April 12, 1932. H. J. ROUND ET AL 1,853,286

TRANSMISSION AND REPRODUCTION OF SOUND

Filed May 6, 1927

Fig. 1

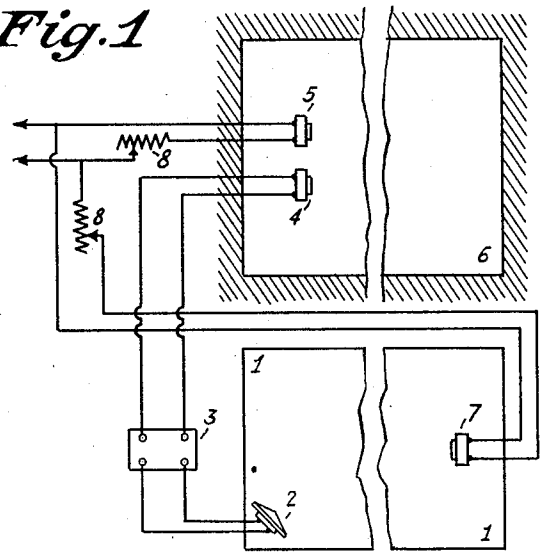


Fig. 3

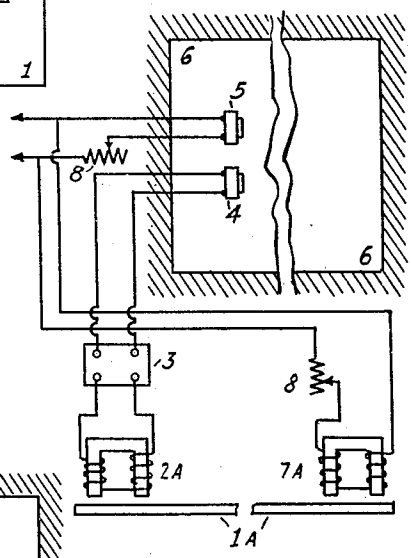
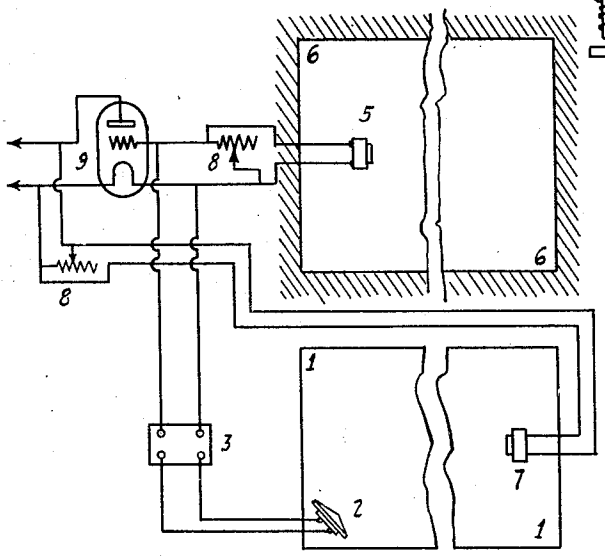


Fig. 2



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UNITED STATES PATENT OFFICE

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TRANSMISSION AND REPRODUCTION OF SOUND

Application filed May 6, 1927, Serial No. 189,211, and in Great Britain May 13, 1926.

This invention relates to the transmission and reproduction of sound, and is particularly applicable to "broadcasting" by wireless telephony.

The main object of the invention is to provide means whereby a musical note or the like may be received with a suitable degree of "echo" or "background" for pleasurable audition.

It is well known that certain acoustical reflections add to the beauty of sound of musical instruments, but hitherto the provision of such acoustical reflections have been limited by practical considerations, and in practice it has been found very difficult to obtain a pleasing degree of "echo" without it being excessive in small buildings.

In order to explain this invention, an approximate theory may be given of what is believed to occur when a sound is made in a room, and the said sound is listened to in that room.

For reasons of simplicity, let it be supposed that the room in which the sound is made consists of two infinite flat planes, and that the source of sound and the listener are on the central plane axis, intermediate between those two said planes. If a sound be generated, part of it will strike the listener directly, while there will also be obtained from the two walls a series of impulses following one another more or less rhythmically.

In general, the ratio of the strength of the first echo to the original sound will bear a direct relation to the distance of the source of sound from the listener, and the distance of the plane walls therefrom. The further away are the walls, the weaker will be the first echo, and the second and succeeding echoes will have strengths whose ratio to one another is dependent upon the absorption factor and other constants of the walls.

In a small room it is practically impossible to arrange a multiple source of sound, such as an orchestra, near to a listener, and as a result, the first echo is bound to be relatively strong. Hence, in order that the total effect of all the echoes shall not be excessive and displeasing, it has been found in practice necessary to damp the walls of the room, drapery being generally employed for this purpose.

Such an arrangement, however, does not give the pleasing effect obtained when the sounds of the orchestra or singer are superimposed with great clearness upon a musical echo background, and we have found that prolonged echoes are desirable to obtain such a pleasing effect. It is, however, difficult to produce them without they be excessive in amplitude; for example, in an ordinary room a good effect can only be obtained if the room have a period of six or seven seconds, and if the source of sound be within two feet of the listener. We have found that with any greater distance the combined sound becomes disagreeable.

