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Parkins et al.

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(54) **EARTIP WITH TETHER**

(75) Inventors: **John W. Parkins**, Ithaca, NY (US); **Mark DeWilde**, Ithaca, NY (US)

(73) Assignee: **Red Tail Hawk Corporation**, Ithaca, NY (US)

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Related U.S. Application Data

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(51) **Int. Cl.**
H04R 25/00 (2006.01)

(52) **U.S. Cl.**
USPC **381/380**; 381/328; 381/329

(58) **Field of Classification Search**
USPC 381/322, 324, 325, 326, 328, 329, 381/380, 382; 181/129, 130, 135; 128/864, 128/867
See application file for complete search history.

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Primary Examiner — Huyen D Le
(74) *Attorney, Agent, or Firm* — Brown & Michaels, PC

(57) **ABSTRACT**

An eartip made of a resilient body with an eartip core inside the open center of the body, and a tether attached to the eartip core at an attachment region along the length of the core. A free end of the tether extends outward from the eartip, allowing a wearer to remove the eartip from their ear by pulling on the tether.

20 Claims, 5 Drawing Sheets

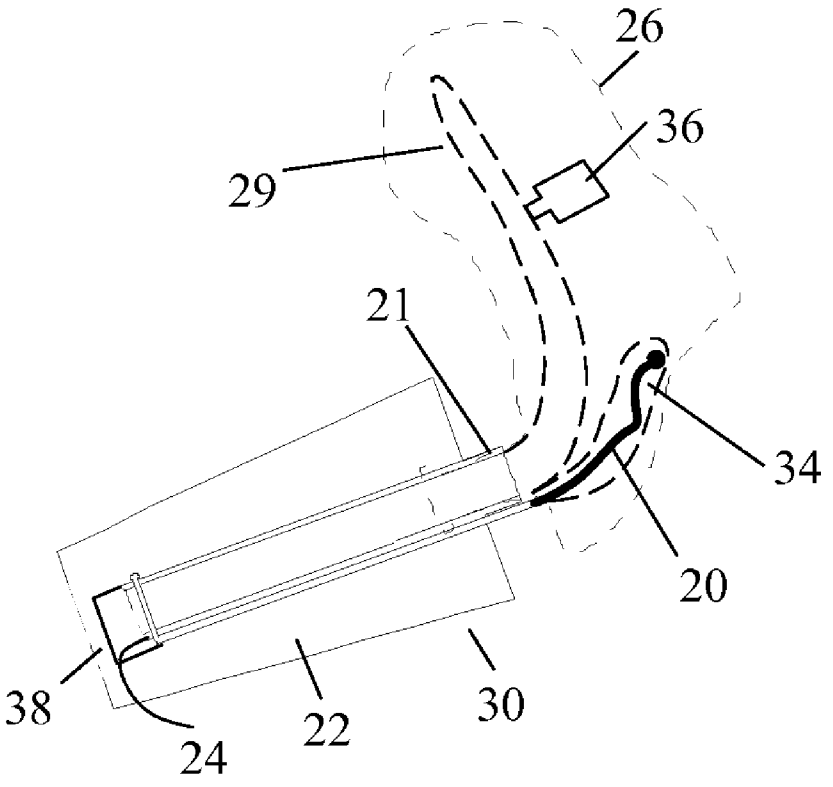


Fig. 1A
PRIOR ART

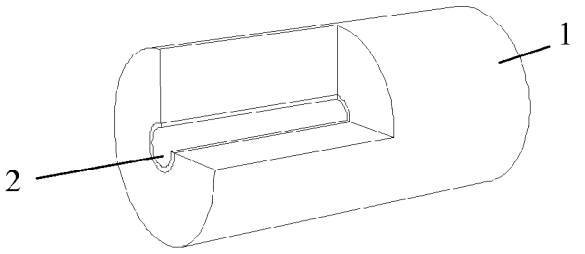


Fig. 1B
PRIOR ART

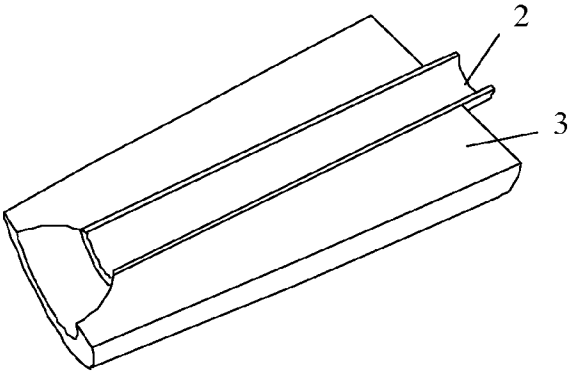


Fig. 1C
PRIOR ART

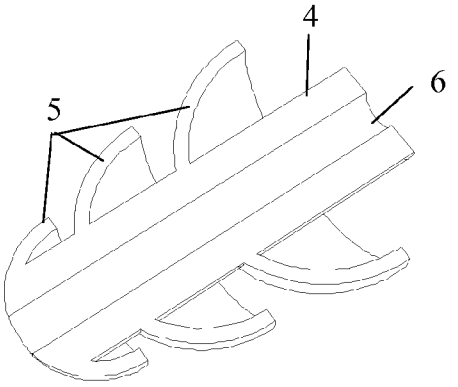


Fig. 1D
PRIOR ART

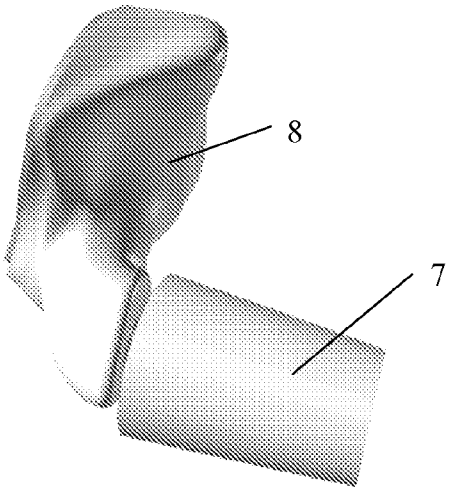


Fig. 2A

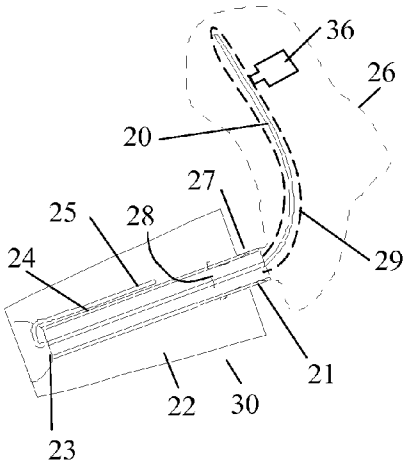


Fig. 2B

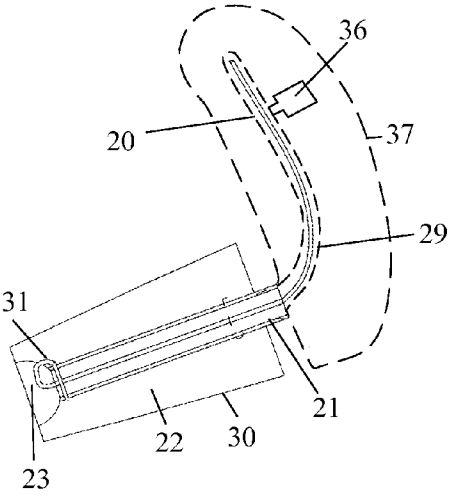


Fig. 2C

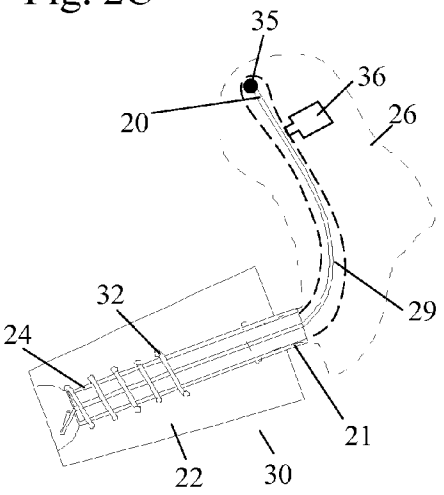


Fig. 2D

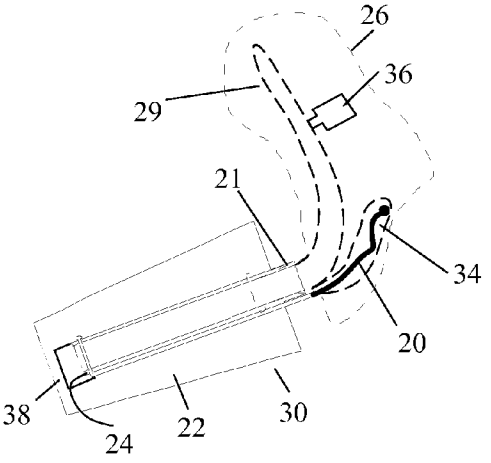


Fig. 3

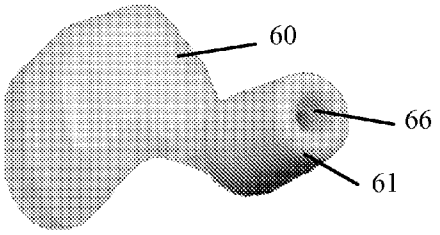


Fig. 4A

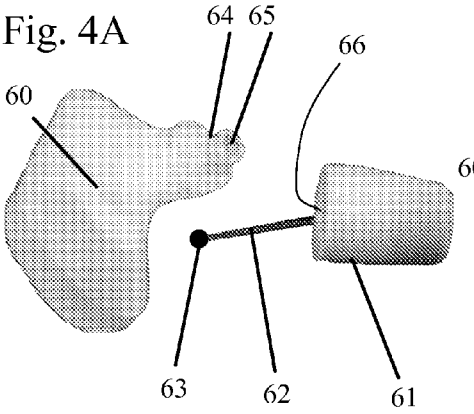


Fig. 4B

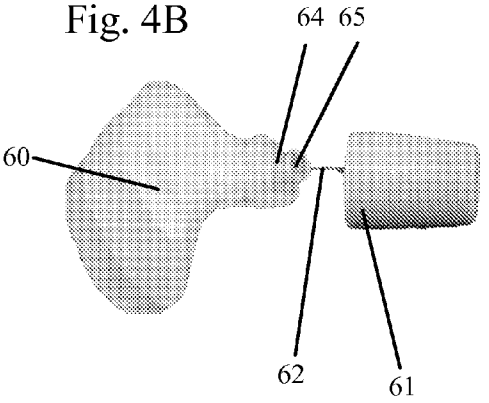


Fig. 4C

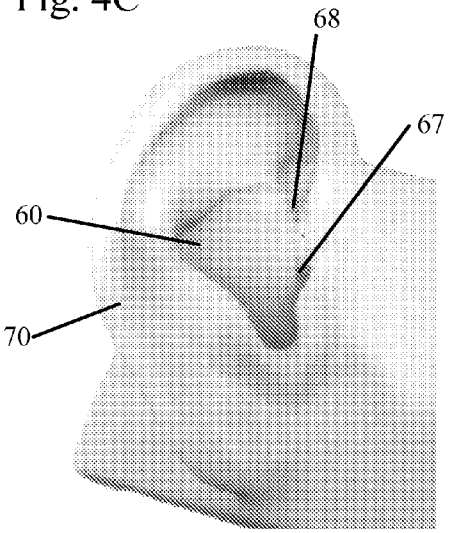


Fig. 4D

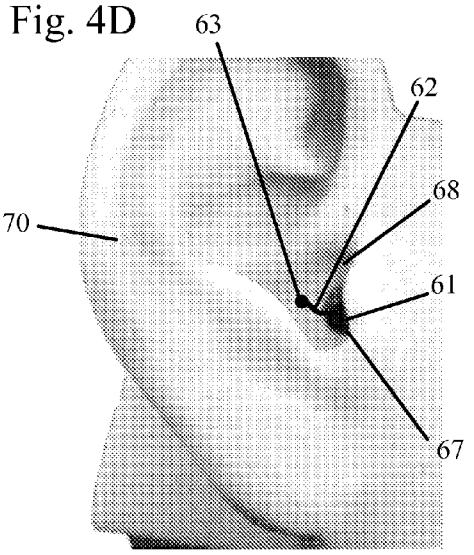


Fig. 5

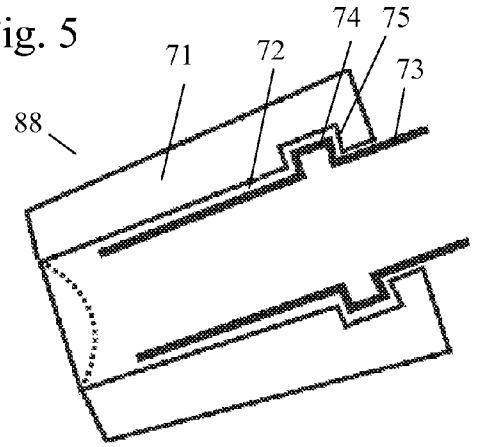


Fig. 6

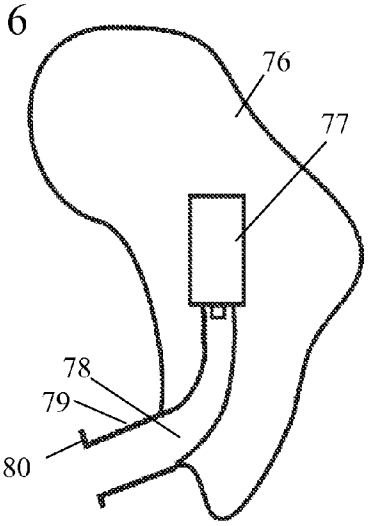


Fig. 7

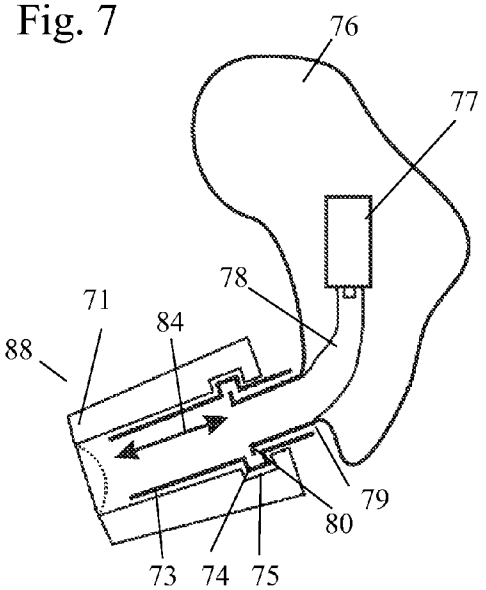


Fig. 8

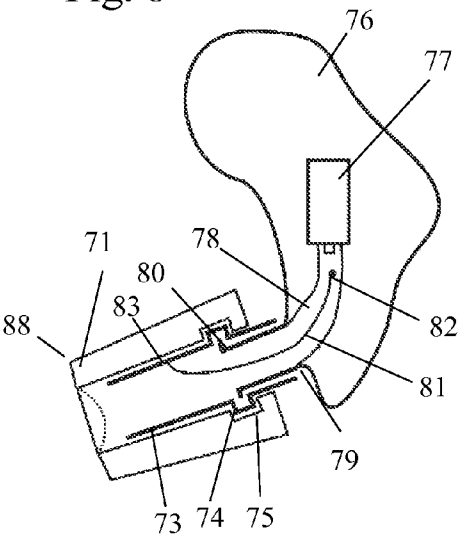


Fig. 9

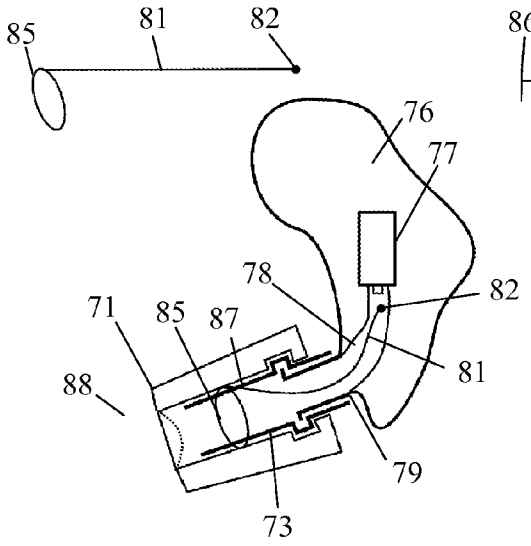


Fig. 10

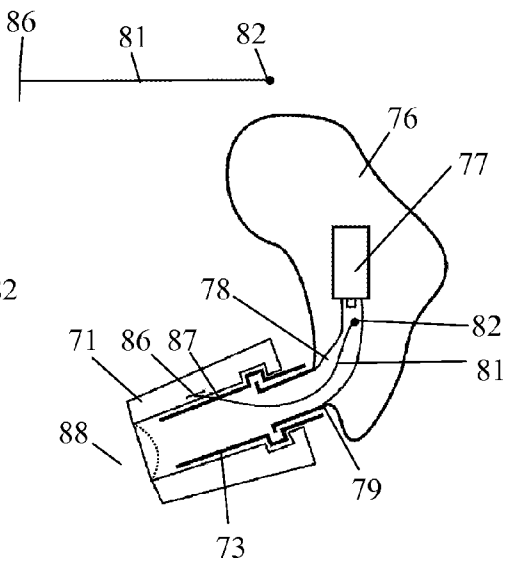
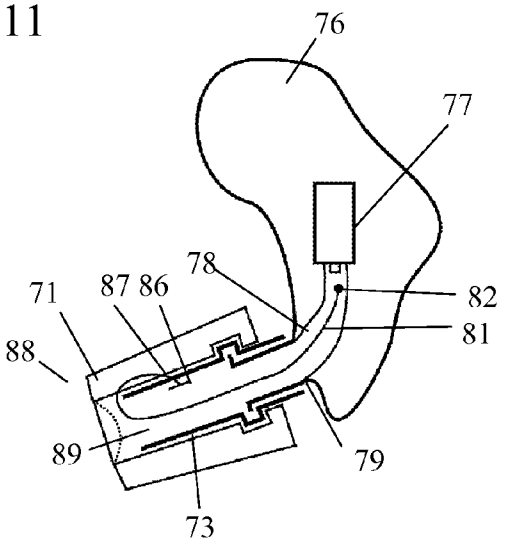


Fig. 11



EARTIP WITH TETHER

