Aug. 27, 1957 J. R. BUTTS 2,804,499

REVERBERATION METHOD AND APPARATUS

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FIG. 1.

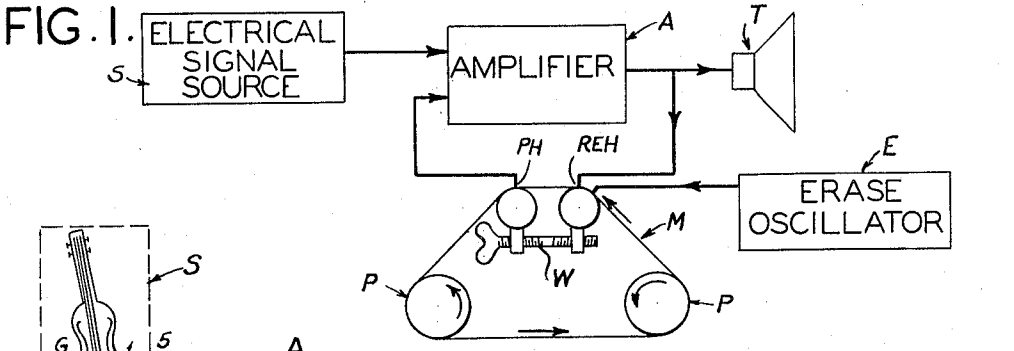

FIG. 2.

