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AUDITORY APPARATUS

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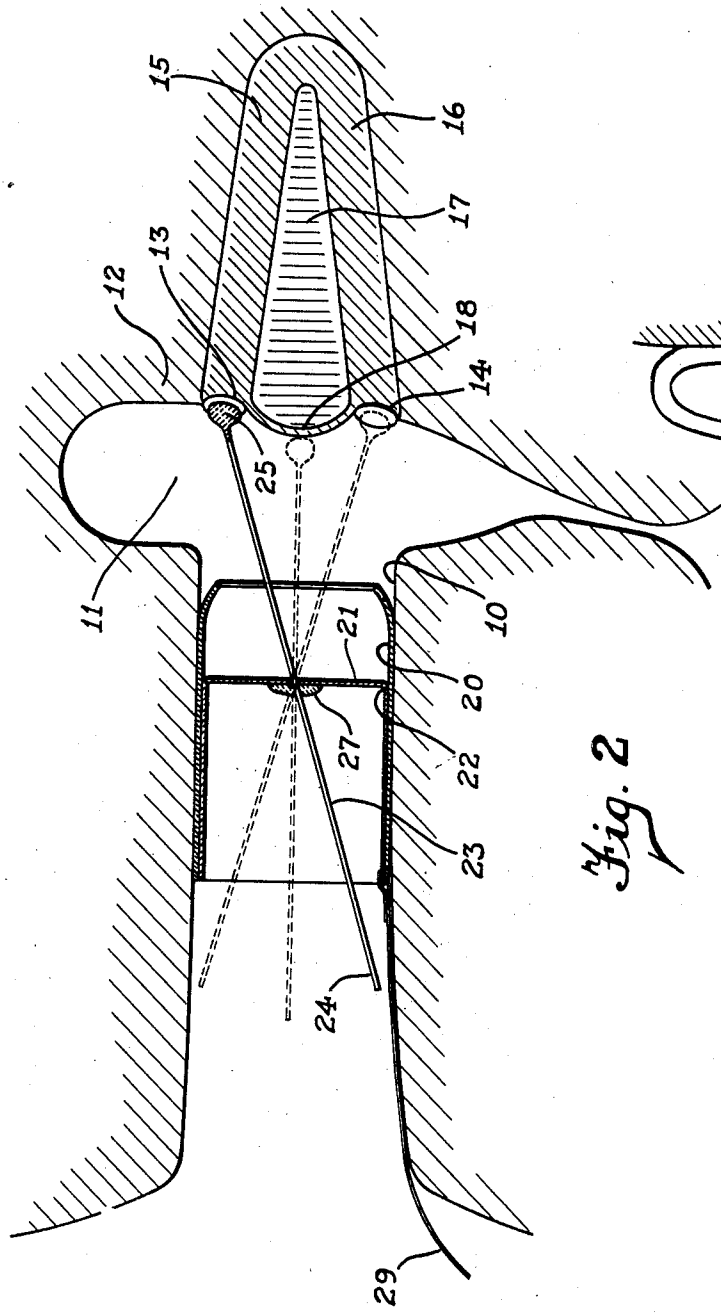


Fig. 2

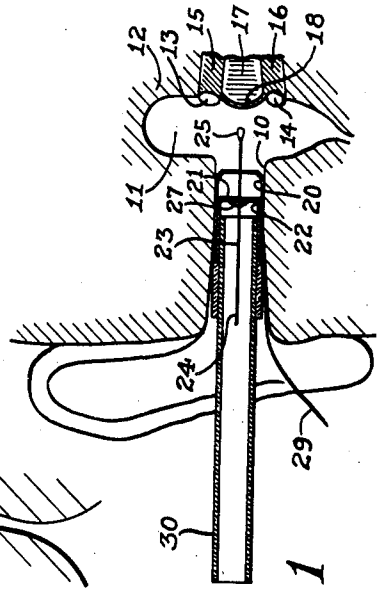


Fig. 1

Inventor

Augustus Grote Pohlman

By Maréchal & Noé

Attorneys

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AUDITORY APPARATUS

Augustus Grote Pohlman, Los Angeles, Calif.

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3 Claims. (Cl. 181—23)

This invention relates to devices adapted for use in the ear of persons lacking a natural ear drum membrane and ossicle chain.

One object of the invention is the provision of an auditory apparatus adapted for use by a person lacking a natural ear drum membrane and the ossicle chain of the middle ear, the device being adapted to be used in the ear to provide an artificial vibratory diaphragm and a mechanical motion-transmitting connection of a flexible shock-absorbing character between the diaphragm and a yieldable sound receptive area of the wall of the inner ear.

Another object of the invention is the provision of an auditory apparatus of the character mentioned, in which the diaphragm extends across and is carried by a tubular supporting member which fits in the bony external auditory canal, the motion-transmitting stem which connects the diaphragm to the sound sensitive area of the ear having a yielding vibration-conducting engagement with the diaphragm but being adapted for endwise movement and for angular adjusting movement with respect thereto by means of an externally projecting stem portion or extension.

