April 14, 1970 S. L. HARVEY ET AL 3,505,999

EARPLUG

Filed Aug. 25, 1967

Fig.1.

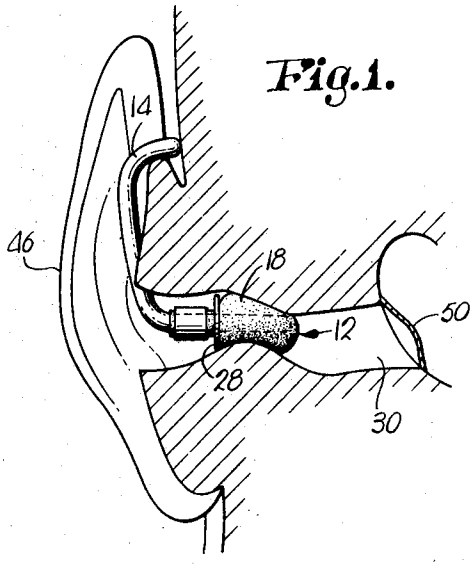


Fig.4.

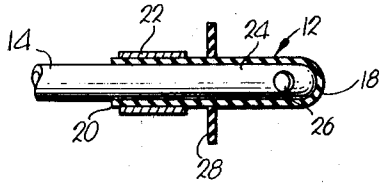
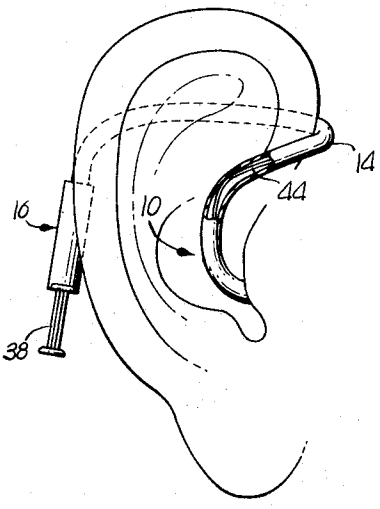


Fig.2.



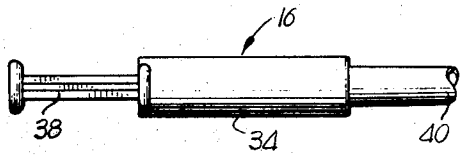


Fig.5.

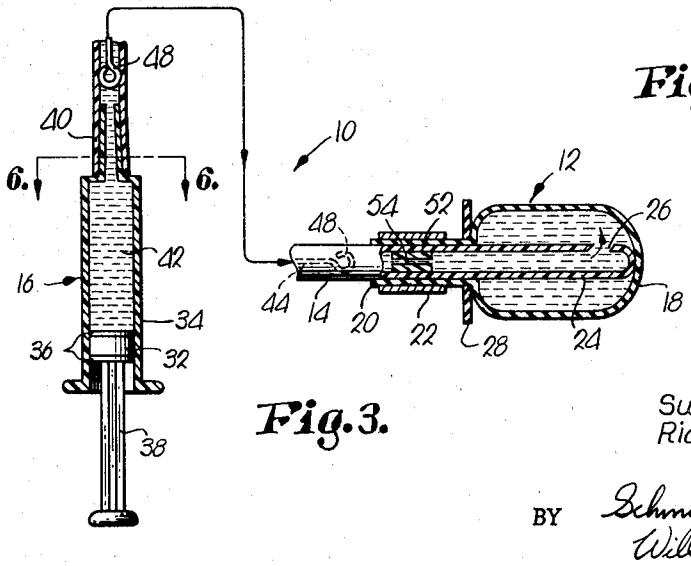
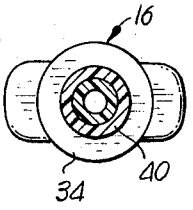


Fig.3.

Fig.6.



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EARPLUG

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U.S. Cl. 128—152 9 Claims

ABSTRACT OF THE DISCLOSURE

An earplug having a flexible, expandable bag adapted for expansion within the auditory canal of the ear, the bag having a relatively rigid tube extending thereinto for delivering fluid from a pump, in communication therewith, to effect expansion of the bag upon actuation of the pump. The tube, being relatively rigid, aids in insertion of the bag into the auditory canal and a disc-like stop surrounds the tube externally thereof and rearwardly of the bag to limit the extent of insertion of the tube and bag into the ear. A bendable element extends along the tube for shaping the same to fit over the external ear whereby the earplug may be supported by the external ear.

This invention relates to an ear-protecting device and, more particularly, to an earplug adapted for insertion into the user's ear to give effective protection against industrial noises and the like.