In broadcasting or gramophone recording, a microphone usually forms the listener.

According to this invention means are provided for generating an echo or an artificial echo which is, in effect additive to the direct sound. Preferably also means are provided for regulating the degree to which the said echo or artificial echo is additive.

In one way of carrying out the invention, the audition room consists of a heavily draped damped main room, communicating through a doorway with a very undamped or "echo" room, the source of sound being located at a suitable place in the doorway, and the listener being in the damped room. We have found that the quantity of echo can can readily be controlled by altering the position of the listener, but this method is not generally applicable.

Alternatively, the two rooms may be arranged as in the previous method, and a microphone or other listener be situated in each room the source of sound being in the draped room.

The electrical waves resulting from the sound impinging on the microphone in the undamped room are superimposed upon the waves resulting from the sound impinging upon the microphone in the damped room, and rheostats or the like are provided so that the amplitude or strength of the waves can be proportioned as desired.

A more complete understanding of the invention will be had from the specification when read in connection with the attached drawings in which

Fig. 1 is a diagrammatic view of one form of our invention.

Fig. 2 is a modification of the form shown in Fig. 1 and

Fig. 3 is a further modification of the invention shown in Fig. 1.

Referring to Figure 1, which shows a construction generally applicable, 1 is an echo room containing a loud speaker 2 of good quality, the said loud speaker being connected through amplifiers 3 to a microphone 4 placed by the side of a main microphone 5 in the main room 6 which is damped in the usual way. In the echo room is placed another microphone 7, arranged to receive the minimum possible direct sound from the loud speaker but to receive the echo in this room, and currents from this said microphone are superimposed in the main microphone circuit, the strengths of the said currents being adjusted by means of shunt, or, as shown, series variable resistances 8.

We have found it possible, by these means, to produce an effect varying from small damped studios to vast halls, cathedrals and opera houses.

In a modification, illustrated in Figure 2, only one microphone in the main audition room is employed, but such an arrangement necessitates the use of means to prevent reaction effects or "singing round the circuit"; such means may conveniently comprise a valve trap which is indicated diagrammatically at 9.

The echo chamber may be replaced by one or more long pipes, or by several pipes of different lengths.

Figure 3 illustrates a further modification, in which artificial echo effects are obtained by means of an iron bar or rod 1A, which replaces the echo room of the previously illustrated constructions. The bar, which may be clamped at either or both ends, is impulsed by means of an electromagnetic or other device 2A and its movement causes variations in the electrical response of a second electromagnetic or other device 7A which is connected to the main microphone circuit.

In some cases long electrical circuits may be employed or a series of closed resonant circuits of appropriate pitch, or a series of tuned mechanical reeds, or, in general, any arrangement which mechanically or electrically reproduces artificial echoes, i. e. resonant effects similar or analogous to echoes.

The invention is applicable to apparatus for receiving broadcast music, for adding missing musical quality thereto.

The invention is also applicable for use with gramophones.

Similar effects can be used to improve the effective sounds, due to bands playing in unsuitable places, such as in the open, the echo being added by means of a loud speaker receiving energy under the control of a microphone placed in an echo room which itself is associated by loud speaker and microphone with the band.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, what we claim is:—

1. In apparatus for the transmission and reproduction of sound, means for generating an echo and adding it to the direct sound comprising a damped room in communication with an echo room, and one or more "listening devices" whose resultants are additive, located in each room.

2. In apparatus for the transmission and reproduction of sound, means for generating an echo and adding it to the direct sound comprising a damped room in communication with an echo room, and one or more "listening devices" whose resultants are additive located in each room, and means for controlling the resultants from one or more of the "listening devices".

3. In apparatus for the transmission and reproduction of sound, means for generating reverberations and adding their resultant to the direct sound, comprising a main room, two "listening devices" located in said main room, a reverberation room, a loud speaker situated in said reverberation room and actuated in accordance with the resultant from one of the "listening devices" in the main room, a third "listening device" located in the reverberation room, and means for superimposing the resultant from the third "listening device" upon the resultant from one of the "listening devices" in the main room.

4. In apparatus for the transmission and reproduction of sound, means for generating direct sound and an echo, and adding the echo to the direct sound comprising a damped main room, a "listening device" located in said room, an echo room a loud speaker situated in said echo room and actuated in accordance with the resultant, from said "listening device", a second "listening device" located in the echo room, and means for superimposing the resultant from said second "listening device" upon the resultant from said main room "listening device".

5. In apparatus for the transmission and reproduction of sound, means for generating an echo and adding its resultant to the direct sound, comprising a main room, two "listening devices" located in said main room, an echo room, a loud speaker situated in said echo room and actuated in accordance with the resultant from one of the "listening devices" in the main room, a further "listening device" located in the echo room, means for superimposing the resultant from the last

mentioned "listening device" upon the resultant from the other "listening device" in the main room, and means for regulating the effective resultants from any or all of the "listening devices".

