATOR 2c
(3)
(5)
(9)
(10)
(e) PLAYED BACK NATURAL SOUND BY 4a
(f) PLAYED BACK NATURAL SOUND BY 4b

Fig.4

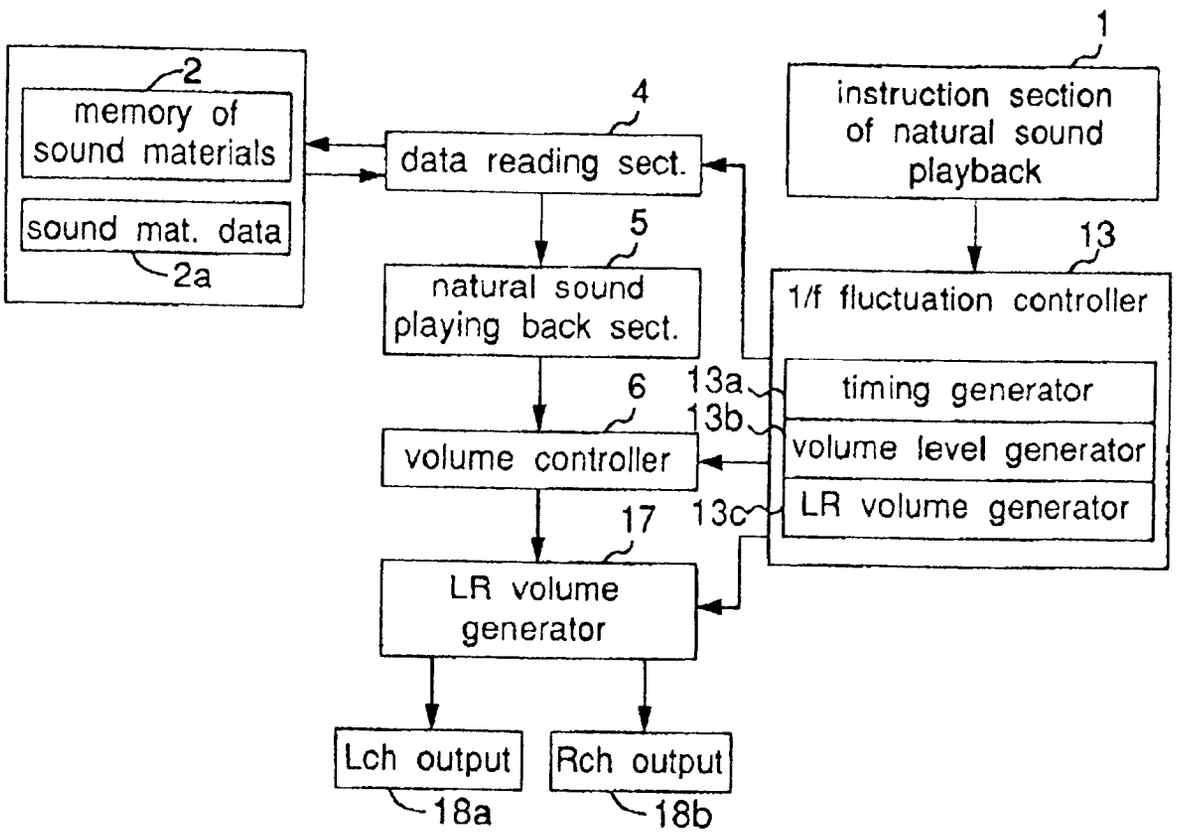
1
instruction section of natural sound playback
2
memory of sound materials
sound mat. data
2a
4
data reading sect.
5
natural sound playing back sect.
6
volume controller
17
LR volume generator
13
1/f fluctuation controller
13a
timing generator
13b
volume level generator
13c
LR volume generator
Lch output
18a
Rch output
18b