It is the primary object of this invention to provide an earplug having a greater efficiency than those heretofore known and conventionally used in industrial plants and the like for protecting the user against noises arising in such plants. Particularly, it is an important object of this invention to provide an earplug assembly which is relatively small in size and which is much more adaptable for convenient use than are the conventional "earmuff" type headgear silencing assemblies now normally utilized in industries.

It is yet another object of this invention to provide an earplug having flexible structure, in the nature of a bag, which is capable of being individually contoured for precise fitting within the auditory canal of the user's ear, there being a relatively rigid tube associated with said bag for aiding in the insertion thereof into the user's ear.

The present invention has been tested under laboratory conditions and it has been found that it is equal to any "earmuff" type headgear silencing assembly such as normally conventionally used and is also superior in performance to insert type earplugs also now used in industry. Thus there is provided a relatively compact, individually fittable earplug which is effective in its protection against industrial noises and the like, thereby permitting widespread use thereof.

Other objects include details of construction which will become apparent from the following specification and accompanying drawing, wherein:

FIGURE 1 is a cross-sectional view of an ear showing the earplug inserted therein;

FIG. 2 is a side elevational view thereof, portions being broken away to reveal details of construction;

FIG. 3 is a fragmentary, enlarged, partially schematic, cross-sectional view of the earplug assembly;

FIG. 4 is a fragmentary, cross-sectional view of the bag portion of the assembly;

FIG. 5 is a side elevational view of a pump for the assembly; and

FIG. 6 is a cross-sectional view taken along line 6—6 of FIG. 3.

The earplug assembly **10** has, as its major components, a flexible, expandable bag **12**; a relatively rigid tube **14**; and a fluid pump **16**. The bag **12** is intended for insertion into the auditory canal of the user of the earplug **10** and is provided with a closed end **18** and an open end **20**, the bag **12** initially assuming the flattened condition such as shown in FIG. 4 wherein the bag is shaped over the end of tube **14**.

Bag **12** is secured, at its free end **20**, to tube **14**, intermediate the ends of the latter, by a collar **22**, which collar tightly secures the free end **20** of the bag to the tube **14**, thereby preventing leakage of fluid from the bag during use of the assembly **10** as will hereinafter be described.

The tube **14** has one end **24** thereof extending well into the bag **12** and normally in contact with the end **18** thereof, both when the bag is in a collapsed condition as shown in FIG. 4 and when the bag is in an expanded condition as shown in FIG. 3. The free end **24** of the tube **14** is provided with a suitable orifice **26**, which orifice **26** is confined within the interior of the bag **12**, that is between the collar **22** and the end **18** of the bag.

Disposed in surrounding relationship to the tube **14** and a portion of bag **12** between collar **22** and end **18**, is a disc-like stop member **28**, which member limits the insertion of the bag **12** into the auditory canal **30** of the user, in the manner best shown in FIG. 1 of the drawing.

The opposite end of tube **14** is in communication with a pump **16**, which pump includes a piston **32** slidable within an elongated cylinder **34**, there being a pair of O-rings **36** providing a tight fit between the piston **32** and the interior wall of the cylinder **34**. The pump **16** is operable by means of a plunger **38** whereby the piston **32** may be reciprocated longitudinally of the cylinder **34**.

A suitable sealing attachment is made between the end **40** of tube **14** which is in communication with pump **16** so that there is provided a closed fluid system in the earplug assembly **10**. The fluid **42** is preferably in the form of a liquid, such as water, and a reservoir thereof is initially provided within the cylinder **34** prior to insertion of the bag **12** within the auditory canal **30** of the user, the bag being initially inserted in its deflated condition as shown in FIG. 4 of the drawing.

In order that the earplug assembly **10** may be comfortably and conveniently carried by the user thereof, an elongated wire **44** extends essentially from one end **24** of tube **14** to the other end **40** thereof, whereby to permit shaping of the tube **14** so that the same may be conformed over the external ear **46** of the user in the manner shown, for instance, in FIGS. 1 and 2. The wire **44** is provided with loops **48** at each end thereof to prevent puncturing of the tube **14** or the bag **12** during use of earplug assembly **10**.

In using the earplug assembly **10**, the bag **12** is inserted into the auditory canal of the user until such time as the stop member **28** engages the walls of the canal to preclude further insertion of the deflated bag **12** and the end **24** of tube **14** which extends thereinto. It will be recognized that the rigidity of tube **14**, which is normally formed from a flexible plastic material, facilitates insertion of the bag **12** inasmuch as it would be difficult to properly position a flexible member such as bag **12** within the relatively small auditory canal **30** without the aid of a somewhat rigid element. The use of stop member **28** is desirable to prevent over-insertion of the bag **12** and tube end **24** and to prevent puncturing of an eardrum, such as eardrum **50**, due to penetration of the bag **12** and tube end **24**.

