United States Patent

[11] 3,582,553

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[73] Assignee Bose Corporation

[54] **LOUDSPEAKER SYSTEM**
35 Claims, 9 Drawing Figs.

[52] U.S. Cl. **179/1,** 181/31
[51] Int. Cl. **H04r 1/28**
[50] Field of Search .... 179/1 E, 1 AT, 1 DIR; 181/31.1; 333/28 T

[56] **References Cited**

UNITED STATES PATENTS

2,544,742	3/1951	Volf	181/31(.1)
2,689,016	9/1954	Lang	181/31(.1)
2,710,662	6/1955	Camras	181/31(.1)
3.026,957	3/1962	Gladstone	181/31(.1)
2,256,057	9/1941	Roberts	333/28T
2,610,694	9/1952	De Boer	181/31.1
2,915,588	12/1959	Bose	179/1E

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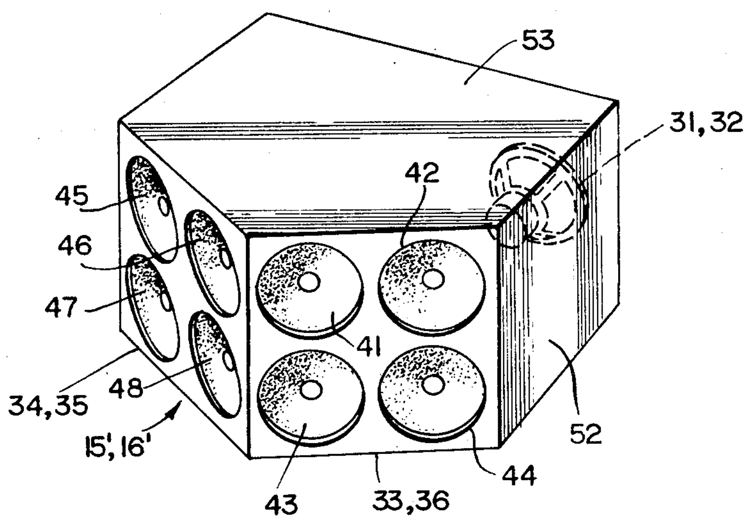
ABSTRACT: A loudspeaker system comprises two angularly displaced rear rectangular baffles each nearly filled with four closely spaced full-range small loudspeakers and partially enclosing a substantially fluid-tight volume also enclosed by a front baffle containing a small asymmetrically located loudspeaker so that the angularly inclined baffles typically face a wall to which the front baffle is generally parallel. The small loudspeakers are connected in phase and energized through means including a complementing circuit so that the overall system is characterized by a phase-frequency response characteristic that pleasingly reproduces music.



