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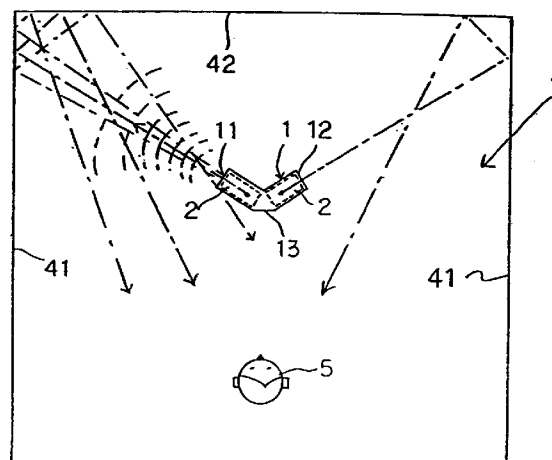
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(54) **Stereophonic sound reproducing apparatus.**

(57) Disclosed is a stereophonic sound reproducing apparatus which produces a range of sounds capable of being heard naturally by a listener. The apparatus has left and right acoustic sources whose sounds are picked up by a sound pick-up mechanism modeled after human auditory organs. The acoustic sources are emitted from two directional speakers in a sound field toward the reflective walls of the sound field in such a manner that the acoustic sources will not interfere with each other. The listener hears the sounds from the two speakers after the sounds are reflected by the walls. The apparatus is capable of reproducing deeper stereophonic sound than the conventional stereophonic sound reproducing apparatus.

Fig. 2



BACKGROUND OF THE INVENTION

(Field of the Invention)

This invention relates to a stereophonic sound reproducing apparatus used in a sound field in which stereophonic sound is capable of being heard.

(Description of the Prior Art)

In order to hear stereophonic sound, ordinarily use is made of a two sources picked up by left and right microphones spaced a prescribed distance apart and disposed at a location remote from the source of the sound. Alternatively, use is made of two sources obtained by intentionally mixing the signals from microphones in a multiple-microphone system, which picks up the sounds from various instruments in an orchestra or the like. In a reproduced sound field, the signals on the track of a record or tape, which signals are based upon the aforementioned two sources, are amplified by respective amplifiers, the two amplified signals are supplied to left and right speakers spaced apart in front of the sound field, and the listener, who is situated so as to face the openings on the front sides of the speakers, is capable of directly hearing the sound waves emitted by the left and right speakers.

By listening to the sounds from the speakers in the reproduced sound field, sound can be experienced in two dimensions. However, the audible frequency range of the human ear extends from several tens of hertz in the low region to 20 KHz in the high region, as is well known. In actual sound, the amounts of sound components in such a broad frequency band and various phases exist in mixed form. Consequently, when the mixing of actual sounds is not performed also in the reproduced sound field, a favorable stereophonic impression cannot be obtained owing to the listener's experience, which is based upon the sense of hearing.

Consider reproduced sound from a speaker. The wavelength of sound waves in the low-frequency region, e.g., 20 Hz sound waves, in the above-mentioned audible frequency range, is about 17 m, which is obtained by dividing the speed of sound, namely 340 m/sec, by 20 Hz. If the diameter of a speaker for reproducing this is 10 cm, this is an extremely small value in comparison with the wavelength of 17 m. Strictly speaking, with a diameter of this size, the emitted 20 Hz sound would be the same as that emitted from a sound source in the form of a point. The sound from such a point sound source is a spherical wave which propagates forwardly while expanding, as illustrated in Fig. 8.

With regard to sound waves having a frequency of 20 KHz, which is in the high-frequency region, the wavelength is 1.7 cm. When these sound waves are

emitted from a speaker having a opening diameter of 10 cm, the sound waves propagate in the form of plane waves, as would be emitted from a planar vibrating plate, as shown in Fig. 9. The reason is that the speaker opening is large in comparison with the wavelength.

