

June 2, 1959

C. A. NIELSON ET AL

2,888,921

EAR INSERTS

Filed March 21, 1956

FIG. 1.

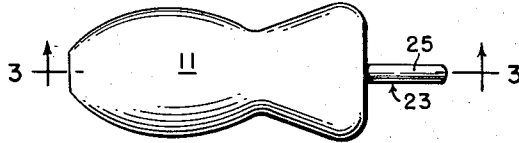


FIG. 2.

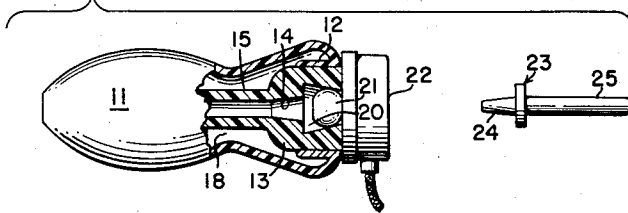


FIG. 3.

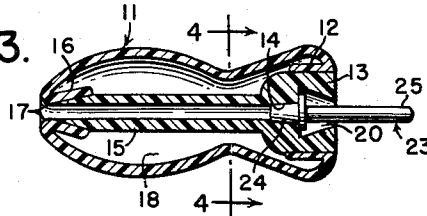


FIG. 5.

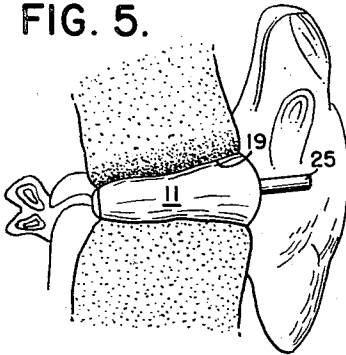


FIG. 4.

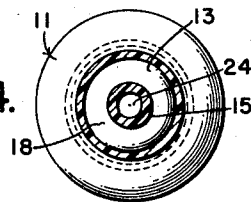


FIG. 7.

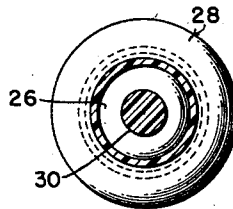
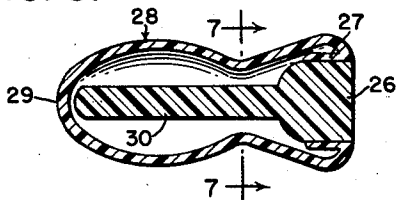


FIG. 6.



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EAR INSERTS

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Application March 21, 1956, Serial No. 572,844

5 Claims. (Cl. 128—151)

This invention relates to ear inserts and is more particularly concerned with devices which may be inserted in the human ear for the purpose of establishing an artificial auditory canal, or for protecting the ear from loud noises, or both, or for keeping water out of the ears while bathing or swimming, as well as protecting the ear from sudden pressure changes, such as that encountered in airplane travel, deep sea diving, mining operations, etc.

Prior ear insert devices, were usually made from solid or relatively stiff materials, such as a rubber or synthetic composition with only a small degree of localized resilience, if any. Devices of this kind are notoriously uncomfortable to the wearer. The materials used are not only irritating to the tender tissues of the skin, but yieldability, if any, of the material, is too small to prevent "pressure spots" or differential pressure areas against these tissues, thereby resulting in irritations which are not only uncomfortable, but which frequently result in inflammatory conditions of the ear.

One of the objects of this invention is the provision of ear insert members, including those which are useful as so-called "noise defenders," water plugs, pressure plugs, and artificial auditory canals for hearing aids, telephone receivers, etc.; which have a high degree of tolerance for the tender tissues of the ear that line the natural auditory canal of the human ear; which are comfortable to wear; which do not result in pressure spots along the auditory canal; and which can be worn indefinitely by persons without irritation and without in any way harming or damaging the ear or any parts thereof.

Another object of the invention is the provision of such ear inserts which obviate the leakage of air between the ear and the insert and thereby prevent sound "feedback," a disturbing phenomenon to the human ear.

A further object of the invention is the provision of such ear inserts which are extremely light in weight, highly resistant to breakage and which require no springs or other special devices or metal parts for attaching or retaining them in the ear.

A still further object of the invention is the provision of such an insert which, when placed in the ear canal, assumes and automatically adjusts itself to the shape and contours of the canal wall, regardless of its configuration, geometry, or surgical intervention, and which results in an even, but light, unit pressure to very part of the canal wall of the ear with which it comes in contact.

A still further object is the provision of such inserts which are impervious to natural secretions of the human ear, to oxidation, sunlight, and aging influences, and which are substantially non-resonant to sounds of various frequencies.

A still further object is the provision of an artificial auditory canal having the attributes and functional efficiency of the natural canal, without the usual disadvantages associated with ear molds, sensory mechanisms, and related devices.