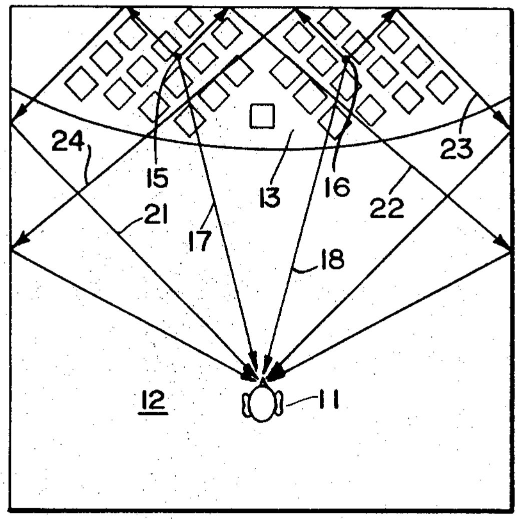


FIG. 1

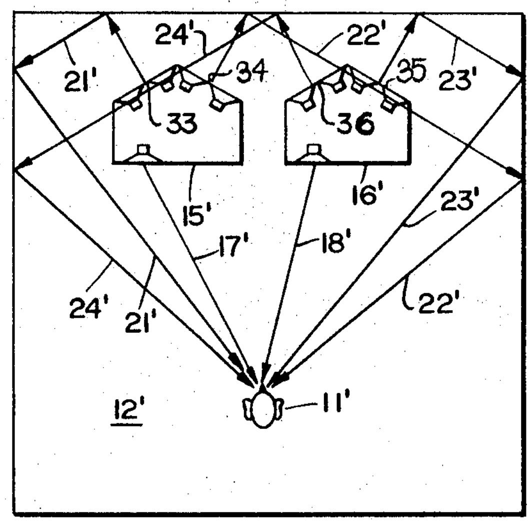


FIG. 2

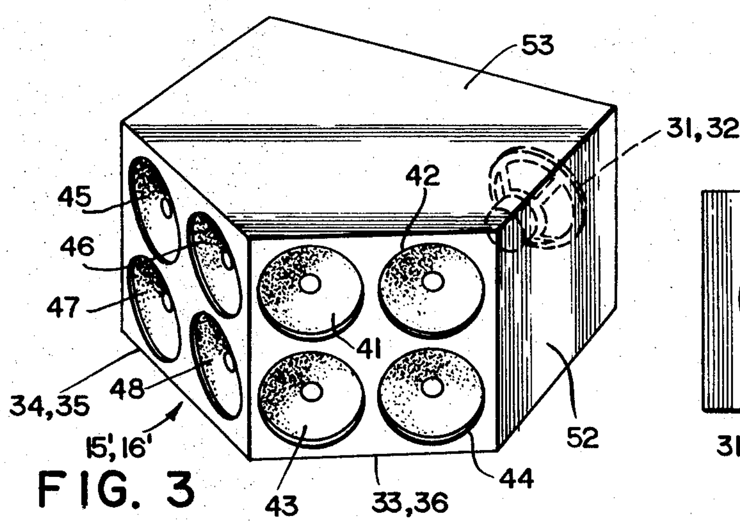


FIG. 3

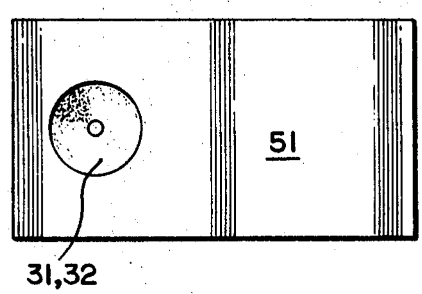


FIG. 4

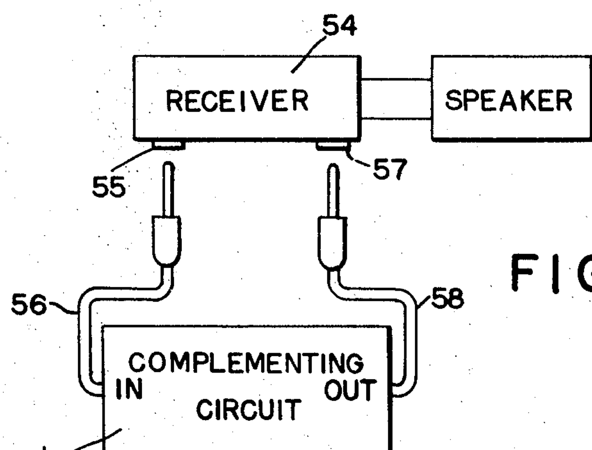


FIG. 5

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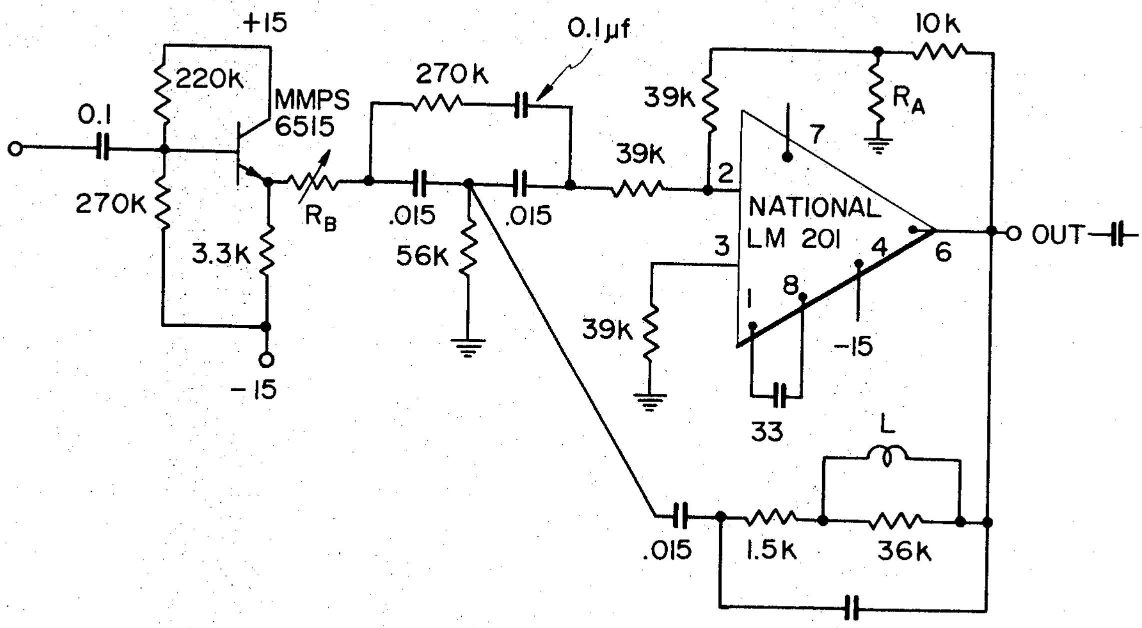

RA LOW FREQ. CONTROL 240Ω ≤ RA ≤ 390Ω
(CONTROLS FREQ. RESPONSE BELOW 50 CPS)

RB HIGH FREQ. CONTROL 0 ≤ RB ≤ 2.5K
(ABOVE 1KC)