Thus, with regard to the acoustic energy of reproduced sound released into air from a speaker, the low-frequency components spread and radiate uniformly in the same manner as spherical waves from the point sound source. As the frequency of the reproduced sound rises, the spherical waves become plane waves and the energy concentrates along the sound axis of the speaker. As for the directional characteristic of a speaker based upon a rise in frequency, a change in sound pressure is seen owing to the frequencies along the 30° and 60° directions with respect to the speaker axis. When the high-frequency region is attained, a different frequency characteristic is obtained with a certain frequency serving as a boundary (the boundary frequency).

The present invention has been devised in view of these various characteristics of reproduced sound, and its object is to provide a stereophonic sound reproducing apparatus in which the impression of stereophonic sound is sufficiently obtained by taking into consideration the source used as the sound source and the characteristics of reproduced sound.

SUMMARY OF THE INVENTION

In accordance with the present invention, the foregoing object is attained by providing a stereophonic sound reproducing apparatus for amplifying two sources and supplying the amplified sources to respective ones of spaced left and right speakers so that stereophonic sound is heard owing to sounds reproduced, comprising a sound field for reproducing two-source sounds, two speaker boxes arranged in the sound field for reproducing the two-source sounds and emitting sounds in such directions that the reproduced two-source sounds will not interfere with each other, a reflecting surface for reflecting the sounds, which have been emitted from the speaker boxes, toward a listener, and a sound-source reproducing device for supplying the two speaker boxes with respective left and right acoustic sources picked up by a sound pick-up mechanism reproduced based upon human auditory organs.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view illustrating an embodi-

diment of the present invention and showing the external appearance of a stereophonic sound reproducing apparatus according to the invention;

Fig. 2 is a diagram for describing the manner in which stereophonic sound is heard according to the illustrated embodiment;

Fig. 3 is a longitudinal sectional view showing an example of a speaker box used in the embodiment;

Fig. 4 is a transverse sectional view showing an example of the speaker box used in the embodiment;

Fig. 5 is a front view showing an example of the speaker box used in the embodiment;

Fig. 6 is a diagram for describing the manner in which stereophonic sound is heard from the top side of the apparatus in another arrangement thereof according to the illustrated embodiment;

Fig. 7 is a diagram for describing the manner in which stereophonic sound is heard from one side of the apparatus in another arrangement according to the illustrated embodiment;

Fig. 8 is a diagram for describing spherical waves from a point sound source; and

Fig. 9 is a diagram for describing plane waves from a vibrating plate.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

Fig. 1 is a perspective view illustrating an embodiment of the present invention and showing the external appearance of a stereophonic sound reproducing apparatus according to the invention.

In Fig. 1, numeral 1 denotes an external housing consisting of thick sheets of fine wood and comprising two boxes A, B, each of which has one side open, joined at their back sides. These joined sides form an acute angle of a prescribed size so that the housing 1 has a V-shaped configuration exhibiting left-right symmetry.

Numeral 11 denotes an open side for box A, and numeral 12 represents an open side for box B. Speakers, described below, are placed within the external housing through the respective openings 11, 12. After the speakers have thus been installed, a Saran net frame through which sound waves pass freely is attached to each of the open sides 11, 12.

The arrangement is such that the sounds from the left and right speakers housed within the housing 1 are isolated from each other by the central portion of the external housing 1. The external housing 1 is oriented in such a manner that a front face 13 of the housing is directed toward the listener when repro-

duced sound is Heard, as shown in Fig. 2. Accordingly, once the housing 1 has been set in place, the axes of the open sides 11, 12 will be directed slightly to the rear of a transverse line passing through the location of installation.

In other embodiments, the outer housing 1 may be disposed to the rear of the listener 5. Alternatively, the housing 1 may be disposed with its front face 13 in contact with the floor so that the axes of the open sides are directed diagonally upward.

Fig. 3 is a longitudinal sectional view showing an example of a speaker box housed within the outer housing of this embodiment, and Fig. 4 is a longitudinal sectional view of the speaker box. Both of these sections include the speaker axis. Fig. 5 is a front view of the speaker box.

Numeral 2 denotes the speaker box, which consists of a fine sheet material, for accommodating a full-range speaker 3 in such a manner that reproduced sound is emitted to the outside in an efficient manner. To this end, the speaker box 2 has the form of a cabinet of the bass-reflex type equipped with a sound way T for sounds in the mid- to high-frequency region and a sound way W for sounds in the low-frequency region.

