This application is a continuation-in-part of my application, Serial No. 314,119, filed October 7, 1963, now abandoned.

This invention relates to an improved sound reproducing apparatus. The invention is concerned with the location and orientation of the high and mid frequency sound radiating means with respect to each other and with respect to an adjacent wall of the room.

An object of my invention is to provide the most favorably transmitted sound from the sound reproducing apparatus to the listener when both are located in a so-called listening room, which may be the average moderately damped living room.

According to my invention, I provide a mid frequency sound radiation source, which may be either a diaphragm type speaker, or a horn type speaker, or a port or opening in a loudspeaker cabinet, close to a wall, with the axis of the source arranged substantially parallel to the wall, and a high frequency radiation source arranged at least partially facing the wall.

I have found that this arrangement when located in a living room, provides an impression of plasticity, resembling that of a natural sound source standing free in a larger room.

The source is diffuse and appears to be located in the plane of or behind the plane of the adjacent vertical wall of the room. In effect, the listening room appears to be enlarged, extending beyond the wall, giving one the impression that he is located in the concert hall where the music has been recorded.

Also, the reproduction is substantially uniform in all directions and practically independent of the distance between the listener and the apparatus; in particular, improved reproduction is obtained even though the listener is only a few feet from the apparatus.

The present invention accomplishes the foregoing objectives with a minimum of disturbances due to a certain time lag phenomena with respect to mid frequency sounds, and due to intensity differences with respect to high frequency sounds. Such disturbances may cause listener fatigue.

The present invention provides a combination of a highly diffused sound field for the high frequency range and a substantially unidirectional sound field for the mid frequency range. This combination is found to result in an increased perceivability of the sound reproduced, while at the same time providing the impression of plasticity previously mentioned.

More specifically, it was found that the arrangement of my prior patent No. 2,979,149, granted April 11, 1961, gives less than perfect reproduction in some directions and also at close distances.

In analyzing the results of the present invention, it appears that maximum perceivability and minimum listening fatigue, when listening to sounds having both mid and high frequency components requires quite different acoustic treatment of the mid and high frequencies, as follows:

For the mid frequency components, the wall spacing, referring to the spacing between the mid frequency source and the adjacent wall, should be small. Thus the sound from the image of the mid frequency source will arrive at the listener's head with a time lag sufficiently short as to be within the reaction time of human hearing. Furthermore, the reflected sound wave is of an intensity comparable to that of the direct source, and the image and the direct source together provide a substantial unidirectional sound field.

For the high frequency components of the sound, the high frequency source or sources should be spaced more remotely from the adjacent wall so as to produce a two directional sound field. This two directional sound field plus the reflections from the other walls of the room have been found to create a much more diffuse sound field for high frequencies than that obtained by a unidirectional sound field plus reflections.

I have also found that when the mid range source is located with its axis substantially parallel to the adjacent wall, that the proximity of the mid range source to the wall does not create the expected interference at the theoretically calculated frequency. This is believed to be due to the fact that the area of the sound source, being substantial, provides a considerable variation in the wall spacing of the near and remote points on the surface of the speaker diaphragm relative to the wall spacing of the axis of the diaphragm. In other words, the mid frequency source plus its image, together constitute a single sound source which is free from wall interference, and which provides a unidirectional sound field in the listening room.

Other objects, features, and advantages will become apparent as the description proceeds.

With reference now to the drawings in which like reference numerals designate like parts:

FIG. 1 is a side elevation showing an embodiment of my invention, partially broken away, and showing also the relationship of the speaker apparatus to the wall and floor of the room;

FIG. 2 is a plan view of FIG. 1;

FIGS. 3 and 4 are plan views similar to FIG. 2 but showing modifications;

FIG. 3a is a fragmentary elevation of FIG. 3;

FIG. 5 is a fragmentary elevation of the high frequency speaker shown in FIG. 4;

FIG. 6 is an enlarged section taken along line 6--6 of FIG. 4;

FIG. 7 is a section of a geometrical figure illustrating the meaning of omnidirectional in a substantially horizontal plane;

FIGS. 8, 9 and 10 are perspective views of modified arrangements; and

FIG. 11 is a plan view of a further modification.

