Sept. 15, 1959 J. J. DREHER ET AL 2,904,640

COMBINATION EAR-MOUNTED MICROPHONE AND RECEIVER INSTRUMENT

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FIG. 3

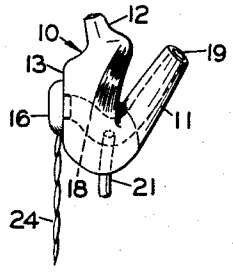


FIG. 2

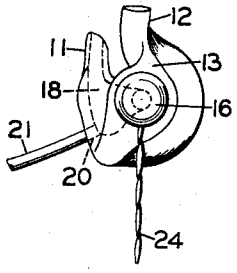


FIG. 4

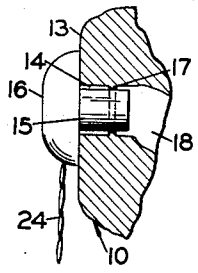
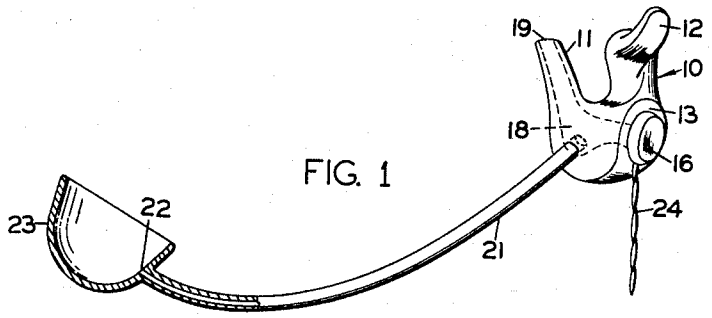


FIG. 1



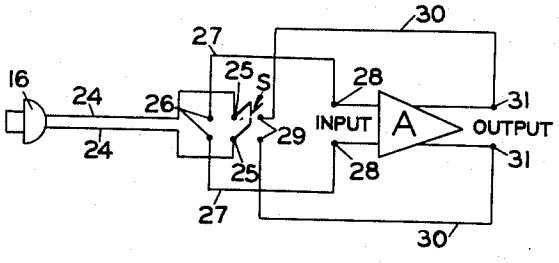


FIG. 6

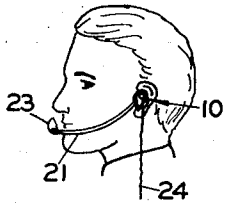


FIG. 5

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COMBINATION EAR-MOUNTED MICROPHONE AND RECEIVER INSTRUMENT

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4 Claims. (Cl. 179—156)

The present invention relates to audible signal transmitting and receiving apparatus and more particularly to a combined microphone and speaker device for use by aircraft personnel, radio operators, telephone operators or other persons using communication systems.

In the past, pilots, radio operators and other aircraft and ground personnel, have commonly used separate earphone-type receiver or speaker devices and lip, throat, or hand-held microphones to respectively receive and transmit voice signals. In some instances, the earphones and microphone are built into, or mounted in aviators' helmets or oxygen masks, or may be simply worn over the head and held in the hand where desirable. With the advent of high altitude flight, the hand-held microphone has been substantially replaced by the throat-type microphone or by a lip-type microphone built into the usual oxygen mask. However, considerable difficulty is still encountered with the so-called built-in types of earphones and microphones and the same are relatively costly and in some cases uncomfortable and unsanitary from the standpoint of the wearer.

Also, it has heretofore been proposed to employ the usual type of electromagnetic-vibrating diaphragm-type of earphone or receiver device as both a receiver and as a microphone, but due to the relatively high noise level encountered in aircraft operation, previous attempts along this line have proved unsuccessful in attaining a desired signal-to-noise ratio necessary to transmit a clear, ungarbled and intelligible signal.

Accordingly, the primary object of the present invention is to provide a structurally simple lightweight combination microphone and speaker device adapted to be mounted in and upon the human ear and operable selectively either as a microphone or speaker in transmitting voice signals to and from the ear of a wearer.

Another object of this invention is to provide a combined ear-mounted microphone-speaker which is characterized by its ability to transmit comparatively clear, ungarbled and intelligible voice signals and which attains, when operating as a microphone, a desirably high signal-to-noise ratio without resort to the use of cumbersome and uncomfortable ear pads or other noise-shielding equipment.

It is a further object of the present invention to provide a device of this character which may be constructed from comparatively inexpensive, lightweight and readily available component parts, and one which may be easily fitted to and supported by the human ear and worn and operated in greater comfort than has heretofore been possible with the use of conventional types of earphones, headsets and microphones.