L 26/16,3B7 A 1000 POT CORE WITH 153 TURNS #28 NYCLAD

FIG. 6

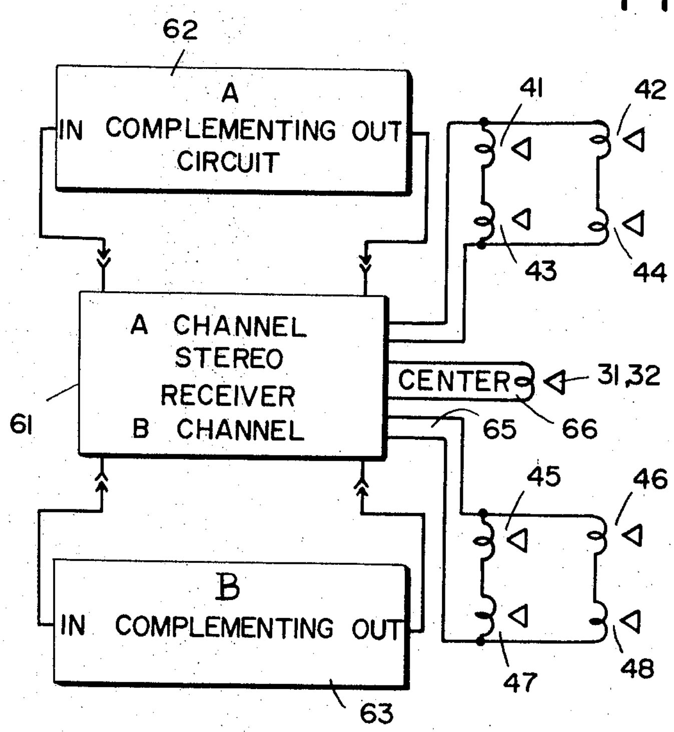

FIG. 7

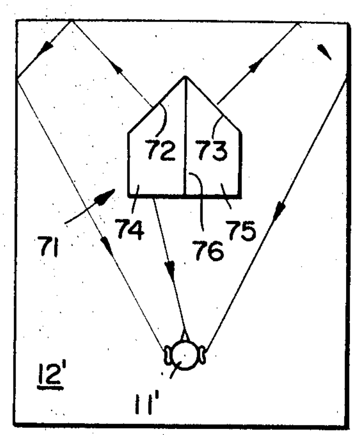

FIG. 9

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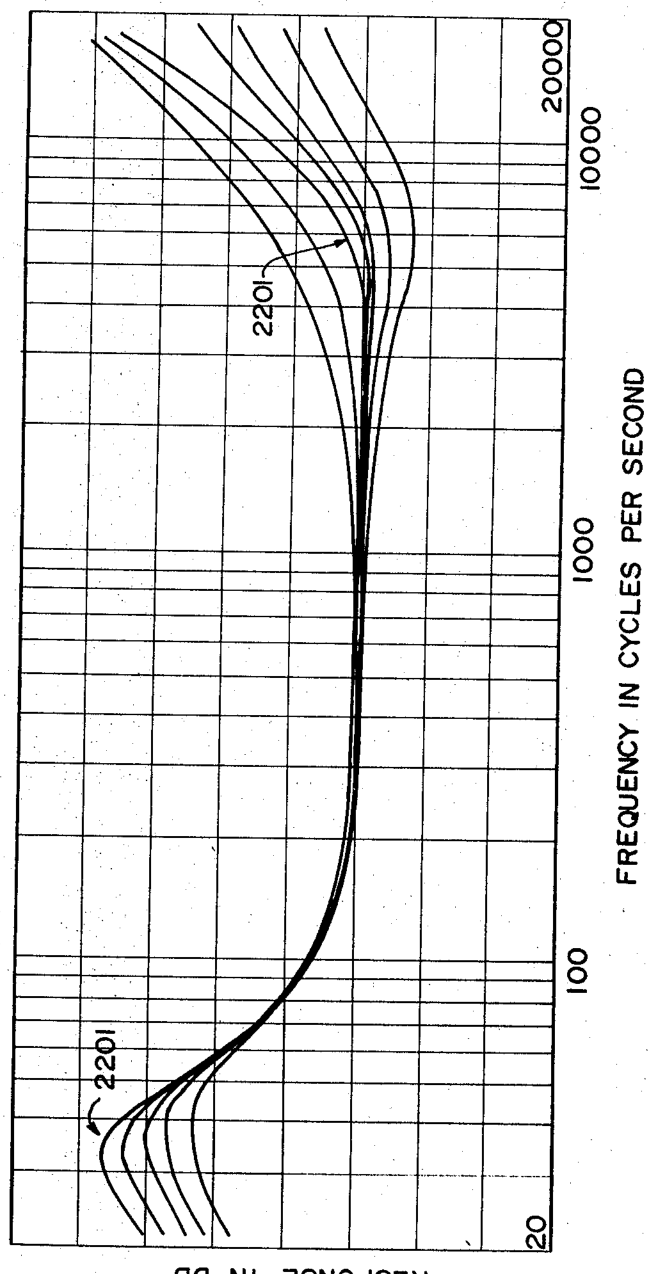

FIG. 8

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LOUDSPEAKER SYSTEM

The present invention relates in general to loudspeaker systems and more particularly concerns a novel compact loudspeaker system that is compact and relatively easy and inexpensive to manufacture and provides realistic reproduction of sound with negligible distortion.

The standard of loudspeaker systems is the commercially available Bose 2201 spherical radiating system comprising 22 closely spaced small loudspeakers substantially filling a spherical triangle baffle of about 25-inch radius and comprising means for enclosing a substantially fluidtight volume preferably situated in the corner of a room. This loudspeaker system takes advantage of Bose known property that in a concert hall most of the sound reaches the listener by reflection. In addition, the Bose 2201 is characterized by the advantages enumerated in Bose U.S. Pat. Nos. 2,915,588 and 3,038,964. These advantages include low distortion arising from sing a number of small closely spaced loudspeakers coacting in reproducing low frequencies to provide large vibrating area so that the deflection of each speaker diaphragm is slight and distortion low. In addition the disadvantages associated with crossover networks are eliminated.

The Bose 2201 represents a practical approximation to an ideal vibrating spherical surface that is so nearly perfect that it is believed listeners are unable to distinguish between music reproduction provided by the Bose 2201 and that which would be provided by an ideal pulsating sphere. This result was established by separating the room transfer characteristics from the loudspeaker system characteristics in the following manner. A spark source situated in the corner of a room was compared with a Bose loudspeaker situated in the same corner. A high speed digital computer determined the Green's function of the room and produced samples of music that would be produced by an ideal pulsating sphere in the room for comparison with the same sample of music that would be provided by a Bose loudspeaker. The complementing circuitry of the latter was adjusted until listeners were unable to distinguish between the reproduction afforded by an ideal pulsating sphere and the Bose loudspeaker. The commercially available Bose 2201 is an absolute standard that can be used to compare in an actual listening room the performance between an existing loudspeaker system and the Bose 2201.