With reference now to FIGS. 1 and 2, the reference numeral 25 designates a mid frequency radiating means in the form of an 8 inch speaker mechanism adapted to radiate sound in the frequency range of from 200 to 400 c.p.s. up to 2000 to 3000 c.p.s. The reference numeral 26 designates high frequency radiating means in the form of a 2 inch speaker mechanism adapted to radiate sound in the frequency range of from 2000 to 3000 c.p.s. up to 12,000 to 16,000 c.p.s. The speakers are located near the vertical wall 2 of a room, the mid frequency speaker 25 being oriented to face in a direction parallel to the plane of the wall 2, in this instance upwardly, so that its axis is vertical, and spaced from the wall by a distance S-1, from 6 to 11 inches.

The high frequency speaker 26 faces the wall 2, and is located at a distance S-2 from the wall, in excess of 12 inches, approximately 20 inches is the preferred wall spacing for normal living rooms. In halls and theaters, the wall spacing S-2 is preferably greater than 20 inches.

Suitable means are provided for supporting the speakers 25 and 26 in this position, the supporting means shown.
3. being in the form of a casing 27 which rests on the floor 1 of the room with the rear end 5 positioned adjacent to the room wall 2. Preferably, the casing 27 provides an enclosure for speaker 25 so that the sound radiation will originate only in the upper surface of the speaker diaphragm.

The high-frequency radiating means also includes a second mechanism 30 which faces outwardly into the room. This may be mounted in the front wall of the casing as shown in FIGS. 1 and 2, or it may be mounted on the top wall of the casing as shown at 30' in FIG. 3, or FIGS. 8, 10 and 11. The exact location is not particularly important, and it may be located between the mid-frequency speaker and the wall as shown in FIGS. 3 and 11, or between the mid-frequency speaker and the room as shown in FIGS. 1, 8 and 10. The important thing is that there be a substantial spacing between the high-frequency image 29 and the high-frequency speaker 30, so as to produce a two directional sound field within the room.

According to the arrangement shown in FIGS. 1 and 2, an acoustical image 28 of the mid-frequency speaker 25 is formed back of the adjacent wall 2, and the spacing between the two is sufficiently close, being from 12 to 22 inches, as to constitute in effect a single source of mid-frequency sound, thus producing a unidirectional sound field within the room, having its source located in or somewhat behind the plane of the wall 2.

However, due to the greater spacing between the image 29 and the high-frequency speaker 30, the high-frequency sound field in the room, if the side and other walls of the room be disregarded, is a two directional field for the purpose of exciting reflections. ("Side" refers to walls 21, 22 (FIG. 2) as contrasted with "adjacent" wall 2.) Due to the fact that the adjacent wall 2 is much closer to the high-frequency speaker 26 than are the side walls 21 and 22, the intensity of sound radiated from the image 29 is close enough to the intensity of the sound radiated from the speaker 30, that both radiations could be considered as being of primary intensity, as contrasted with the first reflections from the side walls and ceiling, which are less intense and could be considered as being of secondary intensity.

For frequencies up to 4000 c.p.s., the high-frequency speaker 26 also radiates outwardly into the room, so that the spacing between the speaker 26 and its image 29 is sufficient to produce a two directional sound field at the lower high frequency range.

For frequencies below 200 to 400 c.p.s. either a separate low frequency speaker may be provided, as shown at 20L in FIG. 8, or the response of the speaker 25 can be extended downwardly as explained hereinafter in connection with FIG. 10; namely, from 40 c.p.s. up to 2000 to 3000 c.p.s.

The high-frequency speaker mechanisms 26 and 30 have an outside diameter of 2 inches, the effective cone diameter being 1½ inches. Preferably the speaker is of the closed back type and does not have any separate baffle or other type of enclosure that would prevent the free radiation of sound.