For a further and more complete understanding of the present invention and the various additional objects and advantages thereof, reference is made to the following description and the accompanying drawing, wherein:

Fig. 1 is a perspective view, partially in vertical section, of a preferred form of microphone-speaker device formed in accordance with the present invention;

Fig. 2 is a side elevational view of the ear plug or body portion of the present microphone-speaker device looking toward the outer side thereof;

Fig. 3 is an end elevational view of the ear plug body;

Fig. 4 is an enlarged fragmentary vertical sectional view taken through the ear plug body and illustrating the relative location of the sound-to-electrical impulse transducer;

Fig. 5 is a small scale perspective view illustrating the present microphone-speaker device as worn in the human ear;

Fig. 6 is a diagram of the electrical circuit of the sound-to-electrical impulse transducer and associated amplifier and switching mechanism.

The present invention proceeds on the principle of using a single, standard type of sound-to-electrical impulse transducer, both in the capacity of a microphone and as a receiver or speaker device. Furthermore, the present invention contemplates the use of such a transducer in combination with a molded plug-like body adapted to be snugly fitted directly to the outer regions of the human ear and formed so as to transmit audible signals both to and from the ear canal. Recent experiments have shown that voice signals may be transmitted with efficiency through the human ear canal and/or through the bone or tissue structure of the skull and ear. However, in surroundings of relatively high ambient noise and/or vibrations, such as in aircraft operation, it has been found that ambient noises and vibrations may also be transmitted through the skull and ear, thus making it difficult to attain a desired high signal-to-noise ratio which is necessary to transmit a clear and intelligible voice signal.

We have found that it is possible to obtain a desired signal-to-noise ratio in aircraft operations by utilizing an acoustic coupling of mouth and ear-emitted signals, such combined signals being conducted to the sound-to-electrical impulse transducer through suitable merging passages where such combined signals are translated into electrical impulses, amplified, and broadcast through conventional radio apparatus.

Referring now more particularly to the drawing, wherein is illustrated a single preferred form of the present invention, the numeral **10** designates generally a plug-like body which is preferably molded or otherwise formed from a suitable synthetic resin, and shaped to snugly and directly fit into the exterior regions of the human ear. The ear plug body **10** may, if desired, be custom molded to fit the ear of the individual wearer, or may, where desirable, be formed in generally standardized sizes and shapes after the manner of the usual ear plug or mold employed in connection with the ordinary hearing aid device. In the usual manner, the ear plug body includes a laterally projecting pipe-like extension **11** adapted to extend a distance within the ear canal, and a convoluted upper and forward retaining finger **12** which is adapted to fit beneath the outer tissue flap of the human ear to hold the plug or mold body **10** in substantially snug, flush-fitting relation to the exterior portions of the ear. The body **10** further includes a flat outer side portion **13** which is formed with a cylindrical socket **14** to frictionally and removably receive the tubular stem portion **15** of the usual button-like hearing aid transducer **16**. In order to frictionally retain the transducer **16** within the socket **14** of the ear plug body **10**, the latter is formed with an annular radially inwardly extending rib **17** which resiliently and frictionally engages the tubular stem portion **15** of the transducer **16** to hold the latter within the socket **14** against accidental withdrawal.

Communicating with the transducer-receiving socket **14** is an internal passage **18** which extends transversely through the body **10** and terminates in an opening **19** at

the end of the canal extension **11** of the body. The body **10** is also formed at its forward end with a relatively small diametered socket **20** communicating with the passage **18**, and in which is press-fitted the inner end of a relatively small diametered hollow tube **21**. The tube **21**, as shown in Fig. 5, is arranged to extend forwardly and laterally inwardly of the plug body **10** so as to partially encircle one side of the face of the wearer, and terminates substantially closely adjacent the lips of the wearer in an opening **22**. Advantageously, the outer open end **22** of the tube **21** may be provided with a relatively small hemispherical cup-like body **23** which opens toward the mouth of the wearer so as to effectively focus voice signals emitted from the mouth and channel the same backwardly through the tube **21**. If desired, particularly when the present device is used in aircraft operations, the open end of the cup-like body **23** may be closed by a protective film of polyethylene resin or the like so as to minimize undesired wind or other ambient noises.

Thus, it will be seen that when the present microphone-speaker device is used in the capacity of a microphone, voice signals, or sounds are conducted both through the tube **21** from the lips of the wearer and also through the ear canal to the internal passage **18** of the plug-like body **10** where the ear and mouth transmitted signals or sounds are combined and impressed upon the sound-sensitive element of the transducer **16**. It is also thought that at least a part of the voice signals emitted by the wearer may be conducted through the bone structure of the skull and thence possibly through the tissue of the ear to the plug-like body **10**, and thence to the sound-responsive element of the transducer. It has been found through experimentation that the signal-to-noise ratio encountered in ordinary aircraft operations is such that ear-transmitted signals alone, without a coupled mouth-transmitted signal results, in some cases, in a garbled unintelligible transmission. This is believed due to the transmission of external noises and vibrations through the body of the wearer and to the plug-like body **10** and thence to the transducer. However, by combining both mouth and ear transmitted signals, the signal-to-noise ratio is increased to a degree where the resultant broadcast is entirely clear, ungarbled and intelligible.