It is well known that loudspeakers perform differently in different rooms and perform in a room differently from the performance in an anechoic chamber (a special suspended compartment surrounded by sound absorbing wedges of material so that the compartment is essentially free of sound echoes). Nevertheless, not infrequently it is thought that anechoic chamber measurements of loudspeakers represent meaningful indicia of loudspeaker performance. In fact, recent work shows that anechoic chamber measurements provide less meaningful information for evaluating the performance of a loudspeaker in a listening room than previously thought.

The reason for this conclusion is that the hard surfaces provided by walls represent a portion of the loudspeaker sound radiating system whereas an anechoic chamber does not have such hard surfaces. Those acquainted with the antenna field and the determination of magnetic and electric fields will readily recognize the analogy between establishing pressure and velocity fields by a loudspeaker system transducer and establishing magnetic and electric fields by an antenna transducer. Antenna engineers are well aware that the proper design of an antenna involves either isolating the antenna from nearby structures or taking into account the surrounding structure. Thus, technical publications commonly display properties of an antenna system, such as radiation patterns and impedance plots, measured with the antenna situated in its operating environment, such as on an aircraft or satellite. Field strength measurements are usually made many wavelengths from the antenna to provide meaningful information on the properties because normally antenna systems are used for communication with other systems many wavelengths away.

Greater difficulties are encountered in attempting to measure the characteristics of a loudspeaker system that radiates energy for use in a room a few wavelengths, or a fraction of a wavelength, from the transducer system itself. That is to say, it is difficult to separate the room characteristics from those of the loudspeaker system to facilitate establishing a meaningful objective evaluation of the performance of the loudspeaker system itself in the room environment. Since the Bose 2201 represents a nearly perfect transducing system itself, a comparison of the field intensity at a point in the room between a Bose 2201 and an unknown loudspeaker system represents a meaningful objective determination of the performance of the unknown relative to that of the standard Bose 2201. When the measured performance of the unknown is essentially undistinguishable from that of the Bose 2201, then the unknown is known to be performing as well as it can as a loudspeaker system transducer.

Accordingly, it is an important object of this invention to provide a high performance loudspeaker system.

It is another object of the invention to provide a loudspeaker system that performs nearly as good as the ideal pulsating sphere.

It is another object of the invention to achieve the preceding objects with a compact structure that is relatively low in cost.

It is another object of the invention to achieve the preceding objects with a structure that may be situated in a convenient location in a room.

It is still a further object of the invention to achieve the preceding objects with a loudspeaker system having the property of spreading the apparent source of sound to the listener to simulate a performance by a large group, such as an orchestra or chorus.

It is a further object of the invention to achieve the preceding objects with a loudspeaker system that provides both direct and reflected sound to the listener so as to more nearly simulate the character of the sound heard in the concert hall.

It is still a further object of the invention to achieve the preceding objects with a system that may be used for stereo reproduction in a manner that avoids the "hole-in-the-center" effect and provides good stereo reproduction in all portions of the room.

It is still another object of the invention to achieve the preceding objects with a loudspeaker system that is relatively efficient and free of distortion so that it defines the individual instruments with great clarity, even when reproducing passages of music involving simultaneous playing by a large number of instruments.

SUMMARY OF THE INVENTION

According to the invention, there are means defining a front panel arranged to be situated normally parallel to a wall and means associated with a loudspeaker cabinet having the front panel for supporting upper frequency radiating means to that the radiating means normally faces out the back of the loudspeaker cabinet with its axis oriented at an angle to the front panel so that with the loudspeaker cabinet normally positioned with the front panel generally parallel to a wall, the upper frequency radiating means emits at least upper frequency sound; that is, sound having spectral components above 200 Hz., in a beam that has both component directed away from the front panel toward the wall and to the side of the cabinet.

Preferably the loudspeaker system comprises at least two normally rear baffles forming an angle with each other and at an angle to the front panel and comprising the loudspeaker cabinet with each baffle having at least one small loudspeaker thereon with each small loudspeaker normally directing upper frequency sound in a beam having both a rearward and sideward component of the sound beam radiated by the speaker associated with the other baffle, the loudspeaker preferably being cophasally excited.

Preferably the normally rear baffles contain a number of closely spaced loudspeaker connected in phase and nearly filling the baffle. Preferably the front panel comprises a baffle containing at least one small loudspeaker cophasally excited with the other small loudspeakers for providing direct sound to the listener. Preferably, the small loudspeaker are essentially full-range high compliance loudspeakers coupled to a signal source by means including a complementing circuit to establish a system phase-frequency response characteristic that results in exceptionally pleasing reproduction of sound.

Numerous other features, objects and advantages of the invention will become apparent from the following specification when read in connection with the accompanying drawing in which;

FIG. **1** is a diagrammatic representation to illustrate how a listener in a concert hall receives mostly reflected sound energy;

FIG. **2** is a diagrammatic representation of a stereo loudspeaker system according to the invention illustrating how the invention tends to simulate the ratio of reflected to direct sound for the listener in a room of the sound received by the listener in a concert hall of FIG. **1**;

FIG. **3** is a perspective view of a preferred embodiment of a loudspeaker system according to the invention;

FIG. **4** is a front view of the system of FIG. **3**;

FIG. **5** is a block diagram illustrating the logical arrangement for incorporating the complementing circuit for coaction with the speaker system according to the invention with a commercially available receiver or integrated preamplifier-amplifier;

FIG. **6** is a schematic circuit diagram of an exemplary complementing circuit;

FIG. **7** is a block diagram illustrating the logical arrangement for using a single one of the speaker systems of FIGS. **3** and **4** to achieve stereo reproduction;

FIG. **8** shows a typical frequency response characteristics of the circuit of FIG. **6**; and

FIG. **9** is a diagrammatic representation of a single unit stereo reproducer in a room.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference now to the drawing and more particularly FIG. **1** thereof, there is shown a representation of a listener **11** in a concert hall **12** facing the stage **13** receiving sound from point **15** on the left side of that stage and **16** on the right side of the stage directly over the paths **17** and **18**, respectively, and indirectly over paths such as **21** and **22** from the left side, and **23** and **24** from the right side. It is believed that of the order of 87 percent of the sound which reaches a listener in the concert hall is through reflection.

