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FLUID FELLED EAR MUFFS

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to a fluid filled earmuff, and more particularly, to a fluid filled earmuff which may be worn as a protective measure against aerotitis caused by a pressure differential on the ear drum.

More precisely, aerotitis is an inflammation or distortion of the tympanic membrane, or ear drum, caused by the existence of a pressure differential between the middle and outer ear, and may occur during rapid ascent or descent through an air or water medium. In certain instances, the distortive effect may be extremely painful. While devices exist in the prior art for the purpose of equalizing the pressure between the middle and outer ear to mitigate aerotitis, the nature of these devices is such that their use is generally incompatible with instrumentalities or appliances to which the device is to be adapted.

Thus, it is one object of the present invention to provide a fluid filled earmuff which completely encloses the outer ear and maintains a substantially constant pressure-volume relationship in the region of the external auditory meatus, regardless of ambient pressure conditions.

Another object of the present invention is the provision of liquid filled ear muff which are characterized by a constant pressure-volume relationship such that distortive effects upon the tympanic membrane are precluded, irrespective of ambient pressure conditions.

Still another object is to provide ear muff with liquid filling and pressure regulating means operable to vary the pressure of the liquid and expel entrapped air therefrom.

A final object of the present invention is to provide a means for maintaining the ear muffs in a secure position about the head of the subject.

Other objects and advantages will become more fully apparent upon examination of the annexed description and attached drawings, wherein:

Fig. 1 is a sectional view of a preferred embodiment of a single ear muff taken on line 1—1 of Fig. 2.

Fig. 2 is an elevation view of a pair of the inventive ear muffs as worn by a subject, showing an exemplary type of headband which may be used for maintaining the ear muffs fixedly secured about the subject's head.

Fig. 3 is an elevation view of a pair of the inventive ear muffs as worn about the subject's head, showing a positive type of headband for maintaining absolute sealing and immobility of the ear muffs relative to the subject's head, and.

Fig. 4 is an enlarged elevation view of an ear muff, showing in cross-section the adjustable tightening means used with the embodiment illustrated in Fig. 3.

Referring now to the drawings wherein like reference numerals designate like or corresponding parts throughout the several views, there is shown in Fig. 1 a preferred embodiment of the ear muff assembly of the instant invention, generally designated by reference numeral 10. Casing 12, a cup-like member of metallic or other material having a rigid characteristic, is fixedly attached to sealing member 11 by conventional means such as bonding or rivets, not shown. The inside dimensions of casing 12 are such as to permit fully enclosing the auricle. Member 11 is a material such as rubber, or the like, capable of being deformed to accommodate the contour of the portion of the head embracing the subject's auricle.

In order to provide absolute sealing consonant with a high degree of required immobility of the casing 12 relative to the head, sealing member 11 may be shown especially to conform with the particular contour of the subject's head in the region of the external ear.

The liquid filling apparatus, generally designated by reference numeral 20 is threadably engaged into casing 12 at threaded aperture 13, as exemplarily shown in Fig. 1. Valve 24 is of a type preferably having two separate openings, which are aligned respectively with inlet pipe 22 and bleedler duct 23 in the open position of the valve.

Manually operated knob 21 controls valve 24. Duct 23 is fixedly attached by soldering, or the like, to the outside of pipe 22, and performs a bleeding function, allowing air entrapped within the liquid to be expelled during filling. Separate valves may be provided, of course, for independent control of the liquid supply and the bleeding functions. Apparatus 20 consisting of valves 24 and pipes 22 and 23, of course, may be entirely integrally formed.

The piston assembly, generally designated by reference numeral 30 on ear muff or earpiece 10, is threadably engaged into casing 12 via threaded aperture 16. Rotation of knob 15 in either direction causes shaft 14 and its attached piston 17 to respectively enter or be withdrawn from the inner confines of casing 12. An O ring 18 on piston 17 provides a water tight seal on cylinder 19. In this manner, not only may the liquid pressure be varied directly according to the particular requirements of an antiaircraft apparatus, but also, such means compensates for incremental changes in pressure and volume due to the softness characteristics of body tissue.

Referring now to Fig. 2, wherein said inventive ear muffs are attached and maintained secure about the external ear area of the subject's head, there is shown a relatively stiff leaf spring 41 connecting a pair of ear muff assemblies 10 by rivets 9, or the like. The resilient tendency of spring 41 is such as to cause ear muffs 10 to be forced inwardly toward the head, so that a positive seal may be effected between the sealing members 11 and the subject's head. In order to assure positive sealing consonant with a high degree of immobility of earpiece 10 relative to the head, leaf spring 41 may be
one of a plurality of such springs, each of which may be consecutively angularly disposed from the others in a fan-like arrangement.