Fig. 6 of the drawing illustrates diagrammatically the operating circuit for the present combination microphone-speaker device. The sound-to-electrical impulse transducer **16** is provided in the usual manner with a pair of lead wires **24** which extend remotely from the button-like transducer and which are electrically connected respectively with the center poles or terminals **25** of a double pole, double throw switch S. It will be understood that the switch S may take any suitable standard form and may be located in a convenient, readily accessible position to be operated by the hand, or foot. The switch may, if desired, be spring pressed to a position to electrically connect the transducer **16** to the output side of the associated amplifier A, in order that the wearer may normally listen to or receive incoming signals, and may be manually switched to an opposite position connecting the transducer **16** to the input side of the associated amplifier A, in order that signals may be broadcast or transmitted by the wearer. Toward this end, the switch S includes a first set of secondary terminals **26** which are connected by the leads **27** to the input terminals **28** of the amplifier A. The switch S further includes a second set of terminals **29** which are electrically connected by the leads **30** to the output terminals **31** of the amplifier A. It will here be understood that the circuit diagram of Fig. 6 does not include in its showing the usual radio receiver and transmitter components, other than the common amplifier A which may be selectively connected either to an associated receiver or transmitter circuit in a manner well known in the art.

Thus, in the operation of the present microphone-speaker device, the switch S may be moved selectively to a position connecting the transducer **16** with the output of the amplifier A by way of the switch terminals **29** and leads **30** in order that the wearer may listen to incoming radio signals or broadcasts. Merely by manipulating the switch S to connect the transducer **16** to the switch terminals **26**, the transducer is connected to the input side of the amplifier A in order that voice signals may be broadcast through the device.

In view of the foregoing, it will be seen that the present ear-mounted combination microphone-speaker or earphone device may be constructed of more or less standard, readily available and lightweight component parts, and may be connected through the use of a suitable double pole, double throw switch mechanism with the amplifier of a standard radio receiver-transmitter apparatus so as to function selectively both as an earphone receiver or speaker device and as a microphone.

The present combined ear-mounted microphone-speaker is characterized by its economy of manufacture, its comfort to the wearer and its operational efficiency and capability of attaining a sufficiently high signal-to-noise ratio, when operated as a microphone, to transmit clear ungarbled and intelligible signals even in surroundings of relatively high ambient noise. Further, due to the relatively small size and compactness of the present microphone-speaker, the same may be used conveniently by aircraft personnel and worn within the usual aircraft crash helmets or the like without in any way interferring with or obstructing the wearer.

While we have disclosed what we look upon to be a presently preferred form and construction of our improved combination microphone-speaker, it will be understood that the same is susceptible to modification in regard to details of construction and design without departing from the spirit of the invention or the scope of the following claims.

We claim:

1. A combination ear-mounted microphone and receiver comprising an ear plug body arranged to directly and snugly fit within the outer portions of a human ear and formed with a relatively elongated extension arranged to extend within the ear canal and an internal passage extending through said extension and terminating in a socket adjacent an outer surface of said body; a sound-to-electrical impulse transducer carried in said socket and communicating with the internal passage thereof; and an elongated tubular member having one end connected with said body and communicating with the internal passage formed therein, said tubular member extending outwardly from said body and terminating in an open outer end portion disposed closely adjacent the lips of a person in whose ear said body is fitted, the passage of said body and said tube serving to conduct sound waves emitted both from the lips and ear of a wearer to said transducer.

2. A combination ear-mounted microphone and receiver as defined by claim 1, including a relatively enlarged cup-shaped device carried on the open outer end of said tubular member.

3. A combined microphone and speaker device comprising an ear plug-type body formed with an open-ended passage extending therethrough and arranged to snugly fit within and be supported by the exterior regions of the human ear; a single sound-to-electrical impulse transducer carried in said body in communication with one end of said passage; and a relatively small diametered, open-ended, hollow tube carried at one end thereof by said body and communicating with the passage of said body intermediate the ends of said passage and having an opposite end portion extending remotely outwardly from said body and arranged to terminate adjacent the lips of a person in whose ear said body is positioned, said tube serving to conduct mouth-emitted sounds from the lips of a person wearing said device to the passage of said body and thence to said transducer.

4. A combined microphone and speaker device comprising a body of a shape and size to at least partially and

snugly fit into a human ear and having a passage therein arranged to communicate directly at one end thereof with the canal of an ear into which said body is fitted; a single sound-to-electrical impulse transducer carried by said body and communicating with the opposite end of said passage; and a relatively small diametered, hollow tube carried at one end by said body and arranged to extend outwardly from said body to a position closely adjacent the lips of a person in whose ear said body is positioned, said tube being open at both ends thereof and having one end communicating with the passage of said body intermediate the ends thereof, whereby sounds emitted from the lips of such person may be conducted

through said tube to the passage of said body and thence to said transducer.

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