Referring to FIG. **2** there is shown a diagrammatic representation of loudspeakers according to the invention providing sound to a listener **11'** in room **12'** by a left speaker **15'** and a right speaker **16'** providing direct sound over paths **17'** and **18'**, respectively from direct loudspeakers **21** and **22**, respectively. The left speaker system **15'** provides indirect sound over paths including path **21'** and **22'** from left rear panel **33** and right rear panel **34**, respectively. Similarly, right speaker **16'** provides indirect sound over paths including path **23'** and path **24'** from right rear panel **35** and left rear panel **36**, respectively.

Referring to FIG. **3** there is shown a perspective view of loudspeaker **15'** and **16'** showing left panels **33** and **36** and right panels **34** and **35**. The position of front loudspeaker **31** and **32** is indicated by dotted lines in FIG. **3**. Each of the rear panels includes four loudspeakers **41**, **42**, **43** and **44** on the left, and **45**, **46**, **47** and **48** on the right. These loudspeakers are preferably closely spaced and substantially fill each of the panels. Typically, these loudspeaker are 4-inch speakers with the 4⅛inch circular opening with speakers separated from adjacent ones by about three-sixteenth inch and from the baffle edges by about one-half inch so that each rear panel is a ¾inch piece of plywood about 10½inches by about 10¾inches forming an angle of 120° so that the angle between each of the rear panels and the wall upon which they direct sound for reflection is substantially 30°.

FIG. 4 shows a front view of the loudspeaker system 15', 16' **showing front baffle** 51. **This baffle may be ¾inch plywood about** 17 inches by about 10¾inches. The essentially fluidtight enclosure is completed by a pair of side panels, such as **52**, a top panel such as **53** and a like bottom panel (not shown). Side panel **52** is typically of ¾inch plywood about 10¾inches high by about 5½inches wide, and the top and bottom panels are dimensioned so that they cover the opening defined by the rear baffle, front baffle and side panels. The distance between side panels is about 16¼inches. The distance between the front baffle and the junction of the rear baffles is about 9 9/16 inches. For decorative reasons, the top and bottom panels may extend beyond the baffles and side panels. For a pleasing decorative effect the baffles an both side panels may be surrounded by suitable grille cloth.

In a specific embodiment of the invention the individual small loudspeakers are all commercially available full range CTS 4C1077 high compliance ceramic magnet 4-inch loudspeakers having a nominal impedance of 8 ohms with the speakers connected in series-parallel so that the impedance to an amplifier of the series-parallel system is 8 ohms. Typically speakers **42**, **43** and **44** may be connected in series to form one series group, speakers **45**, **47** and **48** connected in series to form a second series group and speakers **41**, **46** and the front speaker connected in series to form a third series group. Each of these series groups presents an impedance of substantially 24 ohms. When the three groups are connected in parallel, the effective impedance is then 8 ohms. The individual speakers are cophasally excited so that all the speaker diaphrams move out together and in together in response to the same input signal. The inside volume may be filled with fiberglass if desired.

A feature of the invention resides in minimizing undesired resonances. Thus, there are a number of baffles each containing at least one loudspeaker, but none of these baffles are parallel to another surface. Sharp resonances normally encountered when a baffle is parallel to another surface at frequencies when the separation between the baffle and such another surface is a multiple of a quarter wavelength are thus minimized. And since the individual resonances of each individual loudspeaker when the loudspeakers are acoustically coupled are normally not exactly the same as the other loudspeakers, sharp resonance effects normally encountered when a single loudspeaker reproduces a given frequency range embracing the speaker resonances, are believe to be significantly reduced.

Referring to FIG. **5** there is shown a block diagram generally illustrating the logical arrangement of a system including a conventional receiver **54**, a complementing circuit **55** and a speaker **16'** energized by the 8 ohm output terminals of receiver **54**. A typical receiver **54** has a tape monitor jack **55** which is coupled to the input of complementing circuit **55'** by input cable **56**. A typical receiver **54** also has a pair of tape recording jacks one jack **57** coupling the output of complementing circuit **55** by output cable **58** to the amplifier input when the receiver (or integrated preamplifier-amplifier) selector switch is in the tape monitor position. Jack **55** is coupled to the output of the preamplifier section of the receiver. These normally available jacks are especially convenient for using the invention with a receiver or integrated preamplifier-amplifier. For separate preamplifier components and amplifiers, input cable **56** may be couple to the preamplifier output jack and output cable **58** may be coupled to the amplifier jack.

Referring to FIG. **6**, there is shown schematic circuit diagram of a complementing circuit suitable to use with the specific system described above. Since those skilled in the art will be able to practice the invention by constructing the specific circuit with the indicated parameters, the specific circuit will not be discussed further other than to indicate the frequency response characteristic in FIG. **8**. Adjustment of resistor R_A alters the lift in low frequency end indicated while adjustment of the resistance R_B alters the lift in the high frequency end as indicated with the intermediate range remaining substantially flat as shown. For minimum deviation between reproduction of the system according to this invention and the Bose 2201, the curve designated 2201 should be selected. However, for certain recordings it may be more pleasing to the listener if other settings are chosen.

