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Jaffe

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[54] **SOUND ENHANCING SYSTEM**

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[52] **U.S. Cl.** ..... **179/1 J,** 179/1 AT
[51] **Int. Cl.** **H04r 3/00**
[58] **Field of Search** ..... 179/1 J, 1 AT; 181/30

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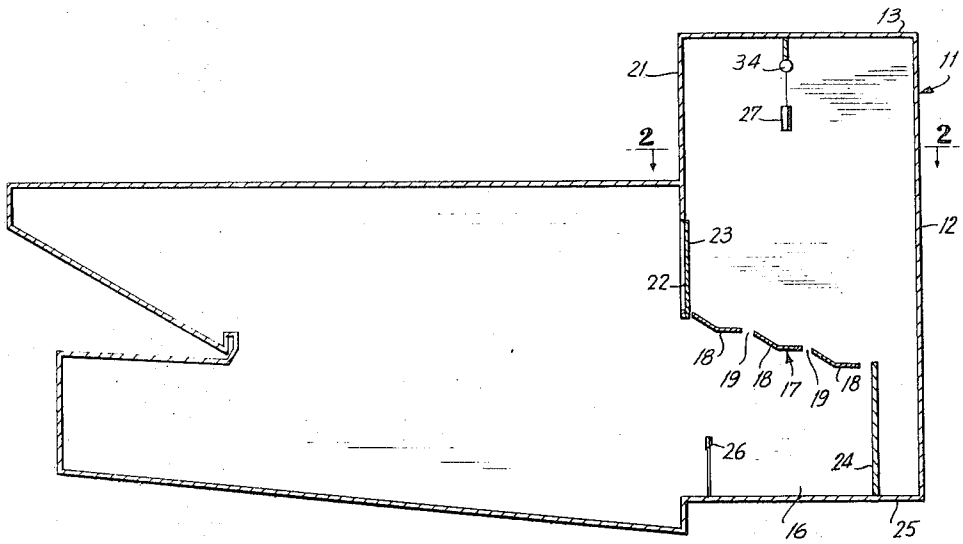
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Attorney, Agent, or Firm—Blum, Moscovitz, Friedman & Kaplan

[57] **ABSTRACT**

A sound enhancing system for either an open or a closed auditorium includes a reverberation chamber positioned above the ceiling of the shell from which said sound originates. Speakers within the reverberation chamber receive low frequency signals from microphones in the shell. The reverberation chamber has an opening in the wall facing the audience through which sound can pass.