Referring next to Fig. 3, there is shown an elevation view of the inventive ear muffs as worn about the subject's head, utilizing in this instance a rigid type of headband for maintaining absolute sealing consonant with requisite immobility of the ear muffs relative to the head of the wearer. The headband is comprised of an inflexible frame member 40, the extremities of which are threadably engageable with a translatable pressure rod 43, such that a pressure or pressure of the ear muffs may be utilized, as shown, on ear muffs 10 in lieu of assembly 29, disclosed in connection with Fig. 1. If desired, the entire ear muffs assembly portrayed in either Figs. 2 or 3, except for the pressure adjusting means in Fig. 3, may be enclosed in a resilient media, such as rubber, or the like, to provide absorption or cushioning of the ear muffs against accidental contact with foreign objects.

Fig. 4 illustrates in partial cross-section the adjustable tightening feature of the instant invention. Pressure transmitting rod 43 is threadably engaged with frame member 40. The shank portion 43A is slidable engaged for limited movement within an aperture 44A in the bracket member 44, which is fixedly secured in a conventional manner to the casing 12 of earpiece 10. A pressure plate 45 is attached to the end of the shank, as illustrated, to thereby transmit a tightening pressure to casing 12. Thus, the earpiece 10 and bracket member 44 are disposed for displacement relative to the rigid frame 40.

With the ear muffs 10 comfortably secured to the subject's head, filling of each ear muffs 10 with a liquid preferably having isotonic properties may be started. In practice, water in distilled or undistilled form is an excellent medium. Valve 24 is opened by rotation of knob 21, allowing liquid 50 to flow preferably under influence of gravity from a source such as a reservoir, not shown. The liquid thus enters the interior of the earpiece through pipe 23, filling the closed space formed by the casing, the tympanic membrane, and external auditory meatus of the subject.

Ambient air entrapped within earpiece 10 is expelled through pipe 23, during the filling process. To insure that ambient air is completely bled off from the interior of the ear muffs, including the region of the external auditory meatus, the subject should move his head occasionally during the filling operation. When all the entrapped air is expelled, as evidenced by a continuous efflux of the liquid medium from duct 23, valve 24 is closed, shutting off both the liquid supply and bleeder tube. If desired, the assembly 20 may be therupon removed and a plug 25 inserted, as shown in phantom in Fig. 1 and by solid line in Figs. 2 and 3.

A degree of adjustment is provided by piston assembly 30 for regulating the pressure of the liquid confined within the ear muffs. Rotation of knob 15 causes piston 17 to be withdrawn from the inner confines of casing 12 by the action of screw thread 16 on threaded shaft 14. The watertight seal provided by O ring 18 and cylinder wall 19 prevents the loss of any liquid 50 therethrough. Hence, in this manner the pressure may be adjusted in accordance with operational requirements of the subject without instrumentality and personal comfort of the subject. Piston assembly 30 also affords a feasible means for compensating for incremental changes in volume of the liquid due to softness characteristics in body tissue.

The principle of operation of the instant invention is based upon physical laws which relate to the behavior of incompressible fluids in a constant pressure-volume relationship. Consider the mechanism by which aerotitis is precluded in the instant invention when changes in ambient pressure occur. Assuming the liquid filled ear muffs to be securely in position about the head of the wearer, an increase in ambient pressure will be reflected through the subject's Eustachian tubes as an increase in pressure within the middle ear. The tympanic membrane or eardrum, would tend under normal conditions, to be displaced outwardly from the center of the head. However, due to the incompressible nature of the fluid occupied within the interior space formed by casing 12 of the ear muff, the external auditory meatus, and the tympanic membrane, no displacement or distortion effect of the tympanic membrane occurs. Now, consider the case when the ambient pressure falls to a level lower than that of the liquid within casing 12. The decrease in ambient pressure will be reflected through the Eustachian tube as a decrease in pressure within the middle ear, and the tympanic membrane in this instance would tend under normal conditions to be inwardly displaced toward the center of the head. However, the distortion effects upon the eardrum are again precluded under this condition, since the liquid within the interior confines of the ear muff assumes a pressure which acts oppositely on the tympanic membrane. The action is analogous to that observed when water filling a glass, is covered by a sheet of paper, is apparently supported by the paper when the glass is held upside down. Thus, in a similar manner, the presence of an incompressible fluid within the closed interior confined by the subject's tympanic membrane, the external auditory meatus, and the caging proper of the inventive ear muff, prevents displacement or distortion of the tympanic membrane when a decrease of ambient pressure occurs. Hence, irrespective of changes in ambient pressure, aerotitis and its painful consequences are prevented.

In summary, the instant invention presents a novel approach in obviating the limitations of the prior art. The principle upon which the instant invention is based resides in the applicability of physical laws embracing the constant pressure-volume relationship of an incompressible fluid. Thus, the instant invention not only precludes aerotitis and its painful consequences, but also, the incompressible fluid filled ear muffs are of a construction such that they are fully compatible for use in anti-blackout systems of contemporary design.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. For instance, a headphone device, not here-with shown, may be embodied within the casing of the ear muff assembly to permit speech communication with a wearer of the inventive device. Such a headphone may be entirely encapsulated so as to be water proof except for its diaphragm which transmits the auditory undulations through the liquid.

It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:
1. A headgear device of the type described adapted for holding a liquid comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members, a headband means having opposite ends thereof respectively attached to each of the cup-like members, a liquid inlet means for said cup-like members, and bleed means for expelling entrapped air from within each of said cup-like members in operable position of said headgear device.
2. A headgear device of the type described adapted for holding a liquid comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members, a headband means having opposite ends thereof respectively attached to each of the cup-like members, a liquid inlet means for said cup-like members, and bleed means for expelling entrapped air from within each of said cup-like members in operable position of said headgear device.
respectively attached to each of the cup-like members, liquid inlet means for said cup-like members, and pressure regulating means for adjusting pressure of said liquid.  

3. The headgear device of claim 2 in which the headband means includes at least one resilient spring member for supporting the headgear device.  

4. The headgear device of claim 2 in which the headband means includes a rigid frame member having extremities respectively attached in a threadable relation with each of the cup-like members.  

5. A headgear device of the type described adapted for holding a liquid medium comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members, a headband means having opposite ends thereof respectively attached to each of the cup-like members, liquid inlet means for said cup-like members, bleeder means for expelling entrapped air from within each of said cup-like members in operable position of said headgear device, and pressure regulating means for adjusting pressure of said liquid medium.  

6. A headgear device of the type described adapted for holding a liquid medium, comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members, a headband means having opposite ends thereof respectively attached to each of the cup-like members, liquid inlet and bleeder means for each of said cup-like members including a commonly operated valve for controlling entry of the liquid medium and expelling entrapped air from the cup-like members in operable position of the headgear device, means for adjusting pressure of the liquid medium.  

7. A headgear device of the type described adapted for holding a liquid medium for protecting the tympanic membrane in a living subject having an external auditory meatus comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members contiguous with a portion of the face of said subject embracing the external auditory meatus, headband means having opposite ends thereof respectively attached to each of the cup-like members, liquid inlet means for operably filling the interior closed space of said headgear device for holding a liquid medium comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members, a headband means having opposite ends thereof respectively attached to each of the cup-like members, liquid inlet means for operably filling the interior closed space of said headgear device, and pressure regulating means for adjusting pressure of said liquid medium.  

8. A headgear device for protecting the tympanic membrane in a living subject having an external auditory meatus against distortive effects due to the rapid changes in ambient pressure comprising, a pair of cup-like members each having a bordering edge, sealing means attached to the bordering edge of each of the cup-like members adapted in use to be contiguous with a portion of the face of said subject embracing the external auditory meatus, headband means having opposite ends thereof respectively attached to each of the cup-like members, fluid inlet means for said cup-like members, the interior closed space of said headgear device adapted in use by each of the cup-like members, the external auditory meatus, and tympanic membrane of said subject adapted to be filled with a liquid fluid, bleeder means operable to expel entrapped air from said interior closed space, and pressure regulating means for adjusting the pressure of said liquid fluid when said headgear device is in use.  

9. A headgear device adapted for holding a fluid for protecting the tympanic membrane in a living subject having auricles and external auditory meatus associated therewith comprising, a pair of cup-like casing members each having a bordering edge and shaped generally to fully enclose each of the auricles of said subject, sealing means attached to the bordering edge of each of the cup-like members adapted in use to be contiguous with a portion of the face of said subject embracing each of the auricles, headband means having opposite ends thereof respectively attached to each of the cup-like members, fluid inlet means for operably filling the interior closed space of said headgear device formed in use by the cup-like members, the external auditory meatus, and tympanic membrane of said subject, and pressure regulating means for adjusting pressure of said fluid when said headgear device is in use.  

References Cited in the file of this patent  

UNITED STATES PATENTS  

989,839 Fowler Apr. 18, 1911  

2,899,683 Wadsworth et al. Aug. 18, 1959  

FOREIGN PATENTS  

467,298 Germany Aug. 27, 1927  

565,986 Germany Dec. 9, 1932  

792,059 Great Britain Mar. 19, 1938