United States Patent [19]

Ojima et al.

[11] **3,790,711**

[45] **Feb. 5, 1974**

[54] **STEROPHONY - SIMULATING EARPHONE**

[75] Inventors: **Shin Ojima; Hiroshi Sano,** both of Yao City, Japan

[73] Assignee: **Hoshi Denki Seizo Kabushiki Kaisha,** Osaka, Japan

[22] Filed: **Nov. 22, 1971**

[21] Appl. No.: **200,669**

[30] **Foreign Application Priority Data**

Nov. 24, 1970 Japan 45/117065

[52] **U.S. Cl.** ..... **179/1 GP,** 181/23, 179/1 ST

[51] **Int. Cl.** **G10k 11/12,** H04r 5/00

[58] **Field of Search** .. 179/1 GP, 1 G, 1 ST; 181/22, 181/23, 26

[56] **References Cited**

UNITED STATES PATENTS

2,209,164	7/1940	Kerr	179/1 ST
2,852,604	9/1958	MacCutcheon	179/1 GP
2,978,543	4/1961	Kennedy	179/1 GP
3,087,988	4/1963	Somer	179/1 GP

Primary Examiner—William C. Cooper
Assistant Examiner—Thomas D'Amico
Attorney, Agent, or Firm—Woodhams, Blanchard and Flynn

[57] **ABSTRACT**

A stereophony-simulating earphone which enables a user of the earphone to hear monaural sound as if it were stereophonic sound. The earphone includes a pair of horseshoe-shaped acoustic paths which lead to left and right ears of the uspr. Mounted at a point on one of the acoustic paths which is one-sided from the midpoint of said one path is a woofer electro-acoustic transducer and mounted at a point on the other of the acoustic paths which is one-sided opposite to said woofer from the midpoint of said other path is a tweeter electro-acoustic transducer. Both electro-acoustic transducers are fed by a common monophonic electrical signal to accomplish excellent stereophonic sound simulation.

6 Claims, 4 Drawing Figures

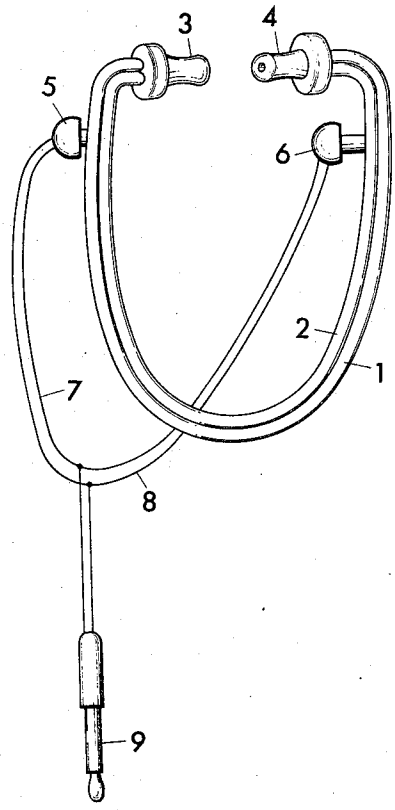
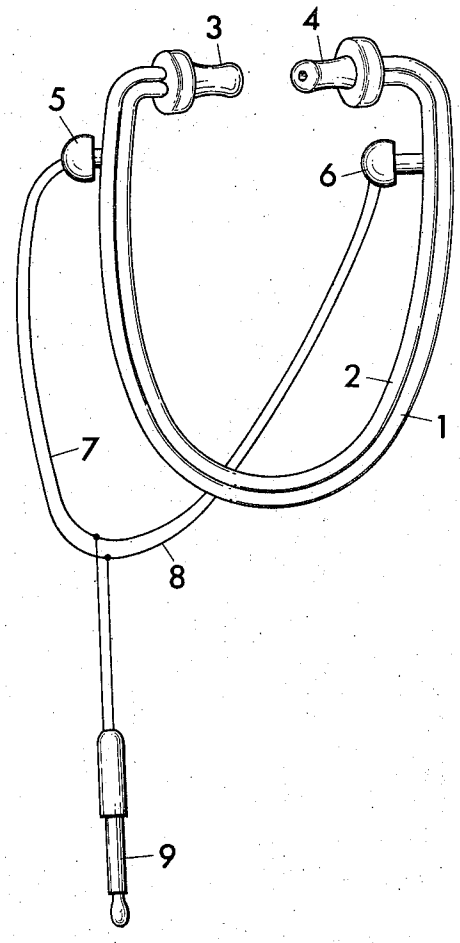