REFERENCE TO RELATED APPLICATIONS

This application claims one or more inventions which were disclosed in Provisional Application No. 61/378,492, filed Aug. 31, 2010, entitled "EARTIP WITH LEASH", and also Provisional Application No. 61/416,631, filed Nov. 23, 2010, also entitled "EARTIP WITH LEASH". The benefit under 35 USC §119(e) of these United States provisional applications is hereby claimed, and the aforementioned applications are hereby incorporated herein by reference.

ACKNOWLEDGEMENT OF GOVERNMENT SUPPORT

This invention was made with Government support under SBIR contract N68335-10-C-0329, awarded by the US Navy. The government has certain rights in the invention.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention pertains to the field of sound producing earplugs. More particularly, the invention pertains to eartips for sound producing earplugs.

2. Description of Related Art

Eartips are typically attached to sound producing earpieces to form in-ear earphones or "ear buds". Earpieces may be custom-made, to form fit to an individual user, or universally-fitting. Eartips are typically constructed out of foam materials, or elastomers such as silicone, in various shapes. The eartip generally creates an acoustic seal with the canal walls which prevents undesirable noise from being heard by the user.

For illustrative purposes, FIG. **1**A shows a simple eartip in the form of a foam cylinder **1** with a rubber sound tube **2** glued internally to carry the sound into the ear from an earpiece into the ear.

FIG. **1**B is a cross-section of a contoured foam eartip having a tapered cylindrical resilient body **3** with a rubber sound tube **2**. One such foam design is shown in US published application No. 2007/0240931 by Killion.

FIG. **1**C is a cross-section of a flanged elastomeric tip having a body **4** with flanges **5**, usually made from a silicone material. The flanges **5**, made of elastomeric material, serve to seal the tip to the ear canal, while the channel **6** in the center serves to couple sound from a speaker in an earpiece to the human ear canal.

FIG. **1**D illustrates a foam eartip **7** installed on a custom-molded earpiece **8**. The custom earpiece **8** is typically made from an impression of the user for which the device is made. Eartips may also be installed on universally-fitting earpieces.