In addition to enhancing the amplitude frequency response characteristic of the system, the complementing circuit is believed to to also enhance the phase frequency response characteristic of the system. The system phase response characteristic is believed to be important toward the proper reproduction of low frequency signals below 200 Hz. Thus, although the ear may not be able to detect wide phase differences at high frequencies, it is believed that the human ear can detect phase differences at the low frequencies corresponding to delays in the order of a number of milliseconds. Most conventional loudspeaker systems have an uncompensated resonance in a low bass region which results in considerable phase distortion. However undetectable this phase distortion may be when reproducing single low tones, the distortion becomes audible when reproducing a complex musical signal having a number of spectral components in the bass region that are displaced in time differently upon reproduction by a conventional loudspeaker system to produce sound waveform that is audibly distorted.

Referrng to FIG. **7** there is shown a combined block-schematic circuit diagram of a means for energizing but a single speaker system to provide many of the advantages of the present invention with but a single loudspeaker enclosure, thereby effecting a mark reduction in the cost of a stereo system and eliminating the space that would be required to accommodate two units. To this end a stereo receiver **61** has its A channel coupled to an A complementing circuit **62** and its B channel coupled to A complementing circuit **62** and its B channel to a B complementing circuit **63** in the same manner as complementing circuit **55** in FIG. **5** is coupled to receiver **54**. Speakers **41, 42, 43** and **44** on the left panel are coupled to the output of the A channel. Speakers **45, 46, 47** and **48** on the right panel are coupled in series, parallel as shown and coupled to the B channel output **65**. The front speaker **31, 32** is coupled to the center channel output **66** of stereo receiver **61**. Most stereo receivers and stereo amplifiers have such a center channel output.

Alternately, the center loudspeaker may be connected so that it receives a signal current representative of the sum of the signals in the left and right channels provided by an appropriate combining circuit. For example, the winding of the center speaker may be connected so that it is in series with at least one winding of a speaker on the left baffle and at least one winding of a speaker on the right baffle.

Referring to FIG. **9**, there is shown a diagrammatic representation of a suitable arrangement in a room **12'** of single unit **71** connected as shown in FIG. **7**. Preferably speaker system unit **71** is located along the center line of the room as shown spaced from the front wall of the room so that listener **11'** receives A channel signal through reflection from the left wall of the room and B channel information from the right wall of the room and center channel information from the front panel. Speaker system unit **71** is preferably placed far enough from the wall (usually about a foot) to achieve a desired degree of apparent spreading of the sound, but not so far that effective reflection from the wall is not obtained. It may be advantageous with a single system to have the angle between left panel **72** and right panel **73** be substantially 90° so that the unit may be placed not too far from the wall and still provide a desired degree of separation between he apparent source of A channel signal and B channel signal.

It may also be advantageous to include an isolating wall **76** that divides the unit into left substantially fluidtight compartment **74** and a right substantially fluidtight compartment **75**. Such an isolating wall helps reduce undesired mixing of left and right channels inside the enclosure and thereby enhances the stereo performance maintaining a relatively high degree of effective channel separation.

Turning now to the preferred method of determining the frequency response characteristic of the complementing circuit, a Bose 2201 is located in the corner of a listening room. A good full-range microphone is also located on a stand in a typical listening position in the room. A suitable microphone for this purpose is the B&K commercially available microphone and associated preamplifier. The Bose 2201 is fed with a swept frequency signal preferably narrow band noise, such as that provided by a commercially available General Radio sound and vibration analyzer energized with pink noise capable of being swept over the full audio frequency range by a mechanical drive that may be synchronized with a General Radio logarithmic graphical recorder. The output of the microphone preamplifier is applied to the General Radio graphical recorder as the analyzer is swept over the frequency range to provide a frequency response characteristic at that point in the room that is representative of the transmission properties of the room.

The microphone remains in the same position and then the loudspeaker system, such as that shown in FIG. **3**, is energized through a power amplifier having an essentially flat frequency response with the signal provided by the sound and vibration analyzer, the loudspeaker being located in a typical location for reproduction about a foot from a wall oriented generally as shown in FIG. **2**. The sound and vibration analyzer is again swept over the audio frequency range, and the output of the microphone preamplifier applied to the graphical recorder to provide a representation of the transfer characteristics of both the loudspeaker system thus energized and the room to that same listening point previously measured with respect to the Bose 2201.

The difference between the graphical representation of the Bose 2201 and that of the uncompensated unit of FIG. **3** is determined graphically on a point-by-point basis over the frequency range to yield the preferred frequency response characteristic of the complementing circuit. If desired, means may be provided or altering the degree of lift at the high and low ends to satisfy the preference of an individual listener, especially since many commercial recordings are overcompensated.

It has been discovered that the overall free field axial infinite baffle pressure high frequency response provided by the complementing circuit coacting with a one of the small loudspeakers is higher relative to the response in the middle range of frequencies. This rise in response typically commences at a frequency above 2 kHz. and may be effected electrically, mechanically, through acoustic attenuation, by combination thereof or by other suitable means. Yet the overall system radiated power density spectrum response (proportional to pressure response squared) provide by the loudspeaker system according to the invention including complementing circuit is essentially uniform.

Numerous variations of the invention may now be practiced. For example, the baffle may be tilted upward or downward for low and high locations, respectively, of the system. Different numbers and different kinds of speakers may be used and the ratio of direct to reflected sound retained in nearly the same desired ratio by radiating less high frequency energy from the speaker on the front baffle as a result of electrical, mechanical or acoustical attenuation. Thus, an especially compact and inexpensive embodiment of the invention might include just one loudspeaker on each rear baffle and one on the front baffle with the front loudspeaker energized trough an attenuating network that delivers about one-fourth the high frequency energy to the front loudspeaker than is delivered to each of the rear loudspeakers.