FIG. 1



INVENTORS:
SHIN OJIMA
HIROSHI SANO

BY WOODHAMS, BLANCHARD and FLYNN
ATTORNEY

FIG.2

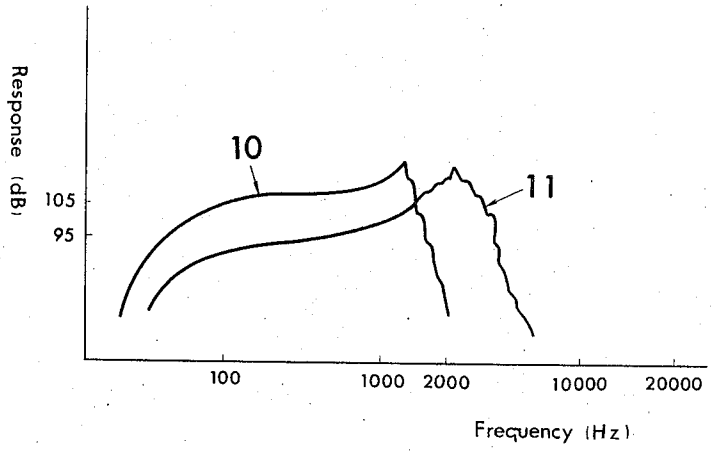


FIG.3

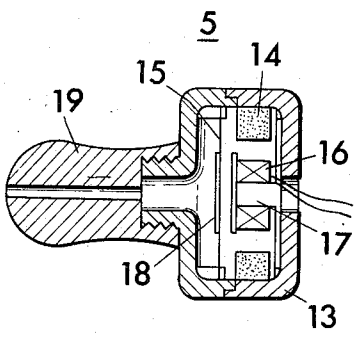
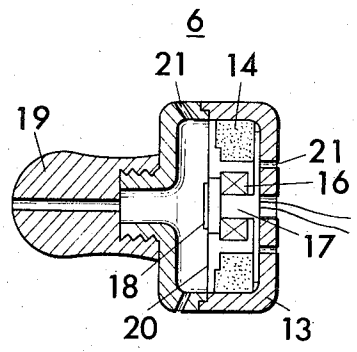


FIG.4



INVENTORS

SHIN OJIMA

HIROSHI SANO

BY WOODHAMS, BLANCHARD and FLYNN

ATTORNEY

STEROPHONY - SIMULATING EARPHONE

The present invention relates to a stereophony-simulating earphone by which the user of the earphone can hear monaural sound as if it were stereo sound.

The stereophonic effect may be obtained acoustic-psychologically and acoustic-physiologically and it enables the user to enjoy the real sound of performance to the fullest. The stereophonic sound provides the positional feeling of the sound source and renders the sound moving and spreading. The stereophonic sound also serves to reduce noise and to make the sound/noise ratio higher. In addition, such a sound sounds as if the frequency band thereof is widened. This phenomena can be analyzed from a physical standpoint. Stated illustratively, the three factors, i.e. a level difference, a time difference and a phase difference between right and left sounds, are considered to contribute the feeling as if the listener were at a line performance.

The stereophony-simulating earphone in accordance with the present invention provides a simulated stereophonic effect by furnishing monaural sound with the above-mentioned three factors through a simple arrangement.

According to the present invention, there is provided a stereophony-simulating earphone comprising a pair of acoustic paths each adapted to lead to left and right ears of a user of the earphone, a tweeter electro-acoustic transducer mounted at a point on one of said pair of acoustic paths which is located to one side of the longitudinal midpoint of said one path for supplying acoustic power through said one path, a woofer electro-acoustic transducer mounted at a point on the other of said pairs of acoustic paths which is located on the opposite side of the longitudinal midpoint of said other path for supplying acoustic power through said other path, and means for supplying a common electrical signal to said woofer electro-acoustic transducer and said tweeter electro-acoustic transducer.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic perspective view showing a preferred form of the stereophony-simulating earphone of the present invention,

FIG. 2 depicts frequency characteristic curves for a woofer earphone and a tweeter earphone used in the earphone of FIG. 1,

FIG. 3 is a schematic cross sectional view showing an example of an electro-acoustic transducer for the woofer, and

FIG. 4 is a cross sectional view showing an example of an electro-acoustic transducer for the tweeter.

In the present invention, there are provided two acoustic paths each adapted to communicate with the left and right ears of the user. As seen from FIG. 1, tubes 1 and 2 of flexible synthetic resin are formed integrally with each other and are bent in a horseshoe shape. These tubes 1 and 2 have inner diameter of 4.8 mm in the present example, and the radius of curvature of said horseshoe shape is determined to be about 6 cm so that an ordinary adult may put both ends of the earphone in his ears across his head. Both ends of the integrated tubes 1 and 2 are bent inwardly toward each other. To each of the bent ends is connected an ear plug 3 or 4 which is common to the tubes 1 and 2.

At a point on one side of the longitudinal mid-point of the acoustic path defined by tube 1, more particularly near the bent end for the ear plug 3 in the illustrated example, there is mounted a woofer acoustic transducer 5. At a point on the opposite side of the longitudinal mid-point of the other acoustic path defined by the tube, i.e. on the opposite side relative to the location of the transducer 5, more particularly near the bent end of the ear plug 4, there is mounted a tweeter acoustic transducer 6. The acoustic transducers 5 and 6 are connected to a common plug 9 through common lead wires 7 and 8.