The interior of the speaker box 2 has a baffle plate 21 to which are attached plates upper and lower plates 22, 23 and plates 24, 25 which diverge from each other toward the front of the box. The plates 22 - 25 form the the sound way T. As a result, sound waves in the mid- to high-frequency region are formed so as to emanate while broadening in the horizontal direction. A rearwardly extending plate 26 is attached to the lower part of the baffle plate 21. The plate 26 guides the low-frequency sound waves emitted from the back face of the speaker 3, extends the path of travel, reverses the phase and causes the sounds waves to emanate from an opening 27 below the plate 23 so that they strengthen the low-frequency sounds together with the sound waves from the front side of the speaker 3. Numeral 28 denotes a bolt hole so that the speaker box 2 may be secured using a prescribed bolt when the speaker box is accommodated within the outer housing 1. Two speaker boxes 2 whose acoustic characteristics are in agreement are used. When these speaker boxes are installed in the outer housing 1, they are secured in such a manner that the sound ways T, W of the respective speaker boxes will open to the open sides 11, 12 on the left and right sides of the housing 1.

Fig. 2 is a diagram illustrating the arrangement of the external housing 1 when listening to stereophonic sound in this embodiment, as well as the manner in which sound waves are emanated. The operation of this embodiment will now be described with reference to Fig. 2.

First, the external housing 1 housing the left and right speaker boxes 2 is placed in front of the listener

5 in such a manner that its front portion 13 faces the listener. The speakers 3 in the left and right speaker boxes are supplied with audio signals for driving them. The audio signals used are obtained by prescribed amplification of a source of the kind described below.

The source used for the left and right speakers is recorded on a record or on two separate tracks. In order to pick up the sound, a sound pick-up mechanism referred to as a dummy head is employed. The dummy head is faithfully modeled after such human auditory organs as the auricle, the external auditory miatus and the auditory canal. The signals used are obtained from left and right microphones disposed at positions corresponding to the eardrum.

When the signals obtained by amplifying such an acoustic source are supplied to the two speakers 3, the signals are emitted toward left and right wall surfaces from the open sides 11, 12 of the external housing 1.

The sounds which emanate to the left and right from the respective speaker boxes 2 propagate through the reproduced sound field without interfering with each other.

By way of example, high-frequency sound waves emitted along the speaker axis from the left open side 11 reach the listener 5 upon being reflected by a left wall 41 and then a back wall 42. Within the speaker 3, sound waves having a frequency slightly less than that of the aforementioned high-frequency sound waves travel toward the left wall 41 or back wall 42 along a line slightly offset from the speaker axis. Owing to these mid- to high-frequency reflected sounds, the aforesaid low-frequency sound waves that propagate in the form of spherical waves, as well as the sounds obtained by reflection of these low-frequency sounds, a reproduced sound field 4, especially the left side thereof, is filled with the acoustic energy of these reflected or diffusely reflected sounds. As a result, the left ear of the listener 5 hears the acoustic energy of the left speaker 3. This acoustic energy is the result of mixing in a highly complex manner.

Meanwhile, reproduced sound from the right speaker also mixes in complex fashion with the mid- to high-frequency sound waves which differ in intensity along the axis in dependence upon frequency, as well as with the low-frequency sound waves which propagate as spherical waves, and the reproduced sound space 4, particularly the right half thereof, is filled with the acoustic energy. The listener 5 hears this mixed acoustic energy from the left speaker or right speaker with the left or right ear, respectively, and therefore the sensation of stereophonic sound is produced.

Fig. 6 is a diagram for describing the manner in which stereophonic sound is heard from the top side of another arrangement of the external housing according to the illustrated embodiment, and Fig. 7 is

a diagram for describing the manner in which stereophonic sound is heard from one side of this arrangement.

Here the external housing 1 is so disposed that the front portion 13 thereof is placed in contact with a floor surface 61 of a reproduced sound field 6 so that the open sides 11, 12 of the housing emit sounds toward side walls 62 of the reproduced sound field diagonally from below.

