Aug. 6, 1957 E. A. G. SHAW ET AL 2,801,423

EAR DEFENDER

Original Filed May 20, 1954

Fig. 1.

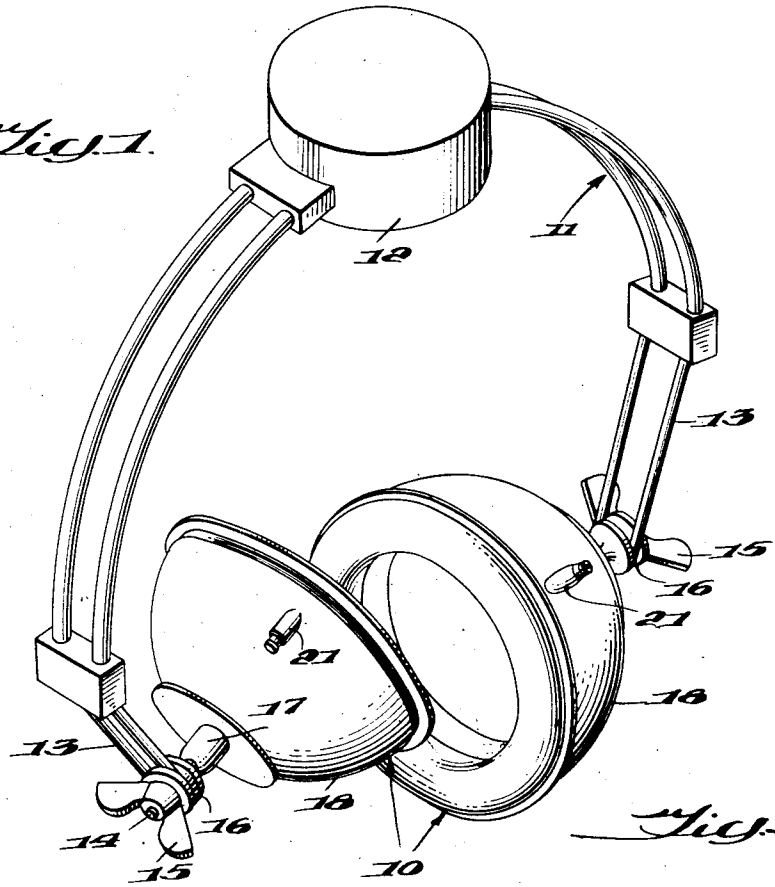
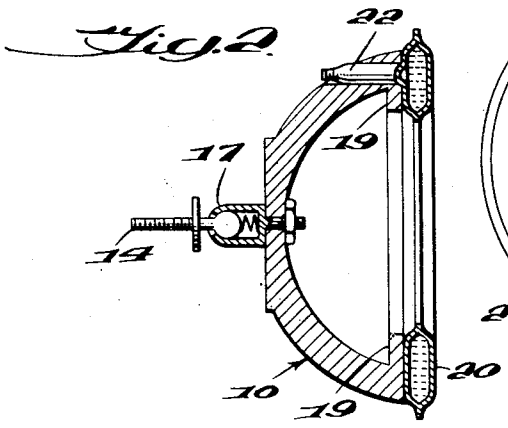
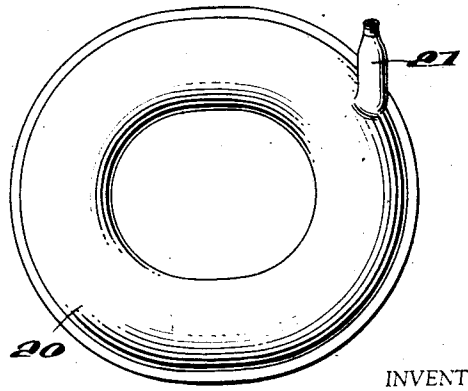


Fig. 3.

Fig. 2.





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EAR DEFENDER

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Continuation of application Serial No. 431,174, May 20, 1954. This application June 5, 1956, Serial No. 589,549

6 Claims. (Cl. 2—209)

The present invention relates to ear defenders, that is, devices which minimize the intensity of noise reaching the ear. The present application is a continuation of application, Serial No. 431,174, filed May 20, 1954, now abandoned.

As a result of a recent study it has been found that deafness has been caused to a large extent by exposure to low-frequency sounds. For example, continued exposure to sounds of from 400 to 600 C. P. S. does not, as one would expect, produce deafness in that region, but, surprisingly enough, tends to produce deafness in the 800 to 1200 C. P. S. region due to a frequency doubling effect. Thus, it is of primary importance to provide adequate means for producing the sound intensities of the low-frequency sounds. Prior art devices have not proved effective for this purpose.

