ABSTRACT

A bucket brigade device constructed of a plurality of units and constituting a signal delay path is supplied with sound signals from a sound source such as an acoustic apparatus.

The bucket brigade device transmits the sound source signals from unit to unit under control of a clock pulse commonly applied to the unit from a clock pulse oscillator and gives forth the sound source signals therefrom with a time delay determined by the number of bucket brigade unit and the clock pulse frequency.

Connected between the input and output of the signal delay path is at least one feedback line constructed of a series circuit comprising an amplifier and a loop gain controller as major components permissibly including another time-variable signal delay path of substantially the same construction as first-mentioned and a filter of high, low or band pass type as minor components, or of another series circuit comprising the major components and either of the minor components.

The reverberation-imparting apparatus thus arranged can provide the sound source signals with a reverberation effect in which the time delay, sustain period, envelope and/or frequency characteristics of the resultant reverberation sounds can be freely controlled.

16 Claims, 23 Drawing Figures
FIG. 6

CLOCK PULSE OSCILLATOR

FIG. 7A

FIG. 7B

FIG. 7C

FIG. 8

VOLTAGE LEVEL

FREQUENCY (Hz)
FIG. 15

FIG. 16
REVERBERATION-IMPARTING APPARATUS USING A BUCKET BRIGADE DEVICE

BACKGROUND OF THE INVENTION

This invention relates to a reverberation-impacting apparatus and more particularly to a reverberation-impacting apparatus using a delaying technique including a bucket brigade device or a charge coupled device.

FIG. 1 shows a schematic block diagram illustrating the typical example of a conventional reverberation-impacting apparatus.

The apparatus comprises a coil spring 11, an electro-mechanical transducer 12 such as a driving coil engaged with one end of the coil spring 11 and a mechnano-electrical transducer 13 such as a pickup coil engaged with the other end thereof.

In the reverberation-impacting apparatus constructed as above described, when an input terminal 14 connected to the transducer 12 is supplied with a sound signal from a sound source consisting of an acoustic apparatus such as a record player, tape recorder, radio receiver or various electrical musical instruments, then the sound signal is converted by the electro-mechanical transducer 12 as subjects the coil spring 11 to twisting vibrations.

The twisting vibrations repeatedly travel between both ends of the coil spring 11.

As a result, a reverberated signal is obtained from an output terminal 15 connected to the mechnano-electrical transducer 13.

The reverberation-impacting apparatus of the abovementioned arrangement, however, had the drawbacks that the reverberation time, and the envelope and frequency characteristics were defined by the arrangement of said apparatus, failing to admit of free control; the apparatus itself occupied a relatively large space; and the reverberation characteristics of the apparatus were noticeably disturbed by external mechanical shocks or shakings.

Another type of prior art reverberation-impacting apparatus was constructed by means of the delayed feedback technique in which the signal delay path consisted of a magnetic drum or tape. Even such reverberation-impacting apparatus was also unavoidably accompanied with the shortcomings that it required a relatively large installation space and the reverberation characteristics were prominently obstructed similarly be external mechanical shocks or shakings.

It is, therefore, the object of this invention to provide a reverberation-impacting apparatus using a signal delay line including a bucket brigade device in which the delaying time, reverberation period, envelope and/or frequency characteristics of the produced reverberation sounds can be freely varied; the apparatus itself occupies a very small space; and the reverberation characteristics are undisturbed by any external mechanical shocks or shakings.

SUMMARY OF THE INVENTION

A reverberation-impacting apparatus in accordance with this invention comprises a signal delay line which includes a first transmission-time-variable signal delay path comprising a plurality of bucket brigade units which, upon receipt of sound signals from a sound source, transmit the sound source signals from unit to unit under control of a clock pulse commonly impressed on the respective units from a clock pulse oscillator; and at least one feedback line comprising an amplifier coupled to a loop gain controller and a second time-variable signal delay path of the same construction as the first-time-variable signal delay path. A filter of high, low or band pass type is optionally provided in the feedback line.

