Dec. 2, 1947. M. RETTINGER 2,431,962

REVERBERATION METHOD AND SYSTEM

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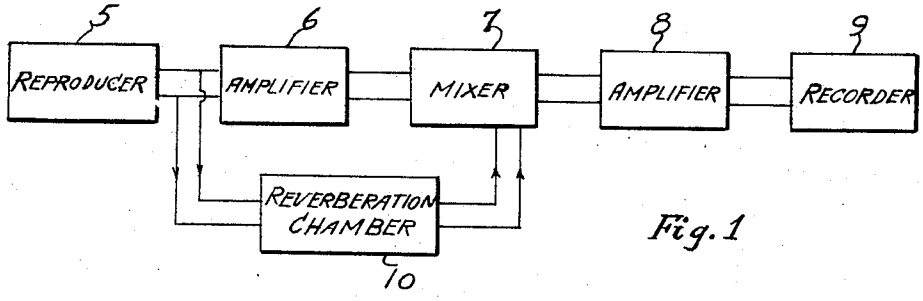

Fig. 1

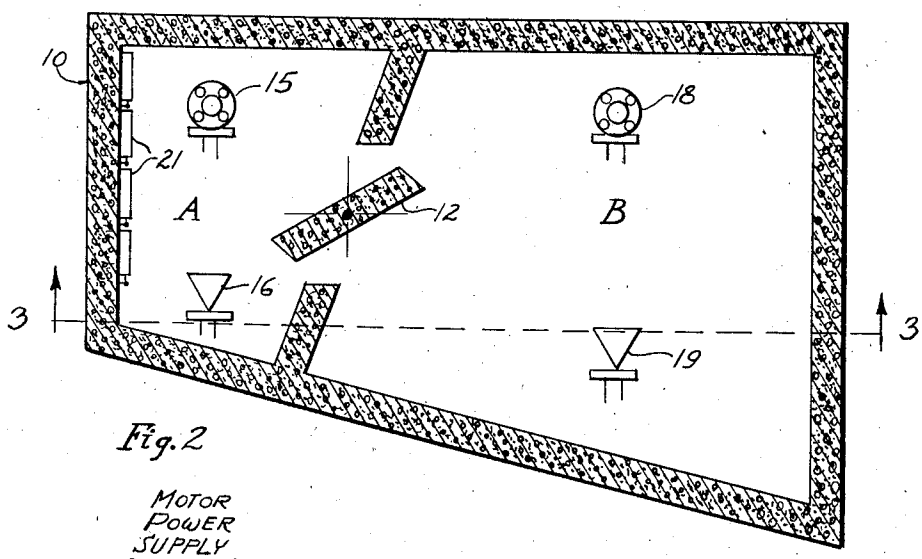

Fig. 2

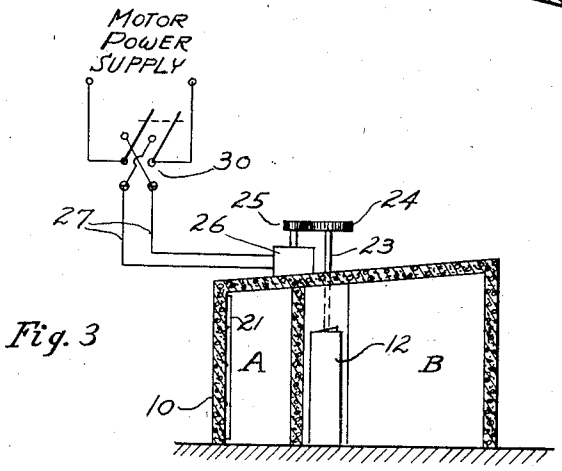

Fig. 3

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REVERBERATION METHOD AND SYSTEM