In the case of this arrangement, the sounds which emanate from the open sides 11, 12 propagate through the reproduced sound field 6 without interfering with each other. The high-frequency sound waves along the speaker axes and the low-frequency sound waves offset from the speaker axes have different paths of propagation, as mentioned earlier, so that the sound field becomes filled with acoustic energy reflected or diffusely reflected from above and from the left and right sides. This acoustic energy, which has been mixed in complex fashion, from the left or right speaker is heard with the left or right ear, respectively, of the listener 5, as a result of which the listener is given the sensation of stereophonic sound.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

In accordance with the present invention, as described above with reference to a preferred embodiment, left and right acoustic sources, which are picked up using a sound pick-up mechanism modeled after human auditory organs, are employed as the sources of sound, and the sources are amplified and then supplied to left and right speakers whose sound axes diverge slightly to the rear of a transverse line situated in front of the listener. The sounds from the left and right speakers, which may be set upon the floor, are reflected or diffusely reflected by left and right walls or a ceiling so that sound waves propagate through a reproduced sound field. As a result, left and right acoustic energies mixed in complex fashion owing to reflection at the walls of the reproduced sound field are heard with the left and right ears of the listener so that the listener is capable of sensing stereophonic sound based upon the sense of hearing.

In accordance with the invention, cabinets of the bass-reflex type are employed for the left and right speaker boxes. This is advantageous in that the reproduction band width of low-pitched sounds is enlarged and sounds can be reproduced highly efficiently even with speaker boxes having a small capacity.

Claims

1. A stereophonic sound reproducing apparatus for amplifying two sources and supplying the amplified sources to respective ones of spaced left and right speakers so that stereophonic sound is heard owing to sounds reproduced, comprising:
- a sound field for reproducing two-source sounds;
- two speaker boxes arranged in said sound field for reproducing the two-source sounds and emitting sounds in such directions that the reproduced two-source sounds will not interfere with each other;
- a reflecting surface for reflecting the sounds, which have been emitted from said speaker boxes, toward a listener; and
- a sound-source reproducing device for supplying said two speaker boxes with respective left and right acoustic sources picked up by a sound pick-up mechanism reproduced based upon human auditory organs.
2. The apparatus according to claim 1, further comprising a generally V-shaped external housing having left and right open ends and a central portion, which defines an acute angle, for isolating sounds, said external housing accommodating said left and right speaker boxes in such a manner that reproduced sounds from these speaker boxes emanate from said left and right open ends of said external housing.
3. The apparatus according to claim 1 or 2, wherein each of said left and right speaker boxes is a speaker box of bass-reflex type having a sound way for a mid- to high-frequency region and a sound way for a low-frequency region for reversing the phase of sound in the low-frequency region.