A reverberation-impacting apparatus arranged as described above has the advantage of occupying a very small space, saving the reverberation characteristics from any external mechanical shocks or shakings and rendering the time delay, reverberation period, envelope and/or frequency characteristics of the produced reverberation sounds all freely controllable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic block diagram illustrating the typical example of a prior art reverberation-impacting apparatus;

FIG. 2 shows a block circuit diagram of a reverberation-impacting apparatus according to an embodiment of the invention;

FIG. 3A is a practical arrangement of the bucket brigade device constituting a time-variable signal delay path shown in FIG. 2;

FIG. 3B shows another practical arrangement of the bucket brigade device;

FIG. 4 shows the practical arrangement of a circuit portion relating to a clock pulse oscillator shown in FIG. 2;

FIGS. 5A and 5B respectively illustrate the input and output signals of a circuitry shown in FIG. 2;

FIG. 5C shows another type of output signals;

FIG. 6 shows a block circuit diagram of a reverberation-impacting apparatus according to another embodiment of the invention;

FIGS. 7A to 7C illustrate the different type of practical arrangement of a filter circuit shown in FIG. 6;

FIG. 8 shows a frequency characteristic curve of the output signal of a circuitry shown in FIG. 6, relative to each case where the filter circuit shown in FIGS. 7A, 7B or 7C is used;

FIG. 9 shows a block circuit diagram of a reverberation-impacting apparatus according to still another embodiment of the invention;

FIG. 10 shows a block circuit diagram of a reverberation-impacting apparatus according to a further embodiment of the invention;

FIG. 11 shows a block circuit diagram of one modification in accordance with the invention;

FIG. 12 is the output waveform of a circuit shown in FIG. 11; and

FIGS. 13 to 18 show block circuit diagrams of further different modifications in accordance with the invention.

PREFERRED EMBODIMENTS OF THE INVENTION

A reverberation-impacting apparatus according to the preferred embodiments of this invention will now be described by reference to the appended drawings.

FIG. 2 is a block circuit diagram of a reverberation-impacting apparatus embodying the invention.

In this figure, reference numeral 21 denotes a transmission-time-variable signal delay path constituted by a bucket brigade device or charge coupled device as hereinunder described.
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FIG. 3A shows one practical arrangement of the charge coupled device 21 as a kind of bucket brigade device. The bucket brigade device 21 comprises numerous metal electrodes 31 having a size, for example, of 10 to 50 \( \mu m^2 \) substantially linearly evacuated at an interval of about 3 to 5 \( \mu m \) on an insulation layer 32 made, for example, of SiO_2 mounted on an N type (or P type) silicon semiconductor substrate 33, and two (or three) control electrode leads 34 and 35 respectively connected to those of the metal electrodes 31 which are selected by leaving out the predetermined number of intervening units 211, 212, 213, . . . 21n (alternating metal electrodes in this example). In those portions of the silicon semiconductor substrate 33 which are positioned outside of both terminal units 211 and 21n of the metal electrodes 31 are formed P type diffused semiconductor regions 36 and 37 each of which constitutes a P-N junction at the boundary facing the N type semiconductor substrate 33. In this case, the P type semiconductor region 36 acts as an input gate and the P type semiconductor region 37 acts as an output gate.

On those portions of the insulation layer 32 which are disposed close to the P type semiconductor regions 36 and 37 are evaporated metal electrodes 38 and 39 respectively acting as input and output gate electrodes.

Where the bucket brigade device 21 of the above-mentioned construction is supplied with sound signals from a sound source (not shown) connected to an input terminal 22 under the condition where the semiconductor substrate 33 is set at a reference or zero potential, the input and output gate electrodes 38 and 39 are impressed with an appropriate positive voltage, and the control electrode leads 34 and 35 are alternately supplied with a clock or shift pulse signal having a frequency falling within the superaudible region from a clock or shift pulse oscillator 23 provided with a frequency control element 24 consisting, for example, of a variable resistor and having an appropriate level of negative voltage (in this example, about −10 volts), then supply of the clock pulse signal to the control electrode lead 34 causes, as is well known to those skilled in the art, holes of minority carrier to be precharged in response to the pattern of the input sound signals in those portions of the semiconductor substrate 33 which are disposed near the boundary facing those portions of the insulation layer 32 which are positioned immediately below the metal electrodes 31 connected to the control electrode lead 34. On the other hand, where the other control electrode lead 35 is supplied with the clock pulse signal (at this time, the control electrode lead 34 is not supplied with the clock pulse signal), then the precharged holes are shifted to those portions of the semiconductor substrate 33 which are disposed near the boundary facing those portions of the insulation layer 32 which are positioned immediately below the metal electrodes 31 connected to the control electrode lead 35.

