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Jinsenji

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[54] **MICROPHONE-SPEAKER DEVICE**

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[30] **Foreign Application Priority Data**

Sept. 28, 1971 Japan 46-75650

[52] **U.S. Cl.** ..... **179/102;** 179/1 MF; 179/179; 181/176

[51] **Int. Cl.** **H04r 1/00**

[58] **Field of Search** .. 179/1 MF, 178, 179, 100.2 Z, 179/102; 181/27 R, 30, 31 A; 340/8 FT; 325/16, 18

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[57] **ABSTRACT**

A hand-held tape recording device comprising, within a casing, a reversible electro-acoustic transducer serving as both a microphone and a speaker which performs the functions of converting sound waves into electrical signals and electrical signals into sound waves, tape recording means connected to the transducer, and a concave elliptic sound reflector having first and second foci and juxtaposed to the reversible electro-acoustic transducer for directing sound waves to and from the transducer. The reflector has plural radial splits to facilitate variation in curvature thereof, and the device further includes means carried by the casing for moving the center of the reflector in a direction aligned with the axis of the reflector to vary the curvature of the reflector.

1 Claim, 5 Drawing Figures

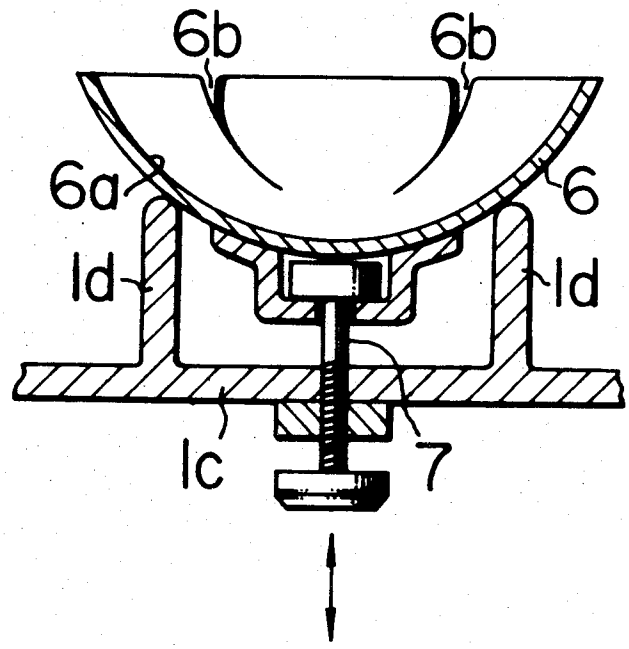


FIG. 1

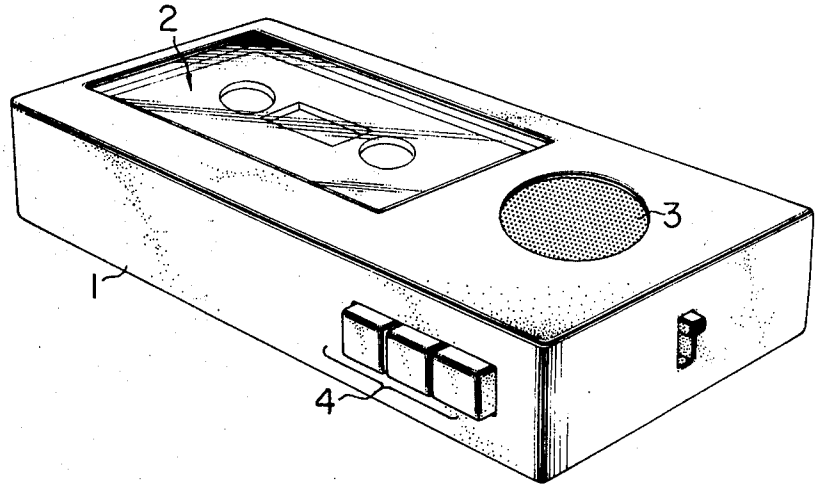


FIG. 2

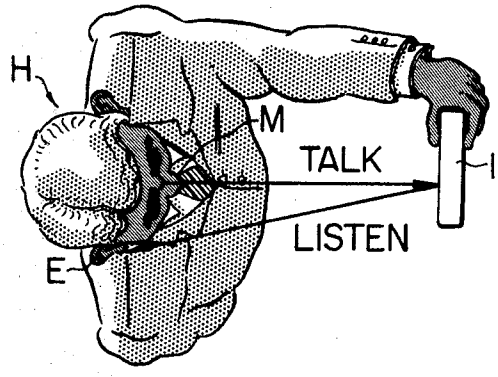


FIG. 4

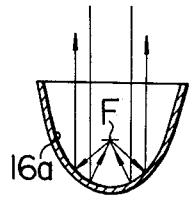