The transition from a nondirectional or omnidirectional source to a directional source occurs very gradually, and it is largely a matter of definition as to the frequency at which the transition is stated to take place. Since it is possible to maintain the frequency response of the total output of my speaker system flat within + or −4 db, this over all variation of intensity, amounting to 8 db, suggests itself as a suitable criterion for describing non-directionality. In the following comments, the expressions "nondirectional" or "omnidirectional" are employed with regard to a certain range of angles and up to a certain frequency, and mean that the difference in intensity between the maximum intensity and the minimum intensity is kept within 8 db for the range of angles and frequencies stated.

In describing the directional characteristics of the 2 inch speaker mechanism 26 or 30, one would say that the speaker is nondirectional or omnidirectional over the whole sphere up to 4000 c.p.s. It is omnidirectional over the frontal hemisphere up to 5000 c.p.s.; it is nondirectional forwardly within 60 degrees off its axis up to 7000 c.p.s., and it is nondirectional forwardly within 45 degrees off its axis up to 10,000 c.p.s. The latter two criteria refer to a listening area circumscribed by a 120 degree cone and a listening area circumscribed by a 90 degree cone, within which listening areas the source is non-directional within the above definition up to 7000 c.p.s. and 10,000 c.p.s., respectively.

Therefore when a second 2 inch high frequency speaker 30 is added, as shown in FIGS. 2 and 3, but facing outwardly into the room, the combination of the two speakers 26 and 30 or 30' provide omnidirectional radiation over the full sphere up to 5000 c.p.s., creating a two directional sound field for all non-axial listening positions in the room. Also a two directional sound field is created up to 7000 c.p.s. for non-axial listening positions less than 60 degrees off axis, and up to 10,000 c.p.s. for non-axial listening positions less than 45 degrees off axis, which means that for most listening positions and for the most important part of the high frequency range, there is a two directional field as far as the adjacent wall 2 is concerned.

If one now includes the effect of the two side walls, 21 and 22 (FIG. 2), it will be seen that the doubling of the number of directions in the sound field provided by each wall makes it possible to create a sound field which ranges from multi directional to diffuse, depending upon whether just the first reflections from the two side walls 21, 22, are taken into account, or all of the reflections from all six walls of the room.

In the FIGS. 2 and 3 arrangements, the diffuse sound field occurs at all points in the room for sounds up to 5000 c.p.s. At the higher frequencies, such doubling occurs only in listening positions which are further back in the room, which would indicate that the diffusivity at the middle and back of the room is somewhat more perfect (that is, the distribution of intensities for the different directions as well as the number of directions) than farther forward.

In order to utilize fully the side wall reflections in the main part of the high frequency range, it is possible to substitute a single cylindrical radiating source 31 (FIG. 4) for the two 2 inch speakers 26 and 30, or else to substitute an array of three 2 inch speakers, as shown in FIG. 10, or an array of four 2 inch speakers, as shown in FIG. 8.

The cylindrical speaker 31 of FIGS. 4, 5 and 6 is mounted on the casing 27 by a suitable support means 32. As shown in FIG. 6, it comprises a number of concentric cylindrical elements which are separated by spacers. This is an electrostatic speaker in the form of a cylindrical push-pull radiator comprising two concentric cylinders 33 and 34 of insulated steel wire mesh which serve as the two fixed electrodes. Located between these two fixed electrodes is an almost weightless electrically conductive mesh diaphragm 35, substantially .0005 inch thick which floats between two surrounding films 36 of plastic film, substantially .0004 inch thick. The space between the two films 36 and the conductive diaphragm 35 is sealed by suitable means, such as pressure sensitive tape 37. The wire mesh electrodes 33 and 34 are secured to each other and to the diaphragm assembly 35–36 by plastic ring-shaped spacers 38 substantially .030 inch thick, the spacer rings 38 also being connected to the supporting stem 32 by suitable spacers.

The fixed electrodes 33 and 34 are connected to a suitable source of DC voltage. In operation, the diaphragm 35 is electrically attracted to one or the other of the electrodes 33, 34, and in so doing, moves the thin plastic films 36 as well as the air between the film and the fixed electrode. The sound energy so developed passes through
the acoustically transmissive mesh of the fixed electrode 33 toward the listeners. Thus omnidirectional radiation is divided in a substantially horizontal plane, the field of radiation being diagrammatically illustrated by the outwardly diverging generally disk-shaped geometrical figure 39 shown in FIG. 7.

