

Feb. 16, 1932.

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1,845,080

STUDIO FOR ACOUSTIC PURPOSES

Filed May 6, 1930

2 Sheets-Sheet 1

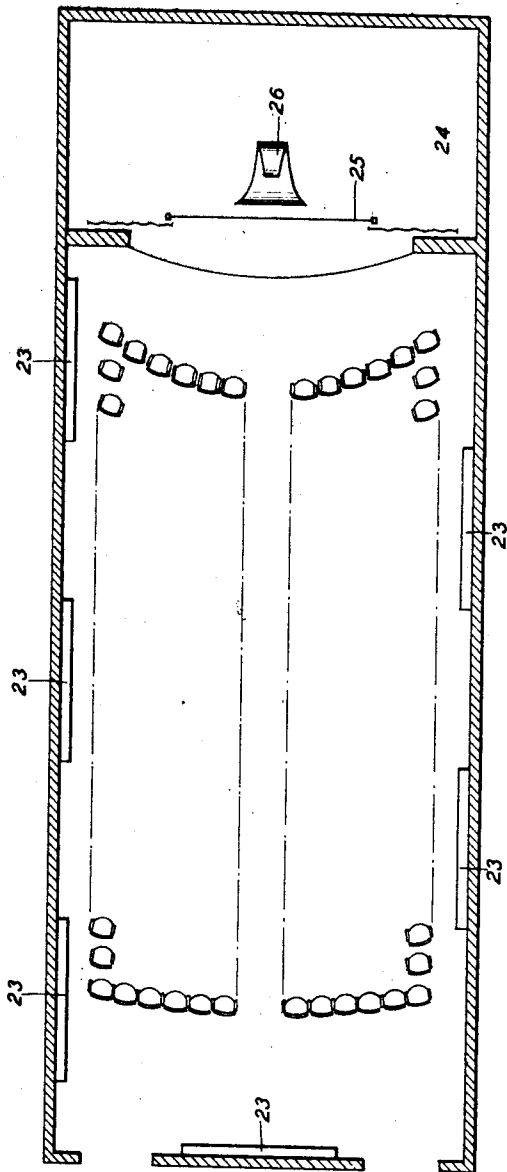


FIG. 1.

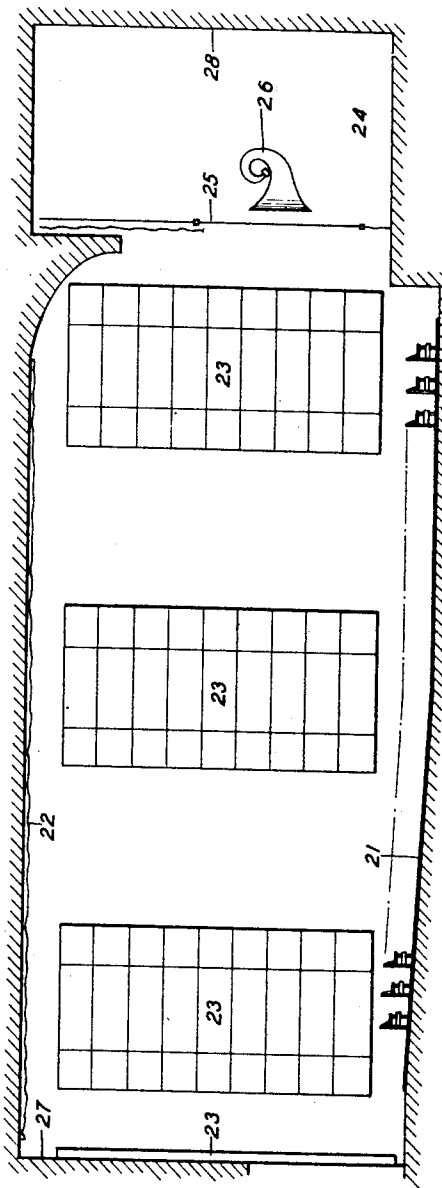


FIG. 2.

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2 Sheets-Sheet 2

FIG. 3.