FIG. 3

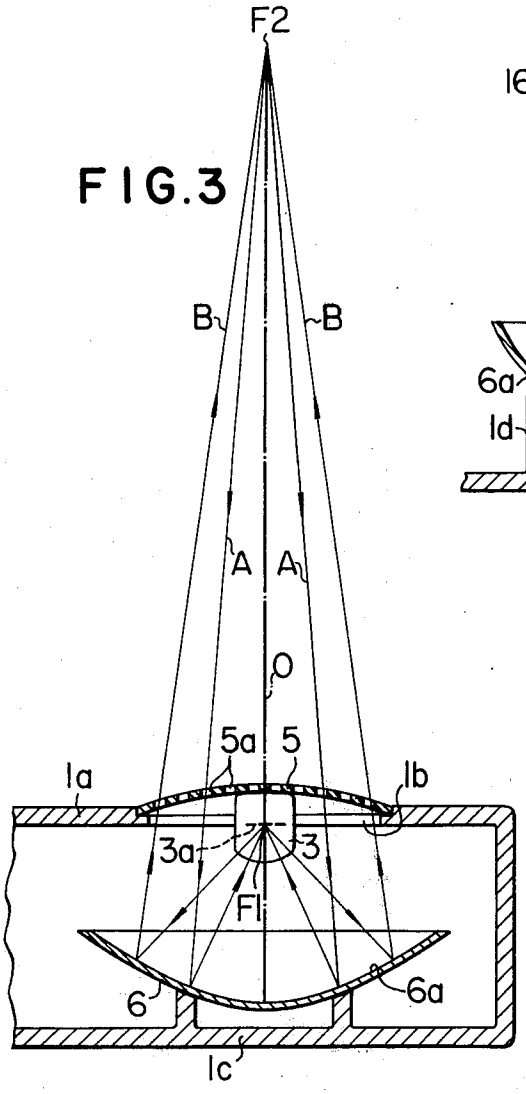
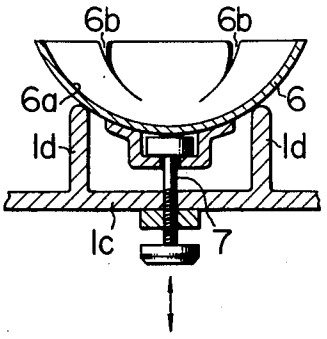


FIG. 5



MICROPHONE-SPEAKER DEVICE

BACKGROUND OF THE INVENTION

This invention relates to a reversible electro-acoustic transducer device or microphone-speaker device serving as both a microphone and a speaker.

A reversible electro-acoustic transducer device serving as both a microphone and a speaker permits the functions of converting electric signals into sound waves and sound waves into electric signals to be performed in a single device. Thus, such transducer device offers the advantage of occupying little space when installed in various equipment. In most cases, the device is used as a speaker concurrently serving as a microphone.

In recent years, attempts have been made to incorporate a reversible electro-acoustic transducer device in various types of equipment for the purpose of obtaining an overall compact size in a tape recorder and other equipment by taking advantage of its compactness. The tendency to use a reversible electro-acoustic transducer device is particularly marked in tape recorders of the ultra small size, particularly tape recorders of the portable type which are sometimes referred to as dictating machines. These devices, which are generally operated while being held by hand, have been developed to serve the purpose of recording apparatus for recording the conversation between persons and the purpose of reproducing apparatus for enabling a single person to hear the reproduced sound.