There has been described a novel loudspeaker system characterized by the ability to reproduce music pleasingly and with great clarity while being relatively easy and inexpensive to fabricate and occupying relatively little space in the listening area. The specific embodiments described herein are by way of example only. It is evident that those skilled in the art may now make numerous uses and modifications of and departures from the inventive concepts. Consequently, the invention is to be construed as embracing each and every novel feature and novel combination of features present in or possessed by the apparatus and techniques herein disclosed and limited solely by the spirit and scope of the appended claims.

I claim:

1. A loudspeaker system comprising, first means defining a front panel arranged to be situated normally generally parallel to a wall,
 second means defining a rear baffle including means for supporting at least one upper frequency radiating means,
 means including said first means and said second mean for defining a loudspeaker cabinet enclosing an internal volume,
 said first and second means being relatively positioned so that with said loudspeaker cabinet normally positioned with said front panel generally parallel to a wall, a plurality of upper frequency radiating means carried by said means for supporting are positioned for emitting upper frequency sound in a beam that has a rearward component directed away from said front panel toward said wall and a sideward component directed generally parallel to said wall,
 means including said upper frequency radiating mean and said loudspeaker cabinet enclosing said internal volume substantially fluidtight
 and means associated with said upper frequency radiating means for establishing the free field infinite baffle pressure frequency response along the axis thereof higher relative to the response in the middle range of audio frequencies while coacting with all the elements in said loudspeaker system to provide an essentially uniform radiated power density spectrum frequency response over substantially the entire audible frequency range when said loudspeaker system is normally positioned with said front panel generally parallel to a wall.

2. A loudspeaker system in accordance with claim 1 and further comprising,
 third means defining another rear baffle including means for supporting at least another upper frequency radiating means,
 said third means being positioned relative to said first and second means so that with said loudspeaker cabinet normally positioned with said front panel generally parallel to a wall, an upper frequency radiating means carried by said means for supporting of said third means is positioned for emitting upper frequency sound in a beam that has a rearward component directed away from said front panel toward said wall and a sideward component directed generally parallel to said wall opposite to said first-mentioned sideward component.

3. A loudspeaker system in accordance with claim 1 wherein said front panel includes mans for supporting at least one front upper frequency radiating means so that with said loudspeaker cabinet normally positioned with said front panel generally parallel to a wall, a front upper frequency radiating means carried by said means for supporting is positioned for emitting upper frequency sound without reflection in a direction away from said wall,
 and further comprising said at least one front upper frequency radiating means carried by said means for supporting,
 and means including said upper frequency radiating means and said loudspeaker cabinet enclosing said internal volume substantially fluidtight

4. A loudspeaker system in accordance with claim 2 wherein said front panel includes means for supporting at least one upper frequency radiating means so that with said loudspeaker cabinet normally positioned with said front panel generally parallel to a wall, a front upper frequency radiating means carried by said means for supporting is positioned for emitting upper frequency sound directed away from said wall,
 and further comprising said at least one front upper frequency radiating means carried by said means for supporting,
 and means including said upper frequency radiating means and said loudspeaker cabinet enclosing said internal volume substantially fluidtight

5. A loudspeaker system in accordance with claim 1 wherein said first means and said second means are nonparallel to one another.

6. A loudspeaker system in accordance with claim 2 wherein said first means, said second means and said third means are nonparallel to one another.

7. A loudspeaker system in accordance with claim 3 wherein said first means and said second means are nonparallel to one another.

8. A loudspeaker system in accordance with claim 4 wherein said first means, said second means and said third means are nonparallel to one another.

9. A loudspeaker system in accordance with claim 6 wherein small loudspeakers comprising said upper frequency radiating means occupy most of the area of each of said rear baffles.

10. A loudspeaker system in accordance with claim 9 wherein said front panel includes means for supporting a number of small loudspeakers that is less than the number of small loudspeakers said means for supporting on said second and third means is arranged to support.

11. A loudspeaker system in accordance with claim 10 wherein said front panel means for supporting is asymmetrically located from the bounding edges of said front panel.

12. A loudspeaker system in accordance with claim 9 wherein said rear baffles are contiguous flat panels forming an angle,
 and said loudspeaker cabinet comprises a pair of side panels each interconnecting a respective normally vertical edge of said front panel with a normally vertical edge of a respective rear baffle flat panel to define said internal volume as of pentagonal cross section and interconnecting generally parallel top and bottom panels to coact therewith and define said internal volume.

13. A loudspeaker system in accordance with claim 12 wherein said front panel includes means for supporting only a single small loudspeaker.

14. A loudspeaker system in accordance with claim 13 wherein said front panel means for supporting is asymmetrically located with respect to the normally vertical and normally horizontal edges of said front panel.

15. A loudspeaker system in accordance with claim 12 and further comprising means for cophasally energizing all said small loudspeakers with electrical energy over substantially the full range of audio frequencies.

16. A loudspeaker system in accordance with claim 13 and further comprising means for cophasally energizing all said small loudspeakers with electrical energy over substantially the full range of audio frequencies.

17. A loudspeaker system in accordance with claim 14 and further comprising means for cophasally energizing all said small loudspeakers with electrical energy over substantially the full range of audio frequencies.

18. A loudspeaker system in accordance with claim 12 wherein each of said rear baffle panels is substantially square.

19. A loudspeaker system in accordance with claim 16 and further comprising,
 means for delivering much less of high frequency electrical energy for direct radiation from said front panel than is delivered for radiation from said rear baffles in a ratio

corresponding substantially to the ratio of direct to reflected energy received by a listener in a concert hall.