Another object of the invention is the provision of an auditory apparatus of the character mentioned and an insertion rod cooperating therewith and adapted to carry the diaphragm support to facilitate the insertion of the latter, the insertion rod having a passage adapted to receive the projecting end of the motion-transmitting stem and having a length sufficient so that it may readily be manipulated by hand at a place externally of the ear.

Another object of the invention is the provision of an auditory apparatus of the character mentioned having a flexible withdrawal member projecting outwardly of the auditory canal and connected to the diaphragm support so that the latter may be readily withdrawn from the ear.

Other objects and advantages of the invention will be apparent from the following description, the appended claims, and the accompanying drawing, in which:

Fig. 1 is a schematic sectional view of a portion of the ear of a person lacking a natural ear drum membrane and ossicle chain, and illustrating the insertion member in cooperative relation with the diaphragm support; and

Fig. 2 is a sectional view of the ear shown on a larger scale and with the auditory apparatus in place.

The auditory apparatus of the present invention is one adapted to be used by a person who does not have a natural ear drum membrane and where the ossicle chain of the middle ear has been removed or lost through disease. Any air vibrations transmitted to the wall of the inner ear of such a person are without any substantial effect in the production of sound sensations in the person although the person may have a sound receptive area in the wall of the inner ear and have an auditory nerve which is receptive. Such a person may be provided with the mechanical auditory apparatus of the present invention, and he can then receive sound sensations since the apparatus provides an artificial ear drum diaphragm and a mechanical connection between the diaphragm and the yieldable sound receptive area of the wall of the inner ear.

Referring more particularly to the drawing by reference numerals, Fig. 2 shows how the auditory apparatus device is constructed and used. In this figure, 10 designates the bony external auditory canal of a person's ear who has had the natural ear drum membrane and the ossicle chain normally located inwardly of the ear drum membrane removed, thus providing a space or chamber 11 between the wall 12 of the inner ear and the auditory canal. The removal of the ossicle chain in such a person exposes and makes accessible a yieldable sound receptive area or areas in the wall of the inner ear. The oval window 13 and the round window 14 provide such yieldable sound receptive areas to which mechanical sound vibrations may be imparted and through which they may be effective on the scala vestibuli 15 or the scala tympani 16. 17 designates the cochlear duct, and the bony promontory 18 of this duct may be sufficiently thin and therefore sufficiently yieldable to form a vibrational receptive area.

In the external auditory canal 10 is a tubular supporting member 20 having a diameter such that it may fit in the inner portion of the canal, the member 20 serving as a support for a thin flexible membrane or diaphragm 21 which is held at its edges so that it may serve as an artificial drum membrane. The supporting member 20 may be made of gelatinous material preferably hardened in formalin alcohol and varnished or it may be made of suitable plastic material or of metal. The diaphragm 21 is a very thin sheet of suitable material such as animal tissue or a light-weight water resistant synthetic substance, and is fastened or press-fitted along its edge at 22 to the supporting member 20, preferably some little distance from the

inner end of the supporting member, which is curved inwardly, as shown, so it may be readily inserted in the bony canal of the ear. Passing through the central portion of the diaphragm **21** is a long stem **23** of very small diameter and of a flexible character, the outwardly projecting portion **24** of this stem extending out far enough past the diaphragm so that the stem may be manipulated by hand to adjust the inner end of the stem in its proper position after the supporting member **20** is in place in the ear. The inner portion of the stem **23** is provided with a small tip or bead **25** such as a bead of dental stent or a seed pearl, having a maximum dimension of about 2 mm. so that it will not touch the bony parts when touching the yielding area within the oval or round window. As shown in full lines in Fig. 2, this bead is placed in contact with the yieldable sound receptive area of the oval window which is ordinarily accessible, or it may be placed in contact with the promontory caused by the first turn of the cochlea which may be sufficiently thin to transmit vibrations to the sensitive portions of the inner ear, or in contact with the area in the round window **14**. The desired yieldable area or soft spot of the inner ear may be readily contacted, since the stem **23** is movable with respect to the diaphragm to give a required angular position and for movement in the direction of its length, at least when the device is first inserted in the ear.

The stem **23** is preferably straight between the diaphragm and the inner tip or bead, but has sufficient flexibility so as to offer satisfactory shock-absorbing properties against excessively loud sounds and against displacements for any reason. A boar bristle may be used for the stem or it may be made of silk worm gut or of other suitable flexible substance capable of effectively transmitting the vibrations of the diaphragm **21** to the sensitive area of the ear while providing sufficient flexibility for shock-absorbing purposes.

With the diaphragm support **20** in position near the inner end of the auditory canal it is arranged so that the diaphragm will not be substantially affected by movements of the jaw as in speaking or in chewing, and the diaphragm will be definitely positioned in spaced relation from the sensitive area of the inner ear but far enough toward the inner end of the bony canal so that the device will be substantially non-directional. When the support **20** is inserted, the stem **23** is positioned so that its tip portion or bead **25** is rather close to the diaphragm. After the support **20** is in position, the stem **23** is then carefully manipulated manually by the user, who pushes it inwardly and moves it to the proper angular position with respect to the diaphragm so that its bead or tip will touch the available sensitive area of the inner ear as indicated in full lines in Fig. 2 or as indicated in the dotted line positions.