This cylindrical speaker 31 is more fully described in Paper 6–61 delivered by Robert L. Rod of Los Angeles, California, at the Fifth International Acoustic Congress held in Liege, Belgium, September 7–14, 1965.

FIG. 8 shows a further modification, the mid range speaker 6L being mounted in the top wall 7 of a casing 20, the casing being placed in direct contact with the adjacent room wall 2. The high frequency radiating means comprises an array of four 2 inch speakers 8 and 9, the speakers 8 being oriented rearwardly at an angle of substantially 45°, and the speakers 9 being oriented outwardly into the room at about 45°. Additionally, there are low frequency radiating means in the lower portion of the casing 20 which comprise a 10 inch speaker 10L and resonator tubes 11R. Preferably a separate channel is provided for driving the low frequency speaker 10L and which has a frequency response from about 25 or 30 c.p.s. up to 200 or 400 c.p.s. The casing 20 is provided with legs 3 which space the bottom wall of the casing about 4 inches above the floor 1. A driving amplifier 12 may be secured to the bottom wall 4.

FIG. 9 shows the upper part of a loud speaker apparatus according to FIG. 8 which is designed for the highest quality of sound reproduction for large rooms or halls where the apparatus of FIG. 8 would be underpowered. In this FIG. 9 arrangement, there are three like arrays of high frequency speakers, one, comprising the four speakers 8 and 9 being mounted on the top wall 7, as in FIG. 8, one array 8', 9' being mounted on a vertical side wall 13' of casing 20, and the third array being mounted on the opposite side wall 13'.

FIG. 9 shows a further modification in which the mid frequency radiation means is mounted in the upper portion of the vertical side walls 13' and 15' of the cabinet, rather than in the top wall. In this arrangement, preferably two mid range speakers 6' and 6" are provided which face sideways in opposite directions so that the mid frequency radiation means 6'–6" is symmetrically oriented with respect to a median vertical plane extending through the casing 20 and perpendicular to the wall 2 and with the effective center of mid frequency radiation located midway between the two speakers 6' and 6". The exact orientation of the mid range radiation means 25, or 6'–6" i.e., facing sideways, upward, or diagonally, is not particularly important as long as the above symmetrical orientation is maintained.

In FIG. 10, the speaker 16L mounted in the top wall 7 of the casing 20 has both low and mid range frequency response, ranging from about 40 c.p.s. up to about 2000 or 3000 c.p.s. This radiation source may be an 8 inch speaker.

The high frequency radiating means comprises an array of three 2 inch speakers 8 and 9, the speakers 8 being oriented partially toward the adjacent wall 2 and the speaker 9 facing out into the room.

In FIGS. 8, 9 and 10, the speakers 8 and 9 are shown as being tilted upwardly, which tends to utilize the reflections from the ceiling to a greater extent than when the axis of the high frequency speakers are horizontal.

As previously pointed out, the purpose of the array of three or four 2 inch speakers, as shown in FIGS. 10 and 6, is to utilize more fully the side wall reflections in the mid part of the high frequency range. Thus it is possible to attain a radiating width which is more directional in a horizontal plane, up to from 9000 to 12,000 c.p.s. When the speakers are tilted upwardly from 20° to 25°, it is possible to obtain non directional radiation throughout the full top hemisphere.

The vertical extent of the listening area or direct radiation field within which the horizontally omnidirectional speaker array provides non directional radiation within the previously given definition, is set forth in the following table, for the range of angles and up to the frequencies stated, wherein θ is the angle θ in FIG. 7:

<table>
<thead>
<tr>
<th>s extends from at least</th>
<th>C.p.s.</th>
<th>C.p.s.</th>
<th>C.p.s.</th>
<th>C.p.s.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10° to 20°</td>
<td>1000</td>
<td>9,000</td>
<td>10,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Tilted up 20°</td>
<td>20,000</td>
<td>10,000</td>
<td>12,000</td>
<td>14,000</td>
</tr>
<tr>
<td>Tilted up 25°</td>
<td>20,000</td>
<td>10,000</td>
<td>12,000</td>
<td>14,000</td>
</tr>
</tbody>
</table>

Since non directional radiation throughout the full sphere is also horizontally non directional, the corresponding frequencies for one and two speakers are given for purpose of comparison.