Prior art devices have generally taken two forms, namely, ear plugs and ear covers. Ear plugs comprise wads of cotton, or wax, or a mixture of cotton and wax, which fit within the ear canal. It is apparent that the plugs must be highly malleable in order to provide an effective seal and sounds tend to cause the plug to move as a whole due to the softness of the ear canal. Furthermore, sounds may also bypass the plug and enter the ear through the soft tissue around the ear and the outer ear tissue itself. Thus, ear plugs have not proved to be the answer to this particular problem.

In connection with ear defenders of the ear cover type, there arises certain special problems. It can be readily appreciated that an effective seal must be provided between the ear cover and the head in order to prevent passage of the sound waves directly through an air space from the outside to the inside of the ear cover. It is also possible that sound waves, particularly lower frequency sound waves, will cause the ear cover to vibrate as a whole thus transmitting the sound waves to the air within the ear cover. In order to avoid this possibility, it is necessary to construct the cover of rigid material and yet in order to provide an effective seal between the ear cover and the head it is most desirable to use a material which will readily adjust itself to changes in contour of the head. The prior art found no way to resolve these conflicting requirements and thus ear covers used heretofore either were of a rigid character preventing vibration of the cover as a whole and yet not providing an effective seal between the cover and the head or prior art ear covers comprised a rigid cover with a soft cushion on the periphery so that an effective seal was provided between the head and the cover but sound waves were transmitted to the ear through vibration of the entire cover.

The present invention provides an ear cover which insures an excellent seal between the cover and the head and yet prevents vibration of the ear cover as a whole. This is accomplished by making the cup-shaped ear cover of a rigid material and by providing a cushion of readily deformable material which has a high spring

constant. Thus, the readily deformable material adapts itself to the contours of the head so as to provide a completely effective seal and yet this same material is non-compressible when in position on the head and will not permit substantial vibration of the ear cover as a whole. The cushion comprises a covering of pliable or flexible but non-elastic material which forms a chamber around the periphery of the rigid cup. This chamber is substantially gas evacuated and partly filled with a liquid. As the ear cover is pressed against the head the liquid within the covering permits the cushion to form exactly to the shape of the head. However, the ear cover as a whole is comparatively rigid when in position on the head due to the incompressibility of the liquid and due to the non-elastic character of the covering. Thus, the cover is prevented from vibrating as a whole and yet an effective seal is provided between the cover and the head.

An object of the present invention is to provide an ear cover which is more effective in attenuating sound waves than prior art structures and which is of particular value in attenuating the lower frequency sounds.

Another object of the present invention is to provide an ear cover in which an effective seal is provided between the cover and the head and yet in which the ear cover as a whole is prevented from vibrating.

Still another object of the present invention is to provide an ear defender of the ear cover type having a cup-like member of rigid material with a cushion disposed on the rim thereof, the cushion comprising a pliable covering forming a chamber with a partial filling of a liquid.

Other objects and many of the attendant advantages of the present invention will become apparent upon consideration of the following detailed specification when considered in connection with the accompanying drawing wherein:

Fig. 1 illustrates a pair of ear defenders according to the invention connected to a suitable frame;

Fig. 2 is a section through one of the ear defenders shown in Fig. 1; and

Fig. 3 is a view in perspective of the cushion of one of the ear defenders of Figs. 1 and 2 illustrating the filling nipple.

In order to fully appreciate the character of the invention and comprehend the properties of the materials used in connection with the invention, it is believed advisable to define certain terms.

The phrase "rigid body" refers to a body which is unyielding and which is not readily changed in shape.

The phrase "spring constant" may be defined as the ratio of the increment of applied force to the corresponding increment of displacement. When a periodic force is applied to an ear defender cup in a direction perpendicular to the surface with which the cushion engages, the resulting periodic displacement causes a periodic variation in air pressure inside the cup and a periodic variation in compression of the cushion. The force attributable to air pressure variation serves to define the spring constant of the air cavity while the force attributable to the variation in cushion compression serves to define the spring constant of the cushion.

The word "pliable" or "flexible" serves to define the characteristic of a material whereby it is readily deformable. This is distinguished from the elastic or stretchable characteristics of a material.