The effectiveness of any plug at keeping out undesirable outside sounds is determined partially by the depth in the ear canal to which the device is inserted. Deeper insertion generally yields greater attenuation of the undesirable outside sounds. Attenuating outside sounds permits reducing the sound levels required in the ear canal to create a comfortable and useful listening level for communications signals (such as music or speech). Moreover, in loud environments, higher noise attenuation can prevent hearing loss. Additionally, the less air volume there is inside the ear canal to be driven by the speaker in the earpiece, the less energy is required in the system which results in smaller and lighter energy sources, and longer operating life per charge or battery replacement. Finally, deeper insertion reduces the occlusion effect,

wherein the wearer's own voice seems to "boom" and be artificially loud while wearing the plugs. It is very desirable, therefore, to place these eartips deeply in the ear canal.

The primary impediment to placing eartips deeply in the ear canal has been the problem of removing them. If they are installed on an earpiece which places them deeply in the canal, then it is possible when removing the earpiece from the ear for the eartip to detach and remain deep in the canal. In this case, medical assistance may be needed to remove the eartip from the canal. The potential for this failure mode can discourage manufacturers from deploying solutions that take advantage of deep placement regardless of the many advantages of doing so.

SUMMARY OF THE INVENTION

The invention provides an eartip made of a resilient body with an eartip core with sound channel inside the open center of the body, and a tether attached to the eartip core at an attachment region along the length of the core. A free end of the tether extends outward from the eartip, allowing a wearer to remove the eartip from their ear by pulling on the tether.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. **1**A-**1**D show prior art eartips.

FIG. **2**A shows a simple method of attaching a tether.

FIG. **2**B shows another method of attachment of a tether, with the eartip on a universally-fitting earpiece.

FIG. **2**C shows coiling a tether around the outside of an eartip core.

FIG. **2**D shows routing a tether along the outside of an eartip core.

FIG. **3** shows a photograph of an eartip attached to a custom-molded plastic earpiece.

FIGS. **4**A and **4**B show photographs of assembling an embodiment of the eartip of the invention to a custom-molded plastic earpiece.

FIG. **4**C shows a photograph of an ear with an earpiece in place.

FIG. **4**D shows a photograph of an ear with the eartip and tether remaining after removal of the earpiece.

FIG. **5** shows the construction details of a commercially available eartip made of foam glued to a core.

FIG. **6** shows an example of a custom-molded style earpiece.

FIG. **7** shows the eartip from FIG. **5** as it is attached to the earpiece of FIG. **6**.

FIG. **8** shows an example of a tether attached to an eartip.

FIG. **9** shows one example of a tether used in one embodiment of the invention.

FIG. **10** shows another example of a tether geometry.

FIG. **11** shows another method of attaching a tether.

DETAILED DESCRIPTION OF THE INVENTION

While one approach to the problem of eartips detaching would be to create a means of attaching the eartips to the earpiece in a manner which would virtually guarantee them never coming off in the ear during removal, any mechanism of doing so would likely make the eartip non-replaceable or difficult to use. Because foam-based eartips are intended to be replaced almost daily, this approach is not practical. The eartip disclosed herein involves the integration of a strong, small diameter, semi-rigid tether to the eartip. If the eartip detaches, the tether provides a convenient means for retrieval. In order to minimize interference by the tether with the seal

between the ear and the earpiece, and to reduce discomfort, the tether is captured within the housing of the custom or universal fit earpiece when the eartip is installed.

FIG. **2**A illustrates a simple method of attaching the tether **20**, in an application using a tapered cylindrical eartip **30** having a tapered resilient body **22** and a sound tube **21** inside an open center of the resilient body **22**. The eartip **30** is fit upon an earpiece **26** with an internal speaker **36** to create a sound producing earplug. It will be understood that the wire connections to the speaker **36** are omitted for clarity purposes.

In this embodiment, a tether **20** passes through the sound tube **21** in the foam eartip body **22**, out the end **23** of the sound tube **21**, then folds back between the outside surface **24** of the sound tube **21** and the foam eartip body **22**.

The resilient body **22** is preferably made of foam, but could also be made of silicone or other resilient materials known to the art. The body **22** is preferably a tapered cylinder, but could also be as shown and discussed in reference to prior art FIGS. **1**A-**1**D, above.

The tether **20** is preferably made of a monofilament line (such as fishing line). Tethers made of other materials may be used, so long as they are relatively small in diameter relative to the sound tube **21**, and also are flexible and high in tensile strength.

One assembly procedure is to fabricate the resilient body **22**, sound tube **21**, and tether **20** separately. The tether is given a crimp to pre-form the tether **20** with a sharp bend. The tether **20** is then threaded through the sound tube **21**. An adhesive such as glue is applied to the outer surface **24** of the sound tube **21** and the portion **25** of the tether **20** that will make contact with the foam **22**. Last, the resilient body **22** is placed over the sound tube **21** before the glue has cured. The resilient body **22** will trap the folded-back part **25** of the tether **21** between itself and the sound tube **21** and will help hold the tether **20** against the sound tube **22** while the glue cures. In this embodiment, the tether **20** is not attached to the inside of the sound tube **21**.

This enables the sound tube **21** to be attached to a custom-fitting earpiece **26** using a nipple **27** where the tether **20** slides into an orifice **28** in the nipple **27**. The sound tube **21** can stretch over and around the nipple **27**, held in place by friction and a lip in the nipple **27**. There are other means of attaching the eartip **20** to the nipple **27**, such as a screw-on type.