Thereafter, the supply of the clock pulse signal alternately to the control electrode leads 34 and 35 causes the input sound signal conducted to the bucket brigade device 21 to be delivered therethrough from an output terminal 25 with the time delay which is determined by the number of the consecutively arranged pairs of metal electrodes 31 or bucket brigade units 211 to 21n and the frequency of the clock pulse signal impressed alternately on the control electrode leads 34 and 35.

For example, where the bucket brigade units are consecutively arranged in a number of 600 and the clock pulse signal generated by the clock pulse oscillator 23 has a frequency of 60kHz, then the input sound signal supplied to the input terminal 22 is delivered through the bucket brigade device 21 from the output terminal 25 with a time delay of about 10ms, because the input sound signal takes a time corresponding to a reciprocal of the frequency of the clock pulse signal, namely, 1/600,000 = 0.017ms for passing through each of the bucket brigade units 211 to 21n.

Thus the bucket brigade device 21 acts as a time-variable signal delay path with a time delay predetermined by the number of the consecutively arranged units 211 to 21n which are included therein and the frequency of the clock pulse signal from the clock pulse oscillator 23.

FIG. 3B shows another practical arrangement of the bucket brigade device 21 acting as a time-variable signal delay path as above described.

The bucket brigade device 21 has the same construction as that of FIG. 3A excepting that a plurality of P type semiconductor regions 40 complementary to the N type semiconductor substrate 33 are formed in those portions of the substrate 33 which face the respective metal electrodes 31.

The bucket brigade device so arranged is operated in a different manner from the bucket brigade device shown in FIG. 3A only in that the precharge-shift operations are executed through the P type semiconductor regions 40 when the aforesaid negative clock pulse signals generated by the clock pulse oscillator 23 are impressed on the metal electrode leads 34 and 35.

FIG. 4 shows the practical circuit arrangement of the clock pulse oscillator 23 having its operation related to the time-variable signal delay path 21 constituted by the bucket brigade device as shown in FIGS. 3A or 3B.

The clock pulse oscillator 23 comprises a relaxation oscillator 41, a flip-flop or bistable circuit 42 triggered by an output signal from the relaxation oscillator 41, and an output circuit 43 for supplying two output signals from the bistable circuit 42 to the time-variable signal delay path 21 as shift or clock pulse signals, respectively constructed as hereinafter described.

The relaxation oscillator 41 comprises an unijunction transistor (or double base diode) Q1 whose emitter is connected via a capacitor C1 to a negative power source line 44N of −12 volts and also via the frequency control element 24 constituted by a variable resistor to a grounded positive power source line 44P. One base of the unijunction transistor Q1 is connected to the ground and the other base thereof is connected to the ground via a resistor R1 and also to the negative power source line 44N via a resistor R2.

The bistable circuit 42 comprises two npn type grounded-emitter transistors Q2 and Q3 each having its base cross-coupled to the collector of the other transistor via a parallel circuit consisting of a resistor R3 or R4 and a capacitor C2 or C3 and its collector connected to the ground via a resistor R5 or R6. The collectors of both transistors Q2 and Q3 are also connected to the other base of the unijunction transistor Q1 via individual diodes D1 and D2 of the indicated polarities and a common coupling capacitor C4 for receiving triggering pulses.
Connected between the junction 45 of the diodes D1 and D2 and the ground is a diode D3 of the indicated polarity.