Fig.5

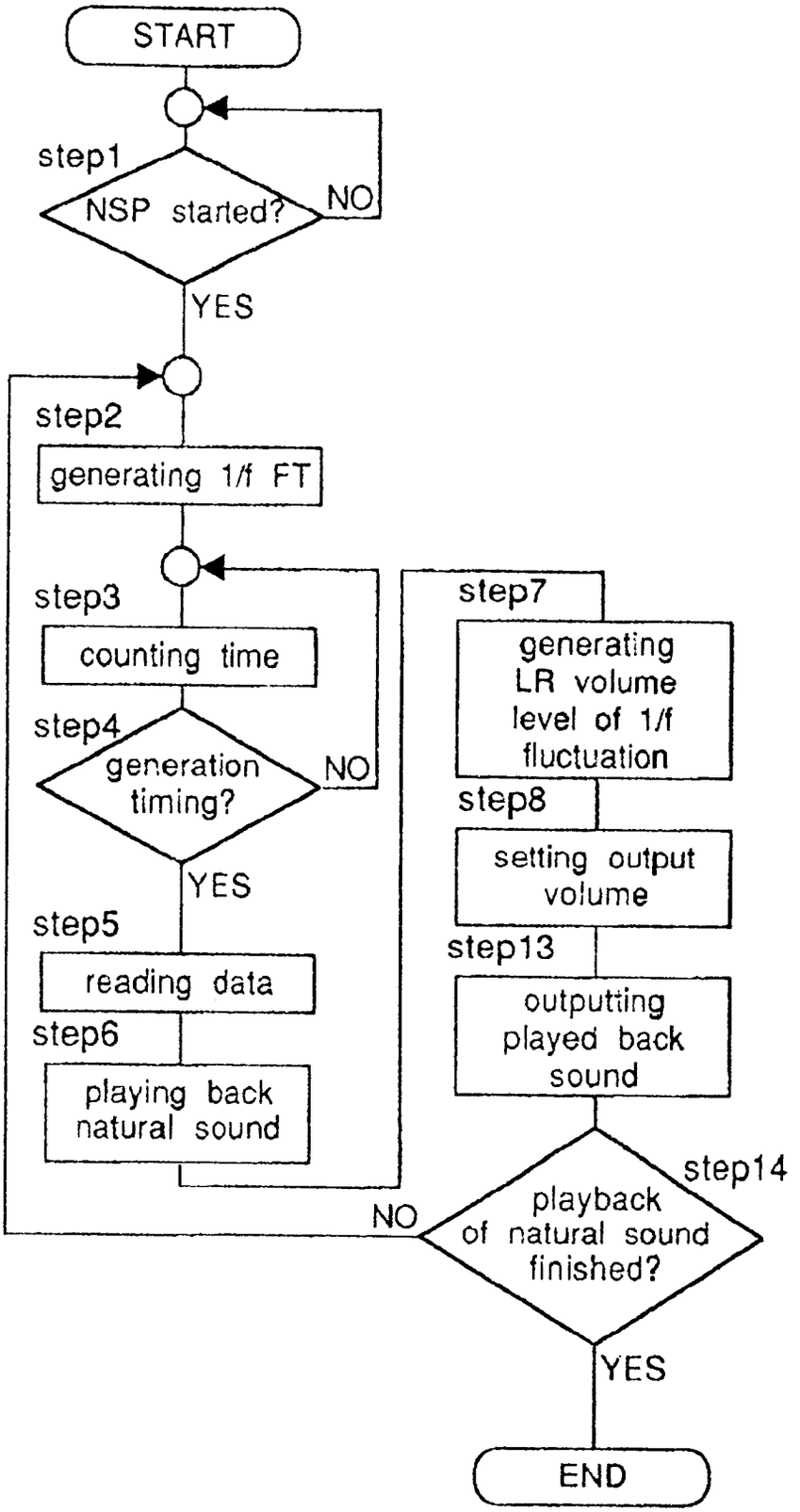
START
step1
NSP started?
NO
YES
step2
generating 1/f FT
step3
counting time
step4
generation timing?
NO
YES
step5
reading data
step6
playing back natural sound
step7
generating LR volume level of 1/f fluctuation
step8
setting output volume
step13
outputting played back sound
step14
playback of natural sound finished?
NO
YES
END