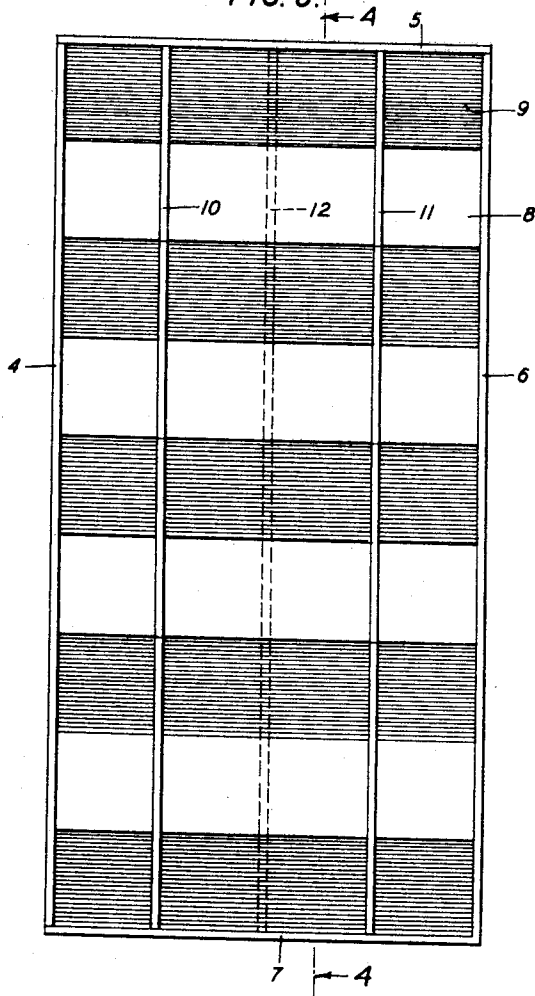


FIG. 4.

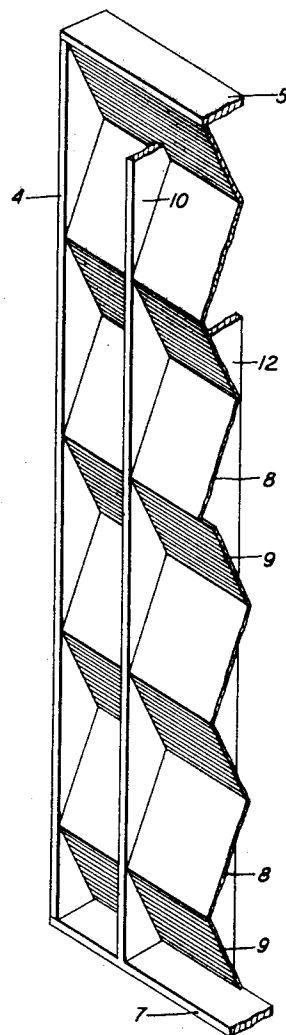
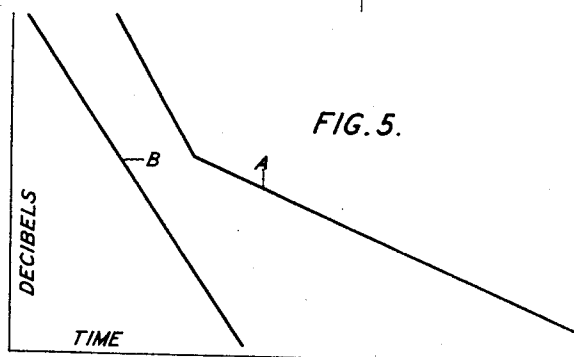


FIG. 5.



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STUDIO FOR ACOUSTIC PURPOSES

Application filed May 6, 1930. Serial No. 450,114.

This invention relates to sound studios and particularly to a method of and means for controlling the rate of decay of residual sound therein.

5 The object of the invention is the improvement of the acoustics of sound studios.

One of the features of the invention is the provision of a sound studio having but one rate of decay of the residual sound, that is, 10 a single reverberation time.

Another feature of the invention is to provide selective sound diffusing apparatus capable of diffusing sound waves within the higher range of frequencies without appreciably affecting those within the lower range. 15

Still another feature is the method of providing a studio which has a single rate of decay of residual sound which consists in scattering the high frequencies to prevent the back and forth flow of energy between the walls. 20