And the output circuit 43 comprises two npn type emitter follower transistors Q4 and Q5 having their bases connected via respective resistors R7 and R8 to the collectors of the transistors Q2 and Q3 and their collectors connected to the negative power source line 44N via separate resistors R9 and R10. The collectors of the transistors Q4 and Q5 are also connected to the control electrode leads 34 and 35 of the time-variable signal delay path 21.

The operation of the clock pulse oscillator 23 constructed as above-mentioned will now be described.

Firstly, when the charged voltage of the capacitor C1 reaches a prescribed value which is determined by the charging time constant of the capacitance of the capacitor C1 and the resistance of the variable resistor 24, then the unijunction transistor Q1 constituting the relaxation oscillator 41 is rendered conductive.

The charged voltage of the capacitor C1 is immediately discharged through the fired unijunction transistor Q1. Thereafter in the same manner as described above, the capacitor C1 is repeatedly charged and discharged, whereby the relaxation oscillator 41 develops a sawtooth wave signal having a frequency (in this embodiment, 80 to 240 kHz) determined by the charge-discharge time constant of the capacitor C1 and the variable resistor 24.

Then, the oscillating signal from the relaxation oscillator 41 is supplied through the coupling capacitor C4 to the bistable circuit 42 as a trigger signal.

The bistable circuit 42 is operated with a frequency (in this embodiment, about 40 to 120 kHz) equal to one-half of that of the oscillating signal generated by the relaxation oscillator 41 and produces a pair of output signal peaks which are different by 180° in phase. The bistable circuit 42 also acts as a wave shaper for the output signals from the relaxation oscillator 41.

A pair of pulse signals each having a frequency of 40 to 120 kHz thus obtained are impressed on the control electrode leads 34 and 35 of the time-variable signal delay path 21 as clock or shift pulse signals through the two emitter follower transistors Q4 and Q5 included in the output circuit 43.

As a result, sound signals supplied through the input terminal 22 from a sound source to the time-variable signal delay path 21 are delivered therefrom after a time delay which is determined by the frequency of the clock pulses generated by the clock pulse oscillator 23 and the number of the consecutively arranged bucket brigade units constituting the time-variable signal delay path 21, said sound source consisting, for example, of an acoustic apparatus such as a record player, tape recorder, radio receiver or various electrical musical instruments.

Sound signals from the time-variable signal delay path 21 thus obtained are then conducted to the output terminal 25 through an emitter follower circuit 46 and three cascaded low pass filters 47, 48 and 49 each having the same construction and a cutoff frequency of about 15 kHz, thereby shunting the clock pulse component included in the sound signals. The diode D3 acts to shunt the positive-going component whose level exceeds the predetermined level of the aforesaid trigger signals applied thereto.

Reverting to FIG. 2, between the output and input of the time-variable signal delay path 21 is connected a feedback line 26 constructed of a series circuit comprising an amplifier 27 and a loop gain controller 28 consisting, for example, of a variable resistor.

Thus, the circuitry 20 of FIG. 2 constructed as described above constitutes a delayed feedback line acting as a reverberation-imparting apparatus in which the input sound signal e1 (see FIG. 5A) supplied through the input terminal 22 to the time-variable signal delay path 21 is repeatedly delivered therefrom with a time delay T1 determined by the number of the linearly arranged bucket brigade units constituting the signal delay path 21 and the frequency of the clock pulse signal generated by the clock pulse oscillator 23.

In this case, where the loop gain of the circuitry 20 is set at a level substantially equal to 1 by the loop gain controller 28, then reverberation sounds e2 repeatedly produced from the output terminal 25 with the aforesaid time delay T1 have, as shown in FIG. 5B, a constant voltage level regardless of any lapse of time, because the circuitry 20 acts as a self-oscillator.

In contrast, the smaller the value 1 is the less the level of the loop gain of the circuitry 20 by the loop gain controller 28, the lower with time the voltage level of the reverberation sounds e2 derived from the output terminal 25, as shown in FIG. 5C.

Thus, the voltage envelope as well as the reverberation period of the produced reverberation sounds e2 or e3 can also be controlled by the loop gain controller 28.