7 Claims, 3 Drawing Figures



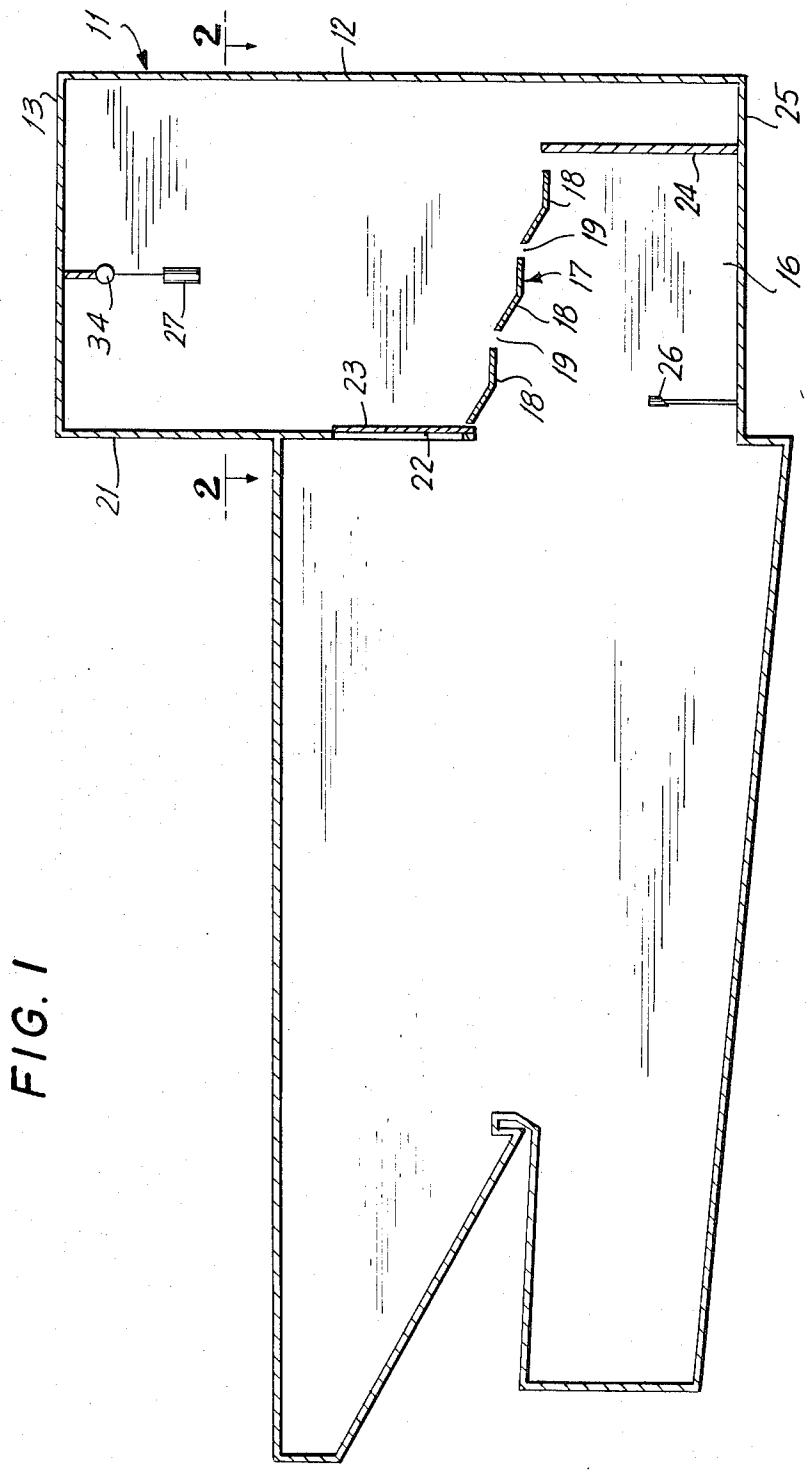


FIG. 1

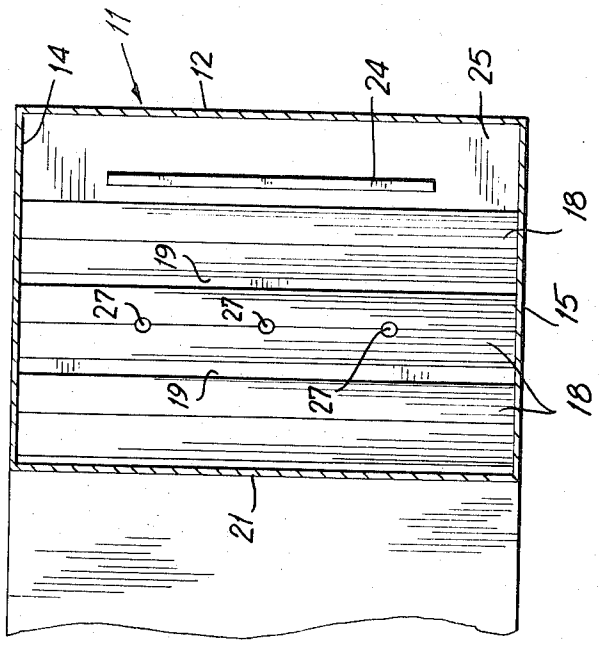

14
11
12
24
25
18
19
27
27
15
19
27
18
21

FIG. 2

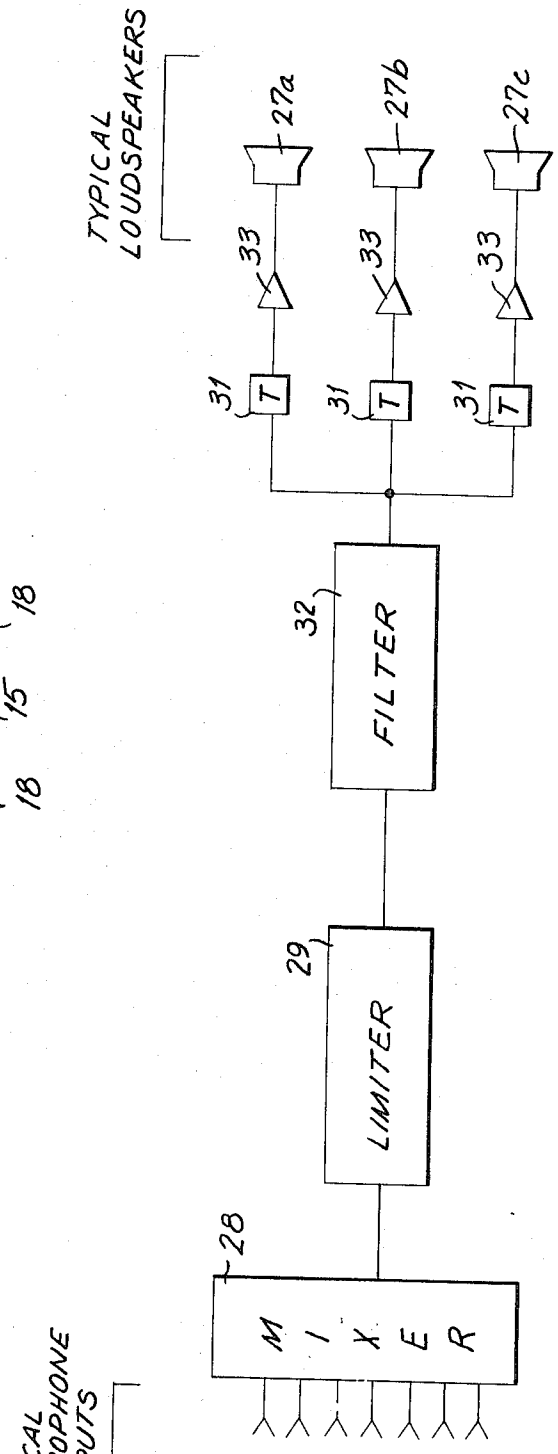

TYPICAL LOUDSPEAKERS
27a
27b
27c
33
33
33
31
T
31
T
31
T
32
FILTER
29
LIMITER
28
MIXER
TYPICAL MICROPHONE INPUTS

FIG. 3

SOUND ENHANCING SYSTEM

BACKGROUND OF THE INVENTION

Studies of the way in which sound in an auditorium reaches the audience from the performer or speaker indicate that medium and high frequency sound, for the most part, travel directly from the source to the listener. However, with respect to low frequency sound, such sound is perceived mostly as reverberation, i.e., by reflection from the walls and ceiling of the auditorium. Theodore Schultz of Bolt, Beranek and Newman constructed a simulator showing the above to be true.

Where an auditorium is suitably constructed with regard to the performance of music ranging from low to high frequencies, sound enhancement, in general, is not needed. Howeever, in most community and school auditoriums the acoustics are designed for the enhancement of the frequencies in the range of normal speech. Such auditoriums frequently have absorbers on the walls, and, of course, the audience itself functions as an absorber. Such auditoriums, in general, serve very poorly for use by musicians and in such case, enhancement of the low frequencies is highly desirable to impart fidelity to the music being generated on the stage. The stage is generally part of a shell consisting at least of a back wall and a floor. The term "shell" will, hereinafter, be used to designate the region in which sound is generated for transmission to an audience.