In all of the above instances, the speaker array is non directional or omnidirectional within the horizontal plane, and in the case of FIG. 8, the radiations is non directional, not only for the full top hemisphere, but also downward to 25° below the horizontal plane. It is also to be noted that the diffuse sound field, created by the side wall reflections from the two separate and widely spaced high frequency sources, the array itself and its image behind the adjacent wall, iron out any interferences at certain frequencies and directions which might otherwise be expected to occur from the use of a plurality of closely spaced speaker mechanisms in the array.

FIG. 11 shows a further modification in which the casing 40 has a mid range speaker 42 mounted in the top wall 41 thereof. Here there is an array of four high frequency speakers 43 and 44, the speakers 43 being oriented rearwardly at an angle of substantially 45°, and the speakers 44 being oriented outwardly into the room, at an angle of about 45°. Here, as in FIG. 3, it will be shown that the high frequency speakers are disposed on opposite sides of the mid range speaker 25, or 42, respectively, in a symmetrical arrangement. The advantage of this symmetrical arrangement is that it makes no difference as to which of the end walls 48 of the casing 40 is placed adjacent the wall 2 of the room.

In all embodiments shown, it is possible to improve the appearance by extending the side walls upwardly beyond the top wall on which the high frequency speakers are located, and to enclose the top with a horizontal wire netting 46, as shown in FIG. 3, which covers the loud speaker mechanisms.

As shown in FIG. 3a, openings 46 are also provided in the side walls which are covered with wire netting 47. Where the high frequency speakers are tilted upwardly as shown in FIGS. 8 and 10, the side openings 46 are not necessary.

In explaining my invention, one object is to maintain the time lag between the mid frequency speaker 25 and its image 28 at about one millisecond or less. Time lags materially greater than this, and particularly at 3 to 4 milliseconds create masking effects in the ear which impede resolution of sounds.

The wall spacing per millisecond image time lag is 674 inches straight in front of the speaker system, and 914 inches as an effective means value integrated over all directions.

The effect of increasing the wall spacing from its minimum value is very gradual. Wall spacings of from 9 to 11 inches have been found to be satisfactory, but from 6 to 9 inches are preferred. Examples of axis locations are given in the drawings.

At those lower frequencies where the wave length is very much greater than the wall spacing, so that the image
sound is practically in phase with the direct sound and thus increases the efficiency of the speaker, no masking due to image sound occurs. Thus, in FIG. 8, the wall spacing of low frequency sources 10L and 11R is not particularly critical in this respect, but is determined by other criteria.

If the casing 27 directly abuts the wall, as in FIG. 3, the speaker 25 can be located in the casing so that the distance between its axis and the rear wall is the same as the desired wall spacing. In other instances the axis to rear wall dimension may be an inch or two less than the desired wall spacing to permit a slight gap between the rear end or wall 5 and the adjacent wall 2, as shown in FIGS. 1, 4 and 11.

The foregoing considerations indicate that in many designs, the rim of the speaker 25 will be very close to the rear casing wall 5, as shown in FIGS. 1 and 2, and its axis will be spaced from the casing wall 5 by less than one-half the distance between the wall 5 and the rearwardly oriented high frequency radiating portion as indicated by the legends in FIG. 4.

Due to the close wall spacing of the mid frequency source, it will be seen that for most positions in front of the apparatus, the angle between the direct and adjacent wall reflected mid frequency sounds will be so small as to be negligible, thus creating a unidirectional sound field in the room.

However, for high frequency sounds, different criteria apply. In order to obtain the maximum angle between the direct sound and the image sound, it is desirable to have both high frequency sources 26 and 30 in FIG. 1, or 8 and 9 in FIG. 8, as far as possible from the wall, as long as the difference in intensity between the direct and reflected sound is not too great.

