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A. E. SWICKARD

1,964,604

ACOUSTIC DEVICE

Filed Dec. 29, 1932

FIG. 1

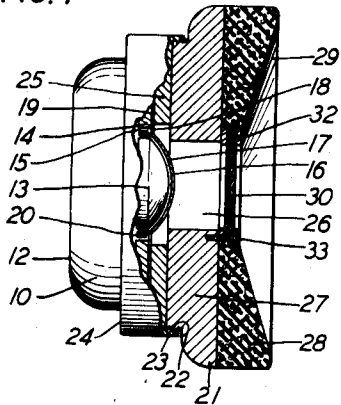


FIG. 2

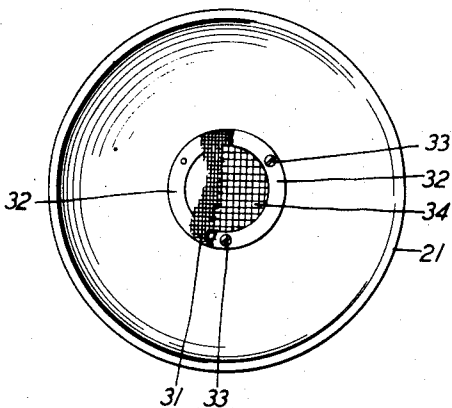


FIG. 3

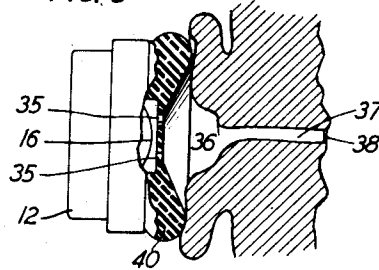


FIG. 4

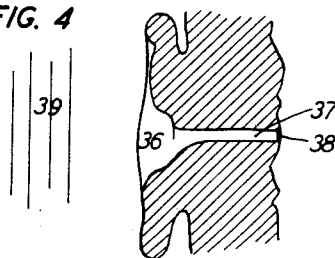


FIG. 5

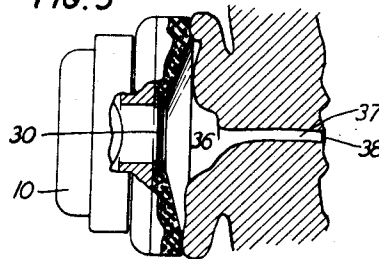
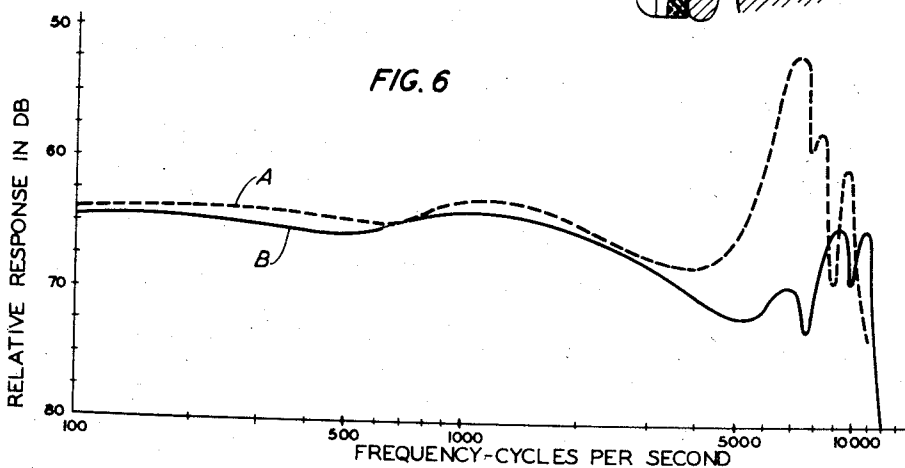


FIG. 6



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ACOUSTIC DEVICE

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1 Claim. (Cl. 179—180)

This invention relates to acoustic devices and more particularly to telephone receivers of the type to be held against the ear of a user.

An object of this invention is to improve the quality of the sound energy transmitted to the ear drum from the diaphragm of a receiver held against the ear.

A further object of this invention is to simulate with a telephone receiver against the user's ear the acoustic conditions of the ear which exist when sound waves are being received by the ear in the ordinary manner.

A feature of this invention comprises a telephone receiver adapted to be held against the ear of a user and having sound energy damping means in such spaced relation to its diaphragm that, when the receiver is held against the user's ear and the sound wave transmission occurs, there is substantially no distortion thereof because of ear chamber resonance, acoustical transients, or reverberant effects.

A further feature of this invention comprises spacing the sound energy damping means from the diaphragm at a distance preferably at which, when the receiver is in use and against the user's ear, particle velocity at ear chamber resonance is at a maximum.

In accordance with this invention, the telephone receiver comprises an earpiece or cap portion having a central opening therein in which is supported sound energy damping means such as silk cloth in spaced relation to the diaphragm. When the receiver is held against a user's ear, the silk cloth is positioned at the point that particle velocity at ear chamber resonance is at a maximum. Supporting the silk cloth at a distance from the diaphragm equal to approximately one-half the distance between the receiver diaphragm and the entrance to the ear canal is preferable and satisfactory.