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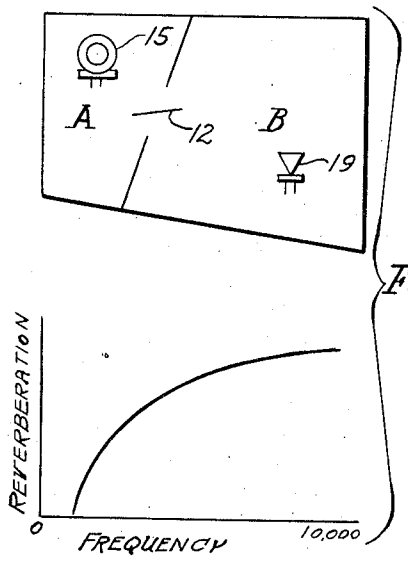

Fig. 4

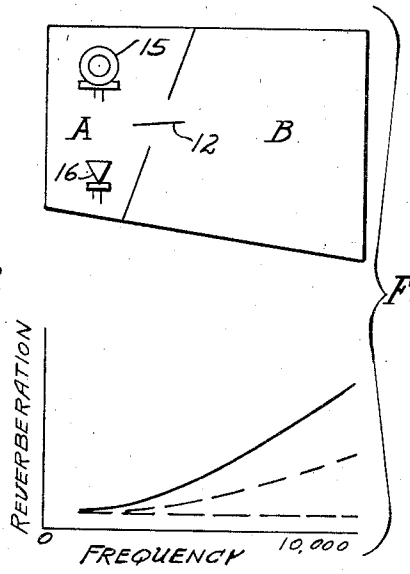

Fig. 5

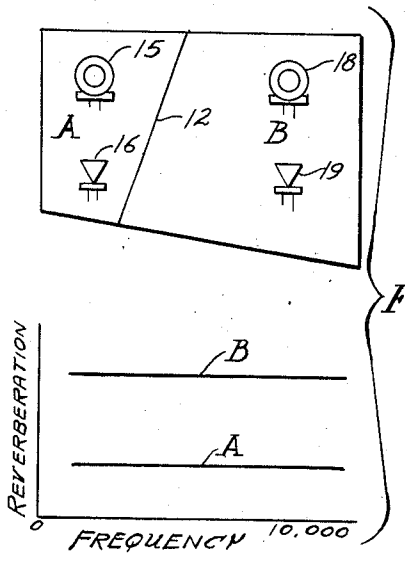

Fig. 6

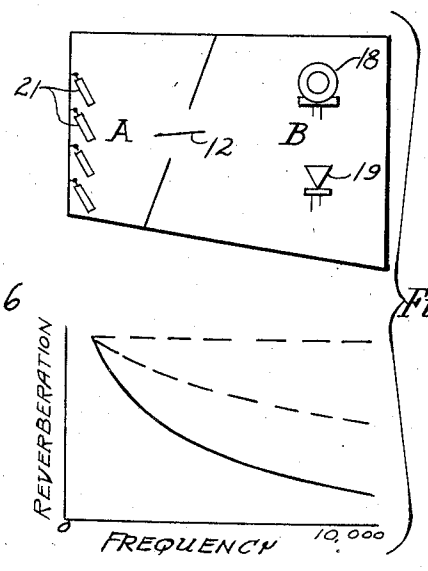

Fig. 7

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REVERBERATION METHOD AND SYSTEM

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14 Claims. (Cl. 179—1)

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This invention relates to sound recording systems, and particularly to a portion of a recording or rerecording system whereby sound is reproduced from a previously recorded record and modified in transmission before being again recorded.

In the art of sound recording and rerecording, it is well-known that the characteristics of the signal may be modified in several aspects. The primary modification pertains to the amplitude of one portion of the signal with respect to another, known as amplitude control, while a second modification relates to variations in amplitude of the different frequencies in the same signal portion, known as equalization. An example of the last mentioned modification is where equalizing filters are used to reduce the high frequency components of a signal with respect to the low frequency components thereof.

It frequently occurs, however, that it is desirable to add an entirely different quality to the sound, known as reverberation. For instance, a picture set may represent a large hall, cave, or other enclosure which would have reverberation if the sound were actually produced at the scene being depicted in the picture. However, the set is actually only a portion of the actual scene, and the sound recorded therein has no appreciable reverberation. Thus, it is necessary in the rerecording operation to add reverberation, and it is to this feature of sound recording and rerecording that this invention is directed. It is to be understood, of course, that although the invention is shown in connection with a rerecording system, that it is also applicable in the direct recording of sound; that is, during the making of the original record, and also to radio broadcasting or direct reproduction, as in public address systems.