The equipment of the aforementioned type is preferably of an ultra small size. It is preferable to incorporate in such equipment a reversible electro-acoustic transducer device serving as both a microphone and a speaker in order to attain the end of obtaining an overall compact size in the equipment of the aformentioned type.

Reversible electro-acoustic transducer devices which are available for the purpose mentioned above can serve as both a microphone and a speaker, but they are generally much lower in sound conversion efficiency than microphones and loudspeakers which individually perform their respective functions.

When reversible electro-acoustic transducer devices are incorporated in equipment of an ultra small type, such transducer devices themselves must be compact in size. A reduction in the size of reversible electro-acoustic transducer devices inevitably has the disadvantage of markedly decreasing their efficiency in performing the functions of converting sound waves into electric signals and electric signals into sound waves.

SUMMARY OF THE INVENTION

This invention has as its object the provision of a microphone-speaker device wherein a sound reflecting plate provided with a curved sound reflecting surface is juxtaposed to a reversible electro-acoustic transducer arranged in a position which corresponds to a focus of the sound reflecting surface, so that the sound energy conversion efficiency of the transducer can be increased and aforementioned disadvantage of the prior art can be eliminated.

The microphone-speaker device according to this invention which is constructed as aforementioned has a much enhanced sensitivity in collecting sound when used as a microphone and can provide a sufficiently high sound pressure energy in the service range for satisfactory use as a speaker.

More particularly, the invention in specific aspects contemplates the provision of a concave sound reflector, and transducer means for receiving and emitting sound mounted at a focus of the reflector, for reflective transmission of sound waves by the reflector between the transducer and a locality spaced from the transducer and reflector. In one embodiment, the reflector is an elliptic reflector; in another embodiment, a parabolic sound reflector is used. Means may be provided for adjusting or varying the curvature of the reflector.

Further features and advantages of the invention will be apparent from the detailed description hereinbelow set forth, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of one form of ultra miniature tape recorder;

FIG. **2** is a plan view showing the manner in which the tape recorder of FIG. **1** is used;

FIG. **3** is a sectional view of a microphone-speaker device comprising one embodiment of this invention;

FIG. **4** is a sectional view of a modified form of sound reflecting surface suitable for use in a device of the type shown in FIG. **3**; and

FIG. **5** is a sectional view showing one form of means for varying the curvature of the sound reflecting surface in a device embodying the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

FIG. **1** illustrates an ultra miniature tape recorder **1** sometimes referred to as a dictating machine, in which a micro-cassette **2** (or a mini-cassette) of the size of a small matchbox (carrying a recording tape) can be detachably inserted. The tape recorder **1** has a built-in small reversible electro-acoustic transducer **3** serving as both a microphone and a speaker and can be set at recording, reproducing and shutoff positions by suitably depressing a pushbutton **4.** Transducers of this type are known in the art and accordingly need not be described in detail.

The ultra miniature tape recorder of the aforementioned type is generally used in a manner shown in FIG. **2** which is a plan view showing a person H using this equipment. As can be seen from this figure, the spacing between the tape recorder **1** and the mouth M of the person H is substantially equal to the spacing between the tape recorder **1** and the ear E of the person H, and the spacings can be regarded as having a value D which is substantially uniform.

This invention is based on the discovery that if a sound reflecting surface is used advantageously by considering the fact that the value D is substantially uniform, the ability of the small reversible electro-acoustic transducer **3** to collect and produce sound can be increased so as to increase its sound energy conversion efficiency markedly.

