Feb. 28, 1939. H. KOCH 2,148,477

BONE CONDUCTION AUDIPHONE

Filed Aug. 31, 1935

Fig. 1

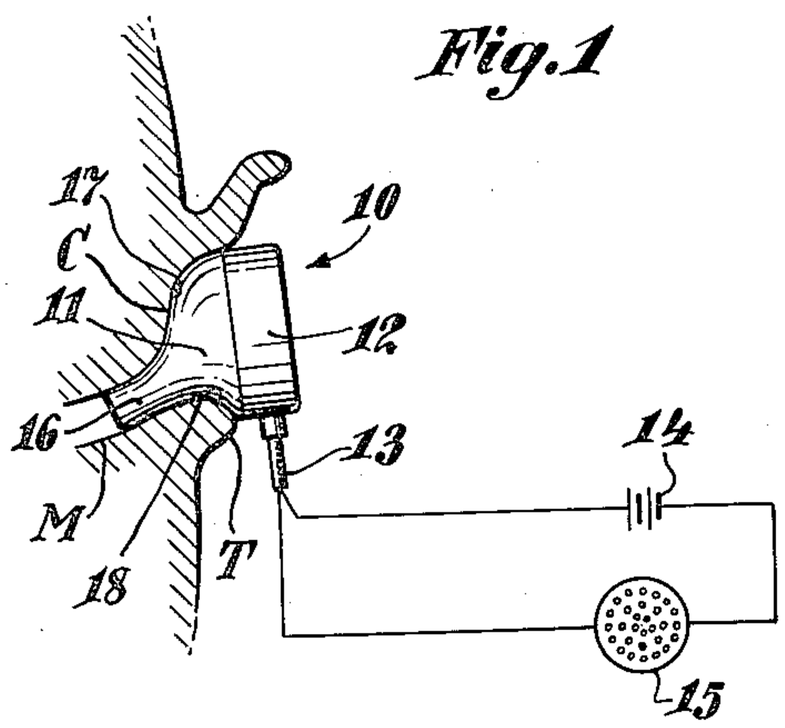


Fig. 2

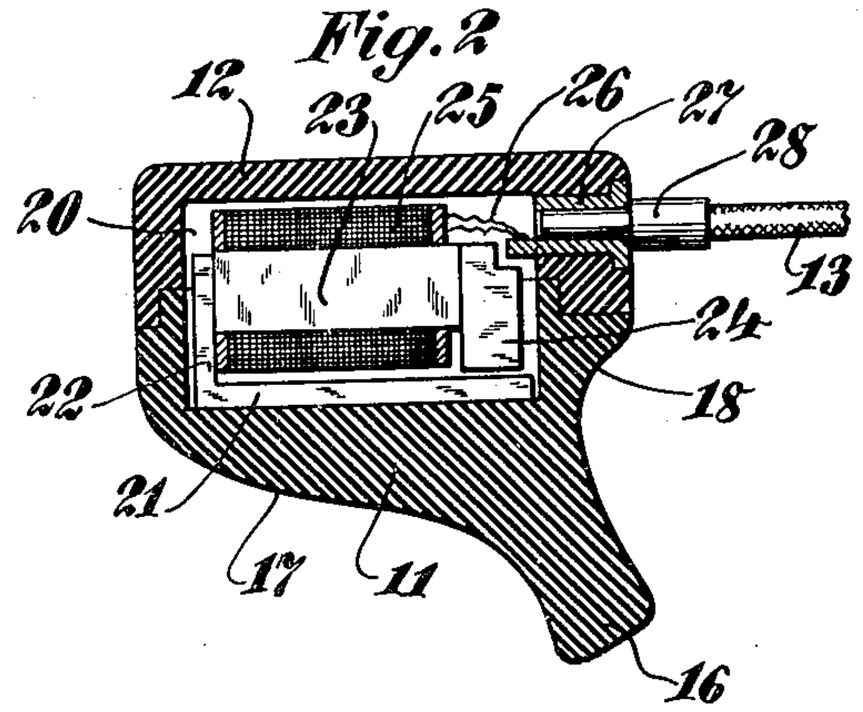


Fig. 3

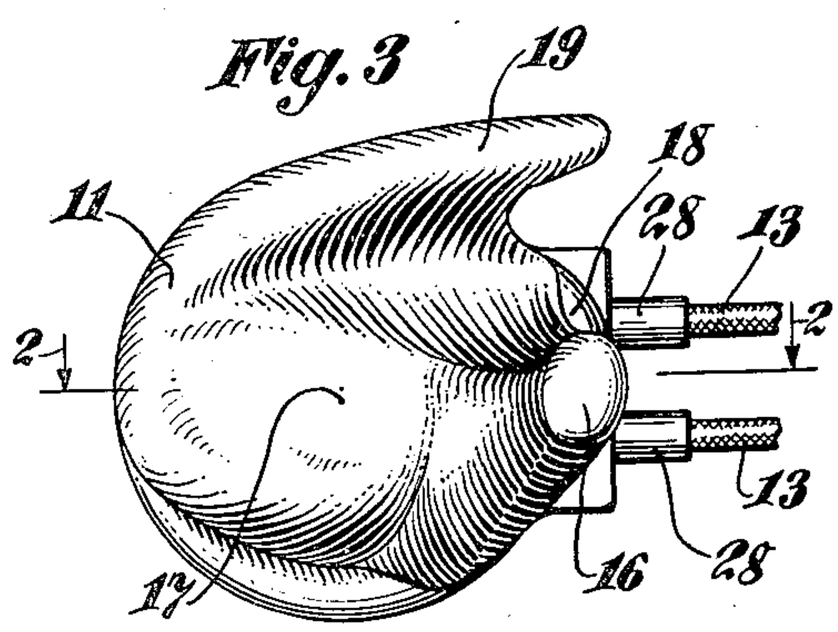


Fig. 4

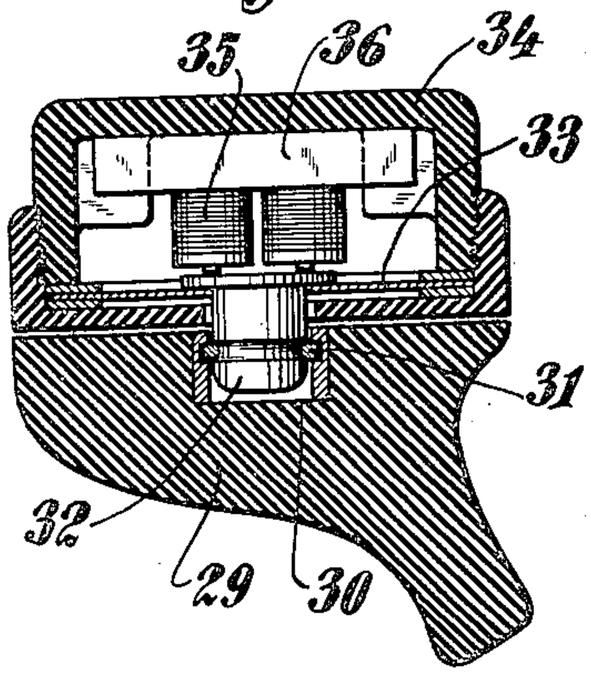
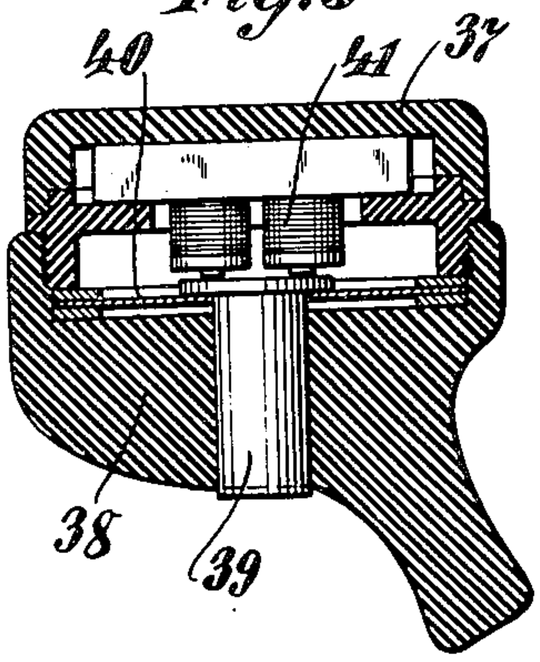


Fig. 5



INVENTOR.
Henry Koch,
BY Hoguet, Neary & Campbell,
HIS ATTORNEYS

Patented Feb. 28, 1939 2,148,477

UNITED STATES PATENT OFFICE

2,148,477

BONE CONDUCTION AUDIPHONE

Henry Koch, Jamaica, N. Y., assignor to Dictograph Products Company, Inc., New York, N. Y., a corporation of Delaware

Application August 31, 1935, Serial No. 38,681

15 Claims. (Cl. 179—107)

This invention relates to a bone conduction audiphone and has particular reference to audiphone receivers adapted to be mounted in and/or carried by the ear for transmitting audible sounds picked up by a suitable microphone to the inner ear through the bone and cartilage structure of the outer ear.

The receiver of conventional bone conduction audiphones is either equipped with a button carried by the diaphragm for operative connection with the bone structure of the user, or is so arranged that the entire housing of the electromagnetic means vibrates so that when it is placed in operative connection with the bone structure of the user its vibrations are transmitted to the inner ear. In this latter form of bone receiver, the electromagnetic means is usually carried by the diaphragm or reed which is secured to the casing, so that the inertia of the electromagnetic means causes the diaphragm and the attached casing to vibrate as a unit. Such an arrangement is disclosed in copending application Serial No. 678,130, filed June 29, 1933. Both forms of receivers are usually supported on a headband in contact with the mastoid eminence behind the ear. Many users find the headband objectionable and would prefer something which is carried by the ear without recourse to a headband or other extraneous supporting means. An example of a vibratile casing receiver, that may be supported in or by the outer ear, is disclosed in Reynolds Patent No. 1,630,028, issued May 24, 1927, on which the present invention is an improvement.

In accordance with this invention a bone conduction audiphone is provided of which the receiver is supported by and in the outer ear with its vibratory member preferably shaped to conform to the contour of the outer ear so that intimate contact between this vibratory member and the outer ear is effected which causes the vibrations of the receiver to be transmitted to the inner ear through the intervening bone and cartilage. It has been generally understood that effective bone conduction was only possible where intimate contact between the bone and the vibrating portion of the receiver is provided, but it appears that the cartilaginous tragus lying before the auditory meatus also serves as a conductor of vibrations to the inner ear, apparently through the intervening cartilage and bone extending along the auditory meatus.

The present invention takes advantage of this vibration-conducting property of the tragus and other cartilaginous or semi-rigid parts of the outer ear like the face of the concha, despite the fact that these parts are elements of the auricle or pinna which is largely flexible and so resilient as to apparently preclude direct transmission of mechanical vibrations to the inner ear. This is in fact the case with the greater proportion of the auricle.

The preferred embodiment of the invention comprises a vibratory ear-piece of rigid material such as hard rubber, a phenolic resin, or the like, shaped to conform to the contour of the concha of the ear of the user, with a lateral extension having intimate contact with the tragus and with an axial extension adapted to fit part way within the auditory meatus, this ear-piece accordingly being of such shape as to frictionally support in the ear the relatively heavy electromagnetic structure adapted to vibrate it. This electromagnetic structure preferably consists of a tympanum or reed secured to the ear-piece and supporting the permanent magnet and speech coil, so that as the latter is energized by suitably amplified voice currents or the like, the inertia of the relatively heavy magnet and its coil causes the resultant vibration of the tympanum or reed to vibrate the ear-piece by reaction.

These vibrations of the ear-piece are transmitted to the tragus and conducted thereby through the intervening cartilage and bone structure to the inner ear. There is also some conduction through the other semi-rigid parts of the outer ear which are engaged by the ear-piece, such as the firm face of the concha, and the relatively firm cartilaginous outer portion of the auditory meatus.

In a modified form of the invention the tympanum or reed is free to vibrate relatively to the ear-piece and has connected thereto a plunger button passing through the ear-piece and ending substantially flush therewith for contact with the firm face of the concha adjacent the opening of the auditory meatus, which transmits its vibrations to the inner ear in the manner described. This button may be arranged to engage the tragus if desired.

It will be seen that with this arrangement, the entire receiver is supported by the ear so that no headband or other extraneous supporting means is necessary, and that even though the outer ear is resilient and would ordinarily not transmit vibrations, the cartilaginous portions thereof are utilized with the present invention for transmitting effective mechanical vibrations to the inner ear, whereby the user hears audible sounds,

even though his normal hearing by air conduction is impaired.

For a more complete understanding of the invention, reference may be had to the accompanying drawing, in which:

Figure 1 illustrates the new bone conduction audiphone of this invention and in particular the manner in which the receiver is supported in the ear;

Fig. 2 is an enlarged axial section through a preferred form of the receiver as seen along the line 2—2 of Fig. 3;

Fig. 3 is a rear view of the receiver showing the shape of the ear-piece thereof;

Fig. 4 is an enlarged section of a modified form of the invention; and

Fig. 5 illustrates a so-called button type of modification of the receiver of this invention.