Referring to Fig. 1 a pair of ear defenders **10** according to the invention are mounted at opposite ends of a resilient frame **11** having a central head pad **12** which may be of sponge rubber. A wire loop **13** is provided at each end of the frame and a threaded stub **14** passes through this wire loop and carries a wing nut **15** for

tightening the wire loop **13** against a washer **16** which bears against the shoulder of a ball joint **17** secured to the cup **18** of the ear defender.

The cup **18** is made of a comparatively rigid material such as, for example, wood or a correspondingly hard plastic substance or a light metal such as aluminum. As shown in Fig. 2 the rim of the cup is widened as at **19** to provide a backing for the cushion **20**. Cushion **20** is secured to the rim by any suitable means and it will be noted that the width of the rim is approximately equal to the radial width of the cushion **20**. The cushion **20** as shown in Fig. 3 is provided with a nipple **21** to provide a means for filling the cushion and the nipple **21** fits within an aperture **22** formed in the cup **18**.

The cushion **20** comprises a covering which in the illustrated embodiment is in the form of an endless tube of pliable or flexible but non-elastic material. A suitable material which may be used is plasticized polyvinyl chloride resin. As pliability is of primary importance it is essential that the covering be of a thin material.

The tube is substantially evacuated to provide a substantially gas-free chamber and is then partially filled with a liquid. It is preferred that the tube be filled to over one quarter of its full cross-section but substantially less than the full cross-section thereof. Any desired liquid may be used as a filling.

It will be appreciated that normally the liquid will all be disposed at the lowermost point in the tube leaving the remainder of the tube empty. In the Fig. 2 showing the cushion is illustrated as it would appear when pressed against the head, that is, with liquid disposed around the entire tube.

The ear defender disclosed herein provides a cushion **20** which is readily deformable so as to conform to the contours of the head. There must be sufficient liquid in the tube so that liquid will be disposed around the entire periphery of the cup in order to insure an effective seal. However, it is equally important that the tube not be overfilled since in that case there is a likelihood of an ineffective seal due to the inelasticity of the covering material. Once the ear defender is in position over the ear it is comparatively rigid and thus the ear cover is not likely to vibrate as a whole. The cushion preferably has a high dynamic Young's modulus of about 5×10^3 p. s. i. for a thickness of from about 0.005 to about 0.01 inch.

Preferably the tube has little or no gas trapped therein. It is apparent that the presence of any substantial quantity of gas within the chamber would introduce an elastic element in the system. Thus, the ear cover would tend to vibrate as a whole to transmit the sound waves to the air cavity within.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. What is claimed as new and desired to be secured by Letters Patent is:

1. A circumaural ear defender comprising a highly rigid non-porous cup and means disposed on the rim of the cup forming a non-porous, readily deformable cushion of high spring constant, said cushion means including a flexible substantially non-extensible covering, said

covering defining a chamber containing a partial filling of a non-gaseous fluid material, said cushion readily conforming to the shape of the head surrounding the ear when pressed thereagainst, the high spring constant of the cushion preventing substantial vibration of the defender in response to acoustic pressure variation.

2. A circumaural ear defender adapted to be pressed against the head and cover the ear comprising a highly rigid, substantially non-porous cup having a rim, a cushion of high spring constant disposed on the rim of the cup, said cushion including a highly flexible substantially non-extensible covering forming a chamber, said chamber being substantially free of gas and a partial filling in said chamber of a non-gaseous fluid material, said filling extending around the entire rim of the cup when the ear defender is pressed against the head to cause the cushion to conform to the shape of the head surrounding the ear, the cushion being adapted to form a non-porous barrier between the head and the non-porous cup, the high spring consant of the cushion substantially preventing vibration of the ear defender in response to sound waves.

3. A circumaural ear defender adapted to be pressed against the head and cover the ear comprising a highly rigid, substantially non-porous cup having a substantially continuous flanged rim, a cushion extending around the defender and supported on the flanged rim of the cup, said cushion including a highly flexible substantially non-extensible covering forming a chamber, said chamber being substantially free of gas, and a partial filling in said chamber of a non-gaseous fluid material, said filling extending around the entire flanged rim of the cup when the ear defender is pressed against the head to cause the cushion to conform to the shape of the head surrounding the ear, when in contact with the head, the cushion forming a non-porous barrier having a high spring constant to substantially prevent vibration of the ear defender in response to sound waves.

4. An ear defender according to claim 3 in which the cushion has a dynamic Young's modulus of about 5×10^3 p. s. i.

5. An ear defender according to claim 2 in which the cushion has a wall thickness of from about 0.005 to about 0.01 inch.

6. An ear defender according to claim 3 in which the covering is formed of a plasticized polyvinyl chloride resin.

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