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Fig. 1

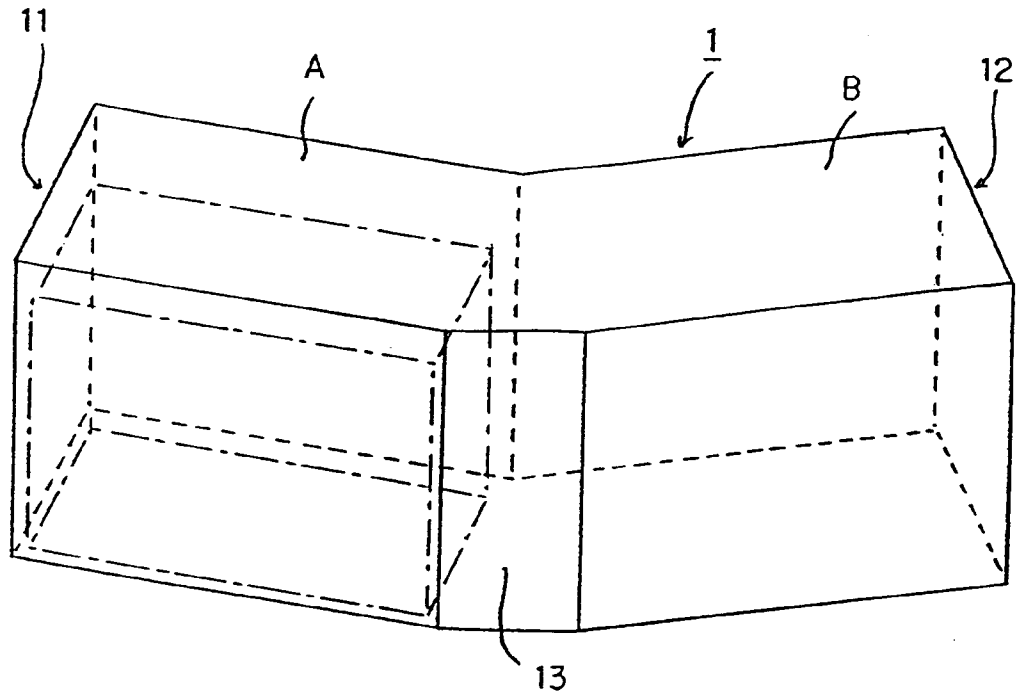


Fig. 2

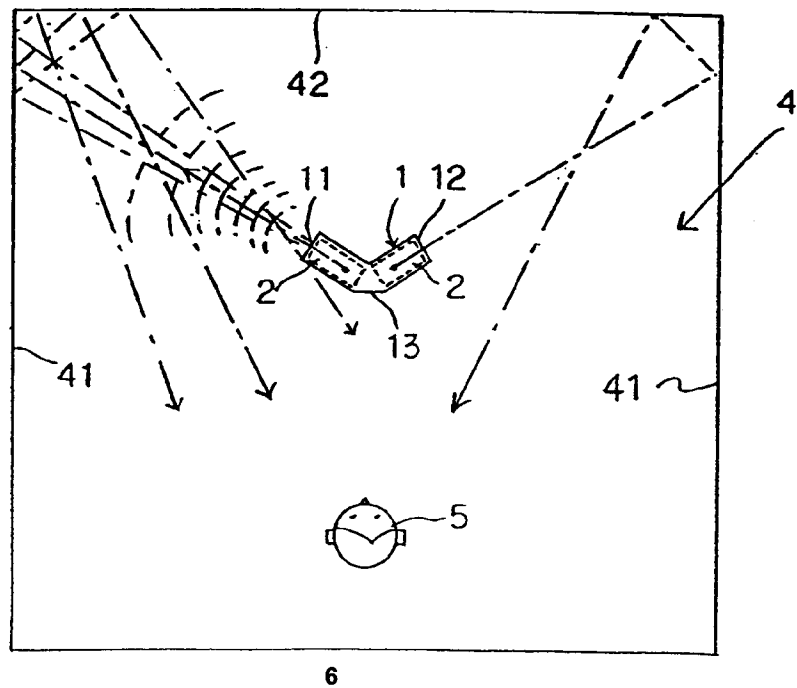


Fig. 3