20. A loudspeaker system in accordance with claim **19** wherein said ratio is of the order of 1:8.

21. A loudspeaker system in accordance with claim **20** wherein each of said rear baffles supports four like small loudspeakers.

22. A loudspeaker system in accordance with claim **12** wherein said angle is substantially 120°.

23. A loudspeaker system in accordance with claim 2 and further comprising an internal panel inside said loudspeaker cabinet extending between said front panel and the junction between said rear baffles for dividing said internal volume into a pair of acoustically isolated chambers.

24. A loudspeaker system in accordance with claim **12** and further comprising an internal panel inside loudspeaker cabinet extending between said front panel and the junction between said rear baffle panels and between said top and bottom panels for dividing said internal volume into a pair of acoustically isolated chambers.

25. A loudspeaker system in accordance with claim **23** wherein said front panel includes means for supporting only a single small loudspeaker.

26. A loudspeaker system in accordance with claim **23** and further comprising a plurality of small loudspeaker comprising said upper frequency radiating means,

means including said small loudspeakers and said loudspeaker cabinet enclosing said internal volume substantially fluidtight with each of said pair of acoustically isolated chambers being substantially fluidtight,

first coupling means for energizing each small loudspeaker carried by said second means with first channel energy,

and second coupling means for energizing each small loudspeaker carried by said third means with second channel energy that may be different from said first channel energy.

27. A loudspeaker system in accordance with claim **26** wherein said front panel also includes means for supporting, and at least one of said small loudspeakers, and further comprising,

means for coupling both first channel energy and second channel energy to the last-mentioned at least one small loudspeaker.

28. A loudspeaker system in accordance with claim **26** wherein each of said coupling means includes means for energizing each small loudspeaker coupled thereto with electrical energy over substantially the full range of audio frequencies.

29. A reflecting loudspeaker system having at least a rear panel for facing an adjacent wall and a front panel for facing the normal listening area when normally positioned in a room comprising,

upper frequency radiating means,

means for supporting said upper frequency radiating means so that most upper frequency sound energy is directed across the plane of said rear panel and reaches a listener after a first reflection from said adjacent wall when normally positioned in a room,

and means associated with said upper frequency radiating means for establishing a radiation characteristic of said upper frequency radiating means so that the free field infinite baffle pressure response along the axis thereof is higher relative to the response in the middle range of audio frequencies while coacting with all the elements in said reflecting loudspeaker system to provide an essentially uniform radiated power density spectrum frequency response over substantially the entire audible frequency range when said loudspeaker system is in a normal room listening position.

30. A loudspeaker system having at least a rear panel for facing an adjacent wall and a front panel for facing the normal listening area when normally positioned in a room comprising,

sound radiating means for first directing most of the sound energy therefrom across the plane of said rear panel upon said adjacent wall and then to a listener when said sound radiating means is normally positioned in a room,

and complementing means coacting with said sound radiating means for establishing an essentially uniform radiated power density spectrum frequency response over substantially the entire audible frequency range for said loudspeaker system when said sound radiating means is normally positioned in a room.

31. A first loudspeaker system in accordance with claim **1**,

a second loudspeaker system in accordance with claim **1**,

said wall,

the first and second loudspeaker system cabinets being spaced along said wall with the front panel of each generally parallel to said wall and said second means of each facing said wall so that upper frequency sound beams directed from each second means are reflected from said wall through the region between said cabinets.

32. A loudspeaker system having at least a rear panel for facing an adjacent wall and a front panel for facing the normal listening area when normally positioned in a room comprising,

a plurality of upper frequency radiating means intercoupled for cophasal excitation,

means for supporting said upper frequency radiating means so that some of the energy radiated therefrom reaches a listener over a first direct path and the remainder of said energy reaches said listener over other indirect paths which are longer than said first direct path and first crosses the plane of said rear panel,

means for establishing said some of the energy less than said remainder,

and complementing means associated with said system and coacting therewith for establishing an essentially uniform radiated power density spectrum frequency response for said system over at least the audible frequency range of energy radiated by said upper frequency radiating means.

33. A loudspeaker system having at least a rear panel for facing an adjacent wall and a front panel for facing the normal listening area when normally positioned in a room comprising,

radiating means for directing most of the sound energy therefrom first across the plane of said rear panel, then said adjacent wall and then to a listener when said sound radiating means is normally positioned in a room while directing at least some of said sound energy directly to a listener when said sound radiating means is normally positioned in a room without reflection,

and complementing means coacting with said sound radiating means for establishing an essentially uniform radiated power density spectral frequency response over substantially the entire audible frequency range for said loudspeaker system when said sound radiating means is normally positioned in a room.

34. A loudspeaker system in accordance with claim **2** and further comprising a plurality of small loudspeakers comprising said upper frequency radiating means,

means including said small loudspeakers and said loudspeaker cabinet enclosing said internal volume substantially fluidtight,

first coupling means for energizing each small loudspeaker carried by said second means with first channel energy,

and second coupling means for energizing each small loudspeaker carried by said third means with second channel energy that may be different than said first channel energy.

35. A loudspeaker system comprising,

sound radiating means,

and means for supporting said sound radiating means for directing of the order of 87 percent of the sound energy therefrom upon a reflecting surface and then to a listener when said sound radiating means is normally positioned in a room while directing of the order of 13 percent of the sound energy therefrom directly to a listener when said sound radiating means is normally positioned in a room.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,582,553

DATED : June 1, 1971

INVENTOR(S) : Amar G. Bose

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 38, before "frequency" insert -- high --.

Column 9, line 61, before "response" insert -- high frequency--.

Signed and Sealed this

eighteenth **Day of** *May 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks