United States Patent

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[54] **ACOUSTICAL EAR MUFF WITH CONE-TYPE CUSHIONS**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **2/209**
[51] **Int. Cl.** **A41d 21/00**
[50] **Field of Search** 2/209, 174, 3; 128/152; 181/23

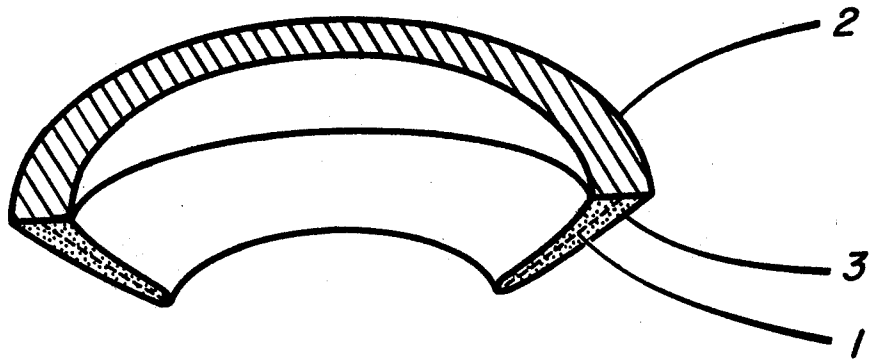
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ABSTRACT: This disclosure deals with a novel acoustical ear muff and the like employing a novel cushion that provides a soft and compliant seal, conforming readily to the irregular contour of the head even when that contour varies with time, as when the wearer is talking or chewing; but, when firmly sealed to the head around the entire periphery of the cushion, the cushion then presents a high stiffness against alternating forces induced by an incident sound field, thus minimizing any resulting change in enclosed volume of the ear muff and consequently minimizing the sound pressure developed at the ear.



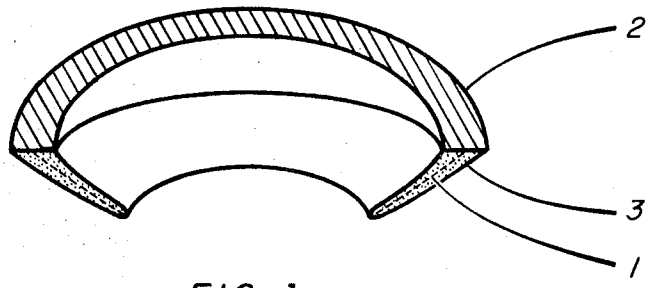


FIG. 1

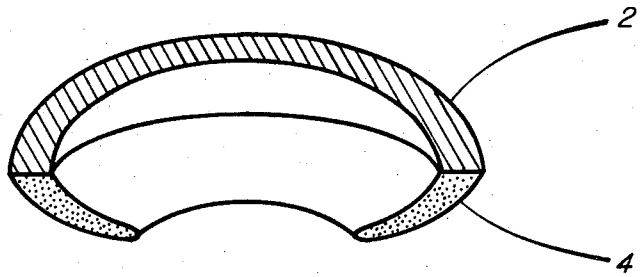


FIG. 2

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ACOUSTICAL EAR MUFF WITH CONE-TYPE CUSHIONS

The present invention relates to acoustical ear muffs or muffler devices and, more particularly, to ear protectors that are employed to protect the hearing of the wearer against the damage of external noise.

While the art is replete with ear muffs and earphones of various types (all hereinafter generally referred to as ear muffs), there has previously not been a satisfactory solution to the problem of providing a sound-protecting ear muff or the like that has sufficient softness to permit ready and comfortable compliance with the head but that obviates the necessity for sizable pressure of the muff against the head, while adequately muffling both the low and high audible frequency sounds. While ear muffs have been provided with soft compliant cushions, the very softness of the cushion against the head inherently produces a yielding in response to low frequency sounds that, in turn, vibrates the hard shell associated with the muff and creates sound pressure therewithin. This renders the wearer subject to the effects of low frequency sounds. Attempts to overcome this problem have involved increasing the volume contained within the ear muff; but this forbids the use of such devices under helmets, or in other restricted applications. Other attempts to solve this problem have been to increase the pressure of he muff against the head; but this prevents the continual comfortable use of the muff over long periods of time. In addition, prior art muffs have employed relatively thick cushions which require a large central opening in order to admit the pinna of the ear. This construction, however, is difficult to seal against the irregular contour of the head in the region surrounding the ear, and, in addition, leaves a relatively large unsupported central area that tends to allow pumping of air within the shell of the muff.

In my copending application, Ser. No. 664,154, now U.S. Pat. No. 3,479,669 filed Aug. 29, 1967 for Acoustical Ear Muff and the Like, a satisfactory solution for many aspects of this problem is proposed involving two sets of rigid members frictionally engaged to slide laterally with respect to one another but otherwise rigidly resistent to deformation, and with the resilient cushion formed by such members being yieldingly perimetrically conformable in response to forces in excess of the friction of said slide, but rigid against deformation produced by low frequency external sounds and the like. In such a device, sound pressures which do not exceed the friction and do not cause sliding between such members leave the cushion substantially rigid and nondeformable. The cushion motion then is restricted to the motion permitted by the resilience of the flesh underneath the cushion between the cushion and the bone of the head.

There are applications, however, where, for purposes of simplicity, economy and for other reasons, it is not desirable to employ two sets of frictionally slidable devices in the cushion. It is to the problem of providing the desired results in a unitary structure void of the necessity of such sets of frictionally slidable members that the present invention is, accordingly, primarily directed.