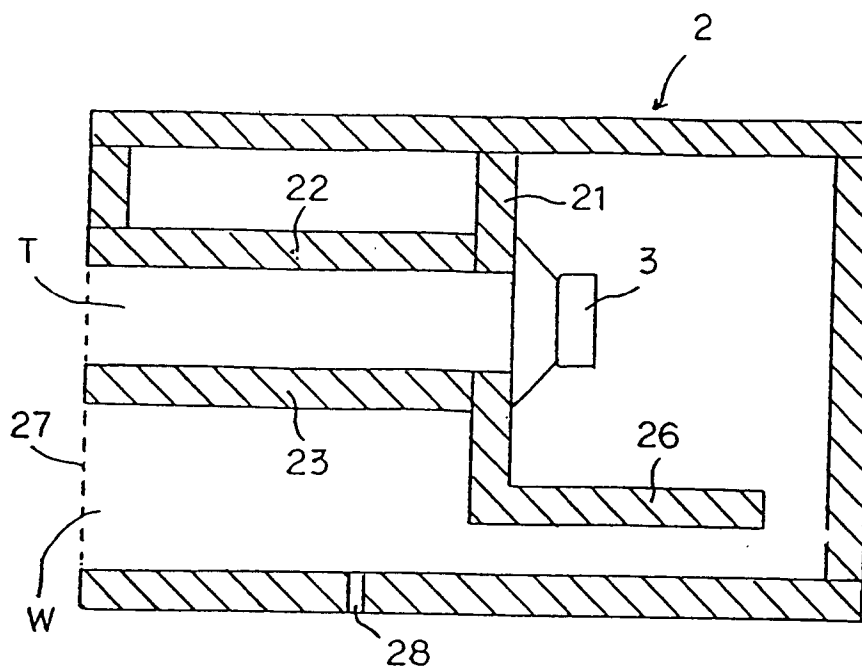


Fig. 4

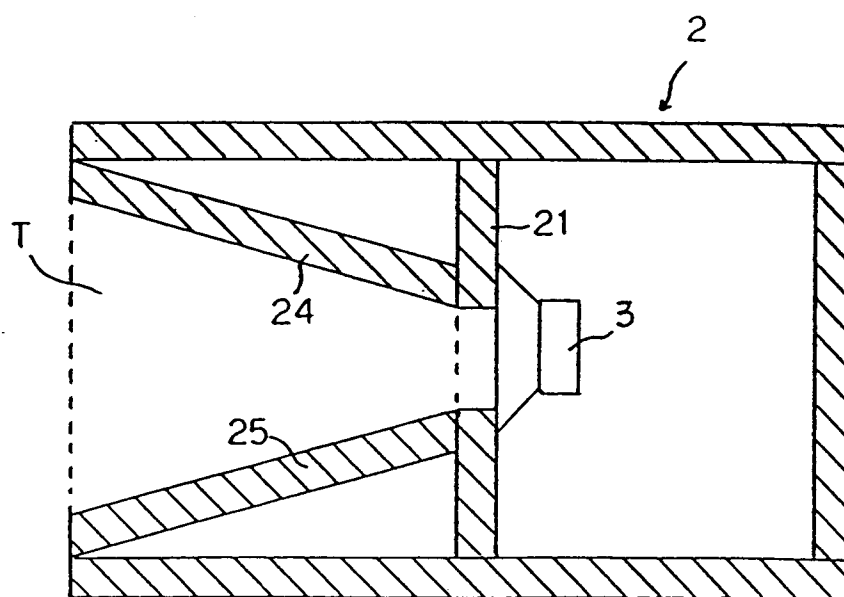


Fig. 5

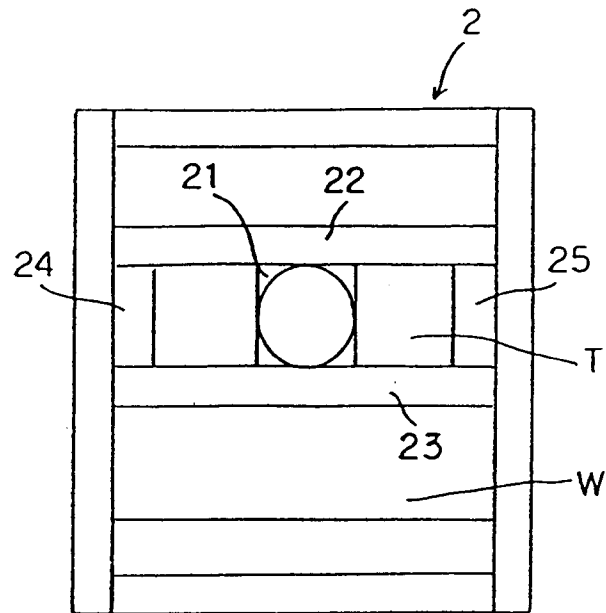


Fig. 6