It is well known that loud speaking devices, such as those used in connection with sound pictures and public address systems are quite 25 strongly directional in the high frequency range and substantially non-directional in the low frequency range. This means that in for example, a room having two opposite walls highly reflecting and a floor and/or 30 ceiling highly absorbing and since the high frequencies tend to bend from their course to a less degree than the low frequencies, after a number of reflections at the surfaces of the room, any frequency beam that starts to be 35 reflected back and forth between the two highly reflecting parallel surfaces will soon be bent into the highly absorbing surfaces if of low frequency; but if of high frequency the back and forth reflection of the beam will 40 tend to persist due to a lack of bending. This means that in a room such as the one under consideration, the low frequency sound beams are diffused, but the high frequency beams exist roughly in two conditions, a diffuse state 45 and a more or less ordered state. The diffuse state of the low and high frequencies gives rise to a certain reverberation time, more or less characteristic of the room as a whole. However, the more or less ordered 50 state, the back and forth reflection between

the two parallel walls of the high frequencies gives rise to a longer reverberation time and hence the higher frequency residual sounds show more than one rate of decay, that due to the diffuse state followed by that due to the 55 ordered state.

A room in which one portion is "live" and the other portion "dead" also shows the presence of more than one rate of decay, the "live" portion acting as an equivalent decay- 60 ing sound source. There are still other conditions which give rise to the presence of more than one rate of decay which is an acoustical defect in auditoriums since one single uniform rate of decay is required if the dura- 65 tion of audibility of residual sound is to be the same in all parts of an auditorium, a requirement for ideal acoustics.

One way of overcoming this defect, that is the two rates of decay, is to introduce sufficient 70 damping to prevent reflection of the high frequencies. This however causes too much absorption of the low frequencies and produce too "dead" a room.

According to the present invention the live- 75 ness of the room is maintained for low frequencies while the second slow decay rate (long reverberation time) for the high frequencies is eliminated by a selective sound diffuser, or diffusers, consisting of sound de- 80 flecting areas disposed within the studio so as to scatter the high frequency sound waves and prevent their reflection back and forth in a regular manner.

Referring to the drawings, Fig. 1 repre- 85 sents a plan view of an acoustic studio or room acoustically treated in accordance with the invention; Fig. 2 is elevation of the studio; Fig. 3 represents a plan view of a sound diffusing panel in accordance with the in- 90 vention; Fig. 4 represents a sectional view in perspective along the line 4—4; and Fig. 5 shows the rate of decay curves for the same room before and after treatment in accordance with the invention. 95

Referring to Figs. 1 and 2 which represents an acoustic studio as for example, a sound picture theatre treated in accordance with the invention there is shown disposed against the side walls of reflecting material sound diffu- 100

ing panels or sections 23 such as shown in Figs. 3 and 4 and sound absorbing material 21 and 22 arranged on the floor and the ceiling respectively.

Although both the ceiling and floor are shown as having damping material applied thereto it is not essential in all cases that both be so treated. It is desirable in any arrangement that the damping material and selective reflecting areas be disposed on adjacent walls (this includes the ceiling and the floor) so that the high frequency sounds will be directed against the sound absorbing material and that no large reflecting areas will be opposite.

At one end of the room is the usual stage 24, picture screen 25 and loud speaker 26. Opposite the loud speaker on the wall 27 is a sound diffusing panel 23 so positioned as to intercept and scatter the high frequency sound beam and thus prevent reflections which tend to set up standing waves between parallel walls 27 and 28. Panels are also shown disposed on the side walls in staggered relation to intercept any stray vibrations and prevent any standing waves from being set up between these walls.

Figs. 2 and 3 show more in detail the selective sound diffuser 23. Between the vertical side members 4 and 6 are secured end members 5 and 7, to form a rectangular frame. Extending between the sides 4 and 6 are secured lateral deflecting members 8 and 9 joined along their lateral edges, the surfaces of adjacent members being angularly disposed with respect to each other to form V-shaped troughs which are closed at opposite ends by the side members 4 and 6. Extending transversely the troughs and dividing them longitudinally into sections are members 10 and 11 substantially equally spaced from members 6 and 4 respectively to reinforce members 8 and 9. A reinforcing member 12 is also shown on the back of the panel.

The reflecting areas 9 and 8 may be made of wood or any non-metallic or metallic material having sound reflecting properties.

Referring to the curves shown in Fig. 5, "A" represents a typical decay curve of a studio before placing the sound diffusers about the studio. This curve shows clearly the two rates of decay. "B" represents the decay after placing the diffusers in position so that the high frequencies are deflected into the damping material on the floor and on the ceiling.

This method of treating an acoustic studio provides a live room which is desirable under most sound reproducing conditions without the detrimental effects usually attending too little damping.