To add reverberation to the sound signal, one well-known method of and means for accomplishing the result is to reproduce the sound in a special chamber wherein the acoustic waves will be reflected from the various surfaces of the chamber and then detected by a microphone and recorded or reproduced. A chamber of a given size and shape has a certain reverberation characteristic. The present invention is directed to plural or dual reverberation chambers which will provide a multiplicity of reverberation characteristics suitable for representing the original sound from many types of scenes ranging in size from a tiled shower bath to large railroad stations and caves. The chief feature of the chambers is that they have no parallel surfaces, while either chamber may be utilized separately, or the chambers

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may be interconnected through an adjustable door to provide a series of different reverberation characteristics. The adjustable door functions as a high pass filter.

The principal object of the invention, therefore, is to facilitate the obtaining of different reverberation characteristics in the reproducton or recording of sound.

Another object of the invention is to provide an improved method of and system for obtaining various types of reverberation characteristics.

A further object of the invention is to provide an improved reverberation system by the use of plural interconnected reverberation chambers.

A still further object of the invention is to provide a method of and means for introducing reverberation into a signal which may be varied during the actual transmission of the signal.

A still further object of the invention is to provide an improved method of and means for obtaining a variable high pass acoustic filter.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the appended claims, the manner of its organization and the mode of its operation will be better understood by referring to the following description read in conjunction with the accompanying drawings forming a part hereof, in which:

Fig. 1 is a diagrammatic view of a rerecording system utilizing a reverberation chamber embodying the invention.

Fig. 2 is a plan view of the reverberation chamber.

Fig. 3 is a diagrammatic elevational view of the reverberation chamber along the line 3—3 of Fig. 2 and showing the acoustic filter control feature.

Fig. 4 is a combination diagrammatic plan view of a reverberation chamber in one arrangement together with the reverberation characteristic obtainable with this arrangement.

Fig. 5 is a combination view similar to Fig. 4 showing the reverberation characteristic obtainable with another arrangement of the chamber.

Fig. 6 is another combination of a reverberation chamber arrangement and the reverberation characteristic obtainable therefrom, and

Fig. 7 is another combination diagram showing a reverberation chamber arrangement together with its respective reverberation characteristic.

Referring now to Fig. 1, a source of sound is shown as a reproducer 5, the output of which is connected to an amplifier 6 feeding a mixer 7 connected to a recorder 9 through a second am-

plifier 8. The output of the reproducer is also connected to reverberation chamber 10, the output of which is fed into the mixer 7. This is a representation of a basic rerecording system whereby all or any part of the output of the reproducer 5 may be transmitted through the reverberation chamber 10 before it is recorded at 9, it being understood that the source of signals may also be a microphone. It is also to be understood that a plurality of sources of signals may be simultaneously reproduced and recorded into a single record, one or more of the signals being reverberated in accordance with the nature of the source of sound being shown in the concomitant picture or in accordance with the story in a radio broadcast program.

Referring now to Fig. 2, the outer walls of the dual reverberation chambers are constructed in the form shown by the trapezoid wherein a partition forms a trapezium chamber A and a trapezium chamber B, chamber B having a volume about twice that of chamber A. A preferred form is when chamber B is approximately 3000 cubic feet and chamber A is about 1500 cubic feet. The walls of the chamber 10 are preferably of solid masonry, such as brick or concrete, of considerable thickness, so that when a door 12 in the partition, and of substantially the same thickness as the partition, is tightly closed, the sound in one chamber will not be transmitted to the other chamber. The door may be approximately six by eight feet. It will be noted that there are no parallel surfaces in either chamber, and in Fig. 3, it will be noted that the ceilings of the chambers are not parallel with the floors of the chambers.