Referring to Fig. 1 of the drawing, numeral 10 designates the receiver of the bone conduction audiphone of this invention and includes a recessed ear-piece 11 and a recessed cover 12, which cooperate to form a housing for the electromagnetic means adapted to vibrate the receiver 10 as a unit. A small electric cord 13 is connected to the receiver 10, and contains two wires in the circuit of a battery 14 and microphone 15. Suitable amplifying means, not shown, may also be provided.

The configuration of the ear-piece 11 is illustrated in Figs. 2 and 3 and it includes a stem 16 adapted to fit part way into the auditory meatus M of the ear; a substantially flat surface 17 adapted to engage the firm face of the concha C; a double-concave portion 18, shaped to closely engage and preferably partially distort the tragus T to insure intimate contact therewith, and a horn-like extension 19 adapted to lodge in the recess of the anti-helix. Ear-piece 11 is preferably formed of initially plastic material, such as hard rubber, a phenolic resin, or the like, and may be provided in several sizes to fit the left and right ears of the average user or may be specially shaped to fit the ear of an individual user from a mould formed of an impression taken in wax of the shape of the outer ear.

The projection 16, adapted to be inserted part way into the auditory meatus M, serves principally as a supporting member as does the horn 19, while the surfaces 17 and 18, principally the latter, serve the important function of transmitting vibrations to the firm portion of the face of the concha C and to the tragus T, respectively, although part 16 and the other surfaces of the ear-piece 11 which engage the other cartilaginous portions of the ear also transmit some vibration.

The cap 12 is sutiably secured to the ear-piece 11 and forms the chamber 20 in which the electromagnetic vibrating means is housed. The reed 21 of the electromagnetic means is rigidly secured to that surface of the ear-piece 11 which forms the bottom of the chamber 20, and one end 22 thereof is preferably bent at right angles and carries bar magnet 23, having at its free end the pole piece 24, which forms a narrow air gap with the corresponding surface of the reed 21. A speech coil 25, mounted on the bar magnet 23, is connected by two filaments 26 to a pair of sockets 27 inserted in the cover 12 and adapted to frictionally receive the connectors 28 of the electric cords 13.

Energization of the speech coil 25 by voice currents developed by the microphone 15 in response to sound, causes relative vibration between the magnetic structure elements, including parts 23, 24 and 25, and the reed 21 in accordance with the well known electromagnetic phenomenon. Because the inertia of the relatively heavy magnetic structure 23, 24, 25 is considerably greater than the inertia of the light reed 21 and its appurtenant parts, the magnetic structure in effect remains stationary and the reed and its appurtenant parts vibrate relatively thereto, so that the entire receiver 10 vibrates as a unit, thus transmitting its vibrations to the tragus T, and to the other cartilage engaged thereby, through the bone intervening between the outer ear and the inner ear, so that the sound is conducted through the bone to the inner ear and the user hears the sound.

In the modified form of the invention illustrated in Fig. 4, the ear-piece 29 is shaped in the manner described and is provided with a socket 30 in its outer flat surface, this socket having an annular spring wire 31 for rigidly receiving the annularly-grooved tip of a button-like extension 32 secured to the relatively stiff diaphragm 33 of a circular telephone receiver of the so-called midget type, which includes the two-part casing 34 housing the speech coils 35 and the permanent magnet 36. The receiver is accordingly supported by its diaphragm 33.

When the receiver of Fig. 4 is connected in the circuit shown in Fig. 1, and the speech coils 35 energized in accordance with sounds picked up by the microphone 15, the diaphragm 33 is vibrated but, because the entire receiver is supported by this diaphragm through the connection between button 32 and ear-piece 29, the heavy magnetic structure of the receiver in effect remains stationary, and the reaction of the vibration of the diaphragm 33 causes the entire receiver to vibrate, producing the effect described in connection with the receiver illustrated in Figs. 1, 2 and 3.

In the modified form of the invention illustrated in Fig. 5, the midget receiver casing 37 is screwed into a socket formed on the face of the ear-piece 38, or is otherwise secured thereto. A button 39 is secured to the diaphragm 40 and passes plunger-like through an opening in the ear-piece 38, projecting slightly beyond the surface thereof, for example, approximately 1/64 of an inch or a distance of that order, so as to engage the firm face of the concha C when this receiver is mounted in the ear. As the speech coils 41 of this receiver are energized in the usual way, vibrations of the diaphragm 40 are not communicated to the ear-piece 38, but are directly transmitted by the button 39 to the firm surface of the concha C, which with the intervening cartilage and bone conducts the vibrations to the inner ear. Instead of engaging the firm surface of the concha C, the button 39 may be arranged to engage the tragus T, the walls of the auditory meatus M, or some other firm portion of the outer ear for conducting the sound through the cartilage and bone in the manner described.