The earpiece **26** is built with a cavity or channel **29** to allow the tether **20** to be fed into it as the eartip is installed and to provide a means by which sound is delivered from the speaker **36** to the ear canal. If the eartip comes off the earpiece **26** when removing the earpiece **26** from the user's ear, the tether **20** extends to outside the ear canal opening and is accessible. By using one's fingers to pinch the tether **20**, one can pull the eartip out of the ear canal. Even if the tether **20** doesn't extend completely out of the ear canal, it still provides an easier means to remove a detached eartip by using tweezers or other tool.

FIG. **2**B illustrates another method of attachment of a tether **20**. A loop **31** is formed at the end of the tether and placed around the end **23** of the sound tube **21**. The free end of the tether **20** is passed down the sound tube **21** and into sound channel **29** in a universally-fitting earpiece **37**.

FIG. **2**C illustrates another method of attaching the tether **20** to the eartip **30**. In this embodiment, the tether **20** is wrapped in coils **32** around the outside **24** of the sound tube **21** prior to installation of the sound tube **21** within the resilient body **22**. Coiling the tether **20** enables a greater length of tether **20** to be glued to the outside **24** of the sound tube **21** for increased adhesion.

FIG. **2**D illustrates still another method of attaching the tether **20**. In this embodiment, the tether **20** does not pass through the sound tube **21**. Instead, the tether **20** is attached to the outer surface **24** of the sound tube **21** and threaded instead into an alternate passage **34** in the earpiece **26**, such as a separate tube or a cavity. This method places additional constraints on the design of the earpiece **26**, since additional channels **34** need to be provided if a channel **29** is used for providing a communications or other audio signal. Any method of securing the tether **20** to the sound tube **21**, for example those described above in FIGS. **2**A-**2**C, may be employed in this configuration as well.

FIG. **2**D also shows an embodiment in which the open center of the resilient body **22** extends substantially through the body **22**, but not entirely through as shown in the other figures. In this embodiment a small sound-permeable layer of resilient material **38** closes off the inner end of the center of the resilient body **22**.

These and many more variations on attachment methods are possible for both routings of the tether.

In preparation for use, the tether **20** is threaded into the earpiece cavity or tubing **29**, and then the eartip **30** is pushed (or screwed or other means) onto a nipple **27** or other means of attachment. In practice, other types of attachment such as twist-lock or snap attachments are equally possible and are made easier by the tether **20** being threaded through the sound tube **21** as mentioned.

The resilient body **22** is rolled down, in the case of foam eartips, and the earpiece **26** and eartip **30** are inserted into the ear and positioned with the earpiece for comfort and full insertion depth. When the earpiece **26** is removed, the foam eartip **30** will typically remain attached to the earpiece **26**, so that both are removed from the ear together.

If, however, the eartip **30** does become detached, the tether **20** will slide out of the earpiece **26** and will extend past the opening of the ear canal where it may be grasped with the fingers and used to pull the eartip **30** out of the ear canal.

The tether **20** can also be embedded into the molded silicone elastomer types of eartips as shown in FIG. **1**C, and will perform the same functions. The spiral version of tether, shown in FIG. **2**C is particularly effective when embedded in a silicone or other elastomer eartip.

The preferred material chosen for the tether **20** is a strong semi-rigid material, such as nylon monofilament. This prevents the tether **20** from folding and resting inside the ear canal out of reach as would happen with a soft and highly flexible (limp) cord.

The end of the tether **20** intended to be grasped can be modified with the addition of a small formed sphere **35**, as shown in FIG. **2**C, to aid both in grasping with the fingers and in feeding through the channels or cavities in the earpiece. One way of creating the sphere **35** at the end of the tether **20** is by exposing the end to heat and melting the end so that a ball shape is formed.

It will be understood that other means of attaching the tether **20**, including those shown in FIGS. **2**B-**2**D, are possible.

FIG. **3** shows a photograph of an embodiment of the invention attached to a custom-molded plastic earpiece **60**. The custom earpiece **60**, or custom shell, is seen as it would fit in an ear **70** in FIG. **4**C. The ear **70** shown in the photograph is an artificial ear used in acoustical testing and is of the general size of a human ear.

FIG. **4**A shows the earpiece **60**, or custom shell. The earpiece **60** has a sound nipple **64** with a sound channel or passage **65** for routing sound from a speaker (**77** in FIG. **6**) into the user's ear. The sound nipple **64** has a slight lip that

helps secure the eartip **61** to the earpiece **60**. The eartip **61** is shown next to the earpiece **60**, with its tether **62** extending from the sound tube **66** through the eartip **61**. A ball **63** is provided at the tip of the tether **62** to aid in gripping the tether **62**.

FIG. **4**B shows the tether **62** being inserted into the sound channel **65** through the sound nipple **64** of the earpiece **60**. When the tether **62** is inserted into the sound channel **65** of the earpiece **60**, it does not interfere with the ear canal **67**, shown in FIG. **4**C, which would be uncomfortable and create a potential acoustic leak. The tether **62** is of small enough diameter that it does not appreciably hinder the ability of sound to travel through the sound channel **65** of the earpiece **60** and through the sound tube **66** of the eartip **61**.