Fig.6

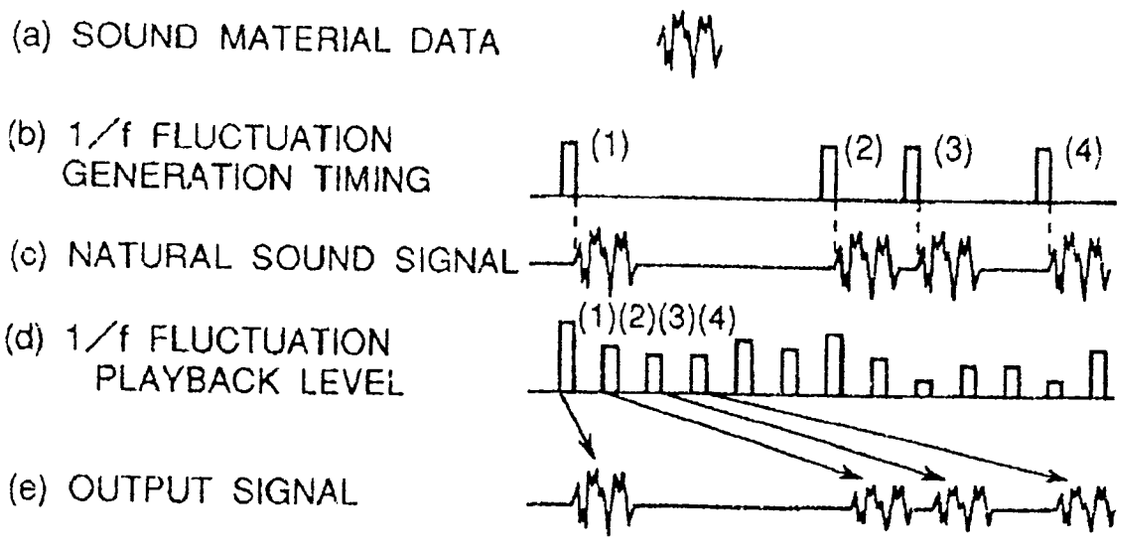
(a) SOUND MATERIAL DATA
(b) 1/f FLUCTUATION GENERATION TIMING
(c) NATURAL SOUND SIGNAL
(d) 1/f FLUCTUATION PLAYBACK LEVEL
(e) OUTPUT SIGNAL
(1)
(2)
(3)
(4)
(1)(2)(3)(4)