On the other hand there is some advantage in distributing both the wall facing and the room facing sources over a certain area, as in FIG. 11, because this permits an increase in the distance between the listener and the room facing sources 44, while maintaining the desired distance between the listener and the image of the wall facing sources 43. Thus, listening conditions are improved when the listener is sitting close to the speaker.

The image 29 in effect constitutes a sound source of an intensity of the same order as the direct source 30, and the two directional sound fields thus created is much more effective in creating a high frequency diffuse sound field in the room than the source 30 alone.

For high frequency sounds, the listener's head creates disturbances in a unidirectional and even in a multidirectional sound field so that the intensity levels at the two ears are quite different, amounting frequently to 20 db or more, and the intensities and the difference between them change with the turning of the head. These disturbances, sometimes called directional effects because they are helpful in determining direction, are disturbing and result in listener fatigue, and they result in a far from smooth frequency response curve to the listener's ears even though a measuring microphone would record a smooth response in the absence of the head.

These directional effects or disturbances surrounding the head begin to develop around 2000 c.p.s. and are fully developed from 3000 c.p.s. and upwards. By providing in this range as diffuse a sound field as possible, at least in the horizontal plane, these directional disturbances are reduced or eliminated. In a completely diffused sound field all parts of the head are exposed to the same intensity even at high frequencies.

The two directional sound field produced by an image and a direct sound source will excite reflections resulting in a more perfectly diffuse sound field than that excited by a unidirectional source. However, the image should be sufficiently close to the direct source as to constitute an effective source of an intensity of the same order as the intensity of the direct source.

The FIG. 1 arrangement provides a diffuse high frequency sound field for the most important frequencies and most listening positions in the room whereas the arrangements of FIGS. 4 and 8 to 11 extend the frequency range and the listening area.

It will be seen that the principles of my invention permit considerable latitude in the location and orientation of the sound sources. For example, where separate speaker mechanisms are used, one or more facing or partially facing the wall 2, and one or more facing or partially facing into the room, they may each be mounted on a different surface of the casing 27, as in FIGS. 1 and 2.

Although only preferred embodiments of the present invention have been described herein, it will be understood that various modifications and changes may be made in the constructions shown without departing from the scope of the invention as pointed out in the appended claims.

1. Sound reproducing apparatus comprising a casing having a front end and a rear end, high frequency radiating means comprising at least one loud speaker mechanism mounted on said casing, said high frequency radiating means having a plurality of main directions of radiation oriented in widely diverging directions including a forwardly and backwardly directed high frequency radiation means radiating approximately the 400 to 2000 c.p.s. range comprising a loud speaker mechanism mounted on the top of said casing and oriented substantially upwardly and having its center of radiation located closer to said rear end of the casing than the rearwardly oriented radiating portion of said high frequency radiating means.

2. Sound reproducing apparatus as claimed in claim 1 in which said rearwardly oriented radiating portion is spaced at least 12 inches from said rear end.

3. Sound reproducing apparatus as claimed in claim 1 in which said center of mid frequency radiation is spaced less than 11 inches from said rear end so that when said apparatus is positioned with its rear end adjacent to the wall of a listening room, the distance between said center of radiation and said adjacent wall will not be greater than 11 inches, said rearwardly oriented radiating portion being spaced forwardly of said mid frequency center of radiation by a distance such that said apparatus may be positioned so that the distance between said rearwardly oriented radiating portion and said adjacent room wall will be substantially 20 inches when said first-mentioned distance is not greater than 11 inches.

4. Sound reproducing apparatus as claimed in claim 1 in which said center of mid frequency radiation is spaced sufficiently less than 9 inches from said rear end so that when said apparatus is positioned with its rear end adjacent to the wall of a listening room, the distance between said center of radiation and said adjacent room wall will be substantially from 6 to 9 inches.

5. Sound reproducing apparatus as claimed in claim 1 in which said mid frequency radiating means also radiates the low frequency range.

6. Sound reproducing apparatus as claimed in claim 1 which includes a loud speaker mechanism located close to said rear end radiating the low frequency range.