A still further object of the invention is the provision

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of inserts of the type mentioned which can be supplied in various sizes and, hence, mass produced to fit practically all persons needing and desiring them without resorting to custom manufacture, except in exceptional cases that might arise, such as that resulting from unusual formations, surgical cases, and other abnormalities.

These and other objects and advantages of the invention will be apparent from the following description considered together with the accompanying drawing.

In the drawing:

Fig. 1 is an enlarged side elevational view of an embodiment of the invention containing an artificial auditory canal and a removable plug therefor.

Fig. 2 is a view similar to Fig. 1 with the plug removed and a hearing aid transmitter inserted in its place, partly in section.

Fig. 3 is a longitudinal sectional view along the line 3—3 of Fig. 1.

Fig. 4 is a cross-sectional view along the line 4—4 of Fig. 3.

Fig. 5 is a sectional view of a typical human ear with the device of Fig. 1 inserted therein.

Fig. 6 is a longitudinal sectional view of another embodiment of the invention.

Fig. 7 is a cross-sectional view along the line 7—7 of Fig. 6.

Referring with more particularity to the drawing in which like numerals designate like parts, the embodiment illustrated in Figs. 1 to 5, inclusive, comprises an elongated balloon 11 composed of a thin membrane-like material, hereinafter more fully described.

One end of the balloon is presented as the outer end, and it comprises a tubular portion 12 glued or otherwise secured to a relatively thick unyielding wall 13. Said wall has a longitudinal central aperture 14 therethrough.

The inner side of the wall 13 is integral with an elongated tubular member 15 extending longitudinally from the inner side of the aperture 14, substantially as shown.

The opposite end of the tubular member 15 is open to form a continuous canal through the device from one end to the other.

The inner end of the balloon member 11 is turned inward to provide an inner nipple 16 which surrounds the inner end 17 of the tubular member 15 and is glued or otherwise secured to it, substantially as shown, thus forming a confined annular space 18 on the interior.

The said annular space 18 contains air under slight superatmospheric pressure at body temperature, sufficient to gently hold the exterior wall in shape, but permitting it to yield resiliently under slight inward pressure applied from the exterior. As a result, the device, if it has the approximate general shape of an individual's ear canal, that is, as to length, diameter and curvature, will, when placed inside the ear canal, automatically adjust itself to the particular individual contour of the wall 19 of the canal, as illustrated in Fig. 5. In order to effect this result, it is necessary that the material be relatively thin and that the resiliency of the device be supplied principally or primarily by the air pressure within the space 18. If, as in the case of other devices, the resiliency of the device were furnished primarily by the properties of the material itself, an equalization of pressure along the canal wall 19 would not be possible. Pressure would then be localized because there would be no means for neutralizing unequal forces from one point to the other. With devices made in accordance with the present invention, local pressure spots are promptly equalized through the medium of the air in the balloon. In fact, unequal pressures cannot, for this reason, develop at all.

The composition of the device should be such that it

does not irritate the tender membranes of the ear canal with which it comes in contact. Rubber compositions have been found to be inadequate in this and other respects.

Preferred compositions are synthetic plastics, particularly the elastomeric materials known as the alkyl acrylates blended with other compatible materials to give the resulting composition the necessary degree of strength, softness and resistance to deterioration, as well as compatibility with the tissues to be contacted thereby.

A particularly effective and preferred composition is ethylacrylate copolymerized with acrylonitrile, the acrylonitrile content being not more than 12½% nor less than 8%. This copolymer is blended with a methacrylate such as methyl, ethyl, propyl or other homologous methacrylates and their isomers, or blends thereof. The preferred compositions also contain a copolymer of butylacrylate and acrylonitrile to give it the desired degree of softness or plasticity.

An organic reinforcing material, such as one or more of the methacrylates, is blended with the butylacrylate-acrylonitrile copolymer to increase its tensile strength and resistance to tearing. Still further strength is obtained by incorporating colloidal silica. A representative recipe which has been used and found satisfactory is as follows:

	Parts
Butylacrylate-acrylonitrile copolymer (90/10) -----	80
Ethyl-methacrylate -----	20
Colloidal silica -----	15

Another recipe is as follows:

	Parts
Butylacrylate-acrylonitrile copolymer (90/10) -----	70
Ethyl-methacrylate -----	20
Methyl-methacrylate -----	10

A further satisfactory reinforcing material is butylacrylate-acrylonitrile-glycidal trimer.

Such compositions also have the property of setting up with mirror smooth surfaces. This is important so as to establish optimum conditions of sound transmission. An uneven or irregular surface over which sound waves pass, particularly in such close association with the ear, sets up interference patterns and at certain frequencies presents the possibility of resonance and standing waves.