Fig.7 PRIOR ART

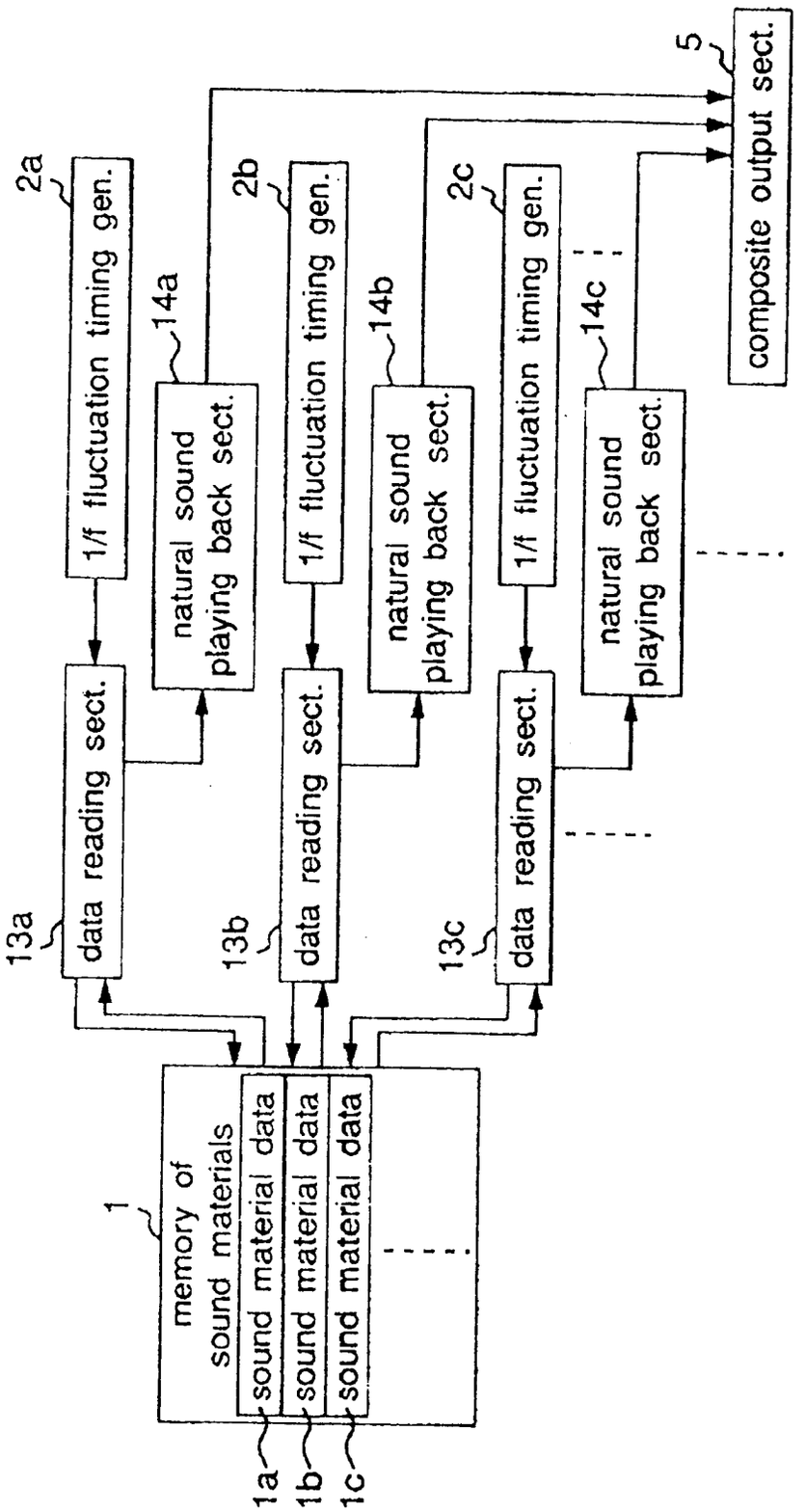

Fig.8
PRIOR ART

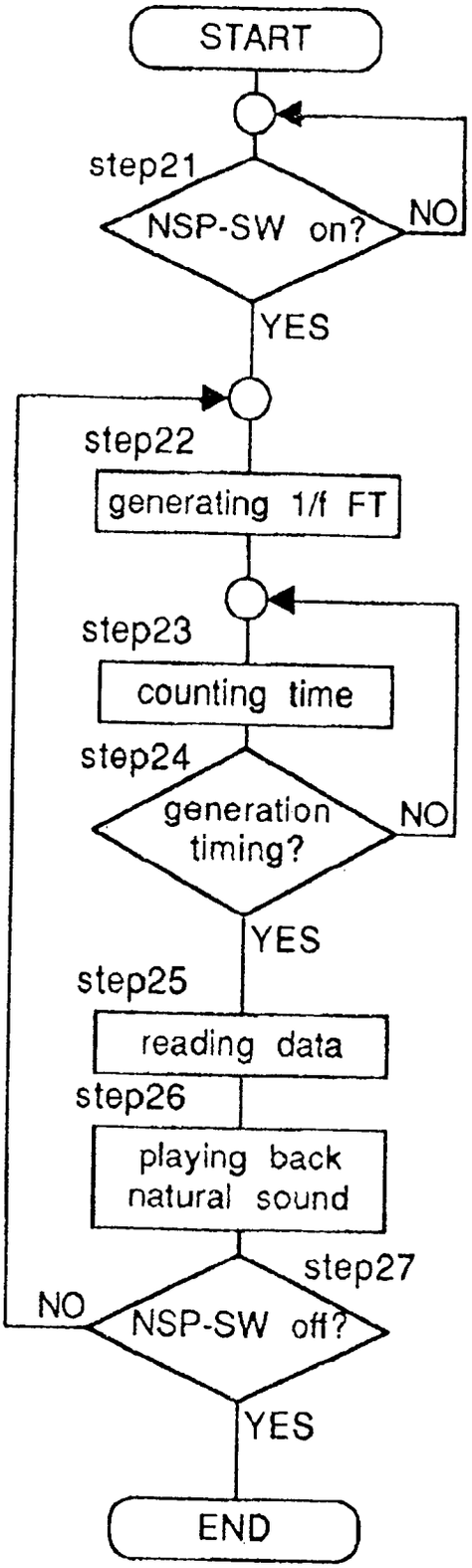

Fig.9 PRIOR ART