7. Sound reproducing apparatus as claimed in claim 1 in which said high frequency radiating means is located in the upper portion of said casing, and which includes a loudspeaker mechanism located in the lower portion of said casing and radiating the low frequency range.

8. Sound reproducing apparatus as claimed in claim 1 in which said rearwardly oriented radiating portion is located at least twelve inches from said rear end, and in which the distance between said center of mid frequency radiation and said rear end is less than one-half of the distance between said rearwardly oriented high frequency radiating portion and said rear end.

9. Sound reproducing apparatus comprising a casing having a front end and a rear end, high frequency radiat-
9

The means comprising at least one loudspeaker mechanism mounted on said casing, said high frequency radiating means having a plurality of main directions of radiation oriented in widely diverging directions including a forwardly directed and a rearwardly directed, and said mid frequency radiating means radiating approximately the 400 to 2000 c.p.s. range comprising a plurality of loudspeaker mechanisms mounted on said casing and having their directions of orientation arranged to be widely diverging and substantially symmetrical with respect to a vertical medial plane extending from the front end to the rear end of said casing, the effective center of mid frequency radiation of said plurality of loudspeaker mechanisms being located closer to said rear end of the casing than the rearwardly oriented radiating portion of said high frequency radiating means.

10. Sound reproducing apparatus as claimed in claim 9 in which said rearwardly oriented radiating portion is spaced at least 12 inches from said rear end.

11. Sound reproducing apparatus as claimed in claim 9 in which said effective center of mid frequency radiation is spaced less than 11 inches from said rear end so that when said apparatus is positioned with its rear end adjacent to the wall of a listening room, the distance between said effective center of mid frequency radiation and said adjacent room wall will not be greater than 11 inches, said rearwardly oriented radiating portion being spaced forwardly of said effective center of mid frequency radiation by a distance such that said apparatus may be positioned so that the distance between said rearwardly oriented radiating portion and said adjacent room wall will be substantially 20 inches when said first mentioned distance is not greater than 11 inches.

12. Sound reproducing apparatus as claimed in claim 9 in which said effective center of mid frequency radiation is spaced sufficiently less than 9 inches from said rear end so that when said apparatus is positioned with its rear end adjacent to the wall of a listening room, the distance between said effective center of mid frequency radiation and said adjacent room wall will be substantially from 6 to 9 inches.

13. Sound reproducing apparatus as claimed in claim 9 in which said mid frequency radiating means also radiates the low frequency range.

14. Sound reproducing apparatus as claimed in claim 9 which includes a loudspeaker mechanism located close to said rear end and radiating the low frequency range.

15. Sound reproducing apparatus as claimed in claim 9 in which said high frequency radiating means and said mid frequency radiating means are located in the upper portion of said casing, and which includes a loud speaker mechanism located in the lower portion of said casing and radiating the low frequency range.

16. Sound reproducing apparatus as claimed in claim 9 in which said rearwardly oriented radiating portion is located at least twelve inches from said rear end, and in which the distance between said effective center of mid frequency radiation and said rear end is less than one-half of the distance between said rearwardly oriented high frequency radiating portion and said rear end.

17. Sound reproducing apparatus for use in a room having at least one substantially vertical wall, said apparatus including a casing having front and rear walls and a substantially horizontal top wall with a loudspeaker opening near said rear wall, and a loudspeaker mechanism mounted in said opening and radiating the mid frequency range, a plurality of loudspeaker mechanisms mounted on said top wall and radiating the high frequency range and facing toward a common center and inclined slightly upward to simulate omnidirectional radiation in a substantially horizontal direction, at least one of said high frequency range loudspeaker mechanisms being located near said front wall and oriented to direct its sound beam toward the vertical wall of said room when said rear wall is placed close to said vertical wall.