An object of the invention, therefore, is to provide a new and improved acoustical ear muff and the like that, in a unitary, nonsliding part structure enables soft compliance with the head while providing each of minimal volume, minimal unsupported area and minimal force against the head, while simultaneously overcoming the problem of muffling the low frequency sounds (as well as the high frequency sounds) and, additionally, brings the pressure point of the muff very close to the ear and in intimate engagement with the head close to the base of the pinna of the ear.

A further object is to provide a novel ear muffler device.

Other and further objects will be explained hereinafter and are more particularly set forth in the appended claims. In summary, however, the invention provides a frustoconical cushion member constrained at its larger end by a hard shell and free to deflect at its smaller end to accommodate to the head around the ear of a wearer, and with certain critical elastic properties. Preferred details are hereinafter set forth.

The invention shall now be described with reference to the accompanying drawing:

FIG. 1 of which is an oblique section of an ear muff constructed in accordance with the invention; and

FIG. 2 is a similar view of a preferred embodiment.

Referring to FIG. 1, the muff is shown comprising what is shown as a lower relatively rigid, frustoconical annular member 1, as of resin-bonded fiberglass cloth or similar material having the property that, while flexible enough normal to its surface to permit adaptation to the contour of the head around the base of the ear, is substantially inextensible and will not stretch or substantially give in the radial or circumferential directions. The frustoconical member 1 is shown embedded in a rubberlike or elastomeric covering 3 that provides a resilient spring force urging the frustoconical member 1 to tend to maintain its desired frustoconical shape even when applied to the base of the ear.

Secured to the outer periphery or larger end of the member 1—3 (shown above), as by cement or otherwise, is a hard shell somewhat ellipsoidal member 2, as of rigid plastic or the like having the property of high vibration loss factor at acoustic frequencies, such as rigid polycarbonate plastic and the like.

This form of the conical cushion provides dual stiffness by the use of the frustoconical member 1—3 which is free to deform in a direction perpendicular to its surface but which is substantially inextensible in any direction along its surface. The small end of the conical member 1—3 (shown at the bottom) fits around the ear and presses against the head, close to the base of the pinna of the ear; and a slight pressure causes the normally oval-shaped perimeter of the opening to alter its shape so as to fit against the head by changing only the angle of the elements of the conical member 1—3 relative to the plane that is fixed by the rim of the hard shell member 2 against which the outer or larger end is firmly held in airtight, unitary contact, as before explained. When the shape of the frustoconical member 1—3 has been distorted so as to fit against the head along the entire perimeter of the conical opening, no further distortion can readily take place since the conical surface itself is, as previously described, substantially inextensible. The cushion then becomes extremely rigid toward any alternating forces caused by incident sound waves and the enclosed volume is held substantially constant.

In the embodiment of FIG. 2, the frustoconical cushion 4 provides the same type of dual stiffness as the cushion 1—3 by use of a viscoelastic material which has a time constant such that it is free to deform elastically at low frequencies, below approximately 5 Hz. and thus can accommodate easily and rapidly to the irregular head contour even though that contour may continually change with the wearer's movements. The viscoelastic material 4 is designed, however, to have time constant short compared to the period of vibration, so as to be substantially rigid against rapidly alternating forces, such as those induced by incident sounds at frequencies of 50 Hz. and higher. The same rigid member 2 is securely bonded to the larger end of the cushion 4, as in the embodiment of FIG. 1. Suitable viscoelastic materials that possess these necessary properties include, for normal ambient temperatures, a high damping viscoelastic core (such as the Lord Manufacturing Company "HD" Elastomer) covered by silicone rubber; whereas, for a wide temperature range of operation, a solid frustoconical cushion of, for example, the Lord Manufacturing Company BTR damping elastomer has the necessary properties. Improvement of at least the order of 10 d. in greater muffling of the low audio frequency sounds has been produced with such structures with substantially the same high frequency sound attenuation of the best present day mufflers.

The frustoconical members 1—3 (FIG. 1) are substantially inextensible in all directions along their surfaces, but may bend freely in the curved direction of the cone while being constrained always to remain substantially rigid in the direction along the elements of the cone. Such elements at the larger end of the frustoconical member are held firmly restrained against the peripheral surface of the hard shell 2

while the same elements at the small end of said conical member are free to deflect in a direction perpendicular to the surface of said cone so as to accommodate to the shape of the head around the ear of the wearer, but with such deflection being accompanied by a change in the angle of the elements relative to the axial direction of said cone. The elastic portion of the cushion, either as part of said frustoconical member 1 or as a separate member 3 intimately connected with said frustoconical member 1, provides a restoring force tending to maintain the frustoconical member in its initial shape, such restoring force being sufficient in magnitude to prevent buckling or collapse of the cushion under the normal biasing force used to hold the ear enclosure against the head of the wearer. The elastic member also provides a smooth pressure pad around the rim of the small end of said frustoconical member for the purpose of comfortably sealing and supporting such cushion on the head of the wearer.

Further modifications will also occur to those skilled in this art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

I claim:

1. An acoustical ear muff having, in combination, a hard shell, a frustoconical cushion member the larger end of which is intimately connected with and restrained by said hard shell, the cushion member being free to deflect at its smaller end in a direction normal to the surface of the cone thereof to accommodate to the shape of the head around the ear of the wearer and having elastic restoring means tending to maintain such frustoconical shape, said restoring means comprising a viscoelastic material of time constant that enables rapid accommodation of changes in shape of the surface of the head of the wearer, as during talking, chewing and the like at frequencies under approximately 5 Hz. but said time constant being short compared with the period of vibratory forces impressed on the cushion member by sound waves of audible frequencies above approximately 50 Hz. incident upon the muff.

2. An acoustical ear muff as claimed in claim 1 and in which said hard shell is generally ellipsoidal and has high vibration loss factor at acoustic frequencies.