FIG. 6 shows a block circuit diagram of a reverberation-imparting apparatus according to another embodiment of the invention.

In this embodiment, a feedback line 261 connected between the output and input of the time-variable signal delay path 21 is constituted by a series circuit comprising an amplifier 271, a loop gain controller 281 and the undermentioned filter circuit 51.

The filter circuit 51 may comprise a high pass filter 511 of differentiation circuit type including a capacitor C11 and a resistor R11 as shown in FIG. 7A, a low pass filter 512 of integration circuit type including a resistor R12 and a capacitor C12 as shown in FIG. 7B, or a band pass filter 513 of parallel resonant circuit type including an inductance coil L and a capacitor C13.

With the reverberation-imparting apparatus 201 of FIG. 6, a curve 61 of FIG. 8 is assumed to denote the frequency characteristic of the reverberation sounds produced from the output terminal 25 where the filter circuit 51 is not included in the feedback line 261.

Under such assumption, when the filter circuit 51 comprises the high filter 511 shown in FIG. 7A, then the produced reverberation sounds will exhibit a frequency characteristic in which the higher frequency component contained therein is emphasized as shown by a curve 62 of FIG. 8.

When the filter circuit 51 comprises the low pass filter 512 shown in FIG. 7B, then the produced reverberation sounds will exhibit a frequency characteristic in which the lower frequency component contained therein is emphasized as shown by a curve 63 of FIG. 8.

In contrast, when the filter circuit 51 comprises the band pass filter 513 shown in FIG. 7C, then the produced reverberation sounds will exhibit a frequency characteristic in which the intermediate frequency component contained therein is emphasized as shown by a curve 64 of FIG. 8.
In the reverberation-imparting apparatus 201 arranged as above described, the frequency characteristics of the produced reverberation sounds can also be freely controlled by the selection of the filter circuit 51, in addition to the delay time, reverberation period and envelope of the reverberation sounds as in the embodiment of FIG. 2.

FIG. 9 shows a block circuit diagram of a reverberation-imparting apparatus 202 according to still another embodiment of the invention.

In this embodiment, a feedback line 262 connected between the output and input of the time-variable signal delay path 21 is constructed of a series circuit comprising an amplifier 272, a loop gain controller 282 and another time-variable signal delay path 21a having substantially the same construction as the first-mentioned one (21) and controlled by a clock pulse oscillator 23a provided with a frequency control element 24a.

According to the reverberation-imparting apparatus 202 of FIG. 9, the time delay of the produced reverberation sounds can be varied over a wider range than in the embodiment of FIG. 2.

FIG. 10 shows a block circuit diagram of a reverberation-imparting apparatus 203 according to another embodiment of the invention.

In this embodiment, a feedback line 263 connected between the output and input of the time-variable signal delay path 21 is constituted by a series circuit comprising an amplifier 273, a loop gain controller 283, another time-variable signal delay path 21b having substantially the same construction as the first-mentioned one (21 or 21a) and controlled by a clock pulse oscillator 23b provided with a frequency control element 24b, and a filter circuit 51a constructed substantially in the same manner as the above-mentioned one (51).

According to the reverberation-imparting apparatus 203 of FIG. 10, the frequency characteristics of the produced reverberation sounds can be freely controlled, as in the embodiment of FIG. 6, by selection of the filter circuit 51a, and also the time delay of the reverberation sounds can be varied, as in the embodiment of FIG. 9, over a wide range.

FIG. 11 is a block circuit diagram of a reverberation-imparting apparatus 204 according to a modification of the invention.

In this modification, a feedback line connected between the output and input of the time-variable signal delay path 21 comprises the parallel connection of the feedback line 26 shown in the embodiment of FIG. 2 and the feedback line 262 shown in the embodiment of FIG. 9.

In the reverberation-imparting apparatus 204 of FIG. 11, the produced reverberation sounds comprise, as shown in FIG. 12, the combination of a first component 2 obtained by the feedback line 261 with the aforesaid time delay T1 and a second component 4 generated by the feedback line 262 with a time delay T2 which is longer than the time delay T1 due to the presence of the time-variable signal delay path 21a.