FIG. **3** shows the microphone-speaker device comprising one embodiment of this invention. It shows in an enlarged sectional view the essential portions of the device comprising the small reversible electro-acoustic transducer **3** serving as both a microphone and a speaker built in the tape recorder **1.** More specifically, the tape recorder **1** is housed in a casing **1***a* which is formed in one portion or front portion thereof with an

opening 1*b* for permitting sound to enter into the casing and radiate out of the casing therethrough. The opening 1*b* has mounted therein a perforated support plate 5 which is formed therein with a multitude of perforations 5*a*. The small reversible electro-acoustic transducer 3 serving as both a microphone and a speaker (i.e. for conversion of sound to electrical signals, and vice versa) is mounted on the perforated support plate 5 in a position in which the center of the sound axis of the transducer 3 coincides with the center of the opening 1*b*.

It will be understood that the tape recorder includes means for driving the tape within the aforementioned micro-cassette and means for recording signals on the tape from the transducer 3 and for detecting signals recorded on the tape for conversion to audible sound by the transducer 3$ all such means may be generally conventional, as will be apparent to those skilled in the art, and are therefore not shown, for simplicity of illustration.

In accordance with the invention, a sound reflecting plate 6 is attached to a bottom wall 1*c* of the casing 1a in facing, spaced relation to the transducer 3 and includes a concave sound-reflecting surface 6*a* which is elliptic in shape, opening toward the transducer 3 with the center of the sound axis O serving as a common center axis of the elliptic reflecting surface 6*a*. An elliptic sound reflector of the type shown at 6 is adapted to reflect sound, emanating from the locality of either of two foci F1 and F2 (spaced along axis O), to the locality of the other of the two foci. The sound reflecting plate 6 and reversible electro-acoustic transducer 3 are disposed in relative positions such that the position of a first focus F1 of the sound-reflecting surface coincides with the location of a vibration plate 3*a* of the transducer 3.

By this arrangement, a second focus F2 of the elliptic sound-reflecting surface 6*a* will be disposed in a position which is outside the casing 1*a*. Thus, if the second focus F2 is used as a sound transmitting and receiving position for the vibration plate 3*a* and the spacing between the first focus F1 and the second focus F2 is set at the value D shown in FIG. 2, the sound emanating from the sound transmitting and receiving position corresponding to the second focus F2 will pass through the perforations 5*a* as indicated by arrows A and will be reflected by the elliptic sound-reflecting surface 6*a* to converge on the reversible electro-acoustic transducer 3 and cause the vibration plate 3*a* to vibrate, for conversion of the sound to electrical signals. The sound radiating out of the reversible electro-acoustic transducer 3 will be reflected by the elliptic reflecting surface 6*a* and pass through the perforations 5*a* to converge on the second focus F2 as indicated by arrows B. As will be understood, the transducer 3 is oriented to receive sound (for conversion to electrical signals) reflected to focus F1 by surface 6*a*, and to emit sound toward surface 6*a* for reflection to focus F2.

Accordingly, if the position of the second focus F2 is determined the curvature of the ellipse of the sound-reflecting surface 6*a* can be obtained. In other words, and again as will be understood by those skilled in the art, the curvature of surface 6*a* is selected to provide a desired location of focus F2 in relation to the device.

The device according to this invention is constructed as aforementioned. If the mouth of a person or other source of sound is disposed near the second focus F2, the elliptic sound-reflecting surface 6*a* will act as a reflector for effecting convergence of sound waves from that source on reversible electro-acoustic transducer 3 when the transducer is made to function as a microphone. Conversely, when the reversible electro-acoustic transducer 3 is made to act as a speaker, the sound radiating out thereof will be reflected by the elliptic reflecting surface 6*a* and have a considerably high sound pressure when it reaches the second focus F2 or its neighborhood. Thus, if a person is positioned at the second focus F2 and listens to the reproduced sound, the reproduced sound can be heard with adequately high sound pressure.

Preferably, the reversible electro-acoustic transducer 3 which is used as aforementioned has a dual directivity in order that sound may be collected and radiated. Also, the surface of the reversible electro-acoustic transducer 3 which faces the sound-reflecting surface 6*a* is preferably convex, and shaped such that it is rounded as much as possible so as to preclude scattering of reflected sound waves near the reflecting surface.