The foam eartip **61** when attached to the earpiece **60** would extend deep into the ear canal **67**, while the earpiece **60** fits in the concha **68** of the ear **70**, as shown in FIG. **4**C. If the user removed the earpiece **60**, and the eartip **61** became detached, the earpiece **61** could be too deep into the ear canal **67** to remove with human fingers. However, when using an eartip **61** with a tether **62**, as described herein, the tether **62** can be pinched between the fingers and pulled, pulling out the complete eartip **61**.

FIG. **4**D shows how the tether **62** would protrude from the ear canal **67** if the earpiece **60** were removed from the ear **70** and the eartip **61** became detached. The end of the tether **62** extends past the entrance of the ear canal **67** enough that it can be grabbed with fingers, and thus pulling the eartip **61** out of the ear canal **67**. Preferably, as shown in FIG. **4**D, the end of the tether **62** was heated so that it would form a ball **63** which would be easier to grab. The ball **63** also makes it easier to insert the tether **62** into a sound channel **65** in the earpiece **60** because the ball **63** is curved and smooth and will tend to slide into the sound channel **65** easier than an end that is cut and has corners.

FIG. **5** shows the construction details of a commercially available eartip **88** made of a resilient body **71** bonded to a core **73** with a layer of glue **72**. The resilient body **71** is typically made of slow-recovery foam, and the core **73** can be made of stiff or compliant material. A compliant material, such as silicone, is sometimes used for the core **73** because it allows the eartip **88** to flex when being inserted into the ear. The core can be formed with a widened area **74**, which forms a flange on the outside and a groove on the inside. The widened area **74** can fit into a groove **75** in the body **71** to provide a positive fit between the body **71** and core **73**.

The core **73** provides a mechanical attachment means to an earpiece. The earpiece may be universal-fitting or of a custom-molded style that fits the features of a specific individual. FIGS. **6-11** show an example of a custom-molded style earpiece **76**. The earpiece **76** may be made of a plastic shell, solid plastic, silicone, or other materials.

The earpiece **76** is used for communications purposes and incorporates a speaker **77** within its body. Wires used to power the speaker **77** are not shown for clarity reasons. For sound to travel to the user's ear canal, a sound channel **78** must be provided. A nipple **79** is a feature of the earpiece **76** shown in FIG. **6** that is used to mechanically attach an eartip **88**, for example the eartip **88** shown in FIG. **5**. When an eartip **88** is attached to the nipple **79**, the eartip **88** is retained by the earpiece during insertion and extraction of the earpiece and eartip **88** from the human ear.

FIG. **7** shows the eartip **88** from FIG. **5** as it is attached to the earpiece **76** of FIG. **6**. A ridge **80** of the earpiece nipple **79** fits in the groove **74** of the eartip **88** to help with retention. Other retention schemes may be used, such as a screw-type geometry.

FIG. **7** indicates the proper attachment region **84** for a tether **81**, shown in FIG. **8**, to enter the core **73**. The tether **81** enters the core **73** of the eartip **88** where it will not interfere with the nipple **79** to eartip **88** attachment region and so that it may be easily fed into the sound channel **78**. The attachment point of the tether **81** may be within the core **73**, on the outside of the core **73**, or on the inside of the core **73** in any region so long as it enters the core **73** in the tether entrance region **84**.

FIG. **8** shows an example of a tether **81** attached to the eartip **88** core **73** at an attachment point **83**. The tether **81** enters the core **73** and earpiece nipple **79** and resides within the sound channel **78**. It can be seen that the tether **81** will not interfere with the attachment of the eartip **88** core groove **74** to the ridge **80** of the earpiece nipple **79**.

The diameter of the tether **81** is chosen to provide the tensile strength needed to withdraw the eartip **88** without breaking, but small enough in size so as not to reduce the open area of the sound channel **78** below acceptable limits. That is, if the tether **81** diameter is too large in comparison to the cross-sectional area of the sound channel **78**, it will impede sound from traveling down the sound tube channel **78**. Tethers of diameter 0.013 inch can be used effectively as well as other sized tethers.

FIG. **9** depicts one example of a tether **81** used in one embodiment of the invention. The tether **81** is molded of a stiff material such as plastic or monofilament with a loop **85** at one end and a ball **82** at the other end. The loop **85** of the tether **81** is placed around the outside of the core **73** of the eartip **88**. A small hole **87** is made in the core **73** for the tether **81** to penetrate through so that it travels through the core **73** and into the sound channel **78**. The foam **71** of the eartip **88** is glued to the core **73**. If the eartip **88** comes off the earpiece **76** and remains in the ear, the user pulls the ball end **82** of the tether **81** to retrieve the eartip **88**.

FIG. **10** depicts another example of a tether **81** geometry. The tether **81** is molded so as to have a "T" **86** at one end and a ball **82** at the other. The ball end **82** of the tether **81** passes through a small hole **87** made in the core **73**, while the "T" end **86** presses against the outside of the core **73** if the ball end **82** of the tether **81** is pulled.

In FIG. **11**, another method of attaching the tether **81** is shown, using the same tether design as in FIG. **10**. In this case, the ball end **82** of a tether **81** is fed through a small hole **87** in the core **73** so that the "T" section **86** remains inside the core **73**. The tether **81** wraps around the core **73** and back in through the open end **89** of the core **73**. If the eartip **88** comes off in an ear, the user pulls on the ball end **82** of the tether **81**. The "T" section **86** of the tether **81** ensures that the core **73** and resilient body **71** of the eartip **88** are retrieved with the tether **81**.