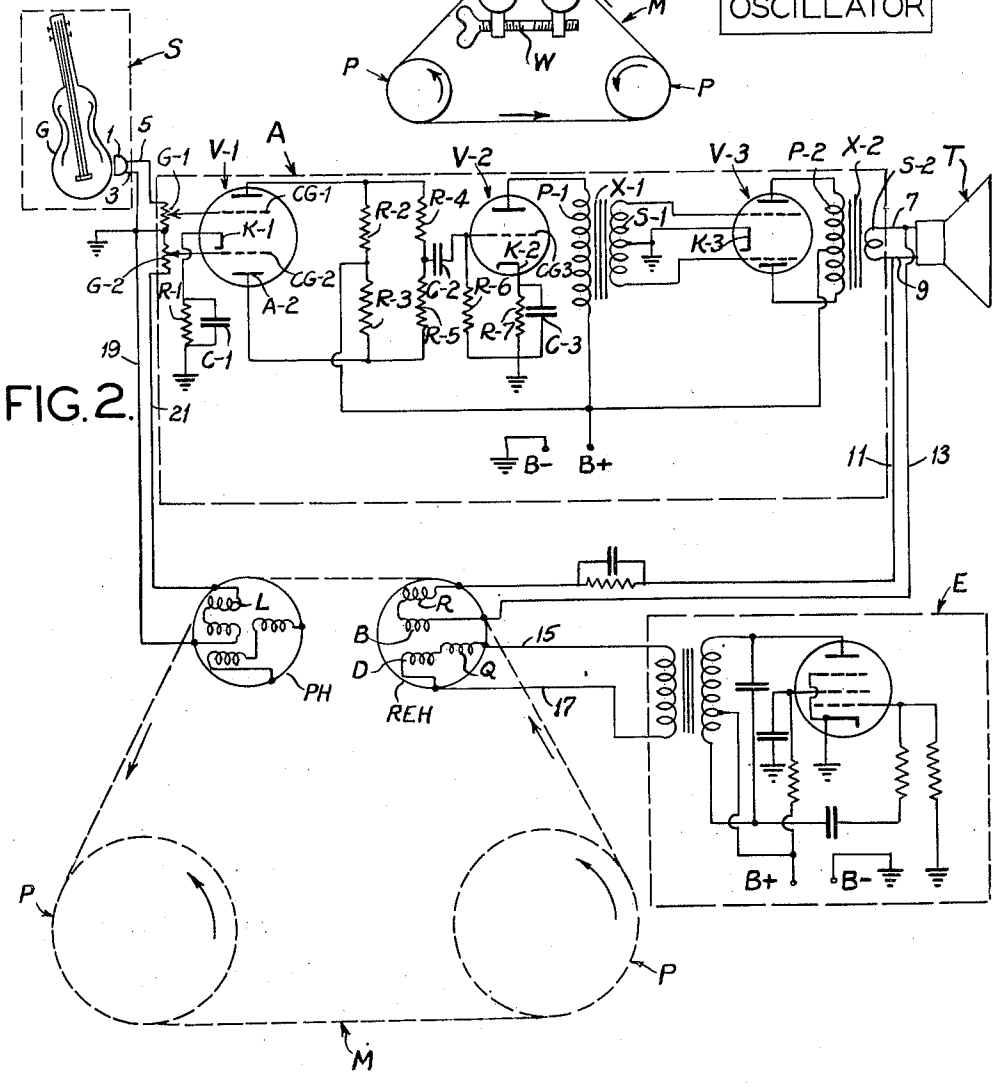

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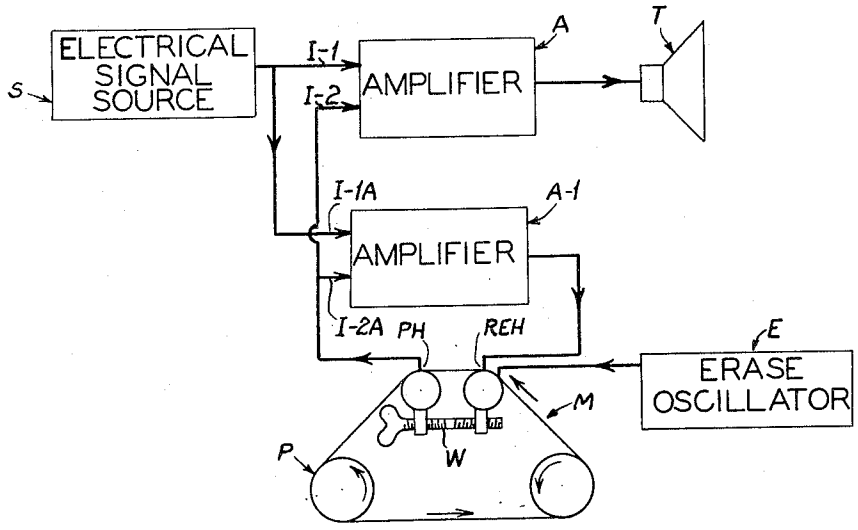
FIG. 3.



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REVERBERATION METHOD AND APPARATUS

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2 Claims. (Cl. 179—1)

This invention relates to reverberation methods and apparatus and more particularly to an electromechanical sound reverberating device.

Among the several objects of this invention may be noted the provision of devices which artificially produce reverberations or echoes of varying intensity, interval and duration; the provision of such reverberation devices which can be conveniently connected to any electrical signal source; and the provision of devices of the class described which are simple and compact in construction and reliable in operation. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, the invention is directed to a reverberation-producing device comprising an electronic amplifier having at least two inputs and at least two outputs, an electrical signal source connected to one input, a transducer connected to one output, an elongate magnetizable recording medium, an erase head for demagnetizing said medium, a recording head connected to the other output and adapted to produce a magnetic pattern in said medium in response to the electrical signal, a playback head connected to the other input adapted to reproduce said electrical signal in response to said magnetic pattern, and means for moving said medium past said erase, recording and playback heads, respectively, whereby the reproduced electrical signal is delayed in time relative to said first electrical signal.

The invention accordingly comprises the constructions and methods hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

Fig. 1 is a block diagram of a reverberation-producing device of the present invention;

Fig. 2 is a circuit diagram of the device, illustrating an exemplary signal source; and,

Fig. 3 is a block diagram of an alternate embodiment of the present invention.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

In the sound reproduction art it is frequently desirable to produce reverberation effects. However, conventional acoustical reverberation chambers are expensive and require substantial space while the artificial reverberation machines hitherto known are complex and expensive. In accordance with the present invention, an electronic reverberation-producing device is provided which is compact, versatile, inexpensive and reliable.

Referring now to Fig. 1, an electrical signal source is indicated by reference letter S. Any of the conventional electrical signal sources, such as microphones, phonograph pickups, the audio sections of radio or television receivers and the like, are equivalents for the purposes of this invention. This electrical signal source is connected to one input of an electronic amplifier A (which includes the customary gain or volume control for each input), one output of which is connected to drive a transducer unit T which may be any suitable electroacoustic transducer, such as a loud-speaker, a line to a load or the like. A second output of amplifier A and an erase oscillator E are connected to a recording and erasing head REH. A playback head PH is interconnected with a second input of amplifier A. An elongate magnetizable recording medium M, shown in the form of a loop, is passed over the recording and erasing head REH and playback head PH in the direction indicated by the arrowhead. The recording medium is driven by a pair of pulleys P, one of which is mechanically actuated by the customary drive motor and the other of which serves as an idler to maintain loop tension. The spacing between heads PH and REH may be varied by means of a reverse-threaded adjusting screw W.

