

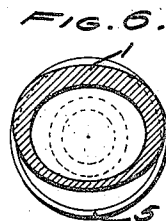
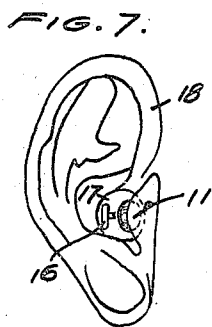
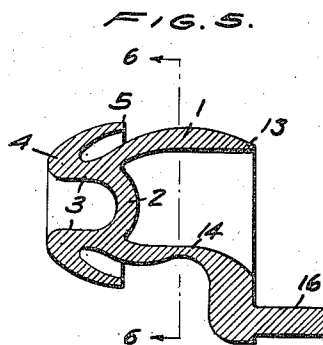
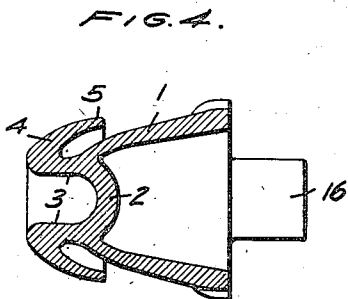
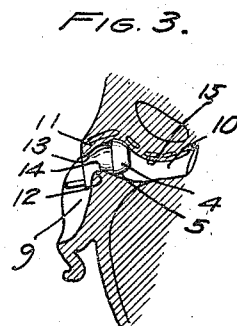
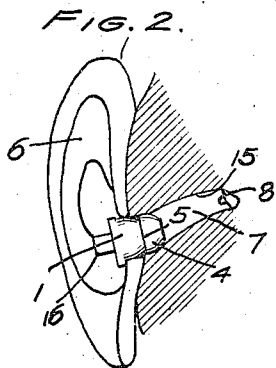
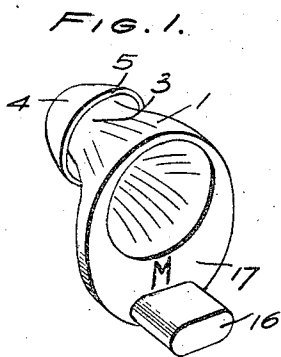
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EAR PROTECTOR

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2,393,005

EAR PROTECTOR

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2 Claims. (Cl. 128—152)

This invention relates to aural attenuating devices and more particularly to an ear protector of the type adapted to be inserted in the ear canal.

Noises such as gun fire, airplane noise, and the like, by reason of their intensity, especially interfere with the normal functioning of the hearing mechanism. Excessive pressures from these sources, when exerted on the eardrum, may cause a great deal of discomfort and frequently may impair the ability of the ear to hear for considerable periods of time, thus rendering communication difficult under combat conditions. It is characteristic of the class of noises referred to that they are largely made up of low frequency sound components, whereas sound such as speech, although of much less intensity, is made up of relatively higher frequency components.

An object of the invention, therefore, is to provide an aural attenuating device which may produce as nearly as possible a uniform shift in aural threshold and thus exclude low frequency noise. Another object of the invention is to provide an improved ear protector capable of functioning in a selective manner to provide a degree of attenuation of sound by which there is effected a compromise between low frequency sound exclusion and speech transmission. Another object of the invention is to devise an ear protector which may be inserted and maintained in the ear canal for extended periods without causing discomfort or requiring removal from time to time. The invention is also directed to providing a simple, cheap and efficient ear protector which may be easily and safely inserted in the ear, which is non-toxic, and which is capable of resisting attack by ear secretions.

The nature of the invention and its objects will be more fully understood from the following description of the drawing, and discussion relating thereto.

In the accompanying drawing:

Fig. 1 is a perspective view illustrating the ear protector of the invention;

Fig. 2 is a detail vertical section of an ear canal diagrammatically illustrating the ear protector inserted therein;

Fig. 3 is a detail horizontal section of an ear canal also diagrammatically illustrating the ear protector inserted;

Fig. 4 is a vertical cross section taken centrally through the ear protector;

Fig. 5 is a plan cross section taken centrally through the ear protector;

Fig. 6 is a cross section taken on the line 6—6 of Fig. 5; and

Fig. 7 is a detail elevational view of an ear showing the ear protector inserted therein.

The ear protector of the invention generally comprises acoustical and mechanical impedances which form a selective sound path and provide a degree of low frequency noise attenuation, while permitting speech transmission. When inserted in the ear, the ear protector lightly engages against the skin lining of the ear canal. It has been found that this skin lining is of an appreciable thickness and compliance, and constitutes an element which determines attenuation of the ear protector. Accordingly, it is a feature of the invention that the ear protector is designed to function as an attenuating device taking into account this element.