Although the diffusing panels have been illustrated as separate units it is obvious that they may be an integral part of the walls of the studio. The number, size and distribu-

tion of panels will depend upon the size of the studio. It is desirable to have one however, opposite the loud speaker and in some instances this one may be sufficient.

Lord Rayleigh (Theory of Sound, Vol. II, 2nd ed., page 96) has shown that "However deep the corrugations may be in reflecting surfaces, if only they are periodic in a period less than the wave length of the vibration, the regular reflection is total. An extremely rough wall will thus reflect sound waves of moderate pitch as well as if it were theoretically smooth." Vibrations less than the period of the corrugations will be scattered by their oblique surfaces, that is, if one half the period of the corrugations is greater than one half the wave length of the vibrations, the surface of each slope of the corrugations will, as an independent plane, reflect all frequencies of shorter wave lengths. In other words, a plane surface will act as an efficient sound reflector when its dimensions are one half the wave length of the vibrations or greater. It will be seen therefore that a sound diffuser in accordance with the invention will effectively scatter sound frequencies of wave length less than twice the slant height of the corrugations and at the same time act as a plane reflector for frequencies of greater wave length. There is a period of transition from substantially no direct reflection from plane boundaries having dimensions less than one quarter the wave length of the vibrations to substantially total reflection for dimensions at least as great as one half the wave length.

The dimensions of the diffuser in accordance with the present invention are preferably such that the frequencies below 300 are little affected, those between 300 to 600 cycles per second are scattered somewhat, and above 600 they are largely reflected into the ceiling and audience where they are absorbed. This will lower the reverberation time for these higher frequencies and the fact that they are no longer reflected back toward the source will reduce greatly the standing wave pattern.

A satisfactory structure has been used in which one dimension of the reflecting surface, that is, the slope of the corrugations, is about four feet, the other dimension about one foot, which corresponds approximately to the wave length of sound at one thousand cycles, these members being joined at their edges and disposed with respect to each other at an angle of approximately 120 degrees.

The selectivity of these areas may be increased by covering them with sound absorbing material such as canton flannel. This will not interfere with low frequencies.

Although the invention has been illustrated as applied to a sound picture theatre, it contemplates broadly the elimination of the

second rate decay by reflecting the high frequencies into sound absorbing material in any room or enclosure where the acoustics are important.

In witness whereof, we hereunto subscribe our names, this 2d day of May, 1930.

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What is claimed is:

1. A sound studio having a sound absorbing surface and a sound reflecting surface of such dimensions that substantially only frequencies above 600 cycles per second are reflected into said sound absorbing surface.

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2. A sound studio having a sound absorbing surface and a plurality of sound reflecting areas, the shortest dimensions of which are comparable with one half the wave length of sound at 600 cycles per second, said reflecting areas being disposed at angles to each other and to said absorbing surface.

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3. A sound studio comprising an enclosure having sound absorbing areas and high frequency sound deflecting areas, said absorbing and reflecting areas being so constructed and arranged that there is present in said enclosure but one rate of decay for residual sound for all frequencies.

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4. In a sound studio having sound absorbing walls, the combination of a sound reproducing device near one end and a sound diffusing panel at the opposite end for scattering only the high frequency sound waves from said device and directing them into said sound absorbing walls.

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5. A sound studio having sound damping material on one wall thereof and sound reflecting surfaces on adjacent walls, said surfaces being disposed at an acute angle with respect to said damped wall.

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6. A sound studio comprising a damped wall and an adjacent undamped wall having a plurality of frequency selective deflecting areas for deflecting high frequencies into said damped wall.

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7. A sound diffuser comprising a plurality of flat reflecting surfaces joined at their edges and angularly disposed with respect to each other.

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8. A sound diffuser comprising a plurality of long and narrow members joined along their edges to form alternate troughs and ridges.

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9. A sound diffuser comprising a plurality of sound deflecting surfaces said surfaces sloping alternately in opposite directions and of such dimensions as to scatter only high frequencies.

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10. In a sound studio opposite sound reflecting walls having small frequency selective reflecting areas disposed at regular intervals and inclined to adjacent walls.

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11. The method of improving the acoustics of studios which consists in intercepting the sounds from a given source and deflecting the high frequencies at a certain angle into sound absorbing material and reflecting the low frequencies at a different angle.

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