As illustrated by a curve 10 of FIG. 2, the woofer acoustic transducer 5 has a transducing characteristic exhibiting a high response below about 1,000 Hz, while the tweeter acoustic transducer 6 has, as shown by a curve 11 of FIG. 2, a transducing characteristic exhibiting a high response in high frequency band between 1,000 Hz and 3,000 Hz. The transducing response of the tweeter transducer 6 below 1,000 Hz should be at least 10 db below that of the woofer transducer 5. The acoustic transducers 5 and 6 may be those used in a conventional earphone.

In case an electro-magnetic type earphone is used, the woofer acoustic transducer 5 has, as shown in FIG. 3, a ring magnet 14 mounted in a casing 13, and a vibrating plate 15 of synthetic resin such as polyester mounted opposite to one end surface of the ring magnet 14. Mounted within the center opening of the ring magnet 14 is a coil 16 coaxial with said ring magnet 14. A magnetic yoke 17 positioned at the central portion of the coil 16 is connected with the other end surface of the ring magnet 14. The vibrating plate 15 has an iron plate 18 attached thereto. Fixed to the side of the casing 13 facing to the vibrating plate 15 is an ear plug 19 through which the acoustic transducer 5 is acoustically coupled to the acoustic path 1. With such a vibrating plate 15 and iron plate 18, the woofer acoustic transducer 5 may present a high response in a lower frequency range.

The tweeter acoustic transducer 6 may be constructed in substantially the same manner as the woofer acoustic transducer, as shown in FIG. 4, but the vibrating plate thereof is made of a thinner iron plate 20. In addition, small bores 21 are provided in outer side of the casing 13 and near the ear plug 19 for attenuating a lower frequency component and obtaining a high response in higher frequency band.

According to the stereophony-simulating earphone of the present invention described above, monophonic electrical signal supplied from the common plug 9 is transduced into acoustic signals by the acoustic transducers 5 and 6, respectively. These signals are fed to the ear plugs 3 and 4 through the acoustic paths 1 and 2 and then to the left and right ears of the listener. With such an arrangement the sound from the woofer acoustic transducer 5 is stronger in the ear plug 3 while the sound from the tweeter acoustic transducer 6 is stronger in the ear plug 4. Thus, the sounds supplied to left and right ears have different frequency responses and are at different levels at a given frequency. In addition, there is a difference in length between the path through which the sound from the woofer acoustic transducer 5 reaches the ear plug 4 via the acoustic path 1 and the path through which the sound from the tweeter acoustic transducer 6 reaches the ear plug 4 via the acoustic path 2. Therefore, a given signal is heard at different

times at both ear plugs. This time difference serves to offer a sense of distance or echo effect. Thus, the feeling of stereophonic sounds, or the feeling as if the listener were at a line performance can be obtained by the three factors, i.e., level difference, time difference and phase difference produced through the stereophony-simulating earphone of the present invention and excellent simulated stereophonic sound is attained.

Although the electro-magnetic earphone is used in the illustrated embodiment, it should be understood that any other acoustic transducers such as crystal earphone or the like may be successfully used.

What is claimed is:

1. A stereophony-simulating earphone, comprising:

a pair of sound-transmitting earpieces adapted to transmit sound to the ears of the user;

a pair of separate, elongated, hollow bodies defining a pair of separate acoustic paths, each body being attached at its opposite ends to said earpieces so that both said acoustic paths are acoustically coupled to both said earpieces;

a tweeter electro-acoustic transducer mounted on one of said bodies for supplying acoustic power to one acoustic path and being located at a position on said one path which is closer to one earpiece than it is to the other earpiece;

a woofer electro-acoustic transducer mounted on the other of said bodies for supplying acoustic power to the other acoustic path and being located at a position on said other path which is closer to said other earpiece than it is to said one earpiece;

and means for supplying a common electrical signal to said woofer electro-acoustic transducer and said tweeter electro-acoustic transducer.

2. A stereophony-simulating earphone according to claim **1,** on which said tweeter electro-acoustic transducer is mounted in said one path at a location close to said one earpiece, and said woofer electro-acoustic transducer is mounted on said other path at a location close to said other earpiece.

3. A stereophony-simulating earphone according to claim **1,** in which said bodies are tubes having the same diameters.

4. A stereophony-simulating earphone according to claim **3,** in which said tubes are of substantially the same length.

5. A stereophony-simulating earphone according to claim **1,** in which said earpieces are earplugs.

6. A stereophony-simulating earphone according to claim **1,** in which said means for supplying a common electrical signal is a single plug adapted to receive the signal, said plug being electrically connected to both of said transducers.

* * * * *