6. In apparatus for the transmission and reproduction of sound, means for producing sound comprising a damped room and a "listening device" in said room, means for producing resonant effects comprising a series of closed circuits, and means for adding said resonant effects to the direct sound effects from the "listening device" in the main room.

7. In apparatus for amplification and transmission of sound, means for generating an echo of the sound to be amplified and transmitted and adding this resultant to the direct sound comprising a location at which echoes are not produced, means for converting sound waves into electrical energy located at said location, an echo producing device, means for conveying a component of said electrical energy to said echo producing device, means at said echo producing device for converting said component into sound vibrations, means for converting said sound vibrations into electrical energy, and means for superposing the electrical energy so obtained on the electrical energy from the sound waves in the main room.

8. In apparatus for amplifying and transmitting sound, a damped main room in which the sound to be transmitted is generated, means for converting said sound into electrical energy for transmission, means for producing an echo with a portion of said energy, means for converting said echo into electrical energy and means for superposing said last named energy on the electrical energy obtained from the sound in the main room.

9. In apparatus for amplifying and transmitting sound, a damped main room in which the sound to be transmitted is generated, means for converting said sound into electrical energy for transmission, means for producing an echo with a portion of said electrical energy, means for converting said echo into electrical energy, means for superposing said last named energy on the electrical energy obtained from the sound in the main room and means for controlling the amplitude of the electrical energy obtained from the sound and from the echo.

10. An acoustic arrangement for use in connection with a source of sound comprising means for converting the sound into electrical variations, means for obtaining an echo of said sound and converting said echo into electrical variations, and means for combining said electrical variations.

11. An acoustic arrangement for use in connection with a source of sound comprising a microphone for converting the sound into electrical variations, a transmission line for conveying said electrical variations, means for obtaining an echo of said sound and for converting said echo into electrical variations, and means for impressing the last mentioned electrical variations upon said transmission line.

12. Apparatus of the class described comprising means for conveying energy from a source of direct sound, means for obtaining reverberations from said source of direct sound, and means for conveying energy from said reverberations and combining it with the energy from said source of direct sound.

13. Apparatus of the class described comprising means for converting a direct sound into electrical variations, means for obtaining reverberations from the direct sound, means for converting the reverberations into electrical variations, and connections for combining the electrical variations from the direct sound with the electrical variations from the reverberations.

14. Apparatus for the reproduction of sound from a source of direct sound comprising a reverberation producing means in communication with said source of direct sound, and means for combining the resultant of the direct sound with the resultant of the reverberations.

15. Apparatus of the class described comprising a substantial enclosure adapted to contain a source of direct sound, reverberation producing means in communication with said substantial enclosure, and means for superposing energy from said reverberation producing means upon energy from said source of direct sound.

16. Apparatus of the class described comprising a nonreverberation producing location, reverberation producing means in communication with said location, a microphone at said location, means for converting the reverberations produced by said means into electrical variations, and means for combining the electrical variations with the electrical output of said microphone.

17. Apparatus of the class described comprising a location at which echoes are not produced to a substantial degree, a microphone at said location, a transmission line for the electrical output of said microphone, a reverberation producing device, connections from said transmission line to said device, means at said device for obtaining electrical variations corresponding to said reverberations, and means for superposing said electrical variations upon the electrical output of said microphone.

18. Apparatus of the class described, comprising a transmission line adapted to convey acoustically modulated electrical energy, means for providing other electrical energy modulated according to a modification of the acoustic modulations of said acoustically modulated electrical energy, and means for

impressing said other electrical energy on said transmission line.

19. Apparatus of the class described comprising means for conveying acoustically modulated electrical energy, and means for superposing on said acoustically modulated electrical energy, other acoustic modulations corresponding to reverberations of the first said acoustic modulations.

20. Apparatus of the class described comprising means for conveying acoustically modulated electrical energy, means for obtaining modulations corresponding to an echo of the acoustic modulations of said acoustically modulated electrical energy, and means for superposing the second mentioned modulations on said acoustically modulated electrical energy.

21. Apparatus of the class described comprising means for producing acoustically modulated electrical energy, and means for obtaining from said acoustically modulated electrical energy other modulations corresponding to a predetermined modification of the acoustic modulations of said acoustically modulated electrical energy.

22. Apparatus of the class described, comprising a pair of conductors adapted to convey acoustically modulated electrical energy, means actuated by the energy traversing said conductors for providing other electrical energy which is modulated according to a desired modification of the acoustic modulations of said acoustically modulated electrical energy, and means for combining said other electrical energy with said acoustically modulated electrical energy.

23. Apparatus of the class described comprising means for providing acoustically modulated electrical energy, means for obtaining from said acoustically modulated electrical energy other modulations corresponding to a modification of the acoustic modulations of said acoustically modulated electrical energy, and means for utilizing said other modulations in combination with the first mentioned acoustically modulated electrical energy.

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CERTIFICATE OF CORRECTION.

Patent No. 1,853,286.

April 12, 1932.

HENRY JOSEPH ROUND ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 110, claim 4, strike out the word "damped"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of October, A. D. 1932.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.

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