The tether **81** may also be molded into the core **73** during fabrication, in the region **84** indicated in FIG. **7**. The tether **81** and core **73** may be made of the same material and molded at the same time so long as the tether **81** is small enough in diameter not to significantly hinder sound from reaching the user's ear when a speaker is used in the earpiece, and as long as it is strong enough not to break under the tension needed when retrieving the eartip **88** from an ear.

Accordingly, it is to be understood that the embodiments of the invention herein described are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments is not intended to limit the scope of the claims, which themselves recite those features regarded as essential to the invention.

What is claimed is:

1. An eartip, comprising:

a) a resilient body having an inner end for insertion into an ear, an outer end, and a length therebetween, having an open center extending through the length of the body substantially from the outer end to the inner end;

b) an eartip core inside the open center of the body, having an inner end adjacent to the inner end of the body, an outer end adjacent the outer end of the body, and a length therebetween with an open central passage from the inner end to the outer end; and

c) a tether having a first end coupled to the eartip core at an attachment region along the length of the core, a free end and a length therebetween, the free end of the tether extending outward from the outer end of the eartip core.

2. The eartip of claim 1, in which the inner end of the eartip core is recessed within the open center of the body from the inner end of the body.

3. The eartip of claim 1, further comprising an earpiece having a body molded to fit within an ear, a nipple coupled to the outer end of the eartip core, a speaker, and a sound channel acoustically coupled to the speaker and passing through the body of the earpiece and the nipple, such that when the nipple is coupled to the outer end of the eartip core, at least part of the length of the tether is within the sound channel of the earpiece.

4. The eartip of claim 3, in which the outer end of the eartip core protrudes from the outer end of the body, for attachment of the eartip to the nipple of the earpiece.

5. The eartip of claim 1 in which the resilient body of the eartip further comprises a plurality of flanges of elastomeric material.

6. The eartip of claim 1, in which the free end of the tether comprises a ball.

7. The eartip of claim 1, in which the length of the tether is at least partially located within the open central passage of the core.

8. The eartip of claim 1, in which the first end of the tether is passed through a hole in the attachment region of the eartip core.

9. The eartip of claim 8, in which the first end of the tether comprises a T, such that when the first end of the tether is passed through the hole in the attachment region of the eartip core, the T lodges against a surface of the attachment region of the eartip core, coupling the first end of the tether to the eartip core.

10. The eartip of claim 8, in which the first end of the tether is formed into a loop, such that the first end of the tether is coupled to the eartip core by passing the first end of the tether from the central passage through the hole in the attachment region of the eartip core and wrapping the loop around the eartip core.

11. The eartip of claim 8, in which the first end of the tether is coupled to the attachment region of the eartip core by folding the first end of the tether back along an outer surface of the eartip core and securing the first end of the tether to the outer surface of the eartip core.

12. The eartip of claim 8, in which the first end of the tether is formed into a loop, such that the first end of the tether is secured to the outer surface of the eartip core by passing the first end of the tether through the central passage of the eartip core and inward through the inner end of the eartip core, folding the first end back toward the outer end of the eartip core and wrapping the loop around an outer surface of the eartip core.

13. The eartip of claim 1, in which the eartip core is glued to the resilient body.

14. The eartip of claim 1, in which the tether is monofilament line.

15. The eartip of claim 1, in which the tether has a diameter small enough that it does not block sound passage through the central passage of the eartip core.

16. A method of making an eartip comprising a resilient body having an inner end for insertion into an ear, an outer end, and an open center extending between the inner end and the outer end; an eartip core having an inner end, an outer end, and a length therebetween with an open central passage from the inner end to the outer end; and a tether having a first end, a free end and a length therebetween, the method comprising:

a) threading the first end of the tether through central passage of the eartip core from the outer end to the inner end, leaving the free end of the tether extending from the outer end of the eartip core;

b) securing the first end of the tether to an attachment region of the eartip core;

c) inserting the inner end of the eartip core into the outer end of the open center of the resilient body; and

d) pushing the eartip core into the open center of the resilient body until the eartip core is in a desired location relative to the resilient body.

17. The method of claim 16, further comprising the step, before step (a) of pre-forming the first end of the tether with a sharp bend, and wherein the step of securing the first end of the tether to an attachment region of the eartip core comprises applying an adhesive to an outer surface of the eartip core and pressing the first end of the tether into the adhesive.

18. The method of claim 16, in which the first end of the tether is formed into a loop, and wherein the step of securing the first end of the tether to an attachment region of the eartip core comprises placing the loop at the first end of the tether around an outer surface of the eartip core.

19. The method of claim 16, in which the first end of the tether is formed into a T, and wherein the step of securing the first end of the tether to an attachment region of the eartip core comprises inserting the T through a hole in the eartip core.

20. The method of claim 16, further comprising:

e) inserting the free end of the tether into a sound channel of an eartip; and

f) attaching the outer end of the eartip core to a nipple of the earpiece, such that at least part of the length of the tether extends through the nipple into the sound channel when the eartip core is attached to the nipple of the earpiece.

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