FIG. 13 shows a block circuit arrangement of a reverberation-imparting apparatus according to another modification of the invention where a feedback line connected between the output and input of the time-variable signal delay path 21 comprises the parallel connection of the feedback line 26 shown in the embodiment of FIG. 2 and the feedback line 261 shown in the embodiment of FIG. 6, the arrangement of said parallel connection being varied as indicated in other FIGS. 14 to 18 which respectively show further modifications of the invention.

According to any of the modified reverberation-imparting apparatuses shown in FIGS. 13 to 18, there can be attained a different type reverberation effect which is determined by the arrangement of said parallel connection of two or three feedback lines connected between the output and input of the time-variable signal delay path 21.

The parts of FIGS. 13 to 18 corresponding to those of FIGS. 2, 6 and 9 are denoted by the corresponding numerals and the description thereof is omitted.

What we claim is:

1. In a sound reproducing system so arranged as to impart a reverberation effect to a sound signal from a sound source, a reverberation-imparting apparatus comprising:

a first signal delay path which includes: a bucket brigade device coupled with said sound source to receive the sound signal produced therefrom and including a plurality of bucket brigade units; and a clock pulse oscillator generating a clock pulse signal having a super-audible frequency and coupled with said respective bucket brigade units for imparting a time delay to the sound signal supplied to said bucket brigade device from said sound source, said time delay being determined by the frequency of the clock pulse signal generated by said clock pulse oscillator and the number of said bucket brigade units; and

at least one feedback line coupled between the input and output of said first signal delay path, said feedback line including: an amplifier; a loop gain controller coupled to said amplifier; and a second signal delay path of substantially the same construction as said first signal delay path coupled to at least one of said amplifier and loop gain controller.

2. A reverberation-imparting apparatus as claimed in claim 1 wherein:

said clock pulse oscillator included in said first signal delay path comprises a relaxation oscillator, and a bistable circuit coupled with the output of said relaxation oscillator; and

a low pass filter means is coupled to the output of said bucket brigade device included in said first signal delay path for filtering out the clock pulse component from said clock pulse oscillator contained in an output signal derived from said bucket brigade device.

3. A reverberation-imparting apparatus as claimed in claim 1 wherein said feedback line further includes a frequency filtering means.

4. A reverberation-imparting apparatus as claimed in claim 3 wherein said frequency filtering means comprises a high pass filter.

5. A reverberation-imparting apparatus as claimed in claim 3 wherein said frequency filtering means comprises a low pass filter.

6. A reverberation-imparting apparatus as claimed in claim 3 wherein said frequency filtering means comprises a band pass filter.

7. A reverberation-imparting apparatus as claimed in claim 1 wherein said amplifier, loop gain controller and second signal delay path are coupled together in series.

8. In a sound reproducing system so arranged as to impart a reverberation effect to a sound signal from a
sound source, a reverberation-imparting apparatus comprising:

a first signal delay path which includes: a bucket brigade device coupled with said sound source to receive the sound signal produced therefrom and including a plurality of bucket brigade units; and a clock pulse oscillator generating a clock pulse signal having a super-audible frequency and coupled with said respective bucket brigade units for imparting a time delay to the sound signal supplied to said bucket brigade device from said sound source, said time delay being determined by the frequency of the clock pulse signal generated by said clock pulse oscillator and the number of said bucket brigade units; and

at least one feedback line coupled between the input and output of said first signal delay path, said feedback line including the parallel connection of: a first series circuit which includes a first amplifier and a first loop gain controller; and a second series circuit which includes a second amplifier, a second loop gain controller and a second signal delay path of substantially the same construction as said first signal delay path.

9. A reverberation-imparting apparatus as claimed in claim 8 wherein said second series circuit further includes a frequency filtering means.

10. A reverberation-imparting apparatus as claimed in claim 9 wherein:

said clock pulse oscillator included in said first signal delay path comprises a relaxation oscillator, and a bistable circuit coupled with the output of said relaxation oscillator; and

a low pass filter means is coupled to the output of said bucket brigade device included in said first signal delay path for filtering out the clock pulse component from said clock pulse oscillator contained in an output signal derived from said bucket brigade device.