The acoustical and mechanical impedances of the ear protector correspond to a very considerable degree to the particular electrical impedances required in an electrical network whose function is to provide low frequency attenuation and a degree of high frequency attenuation which still permits speech transmission. An ear protector design acoustically embodying the proper impedances, as determined by electrical analogy, has been found to be one which is characterized by a relatively small mass; which has a relatively large contact area for engaging against the skin lining of the ear canal in order to keep the shear compliance as small as possible; and which includes a septum of relatively great stiffness in relation to its mass.

Referring more in detail to the drawing, Figs. 1, 4 and 5 illustrate the ear protector of the invention, which comprises a tubular body portion 1, open at its outer end and closed at an opposite end by a septum or partition 2. The body portion 1 is somewhat oval shape in cross section and tapers inwardly to form a neck 3 extending forwardly of the septum 2. Supported on this neck 3 is a hollow rounded head 4, which is provided with a thin resilient skirt 5, extending in spaced relation about the neck portion and the septum.

The outer periphery of the body portion 1, together with the surface area of the skirt 5, affords a relatively large contact area for engaging against the skin lining of an ear canal. This large contact area serves to keep the shear compliance of the skin lining as small as possible. The tubular body portion, in addition to being open at its outer end and constructed of a light yieldable material such as soft rubber, is characterized by

thin walls, which generally imparts to the protector a relatively small mass. The septum 2, on the contrary, is constructed with a relatively thicker wall, and in addition is of a spherical shape with the convex side facing toward the outer open end of the plug. The relatively thick character of the septum, together with the spherical shape, provides an alternate sound path of maximum stiffness in relation to its mass. The thickness of septum, to a certain degree, controls the resulting attenuation.

It will thus be seen that in place of relatively large mass impedance, relied upon in conventional ear protectors, there is substituted a plug or ear protector of relatively small mass impedance, and at the same time there has been combined with the small mass impedance a relatively large contact area. This combination of a thin-walled open tubular member, having a relatively thick-walled septum or sound path, and an exaggerated contact area, has been found to provide an attenuating device which is capable of shifting the aural threshold and excluding low frequency noise to an appreciable degree while permitting speech transmission.

In Figs. 2 and 3 of the drawing, the plug has been diagrammatically shown associated with an ear canal. Fig. 2 is a vertical cross section illustrating a right ear 6, and an ear canal 7, closed at its inner end by the tympanum 8. It will be noted that the ear canal or meatus, as viewed in a vertical dimension, extends inwardly and slightly upwardly, and the ear protector, by reason of its yieldable character, readily conforms to this general shape.

Most ear canals are commonly characterized by being substantially oval shape in cross section, at least at their outer portions, and the oval cross section of the body portion 1 already referred to, and particularly illustrated in Fig. 6 of the drawing, is especially effective in occluding the ear canal aperture, with a light pressure being exerted uniformly over the skin lining contact area and with a minimum distortion of the ear protector taking place. It is also pointed out that the length of the ear protector is substantially less than the distance between the outer opening of the ear canal and the eardrum 8 so that the possibility of interference with the eardrum is entirely eliminated.

In Fig. 3 there has been diagrammatically illustrated a plan cross section of an ear canal and the corresponding position assumed by the ear protector therein. In this case, a left ear 9 has been indicated, and in the horizontal dimension it will be noted that the ear canal 10 extends inwardly and forwardly, and then slightly rearwardly in a reversely curved manner, with the size of the ear canal aperture decreasing at a point slightly in back of the tragus 11, and directly in front of the point of curvature 12 in the cartilage of the ear.

Considering the ear protector in relation to the shape and size of the ear canal, it is pointed out that the tubular body portion 1 is slightly curved in the manner illustrated in Figs. 3 and 5, to provide for the protector conforming to some extent to the reversely curved contour of the ear canal 10 indicated in Fig. 3. An immediate result of this design of the body portion is to avoid development of excessive pressures at isolated points on the ear canal lining.

In addition to its slight curvature and oval cross section, the body portion 1 has been thinned at two points corresponding to those points where

the ear canal aperture decreases, as described above. This thinned wall construction is particularly illustrated in Figs. 3 and 5, in which it will be observed that the protector has a forward wall portion adjacent its outer end, thinned at the point denoted by numeral 13, and at an opposite side the rear wall has been thinned at point 14. By this relatively thin wall construction at the two points noted, highly yieldable areas are provided at the particular points where most pressure may develop in the ear canal.