The problem of enhancement of the lower frequencies is even more acute in an open-air auditorium since there are then no walls from which reflection can take place. Consequently, enhancement of low frequencies, say from 30 to 250 Hz is also desirable for such auditoriums.

It should be noted that increased amplification of the lower frequencies will not compensate for selective absorption of such frequencies. Such a procedure would result in a most unnatural sound frequency distribution. What is needed is an extension of the reverberation time, i.e., the decay time. Depending on the size of the auditorium or hall the decay time should be up to about 2 seconds.

SUMMARY OF THE INVENTION

For sound enhancement in accordance with the present invention, a reverberation chamber is constructed over the shell and separated therefrom by an apertured ceiling. The wall of the reverberation chamber facing the audience has an opening therein through which sound can reach the audience. Microphones in the shell transmit signals through electronic circuitry to speakers within the reverberation chamber. The electronic circuitry and the loud speakers are designed for transmitting and amplifying only low frequency signals.

Where a plurality of amplifiers is used, delay circuits are incorporated in the electronic circuitry so that a given signal energizes the loud speakers in sequence, the interval between energization of successive loud speakers being adjustable. Also, where a plurality of loud speakers is used, each successive loud speaker is energized at a lower intensity, the intensities being separately adjustable.

The ceiling separating the shell from the reverberation chamber is preferably apertured, thus permitting coupling between low frequency vibrations emanating directly from the source and the output of the speakers.

Accordingly, an object of the present invention is to provide an improved low frequency sound enhancement system for use in auditoriums.

Another object of the present invention is to provide an improved low frequency sound enhancing system which includes a reverberation chamber and at least one loud speaker supplied with low frequency energy from a microphone in the region where sound is being produced.

A further object of the present invention is to provide an improved low frequency sound enhancing system in which a plurality of loud speakers in a reverberation chamber may be energized in sequence by a given signal.

Still another object of the present invention is to provide an improved low frequency sound enhancing system in which a plurality of speakers in a reverberation chamber, in response to a given signal, are energized in sequence and at progressively lower levels.

Yet another object of the present invention is to provide an improved low frequency sound enhancing system in which low frequency sound from the shell of an auditorium is coupled with sound electronically produced from loud speakers in a reverberation chamber.

Yet a further object of the invention is to provide an improved method of increasing the reverberation time of low frequency sounds.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combination of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is has to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a diagrammatic elevational view in partial cross section of an auditorium with a reverberation chamber in accordance with the present invention;

FIG. 2 is a partial cross sectional view taken along line 2—2 of FIG. 1; and

FIG. 3 is a schematic diagram of the circuitry between microphones in the shell of the auditorium and loud speakers in the reverberation chamber.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference numeral **11** indicates generally a reverberation chamber in accordance with the present invention. This chamber has at least four closed walls **12, 13, 14** and **15.** Reverberation chamber **11** is separated from shell **16** by ceiling indicated generally by reference numeral **17.** Ceiling **17** preferably is apertured. In the construction shown dihedral panels **18** are separated by gaps **19** through which sound can pass directly from shell **16** into reverberation chamber **11.** Front wall **21** of reverberation chamber **11** has therein an opening **22** covered by sound-transparent scrim **23** which is opaque to light.

In the embodiment shown in FIGS. 1 and 2 back wall 24 of shell 16 also serves as part of the enclosure comprising reverberation chamber 11. The same is true of floor portion 25.

The principal means by which sound energy is transmitted from the shell to the reverberent chamber 11 is by means of one or more microphones 26 connected to one or more reverberent field energizer loud speakers 27. Loud speakers 27 must be hung at a height such that direct line-of-sight transmission to any part of the audience through opening 22 is avoided.