A more complete understanding of this invention will be obtained from the detailed description which follows taken in conjunction with the appended drawing, wherein:

Fig. 1 is a side elevational view, partly broken away and partly in section, of a telephone receiver embodying this invention;

Fig. 2 is a plan view of the front of the receiver shown in Fig. 1 partly broken away to show details of the damping means used therein;

Fig. 3 shows a telephone receiver not embodying this invention applied to the ear of a user and equipped with an ordinary earpiece or cap;

Fig. 4 illustrates the acoustic conditions exist-

ing at the ear in ordinary conversation or sound wave transmission through the air;

Fig. 5 shows the telephone receiver of Figs. 1 and 2 to a reduced scale, applied to the ear of a user; and

Fig. 6 shows graphically the improvement in frequency response of a receiver occasioned by the embodiment therein of this invention.

There is shown in Figs. 1 and 2 a telephone receiver 10 of the electrodynamic type embodying this invention and comprising a magnetic structure 12 including a central pole piece 13 and an outer pole piece 14 defining an annular air gap 15. Supported on the outer pole piece is a diaphragm 16 having a central stiffened, dished portion 17, a flexible annulus 18 and a peripheral portion 19. A driving coil 20 is attached to the diaphragm at the junction of the flexible annulus and central portion. An earpiece 21, having an exteriorly threaded portion 22 for engagement with the interiorly threaded portion 23 of the member 24, is clamped against the diaphragm periphery clamping member 25. The earpiece contains a sound wave passage 26, preferably centrally disposed, and comprises a rigid portion 27, for instance, of hard rubber or of metal, and a less rigid or resilient portion 28, for instance, of soft sponge rubber. The resilient portion has a dished or concave outer surface 29 and is adapted, when the receiver is applied to and held against the ear, as shown in Fig. 5, to seal the ear chambers or cavities from the atmosphere. Positioned in the sound passage 26 at the end thereof most remote from the diaphragm is a sound energy damping means 30 comprising an acoustic resistance element, preferably a silk cloth strip 31, peripherally clamped between annular or ring members 32 which are secured to the earpiece portion 27 by fastening means 33, such as screws. To protect the diaphragm and damping means against injury, a gauze screen 34 having apertures sufficiently large to allow the passage of sound waves without modification thereof, may be employed.

When an ordinary telephone receiver, such as that shown in Fig. 3, is placed against the ear of a listener or user, a chamber is formed between the outer ear and the receiver diaphragm, which chamber can be approximated by a closed tube. Such a closed tube has a resonance frequency and distorts the acoustic transmission from the receiver diaphragm to the ear drum. In order that sound waves reaching the ear drum be undistorted, transmission from the outer ear through the ear canal to the ear drum should be the same for telephone transmission as for ordinary con-

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versation or other sound wave reception, in which case, as illustrated by Fig. 4, the entrance to the outer ear is not closed off and the ear is freely exposed to sound waves represented by the parallel lines 39. Fig. 3 discloses a telephone receiver of the type shown in Figs. 1 and 2 provided with an ordinary earpiece 40 having the usual perforations 35 above the diaphragm 16. When impulses of sound wave frequency are impressed on the receiver, its diaphragm produces sound waves which pass through the perforations 35, the outer ear chamber 36, and the ear canal 37 to the ear drum 38. Since the ear canal is very much smaller in cross-sectional area than the outer ear chamber and the receiver diaphragm closes the end of the ear ordinarily open to the atmosphere, the outer ear chamber 36 can be approximated by a tube which is closed at both ends. For sound wave reception direct from the atmosphere, as in the case of Fig. 4, the outer ear chamber can be represented by a tube which is closed at one end, at the ear drum and open at the other.

The difference in acoustical transmission between a tube closed at both ends and a tube closed at one end only is quite marked. The resonant frequencies for the two are not the same and the intensity at resonance is much less for the open tube than the closed tube, since the radiation of sound energy from the open end of the tube acts as damping. The telephone transmission conditions differ, therefore, from the natural transmission conditions in two important respects: (1) There is practically no damping or dissipation of energy in the outer ear chamber, and (2) the outer ear chamber resonance occurs at a different frequency for telephone transmission than for natural transmission and is also more intense.

By introducing acoustic damping or resistance in the outer ear chamber, telephone transmission quality is greatly improved, the undesirable closed tube resonance being substantially entirely eliminated, reverberant effects are reduced and acoustic transients in the outer ear chamber produced

by changes of frequency or intensity of speech or music are rapidly suppressed; at the same time acoustic transmission at frequencies other than that of tube resonance will not be appreciably affected.

In the receiver described with reference to Figs. 1 and 2 and shown against a user's ear in Fig. 5, the acoustic damping is provided by the silk cloth 31 having a high acoustic resistance. It is supported by the earpiece at a distance from the diaphragm of the receiver which, when the receiver is held against the user's ear, is approximately half the distance between the receiver diaphragm and the entrance to the user's ear canal, since at resonance the particle velocity is a maximum at the center of a closed tube and damping is a direct function of particle velocity. Damping introduced in this manner does not react appreciably on the motion of the receiver's diaphragm.

In Fig. 6 are shown response characteristics of a receiver before and after this invention was embodied therein. Curve A is a frequency response of the receiver with the ordinary earpiece, and curve B is a frequency response of the same receiver embodying this invention and illustrates how air chamber resonance is effectually suppressed to make the response more uniform over the frequency range translated.

What is claimed is:

A telephone receiver to be applied to the ear of a user, comprising a diaphragm having a centrally stiffened portion, electro-dynamic means to actuate said diaphragm, means having a centrally disposed sound wave passage having its inlet end adjacent the diaphragm and within the periphery of the centrally stiffened portion thereof, said second mentioned means comprising a resilient portion to be placed against a user's ear to seal the chambers thereof from the atmosphere, and a silk screen positioned in and extending across the sound wave passage.

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