18. Sound reproducing apparatus for use in a room having at least one substantially vertical wall, said apparatus including a casing having a front wall, a rear wall adapted to be located adjacent to said vertical room wall, and a substantially horizontal top wall, a loudspeaker mechanism mounted on said top wall near said rear wall and radiating the mid frequency range, at least three loudspeaker mechanisms mounted on said top wall and radiating the high frequency range and facing in horizontally different directions with respect to a common center to simulate omnidirectional radiation in a substantially horizontal direction, at least one of said high frequency range loudspeaker mechanisms being oriented rearwardly to direct its sound beam toward the vertical wall of said room when said apparatus is located with its rear wall adjacent to said vertical room wall, said rearwardly oriented high frequency loudspeaker mechanism being spaced further away from the rear wall of said casing than said mid frequency range loudspeaker mechanism.

19. Sound reproducing apparatus as claimed in claim 18 in which said mid frequency range loudspeaker mechanism also radiates the low frequency range.

20. Sound reproducing apparatus as claimed in claim 18 which includes a loudspeaker mechanism located close to said rear wall and radiating the low frequency range.

21. Sound reproducing apparatus as claimed in claim 18 in which said casing includes a bottom wall and legs, said low frequency range loudspeaker mechanism being mounted on said bottom wall.

22. Sound reproducing apparatus for use in a room having at least one substantially vertical wall, said device including a casing having a front wall, a rear wall adapted to be located adjacent to said vertical room wall, and a substantially horizontal top wall, a loudspeaker mechanism mounted on said top wall with its center of radiation located substantially six inches from said rear wall and radiating the mid frequency range, at least three loudspeaker mechanisms mounted on said top wall and radiating the high frequency range and facing in horizontally different directions with respect to a common center to simulate omnidirectional radiation in a substantially horizontal direction, at least one of said high frequency range loudspeaker mechanisms being oriented rearwardly to direct its sound beam toward the vertical wall of said room when said apparatus is located with its rear wall adjacent to said vertical room wall, said rearwardly oriented high frequency loudspeaker mechanism being located with its center of radiation at least twelve inches from said rear wall.

23. Sound reproducing apparatus for use in a room having at least one substantially vertical wall, said device including a casing having a front wall, a rear wall adapted to be located adjacent to said vertical room wall, and a substantially horizontal top wall, a loudspeaker mechanism mounted on said top wall and radiating the mid frequency range,
at least three means mounted on said top wall and
radiating the high frequency range and
facing in horizontally different directions with re-
spect to a common center
to simulate omnidirectional radiation in a substan-
tially horizontal direction,
at least one of said high frequency range radiating
means being oriented rearwardly to direct its sound
beam toward the vertical wall of said room
when said apparatus is located with its rear wall
adjacent to said vertical wall room,
said rearwardly oriented high frequency range radiating
means being spaced further away from the rear wall
of said casing than said mid frequency range loud-
speaker mechanism.

24. Sound reproducing apparatus as claimed in claim
23 in which the center of radiation of said mid frequency
range loudspeaker mechanism is located substantially six
inches from said rear wall.

25. Sound reproducing apparatus as claimed in claim
23 in which said rearwardly oriented high frequency range
radiating means is spaced substantially twenty inches from
said rear wall.

26. Sound reproducing apparatus as claimed in claim
23 in which said rearwardly oriented high frequency range
radiating means is located at least twelve inches from said
rear wall, and in which the distance between the center
of radiation of said mid frequency range loudspeaker
mechanism and said rear wall is less than one-half the
distance between said rearwardly oriented high frequency
range radiating means and said rear wall.

27. Sound reproducing apparatus for use in a room
having at least one substantially vertical wall,
said apparatus including a casing having a front wall,
a rear wall adapted to be located adjacent to said
vertical room wall, and top and side walls which

bound the space between said front and rear walls
a loudspeaker mechanism mounted on one of said
bounding walls and radiating the mid frequency range,
at least three means mounted on one of said bounding
walls and radiating the high frequency range and
facing in different directions with respect to a
common center
at least one of said high frequency range radiating
means being oriented rearwardly to direct its sound
beam toward the vertical wall of said room
when said apparatus is located with its rear wall
adjacent to said vertical room wall,
said rearwardly oriented high frequency range radiat-
ing means being spaced further away from the rear
wall of said casing than said mid frequency range loud-
speaker mechanism.

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