11. In a sound reproducing system so arranged as to impart a reverberation effect to a sound signal from a sound source, a reverberation-imparting apparatus comprising:

a first signal delay path which includes: a bucket brigade device coupled with said sound source to receive the sound signal produced therefrom and including a plurality of bucket brigade units; and a clock pulse oscillator generating clock pulse signal having a super-audible frequency and coupled with said respective bucket brigade units for imparting a time delay to the sound signal supplied to said bucket brigade device from said sound source, said time delay being determined by the frequency of the clock pulse signal generated by said clock pulse oscillator and the number of said bucket brigade units; and

at least one feedback line coupled between the input and output of said first signal delay path, said feedback line including the parallel connection of: a first series circuit which includes a first amplifier and a first loop gain controller; and a second series circuit which includes a second amplifier, a second loop gain controller and a frequency filtering means.

12. A reverberation-imparting apparatus as claimed in claim 11 wherein:

said clock pulse oscillator included in said first signal delay path comprises a relaxation oscillator, and a bistable circuit coupled with the output of said relaxation oscillator; and

a low pass filter means is coupled to the output of said bucket brigade device included in said first signal delay path for filtering out the clock pulse component from said clock pulse oscillator contained in an output signal derived from said bucket brigade device.

13. In a sound reproducing system so arranged as to impart a reverberation effect to a sound signal from a sound source, a reverberation-imparting apparatus comprising:

a first signal delay path which includes: a bucket brigade device coupled with said sound source to receive the sound signal produced therefrom and including a plurality of bucket brigade units; and a clock pulse oscillator generating a clock pulse signal having a super-audible frequency and coupled with said respective bucket brigade units for imparting a time delay to the sound signal supplied to said bucket brigade device from said sound source, said time delay being determined by the frequency of the clock pulse signal generated by said clock pulse oscillator and the number of said bucket brigade units; and

at least one feedback line coupled between the input and output of said first signal delay path, said feedback line including the parallel connection of: a first series circuit which includes a first amplifier and a first loop gain controller; and a second series circuit which includes a second amplifier, a second loop gain controller and a frequency filtering means.

14. A reverberation-imparting apparatus as claimed in claim 13 wherein:

said clock pulse oscillator included in said first signal delay path comprises a relaxation oscillator, and a bistable circuit coupled with the output of said relaxation oscillator; and

a low pass filter means is coupled to the output of said bucket brigade device included in said first signal delay path for filtering out the clock pulse component from said clock pulse oscillator contained in an output signal derived from said bucket brigade device.

15. In a sound reproducing system so arranged as to impart a reverberation effect to a sound signal from a sound source, a reverberation-imparting apparatus comprising:

a first signal delay path which includes: a bucket brigade device coupled with said sound source to receive the sound signal produced therefrom and including a plurality of bucket brigade units; and a clock pulse oscillator generating a clock pulse signal having a super-audible frequency and coupled with said respective bucket brigade units for imparting a time delay to the sound signal supplied to said bucket brigade device from said sound source, said time delay being determined by the frequency of the clock pulse signal generated by said clock pulse oscillator and the number of said bucket brigade units; and

at least one feedback line coupled between the input and output of said first signal delay path, said feed-
said clock pulse oscillator included in said first signal delay path comprises a relaxation oscillator, and a bistable circuit coupled with the output of said relaxation oscillator; and a low pass filter means is coupled to the output of said bucket brigade device included in said first signal delay path for filtering out the clock pulse component from said clock pulse oscillator contained in an output signal derived from said bucket brigade device.

* * * *

16. A reverberation-imparting apparatus as claimed in claim 15 wherein:

back line including the parallel connection of: a first series circuit which includes a first amplifier and a first loop gain controller; a second series circuit which includes a second amplifier, a second loop gain controller and a second signal delay path of substantially the same construction as said first signal delay path; and a third series circuit which includes a third amplifier, a third loop gain controller and a frequency filtering means.

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