The tubular member 15 is resilient, but somewhat stiffer than the material of the balloon member 11 to act as a pusher for the inner end of the balloon member when inserting the device in the ear.

The outermost portion of the end wall 13 is provided with a counterbore or enlarged opening 20 which is adapted to fit the nipple 21 or other connecting device of a hearing aid 22, as shown in Fig. 2.

Alternatively, it may be used as an ear defender by persons of normal hearing by the use of a removable plug 23, having portions 24 at one end to slidably and removably fit into the aperture 14 and an opposite end portion 25 enlarged to act as a finger grip and to facilitate placing it in and removing it from the device. By these means, the device with the plug 23 inserted becomes a noise defender and is useful for persons working in noisy places, like forging plants, steel mills, in the vicinity of riveters, pile drivers, air hammers, or by military personnel and sportsmen engaged in the operations of firearms, including rifles, cannons, mortars, machine guns, etc.

The removal of the plug 23 makes it possible for the person wearing the device to regain substantially normal hearing conditions for such temporary periods as may be desired, without removing the entire device from the ear, such as during lunchtime or other periods of recess from the noise-producing work.

The hearing aid 22 shown in Fig. 2 may also be sub-

stituted by ear phones (not shown), such as those used by the members of a crew in an airplane, war ship, etc. It provides a more comfortable ear piece in comparison to the type which presses against and irritates the delicate ear lobes.

A modified form of device useful solely as a noise defender and ear plug, is illustrated in Figs. 6 and 7. It is essentially similar to the previously described embodiment, except that the end wall 26, corresponding to the end wall 13, is solid. However, it is likewise surrounded by a tubular outer end portion 27 of a balloon member 28, the said balloon member being closed at its inner end 29. Also, the hollow tubular portion 15 is replaced by a solid pusher bar 30 which is integral with the end wall 26 and which extends to the inner end 29 of the device, free of, but in contact with or substantially in contact with, the said inner end. This latter relation is very important in order to prevent undue distortion of the device as it is being placed in the ear. With the pusher bar 30 in contact with the end wall 29, the device, in effect, is pulled rather than pushed into the ear.

Having thus described our invention, we claim:

1. An ear insert device comprising an elongated hollow balloon of soft, flexible material tolerant of the delicate tissues of the canal wall of the human ear and generally shaped to fit an entire ear canal, the interior of the balloon containing air under superatmospheric pressure at body temperature sufficient to impart a gentle elastic resiliency to the device as a whole, apart from any resiliency in the material itself, said balloon having end walls, a longitudinal open-ended hollow push bar disposed within the balloon along its longitudinal axis, said bar being connected to said end walls with its open ends exposed to transmit sound waves through the balloon, and removable closure means for said hollow push bar.

2. An ear insert device comprising a hollow balloon generally shaped to fit an entire ear canal, the wall of the balloon being of a soft flexible material comprising a blend of ethylacrylate copolymerized with acrylonitrile, the acrylonitrile content being in the range of about 8 to 12½%, a methacrylate, and a plasticiser, the interior of the balloon containing air under superatmospheric pressure at body temperatures sufficient to impart a gentle elastic resiliency to the device as a whole apart from any resiliency in the material itself.

3. An ear insert device comprising a hollow balloon generally shaped to fit an entire ear canal, the wall of the balloon being of a soft flexible material tolerant of the delicate tissues of the canal wall, said material comprising a blend of ethylacrylate copolymerized with acrylonitrile, the acrylonitrile content being in the range of about 8 to 12½%, a methacrylate, and a copolymer of butylacrylate and acrylonitrile, the interior of the balloon containing air under superatmospheric pressure at body temperatures sufficient to impart a gentle elastic resiliency to the device as a whole apart from any resiliency in the material itself.

4. An ear insert device comprising a hollow balloon generally shaped to fit an entire ear canal, the wall of the balloon being of a soft flexible material tolerant of the delicate tissues of the canal wall, said material comprising ethylacrylate-acrylonitrile copolymer, a methacrylate, and butylacrylate-acrylonitrile-glycidal trimer, the interior of the balloon containing air under superatmospheric pressure at body temperatures sufficient to impart a gentle elastic resiliency to the device as a whole apart from any resiliency in the material itself.

5. An ear insert device comprising an elongated hollow balloon of soft, flexible material tolerant of the delicate tissues of the canal wall of the human ear and generally shaped to fit an entire ear canal, the interior of the balloon containing air under superatmospheric pressure at body temperatures sufficient to impart a gentle elastic resiliency to the device as a whole, apart from any resili-

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iciency in the material itself, said balloon having end walls, a longitudinal open-ended hollow push bar disposed within the balloon along its longitudinal axis, said bar being connected to said end walls with its open ends exposed to transmit sound waves through the balloon, and means associated with one of said end walls for removably attaching to the hollow push bar a hearing aid transmitter.

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