Located in chamber A, a microphone 15 and a loud speaker 16 are shown diagrammatically, while in chamber B, a microphone 18 and a reproducer 19 are shown, it being understood that more than one microphone and more than one loud speaker may be employed if desired. It is also to be understood that special sound absorbing movable screens may be used in different positions in either chamber to produce special effects. Along the left-hand wall of chamber A and extending over the major portion of its surface, as shown in Fig. 2, are a series of hinged panels 21 which have a hard surface on one side and a sound absorbing surface on the other side, and which are rotatable to expose either the hard surface or the sound absorbing surface to the sound waves. Any intermediate adjustment of the panels will provide an intermediate effect from that obtained when the panels are in their extreme positions, as will be described hereinafter.

As mentioned above, the door 12 is of a thickness comparable to the walls and may have felt padding along its edges to prevent sound transmission therethrough when closed. However, the door is adjustable from a remote point, such as a mixer console from where it may be closed or opened to any amount desired to produce the proper reverberation characteristic as will be explained hereinafter. As shown in Fig. 3, the door 12 is mounted on a vertical shaft 23 having a gear 24 at the end thereof, the gear 24 being in mesh with a smaller gear 25 on the shaft of a motor 26. Energization of the motor 26 over conductors 27 will rotate the door 12 and either close it or open it to any desired extent by actuation of a reversing switch 30. In this manner, if the mixer does not believe the reverberation characteristic as indicated on his monitor is of the type desired, he can vary it during the recording operation by actuation of the switch 30.

Referring now to the specific types of characteristics obtainable with the above described dual chambers, reference is made to the remaining figures wherein Fig. 4 shows an arrangement wherein the microphone 15 in chamber A and the loud speaker 19 in chamber B are utilized to provide a characteristic having a greater reverberation time over the upper end of the audio spectrum than the lower end. This result is obtained because the door 12 functions as a high pass filter, thereby passing the high frequencies better than the low frequencies. Thus, the high frequencies will not only be reverberated in chamber A and pass through the door to speaker 19, but will also be further reverberated in chamber B to provide the characteristic shown in the graph in Fig. 4. It will be noted that the characteristic has a certain curvature which may be desirable to introduce into a signal originating in a certain type of scene.

In Fig. 5, the same microphone 15 is employed, but in cooperation with the speaker 16, both of which are located in the chamber A. In this instance, as shown by the graph by the solid line, a rising reverberation characteristic is also obtainable, but with the reversed curvature of that in Fig. 4. This characteristic results because the door 12 will more readily pass the high frequencies into chamber B wherein they will be reverberated, but they must again pass back through door 12 in order to reach the microphone 15. Thus, the high frequencies receive a greater reverberation than the low frequencies, but since they pass through the door 12 twice, the opposite curvature to that obtainable with the arrangement in Fig. 4 results. With the arrangement shown in Fig. 5, however, various positions of the door 12 from wide open condition to closed condition will vary the characteristic as shown by the dotted lines in the graph of Fig. 5.

Referring now to Fig. 6, both microphones 15 and 18 are illustrated together with their cooperative speakers 16 and 19. If only microphone 15 and speaker 16 are used, the reverberation characteristic will be as shown in curve A, and if only microphone 18 and speaker 19 are employed, a constant reverberation characteristic is obtained, as shown by curve B, but in which the reverberation time is higher because of the larger size of the chamber. These conditions, of course, obtain only when door 12 is closed. In this arrangement, either of the two cooperative microphones or speakers may be used individually or simultaneously to produce an intermediate reverberation characteristic between the chambers A and B, or each chamber may be used for separate signals in two recording channels. In each of the illustrations shown in Figs. 4, 5, and 6, it is to be understood that the panels 21 are arranged so that the left-hand wall has a characteristic similar to the other inner surfaces; that is, the hard surfaces of the panels are exposed to the sound waves. By varying the angle of the panels, the characteristics shown in Figs. 4, 5, and 6 may be varied.

To illustrate the effect of the panels 21, reference is made to Fig. 7 wherein the effect of using a microphone 18 and a loud speaker 19 is shown with the door 12 open and the panels 21 adjusted at an angle. With the panels adjusted to present the sound absorbing surfaces of the panels to the sound waves in chamber A, a drooping characteristic, such as shown by the solid line in Fig.