Operation is as follows:

Any electrical representation of an audible frequency signal impressed by source S on the first input of amplifier A is amplified and translated into acoustic or sound energy by the transducer or a loud-speaker T. If the electrical output is also connected to the recording and erase head REH as indicated, a magnetized pattern replica of the electrical signal is impressed upon the moving recording medium M (previously demagnetized by the action of erase oscillator E) by varying the magnetization thereof. This pattern (after a time interval) is transferred by the medium to playback head PH which retranslates the magnetic pattern into a reproduction of the electrical signal. The primary difference between the original signal and the reproduced signal is the delay in time of the latter, which is a function of the spacing between heads PH and REH and the speed of medium M. The reproduced signal is similarly amplified by A and converted into sound energy by loud-speaker T, thus providing an echo or a reverberation. It will be noted that a portion of the reproduced or time-delayed signal is also fed to head REH and itself reproduced to yield a second reverberation or echo. This occurs repeatedly. The number of reverberations obtainable is controlled by adjustment of the volume control associated with the input to amplifier A from head PH. If the respective volume levels of the original signal from S and the reproduced signal from PH are balanced or equal, then any one sound or signal will theoretically be reproduced or reverberated an infinite number of times, as each delayed signal is continuously recirculated through A (separated along the time axis from its preceding signal only by a time increment). On the other hand, a lesser or finite number of reverberations can be reproduced by attenuating the volume level of the input from the playback head PH to amplifier A, relative to the volume level from electrical signal source S. The loop arrangement for passing medium M first over an erasing-head section and then a recording-head section and finally a playback head, provides an endless or continuous supply to carry the signal between the heads for the time-delay increment.

Exemplary detailed circuits and specific components are shown in Fig. 2, source S consisting of a musical instrument, such as a guitar G, and a microphone 1 in acoustical communication therewith. Wires 3 and 5 are connected to the first input of amplifier A, comprising a volume control G–1, the rotor of which is connected to a control grid CG–1 of a duo-triode vacuum tube V–1. A second control grid CG–2 of V–1 is connected to the rotor of a volume control G–2 which serves to vary the gain or volume level of the second input to amplifier A. Cathode K–1 of tube V–1 is connected through a cathode resistor R–1 and a by-pass condenser C–1 to ground. The plate circuit of V–1 comprises anodes A–1 and A–2 and resistors R–2, R–3, R–4 and R–5. V–1 and its associated components constitute a two-channel audio mixer which provides a single mixed signal (made up of

the amplified two input signals to G–1 and G–2) through a coupling condenser C–2 to grid CG–3 of a vacuum tube V–2. V–2 and its associated components, resistor R–6, cathode resistor R–7, by-pass condenser C–3 and primary P–1 of an interstage transformer X–1 serve as a voltage amplifier to drive a power amplifier stage comprising secondary S–1, duo-triode V–3 and primary P–2 of an output transformer X–2. Cathode K–3 and the center tap of secondary S–1 are connected to ground. A secondary S–2 of this transformer is connected to loudspeaker T by wires 7 and 9. An appropriate D. C. potential source is connected at B+ and B—. The filaments (not shown) for tubes V–1, V–2 and V–3 are connected to the usual A. C. supply.

A second output from amplifier A is provided by connecting wires 11 and 13 through an equalizing network, comprising a shunt-connected resistor R–8 and a condenser C–3, to a recording winding R of head REH. The A. C. output of a conventional circuit for an erase oscillator (shown in box E) is connected through wires 15 and 17 to an erase winding Q and a coupling winding D of head REH. A portion of the A. C. erase oscillator output signal is inductively coupled to winding B to provide A. C. bias during recording. A playback winding L of head PH is connected through wires 19 and 21 to the second input of amplifier A via volume control G–1.

The elongate magnetizable recording medium, which is a "hard" magnetic material possessing high coercivity (on the order of about 200–500 oersteds) and preferably high retentivity, is passed over the "soft" magnetic pole pieces associated with windings Q, R and L, in that order. This medium, which may be wire, tape, coated tape, etc., is driven at a substantially constant speed past the heads. If, as in one of the preferable embodiments, a continuous loop is used, the joint should be homogeneous, or one of the known blanking circuits should be provided to deactivate the heads during the instant the joint passes thereover. Another useful form of recording medium is a coated or plated disc or drum. Regardless of the particular species of recording medium, it is advantageous to have an adjustable physical spacing between heads PH and REH and a variable-speed drive for the medium, so that the interval between reverberations may be varied conveniently.

It will be noted that the construction of heads PH and REH are identical in the illustrated embodiments so that their functions could be electrically reversed by customary switch means, thus reversing, in effect, the relative motion of medium M without reversing the direction of rotation of the drive motor. The unused winding in head PH would then be used as an erase section. This would provide a long interval between reverberations represented by the time it would take medium M to travel from PH to REH via pulleys P. Any of the usual playback, recording and erase heads, made as separate units or combined, are operable for the purposes of the present invention.