Although the sound reflector employed in the devices of the present invention is shown in FIG. 3 as elliptic, other configurations of concave sound reflectors may be employed, e.g. in the same structural relation to other parts of the device as the reflector 6 of FIG. 3. FIG. 4 shows another form of the concave sound-reflecting surface which is a parabolic sound-reflecting surface 16*a* as contrasted to the elliptic sound-reflecting surface of FIG. 3. By using the parabolic sound-reflecting surface 16*a* (i.e. a concave parabolic sound reflector opening toward the transducer 3) mounted within the casing while placing the vibration plate of the reversible electro-acoustic transducer 3 at a first focus F of the reflecting surface 16*a*, it is possible to cause reflected sound waves (from the mouth of a person or other sound source external to the casing, and directed toward the reflector) to converge on the transducer 3, thereby permitting the same to function as a microphone as satisfactorily as described with reference to FIG. 3. A second focus of the parabolic reflecting surface shown in FIG. 4 is infinite, so that the sound radiated out of the reversible electro-acoustic transducer (when the transducer is made to function as a speaker) reaches the sound receiving position in the form of parallel sound beams. However, since the radiated sound has a high directivity, it is possible for the transducer to effect sound energy conversion efficiently.

According to this invention, it is possible to adjust the sound emanating and receiving position suitably by varying the curvature of the sound-reflecting surface 6*a* or 16*a* so as to determine such position optimally. FIG. 5 shows means for attaining the end. The sound-reflecting plate 6 provided with the elliptic sound-reflecting surface 6*a* is shown in the figure as being formed with a plurality of splits 6*b* directed radially of the elliptic surface, so as to facilitate variation or adjustment in curvature of the surface. By moving the center of the sound-reflecting plate 6 axially, it is possible to vary the curvature of the ellipse, i.e. of surface 6*a*. If the curvature is varied, then the position of the focus is also varied, so that it is possible to vary the sound-emanating and receiving position optimally.

The means for moving the position of the center of the sound-reflecting plate 6 along the sound axis shown

in FIG. 5 comprises an adjusting screw 7 threaded into the bottom wall 1c of the casing 1a so that its forward end may bear against the position of the center of the sound-reflecting plate 6 to move the plate along the sound axis. When the adjusting screw 7 is moved outwardly, the curvature of the reflecting plate 6 resting on a supporter 1*d* is reduced; when it is moved inwardly, the curvature is increased.

By varying the curvature of the elliptic sound-reflecting plate as aforementioned, it is possible to adjust the elliptic sound emanating and receiving position optimally. In case the sound-reflecting plate or reflector is parabolic in shape, the thickness of the beams of the sound radiated out of the transducer and reflected by the reflector can be increased by varying the curvature of the sound-reflecting plate.

It is to be understood that the invention is not limited to the particular form of the curvature varying means shown and described above, and that any other suitable means may be used to attain that end without deviating from the scope and spirit of the invention.

In the foregoing description, the invention has been described as being incorporated in an ultra miniature tape recorder. It is to be understood, however, that the invention may be incorporated in other types of equipment, e.g. dictating machines.

I claim:

1. A hand-held tape recording device comprising

a. a casing dimensioned to be held in the human hand, having an opening for passage of sound between the interior and exterior of the casing;

b. a concave elliptic sound reflector having first and second foci and mounted within said casing in facing relation to said opening for directionally reflecting sound between said first focus and a locality external to said casing, said first focus being located within the casing and said second focus being at said external locality;

c. transducer means for receiving and emitting sound, supported by said casing and disposed at said first focus in facing relation to said reflector for receiving sound entering said casing through said opening from said external locality and reflected to said first focus by said reflector and for emitting sound for reflection by said reflector through said opening to said external locality;

d. tape recording means contained within said casing and connected to said transducer means, for recording and reproducing sound; and

e. means for varying the curvature of said reflector, said reflector having plural radial splits to facilitate variation in curvature thereof, and said curvature-varying means comprising means carried by said casing for moving the center of said reflector in a direction aligned with the axis of said reflector.

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