It is pointed out that most ear protecting devices have been subject to the difficulty that they cannot be maintained in the ear canal for any appreciable length of time without the occurrence of considerable discomfort, which soon increases to a point where removal of the ear protector is necessary. The occurrence of such discomfort may be attributed in part at least to the highly irregular formation of the ear canal, and to the fact that there has been a complete failure to design occluding devices with a contour conforming to that of the canal. The result is that the tender ear cartilage has been subjected to distortion, and in a short time reaches a state of fatigue which becomes painful.

It should be observed that the ear protector of the invention has been carefully designed to conform to the ear canal shape in several respects. The body portion 1 has been formed with an oval cross section (Fig. 6), corresponding to that of the outer ear canal. The body portion has been slightly curved to conform to deviation of the canal, as viewed in a horizontal dimension, and finally the walls of the body portion which engage against the constricted ear canal portions have been substantially varied in thickness, so that a minimum of pressure will occur at these areas. The effect of these features, both separately and in conjunction with one another, is to eliminate discomfort, and it has been found that the ear protector of the invention may be worn indefinitely, and in fact kept in place during both working and sleeping hours.

The function of the rounded head 4 is to act as a sealing member in the ear canal, and the skirt 5 is especially effective in securing an adequate seal without developing excessive pressures. The extended skirt portion presents an increased bearing area and hence there is a distribution of pressure which further acts to eliminate discomfort at the point of sealing. A common arrangement in earlier devices has been a sealing head with relatively sharp fins, which are forced against the tender skin lining of the ear canal more or less at right angles. In the case of the extended skirt 5, there is provided a gradually curved surface which is adapted to lie in tangential relation to the skin lining of the ear canal, thus avoiding localized areas of pressure.

When inserting the ear protector in the ear, it is necessary to properly position the various portions described, and for this purpose there has been provided a tab 16, which extends outwardly and affords a convenient surface to be held between the thumb and forefinger. The tab 16 is mounted upon a lip portion 17, irregularly extending around the outer extremity of the plug. This lip portion 17 is designed to bear against the hollow portion of the ear and to afford a safety member for preventing the ear protector from being advanced too far into the ear canal. Fig. 7 illustrates the correct position of the tab and lip portion 17 with relation to an ear 18. In this figure, it will also be noted that the thinned

wall portion 13 of the protector falls directly in back of the tragus 11. The tab 16 is equally useful in removing the ear protector from the ear canal.

It may be desired to modify the ear protector in respect to the particular type of acoustical and mechanical impedances which may be employed in carrying into effect the idea of a selective attenuating device. For example, the septum may be of a conical shape, or the stiffness element may be located at other points as at the mouth of the ear protector. A preferred type of material for use in making the ear protector is a synthetic rubber such as neoprene. Material such as other synthetic rubbers, plastics, and similar substances may be desired to be employed. It may also be desired to add mass to the ear protector as by increasing the thickness of the body or by inserting metal plug elements or in other ways. Various other changes may be resorted to.

A number of advantages are present in the ear protector described, a principal one being that by its use it is possible to maintain speech transmission in the presence of intense noise such as gun fire, airplane noise, and the like, and temporary deafening effects may be avoided with the ear drum being thus protected from rupture in some cases. The practical use of any device of an occluding nature is largely dependent upon whether it can be maintained in the ear without excess discomfort, and even without having to remove it infrequently. In these respects, outstanding comfort characteristics of the ear protector of the invention are of great advantage. In various other respects the ear protector offers advantages, for example, when made of a synthetic rubber compound such as neoprene, it is

both non-toxic and unaffected by ear secretions. Similarly, the lip and tab construction offer a positive and convenient means for inserting the ear protector and insuring that it is positioned in the correct manner. The device itself is adapted for use in either a right or left ear canal, and is characterized by durability and long life.

While I have shown a preferred embodiment of my invention, it should be understood that various changes and modifications may be made, in keeping with the spirit of the invention as defined by the appended claims.

Having thus described my invention, what I claim is:

1. An ear protector comprising, a thin-walled curved tubular body portion having an oval cross-section, said body portion being open at its outer end and closed at the opposite end by a relatively thick-walled curved septum, said body portion tapering inwardly to form a neck, a hollow rounded head supported on said neck, a thin resilient skirt of relatively large area extending in spaced relation about said neck, said skirt extending at such an angle as to make substantially tangential contact with the skin lining of the ear.

2. An ear protector comprising a curved tubular body portion having an oval cross-section, said body portion being open at its outer end and closed at the opposite end by a stiff curved septum, said body portion tapering inwardly to form a neck, a hollow rounded head supported on said neck, a thin resilient skirt of relatively large area extending in spaced relation about said neck, said skirt extending at such an angle as to make substantially tangential contact with the ear lining.

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