It will be seen that, as was suggested in the aforementioned copending application, vibrations which enable a deaf person to hear may be conducted to the inner ear by the cartilaginous portions of the outer ear as well as directly by the bone structure and that, because of this property of the cartilage of the outer ear, a bone receiver may be conveniently supported by the outer ear, thus dispensing with headbands and other extraneous holding means and, in some cases, securing better hearing for the users than with other bone conduction instruments, because, in

those cases, conduction by the cartilage appears to be more efficient than that by the skull bones.

While the devices illustrated and described herein represent preferred embodiments of the invention, it is to be understood that the invention is not limited thereby, but is susceptible of changes in form and detail within its scope.

I claim:

1. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear and shaped to substantially conform to the contour thereof, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

2. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, said member being shaped to substantially conform to the contour of said cartilaginous portion, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

3. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, said member being shaped to substantially conform to the contour of the outer ear and having a portion for at least partial insertion into the auditory meatus of the ear, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

4. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, said member being shaped to support itself within the outer ear, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

5. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, said member being shaped to substantially conform to the configuration of at least a part of the outer ear for support thereby, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through the cartilaginous portion and intervening bone to the inner ear of the user.

6. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, means shaped to substantially conform to the contour of the outer ear for supporting the member within the outer ear, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

7. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, an ear-piece shaped to conform to the configuration of at least a part of the outer ear for supporting the member, and electromagnetic means carried by the member for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

8. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear, an ear-piece shaped to substantially conform to the contour of the outer ear for supporting the member in the outer ear and having a portion for at least partial insertion into the auditory meatus of the ear, and electromagnetic means for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through said cartilaginous portion and intervening bone to the inner ear of the user.

9. In an audiphone, the combination of a member shaped to fit into the outer ear and having a portion operatively engaging the tragus of the ear of the user, and electromagnetic means for vibrating the portion in accordance with sounds within the audible frequency range for transmitting the vibrations by means of said portion through the said tragus and intervening bone to the inner ear of the user.

10. In an audiphone, the combination of a member shaped to fit into the outer ear and having a portion operatively engaging the firm face of the concha of the ear of the user, and electromagnetic means for vibrating the portion in accordance with sounds within the audible frequency range for transmitting the vibrations by means of said portion through the said firm face of the concha and the intervening bone to the inner ear of the user.

11. In an audiphone, the combination of a member operatively engaging the tragus and the firm face of the concha of the ear of the user, and electromagnetic means for bodily vibrating itself and the member by reaction in accordance with sounds within the audible frequency range for transmitting the vibrations by means of the member through the said tragus and concha and intervening bone to the inner ear of the user.

12. In an audiphone, the combination of a member operatively engaging a cartilaginous portion of the outer ear and supported by the outer ear, electromagnetic means carried thereby and adapted to respond to varying currents substantially throughout the audible frequency range, an element vibrated thereby, and an operative connection between said element and the member, whereby the vibrations of the element are transmitted by the member through the said cartilaginous portion and intervening bone to the inner ear of the user.

13. In an audiphone, the combination of a member shaped for support by the outer ear and operatively engaging a cartilaginous portion of the outer ear, electromagnetic means adapted to respond to varying currents substantially throughout the audible frequency range, an element carrying the means and vibrated thereby,

and a supporting and operative connection between said element and the member, whereby the bodily vibrations of the element, means and member are transmitted by the member through the said cartilaginous portion and intervening bone to the inner ear of the user.

14. In an audiphone, the combination of an ear-piece shaped to substantially conform to the contour of the outer ear of the user for operative contact with certain cartilaginous portions thereof, a telephone receiver, and an operative connection between the receiver diaphragm and the ear-piece whereby energization of the receiver by voice currents causes the diaphragm to bodily vibrate the receiver and ear-piece by reaction for transmitting vibrations through the contacting cartilaginous portions of the outer ear and intervening bone to the inner ear of the user.

15. In an audiphone, the combination of an ear-piece shaped to substantially conform to the outer ear of the user, a telephone receiver supported thereon, and a button vibrated by the receiver in response to voice currents and operatively engaging a firm portion of the outer ear within the latter for transmitting the vibrations through said firm portion to the inner ear of the user.

HENRY KOCH.