For best sound enhancement, a plurality of microphones and a plurality of loud speakers 27 are used. Outputs from the microphones 26 pass to a mixer 28 and then to a limiter 29 the function of which is to protect succeeding circuitry and circuit elements from overload due to sound peaks generated within the shell.

FIG. 3 shows the output from limiter 29 being fed to three loud speakers; however, this number has been selected merely for convenience and is not to be considered as limiting the number of loud speakers to be used in any actual case. The circuitry from limiter 29 to the speakers 27*a*, 27*b* and 27*c* includes low frequency band pass filter 32, adjustable time delays 31, and amplifiers 33. It has been found highly desirable to introduce a given signal after increasing time delays to successive speakers. Thus, for instance, the delay in introducing a given signal to speaker 27*a* might be zero milliseconds, to speaker 27*b* might be 80 milliseconds and to speaker 27*c* might be 160 milliseconds. In general, the maximum delay introduced should be about 300 milliseconds. Since the size of the reverberation chamber may be of the order of 100 feet wide by 50 feet high by 40 feet long, the distance from the opening 22 to the nearest part of the audience will generally be great enough to introduce a time delay of about 25 milliseconds. Consequently, it is not necessary to introduce any time delay into the first speaker activated though, in certain cases, it may be desirable to do so.

The signal from limiter 29 passes through low-frequency band-pass filter 32. This filter is designed to pass frequencies between about 30 Hz and 250 Hz; however, the filter is not designed for sharp cut off but rather for a tapering cut off in order to avoid a sudden jog in the frequency-intensity relationship as perceived by the audience.

Amplifiers 33 which receive the signals from time delays 31 also serve as volume controls, with the control elements being positioned on a panel accessible to an operator. The volume controls of the amplifier 33 are so adjusted that the signals reaching successive speakers after increasing time delays decrease in intensity. For the embodiment shown in FIG. 3 the amplitudes of the signals emanating from speakers 27*a*, 27*b* and 27*c* would decrease in that order.

In general, it will be found that there is an optimum location with respect to height for the speakers 27. Adjustment of the height of the speakers 27 can be made by means of winch 34. The optimum height for the speakers 27 can easily be determined by one skilled in the art and need not further be specified. Similarly, the optimum time delays between successive speakers and the optimum decrease in intensity between successive speakers can also be determined by one skilled in the art.

It will thus be seen that objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in carrying out the above method and in the construction set forth without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also be to understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A system for improving the fidelity of sound emanating from a stage and directed toward an audience positioned in front of the stage comprising a reverberation chamber positioned above said stage, said reverberation chamber having a first wall facing the audience and a second wall facing said stage, at least one loudspeaker in said reverberation chamber, at least one microphone above said stage for receiving sound emanating from said stage, means connecting said microphone with said loudspeaker for delivering amplified sound from said microphone to said loudspeaker, an opening in said first wall for delivering sound from said reverberation chamber to the audience and an opening in said second wall for acoustically coupling the sound produced in said reverberation chamber with the sound emanating from said stage.

2. A system as defined in claim 1, wherein said system comprises a plurality of loud speakers in said reverberation chamber and said means includes time delay means so adjusted that a signal from said microphone reaches each of said plurality of loud speakers in sequence, the time delay between the output of said signal from said microphone and the energization of each successive loud speaker in response to said signal being adjustable.

3. A system as defined in claim 2, wherein the minimum time delay introduced is zero and the maximum is about 300 milliseconds.

4. A system as defined in claim 2, wherein said means further includes level control means so adjusted that the level to which each successive speaker is energized in response to said given signal is lower than that of the preceding speaker.

5. A system as defined in claim 1, wherein said means and said loud speaker is designed for amplification and transmission of frequencies from about 30 to 250 Hz.

6. A system as defined in claim 1, wherein said second wall is composed of panels spaced-apart and oriented to reflect sound from said stage to said audience.

7. A system as defined in claim 1, wherein said speaker is located above any line of sight from the audience through said opening in said first wall.

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