Once the bag **12** has been positioned in the auditory canal **30** of the user, the plunger **38** is actuated whereby to move from the position shown in FIG. 3 to a depressed condition, thereby forcing the fluid **42** from the cylinder

34, through hollow tube 14, and through a restrictor 52 positioned therein, the restrictor 52 having a passage 54 therethrough of smaller diameter than the inside diameter of tube 14 whereby to maintain the flow of fluid in and out of bag 12 at a predetermined rate. The fluid leaves tube 14 by way of orifice 26 and passes into the interior of bag 12, thereby causing expansion of the bag. It will be readily recognized that, since the bag 12 is within the auditory canal of the user, the maximum expansion thereof will be limited by contact of the exterior of the bag with the walls of the user's auditory canal. Thus, when the bag is expanded, a plug is effected in the auditory canal.

Such a plug is easily maintained inasmuch as the O-rings 36 of piston 32 are in sufficiently tight frictional engagement with the interior wall of the cylinder 34, that when the piston 32 is moved to a depressed position to force fluid into the bag 12, the contact between the O-rings 36 and the interior wall of cylinder 34 will maintain the piston in such depressed condition. The plug is also maintained by virtue of the valving effect of restrictor 52 and the reduced size of its passage 54.

After the bag 12 in inflated, thereby effecting the plug, the tube 14 and its associated wire 44 can be conformed, as illustrated in FIGS. 1 and 2, so that the wire and the tube extend out of the auditory canal and up and over the external ear of the user as is clearly shown in FIG. 2 of the drawing. The device then may be readily utilized and will be comfortably and conveniently maintained on the ear of the user until such time as it is desired to remove the plug effected by expanded bag 12.

When this is desired, the plunger 38 may be shifted in the opposite direction, moving the same away from the bottom of cylinder 34 to thereby create a slight suction or vacuum, thereby causing the removal of fluid from the tube 14 and thereby from the bag 12 to cause deflation of the bag 12 for ease in removing the bag from the ear of the user. It is, of course, apparent that the deflated bag may be readily removed by merely grasping tube 14 adjacent collar 22 and merely withdrawing the same from the ear of the user.

It will be readily appreciated that the extent of plug effected by use of earplug assembly 10 may be individually and selectively controlled by the user inasmuch as the bag 12 may be expanded to the extent desired through selective operation of the pump 16 by the user.

In the ear-protection field a commonly used standard is that emanating from the British Study of Rice & Coles, made in 1966 which established the arbitrary value of V51R as equivalent to certain insert, rigid, plug-type protection devices. Standard earplugs with this range are made by American Optical Company and the Wilson Division of Ray-O-Vac, but a person working in an area where exceedingly noisy machines or jet engines are operating is often not adequately protected by the V51R plug. Hence, it has frequently been necessary to utilize a headgear arrangement wherein specially constructed earmuffs are provided to protect against the noises.

Our invention, by its unique individual fitting into the person's ear, is 40% more effective through the speech range than the V51R plug, thereby presenting an ear protection device which is substantially as effective as the bulky earmuff arrangements. The present device is, of course, advantageous in that it is relatively small and easy to operate, thereby obviating the need for bulky and relatively expensive earmuff assemblies.

Thus, there is provided an earplug assembly which is economical in construction, light in weight and not bulky in use, as is desirable, and yet which provides a most effective sound barrier when properly inserted within the ear of the user.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. An earplug comprising:
a tube having a fluid outlet at one end thereof;
a fluid-impervious bag for insertion in the ear and in communication with said outlet, the bag being flexible for ballooning tightly in the ear when fluid is forced thereinto through the tube under pressure; and
structure coupled with the tube for forcing fluid into the bag, said structure including a piston and cylinder assembly.

2. The invention of claim 1,
said bag having a pair of opposed ends,
said tube extending into one end of the bag with said end of the tube terminating adjacent the opposite end of the bag placing the latter in surrounding relationship to a portion of the tube.

3. The invention of claim 2,
said outlet being in the side of the tube spaced from said one end of the latter.

4. The invention of claim 2,
the rigidity of the tube being substantially greater than that of the bag to facilitate insertion into the ear.

5. The invenion of claim 1, and
a stop on the tube for limiting the extent of insertion thereof into the ear.

6. The invention of claim 1,
said tube having a bendable element therein for shaping the same to fit over the external ear.

7. The invention of claim 1,
the piston of said assembly having means thereon frictionally engaging the cylinder for maintaining the pressure of the fluid in the bag.

8. The invention of claim 4, and
a stop of the tube for limiting the extent of insertion thereof into the ear.

9. The invention of claim 3,
said bag being resilient and the opposite end thereof being drawn against said one end of the tube, said one end of the bag affixed to said tube to maintain said bag in a stretched position.

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