The alternate embodiment of Fig. 3 is basically similar in operation and construction to that described in regard to the embodiment of Figs. 1 and 2. However, in the second embodiment, a second amplifier A–1, which may be identical or similar to amplifier A, is employed, and the amplifier input and output connections are modified in certain respects. For example, the electrical signal from source S is fed to the first inputs of each of the amplifiers A and A–1, and the playback head PH is interconnected to the second inputs of each of the amplifiers A and A–1. Also, the output of amplifier A is connected to transducer T, and the recording and erasing head REH is connected to the output of amplifier A–1, rather than to the output of amplifier A.

The operation of the Fig. 3 apparatus differs from that described above in regard to Figs. 1 and 2 primarily in that the reproduced signal will recirculate through a separate amplifier A–1. In another aspect, the electrical signal energizing head REH is isolated from the electrical signal driving transducer T. This arrangement provides additional operating flexibility. If, in the first embodiment, the level of the reproduced or delayed signal to amplifier A exceeds the level of the original signal from source S, instability would result from the fact that each succeeding reverberation would be increasingly accentuated and override the original signal. By providing a separate amplifier to amplify the input signal from source S and recirculating its time-delayed reverberations, the level of at least the first reverberation can be made to exceed that of the original signal, and the level of succeeding reverberations can be attenuated from the latter level. Moreover, the rate of attenuation of succeeding reverberations may be controlled over a wider range.

Thus, the level of the original signal at the output of amplifier A is adjustable by the usual volume control associated with the original signal input (numeral I–1) from source S. The volume control associated with the first input (numeral I–1A) of amplifier A–1 controls the energy level of the electrical signals fed to head REH. The volume control associated with the second input (numeral I–2A) of the amplifier A–1 controls the number of reverberations, i. e., the rate of attenuation of succeeding reproduced signals. The volume control associated with the second input (numeral I–2) of amplifier A determines the over-all level of the reproduced or reverberated signals. Either of the volume controls associated with inputs I–2 or I–1A could be eliminated, if desired; and a fixed setting of either I–1 or I–2 could also be employed.

It will be understood that the many conventional audio amplifier circuits in use today are suitable equivalents for the purposes set forth herein. It is preferred, however, that the amplifier be capable of reproducing audible frequencies with substantially flat response. If the amplifier response curve is not flat, the recirculating echoes may be attenuated in tone quality to some extent because of the deviation of the response curve. However, this is not usually noticeable to the ear and in some instances, may provide a novel sonic effect.

Also, it will be noted that any of the known methods and apparatus used in D. C. or A. C. erasing and biasing may be employed and that other equalizing networks, for either post- or pre-emphasis, or both, are useful herein.

Further, it will be understood that for the purposes set forth herein an amplifier having, for example, only one output winding to which the recording head and a load (e. g., transducer T) are both connected, has two outputs. Similarly, an amplifier has two inputs if the signal from source S is mixed with the reproduced signal from PH externally of the amplifier, and the mixed signals are fed in through one channel to the first amplifier vacuum tube.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A reverberation-producing device comprising first and second electronic amplifiers each having at least two inputs and at least one output, an electrical signal source connected to one input of each of said amplifiers, a transducer connected to the output of the first amplifier, an elongate magnetizable recording medium, an erase head for demagnetizing said medium, a recording head connected to the output of said second amplifier and adapted to produce a magnetic pattern in said medium in response to an electrical signal from said signal source,

a playback head connected to the other input of each of said amplifiers adapted to reproduce said electrical signal in response to said magnetic pattern, and means for moving said medium past said erase, recording and playback heads, respectively, whereby the reproduced electrical signal is delayed in time relative to the first said electrical signal.

2. A reverberation-producing device comprising first and second electronic amplifiers each having at least first and second inputs and at least one output, an electrical signal source connected to the first input of each of said amplifiers, an electroacoustical transducer connected to an output of the first amplifier, an elongate magnetizable recording medium, an erase head for demagnetizing said medium, a recording head connected to the output of said second amplifier and adapted to produce a magnetic pattern in said medium in response to the electrical signal, a playback head connected to the second input of each of said amplifiers adapted to reproduce said electrical signal in response to said magnetic pattern, means for moving said medium past said erase, recording and playback heads, respectively, whereby the reproduced electrical signal is delayed in time relative to the first electrical signal, a first volume control for said first input of said first amplifier adapted to vary the level of said electrical signal, a second volume control for said second input of said first amplifier adapted to vary the level of said reproduced signal, and a third volume control for said second input of said second amplifier adapted to vary the number of reverberations produced.

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