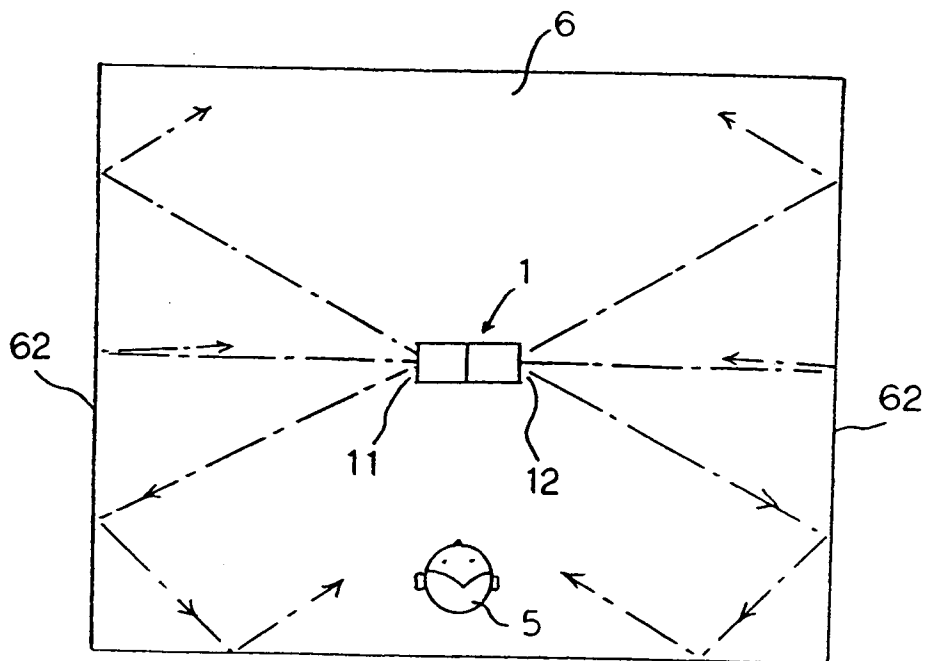


Fig. 7

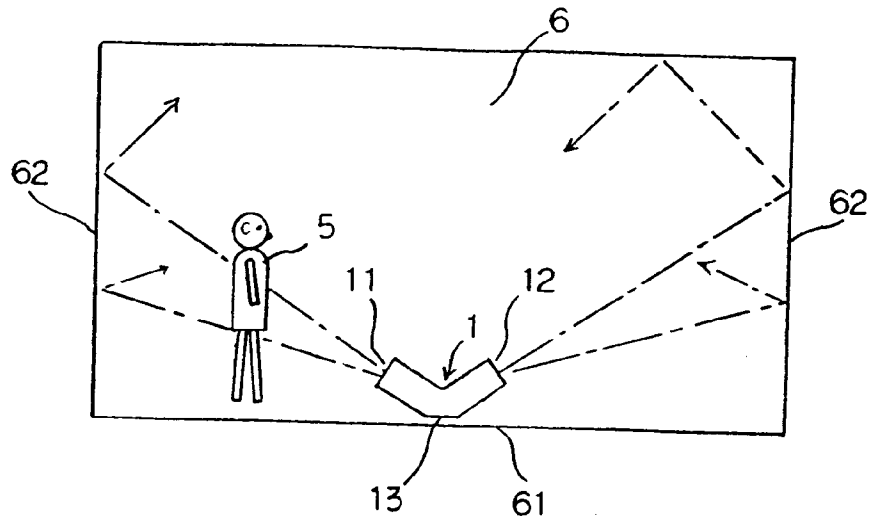


Fig. 8

SPEAKER

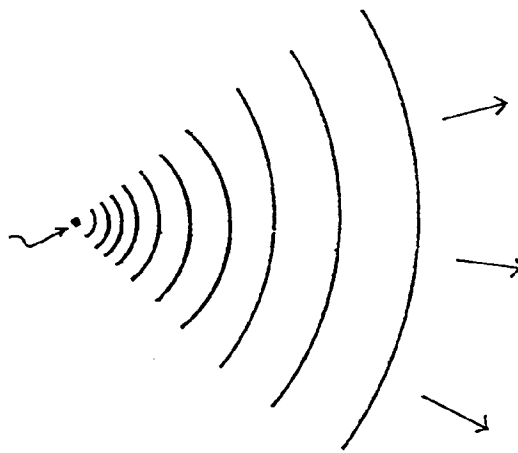


Fig. 9

SPEAKER