The engagement of the stem **23** with the diaphragm is such as to afford a vibration conducting engagement between these parts. The hole in the diaphragm may be made about the same size as the diameter of the stem so that the stem may be moved longitudinally or endwise while maintaining a vibration conducting engagement of a yielding character with the diaphragm. The center of the diaphragm is preferably provided with a waxy substance **27** of a fluid or semi-fluid character and capable of obtaining sufficient hardness or semi-hardness after a short time following its application to the diaphragm so as to provide an adequate connection between the rod and the member. Thus a drop of wax or cement for example may be applied to the center of the membrane on its outer side just before the support is applied to the ear, permitting the stem to be adjusted with respect to the diaphragm and then attaining a hard or semi-hard condition.

Attached to the support **20** is a flexible withdrawing or pulling member **29**, preferably a strong thin thread which is of such length as to extend outwardly to the end of the bony auditory canal. This thread may be grasped and pulled by the user when he wishes to withdraw the auditory device from his ear so that he may replace it with another. It is intended that the device should be very frequently changed or replaced.

To provide for convenient insertion of the device into its proper position in the ear it is adapted to cooperate with an insertion member or rod **30** shown in Fig. 1. This insertion member is sufficiently long so that its outer end may be held by the fingers while its inner end, which interfits telescopically and rather loosely with the support **20**, is applied in its proper position in the ear. The insertion member **30** is preferably a paper or glass tube or rod the outer diameter of which is slightly less than the inner diameter of the tubular support **20**. Near the support engaging end of the insertion member **30** the latter is provided with an annular enlargement which may be merely a band of paper secured to the glass tube, and having an outer diameter substantially the same as the outer diameter of the support **20** and so positioned with respect to the end of the rod that the diaphragm **21** will not be engaged by the end of the rod. With the support **20** on the end of the rod, and with the outwardly projecting end of the stem **23** extending into the rod **30** as shown in Fig. 1, the device may be readily applied to the ear so as to insert the member **21** in its proper position, and the tube **30** can then be withdrawn leaving the support in the ear canal. As above indicated, the outer end of the stem **23** is then manipulated to engage the bead **25** with the soft spot of the ear that may be accessible, the length of the stem **23** being such that it will not project out beyond the outer structure of the ear where it might be contacted with external objects, when it is in its proper adjusted position.

The device of the present invention is substantially non-directional in its response and increases a thousandfold the sound perception of an ear of the character with which this invention is concerned. It operates by mechanically transmitting the vibrational movements of the artificial diaphragm **21**, caused by sound vibrations of the surrounding air, to a sensitive sound perceptive area of the inner ear. The diaphragm is quite efficient in the higher frequencies and is quite satisfactory in the lower frequencies of the audible range and operates without producing a background of adventitious noises to give a hearing ability comparable to normal. It forms a very satisfactory and quite cheap device for persons lacking a natural drum membrane and ossicle chain.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without

departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An auditory apparatus of the character described adapted for use by a person lacking a natural ear drum membrane and the ossicle chain of the middle ear, said apparatus comprising a tubular support of substantial length in the direction of the bony external auditory canal and adapted to fit in the bony external auditory canal, a diaphragm extending across and fixed to said support, a flexible stem extending through said diaphragm and having a vibration conducting engagement with the portion of said diaphragm through which it passes, said stem having an outwardly projecting portion adapted to be moved by hand to adjust the stem with respect to the diaphragm and having a bead on its inner end adapted to contact a yieldable sound receptive area of the wall of the inner ear.

2. An auditory apparatus of the character described adapted for use by a person lacking a natural ear drum membrane and the ossicle chain of the middle ear, said apparatus comprising a tubular support of substantial length in the direction of the bony external auditory canal and adapted to fit in the bony external auditory canal, a diaphragm extending across and fixed to said support, a flexible stem extending through said diaphragm and having a yielding engagement with the portion of the diaphragm through which it passes, said stem having an outwardly projecting portion adapted to be moved by hand to adjust the stem longitudinally within the diaphragm and to give a desired angular position with respect to the diaphragm, said stem having a bead on its inner end adapted to contact a yieldable sound receptive area of the wall of the inner ear.

3. An auditory apparatus of the character described adapted for use by a person lacking a natural ear drum membrane and the ossicle chain of the middle ear, said apparatus comprising a tubular support of substantial length in the direction of the bony external auditory canal and adapted to fit in the bony external auditory canal, a diaphragm extending across and fixed to said support, a flexible stem extending through said diaphragm and having an engagement with the portion of the diaphragm through which it passes, said stem having an outwardly projecting portion adapted to be moved by hand to adjust the stem longitudinally within the diaphragm and to give a desired angular position with respect to the diaphragm, said stem having a bead on its inner end adapted to contact a yieldable sound receptive area of the wall of the inner ear, and a flexible elongated pulling member connected to said support and of such length as to extend from the support in an outward direction to the end of the external auditory canal.

AUGUSTUS GROTE POHLMAN.