7, is obtained inasmuch as the high frequencies which are more readily passed through the door 12 are not returned to chamber B because of the absorption thereof by the panels 21. By varying the opening of the door 12, various characteristics can be obtained, as illustrated by the dotted lines in Fig. 7.

From the above, it will be noted that the above described reverberation chambers are particularly flexible from the standpoint of providing a multiplicity of reverberation characteristics; that is, from uniform characteristics to rising and drooping characteristics in various degrees. By the interconnection of the different microphones and loud speakers in the two chambers, adjustments of the door 12 and adjustments of the panels 21, many different reverberation characteristics are obtainable. It is also possible to arrange in the chambers A and B temporary absorbing screens in case a special type of characteristic is to be produced. It is to be understood that instead of the dual chamber arrangement, three or more chambers may be interconnected by adjustable doors if characteristics not possible with dual chambers are desired.

In the above description, only the door 12 is described as controllable from without the chambers, but such a control may also be applied to the panel sections 21 so that they may be adjusted from a remote point such as the mixing console.

I claim as my invention:

1. A reverberation chamber system comprising outer wall sections, a floor section, a ceiling section, a partition between two wall sections to provide two separate chambers having no inner surfaces parallel, and a door in said partition to pass sound waves between said chambers.

2. A reverberation chamber in accordance with claim 1, in which adjustable panels are provided on the walls of at least one of said chambers for varying the sound absorbing characteristics in said chamber.

3. A reverberation chamber in accordance with claim 1, in which means are provided for adjusting the opening of said door.

4. A reverberation chamber system having a plurality of wall sections, a partition between two of said wall sections for dividing said chamber into two chambers having non-parallel inner surfaces, a door for passing sound waves between said chambers, and means for remotely controlling the degree of opening of said door to control the acoustic coupling between said chambers.

5. A reverberation chamber system in accordance with claim 4, in which a microphone is positioned in one of said chambers, and a loud speaker is positioned in the other of said chambers, sound reproduced in one of said chambers being detected by the microphone in the other of said chambers after passage through said door.

6. The method of obtaining a plurality of reverberation characteristics in a signal comprising reproducing said signal in a reverberation chamber, detecting said signal in another reverberation chamber, and varying the acoustic coupling between said chambers to vary the reverberation characteristic.

7. The method of obtaining a variation of a reverberation characteristic being introduced into a signal during the transmission of said signal comprising reproducing said signal in a reverberation chamber of a certain size, detecting said signal in another reverberation chamber of a size different from that of said first reverberation chamber, and varying the acoustic coupling between said reverberation chambers during the transmission of said signal.

8. The method of artificially modifying a sound produced in one location to correspond to the characteristic of said sound when produced in another location comprising reproducing said sound in a chamber having a certain reverberation characteristic, passing said sound through an acoustic filter into a chamber having a certain other reverberation characteristic, and detecting said sound in said second mentioned chamber.

9. The method in accordance with claim 8 in which said acoustic filter is adjustable during reproduction and detection of said sound.

10. The method of introducing different reverberation characteristics into a sound wave comprising reproducing said sound in a chamber having a certain reverberation characteristic, passing said sound through an acoustic filter into a chamber having a certain other reverberation characteristic, detecting said sound in said first mentioned chamber to provide one type of reverberation characteristic, and detecting said sound in said second mentioned chamber to provide a second type of reverberation characteristic.

11. The method in accordance with claim 10, in which said acoustic filter is adjustable during reproduction and detection of said sound.

12. A reverberation system for sound waves comprising a plurality of chambers of different sizes, means for reproducing sound waves in any one of said chambers, means for detecting sound waves in any one of said chambers, and means for variably coupling said chambers acoustically to vary the reverberation time of certain frequencies in said sound waves with respect to certain other frequencies in said waves.

13. A reverberation system in accordance with claim 12, in which said last mentioned means includes an opening between chambers with means in said opening for varying the size thereof.

14. A reverberation system in accordance with claim 12, in which said last mentioned means includes an adjustable door between chambers and means for controlling the position of said door from a remote point.

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