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Peart

[11] **3,710,888**

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[54] **ROTATABLE EARTIP STETHOSCOPE**

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[73] Assignee: **Sybron Corporation,** Rochester, N.Y.

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[52] **U.S. Cl.** **181/24,** 181/23

[51] **Int. Cl.** **A61b 7/02**

[58] **Field of Search** 181/24, 23; 179/182

[56] **References Cited**

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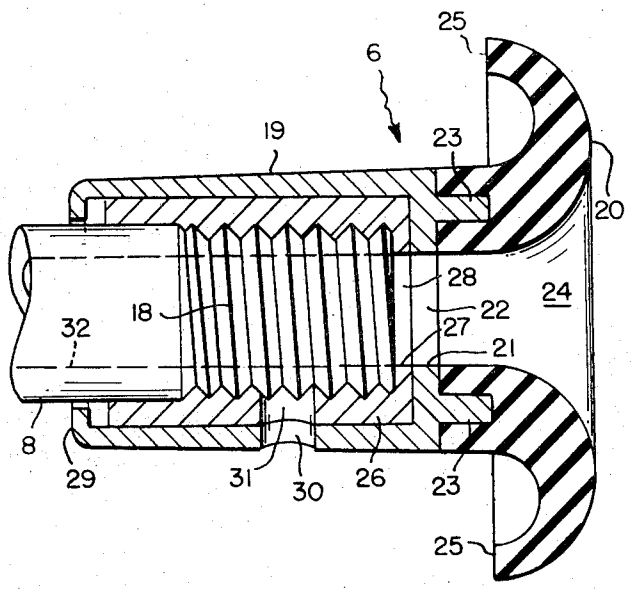
Primary Examiner—Stephen J. Tomsky
Attorney—Theodore B. Roessel

[57] **ABSTRACT**

A stethoscope having eartips rotatably mounted on its sound tubes, permitting the tubes to move relative to the eartips without traumatizing the ear canals of the stethoscope user.

6 Claims, 9 Drawing Figures



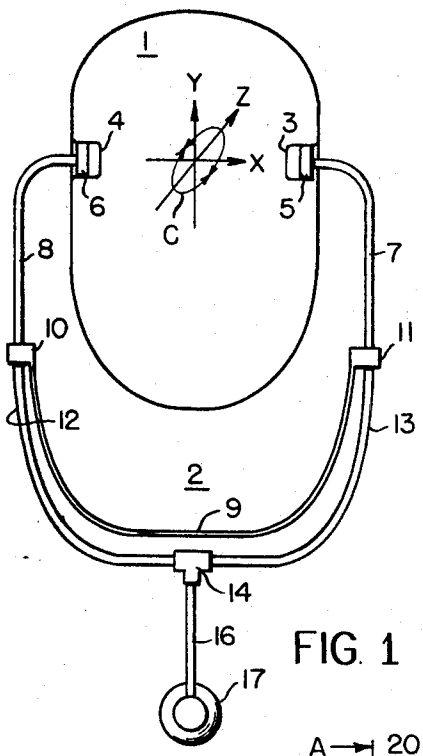


FIG. 1

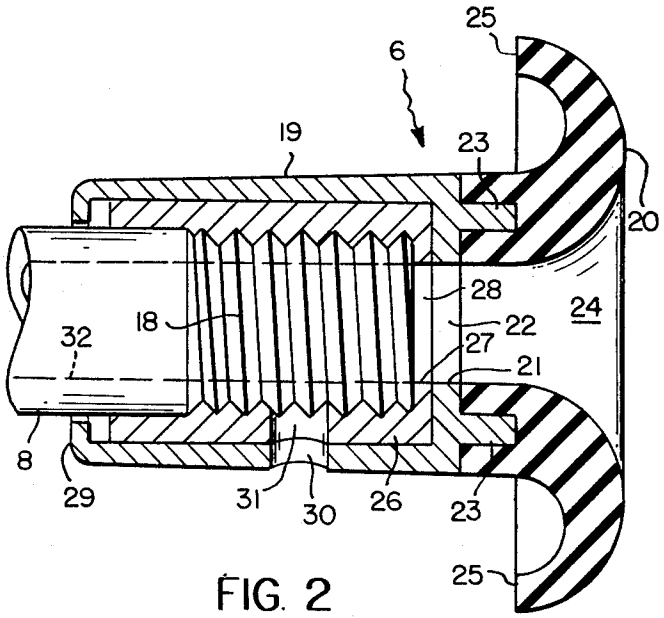


FIG. 2

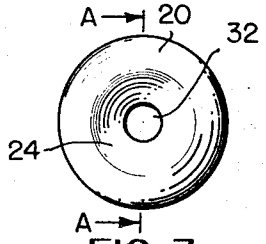


FIG. 3

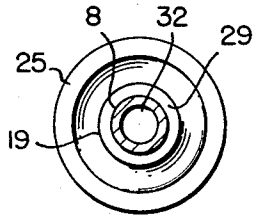


FIG. 4

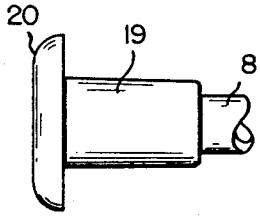


FIG. 5

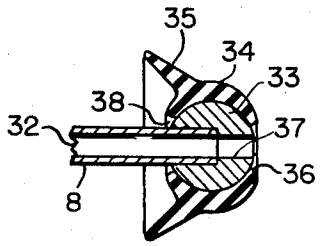


FIG. 6

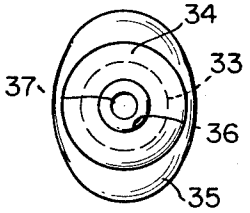


FIG. 7

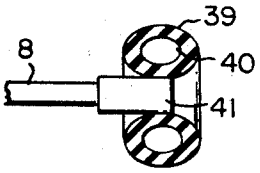


FIG. 8

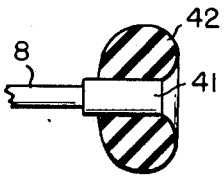


FIG. 9

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ROTATABLE EARTIP STETHOSCOPE

FIELD OF THE INVENTION

The field of invention is medical diagnostics, in particular, with stethoscope. Prior art stethoscopes have their eartips fixed to their sound tubes. The use of the stethoscope involves a good deal of moving it around bodily, but as the eartips are fixed in place in the user's ear canals, such movement creates a stress on the tissue lining the ear canals. Such stress is often traumatic, the trauma ranging from discomfort during use of the stethoscope, to tissue damage, which obviously outlasts such use.

SUMMARY OF tHE INVENTION

In the present invention, the eartips are rotatably mounted on the sound tubes. The ear canals of a human user are more or less cylindrical, and the axis of rotation of the tips is selected to be the cylinder axis of the ear canal, or parallel thereto. The rotatability of the eartips need not be so restricted, and in another form of the invention, the eartips are connected to the sound tubes by ball and socket joints, so that when the eartips are in place in the ear canals, the axis of rotation between sound tubes and eartips can have any angular orientations whatsoever.

However, the more restricted rotatability suffices since it substantially eliminates, completely, tangential stress on the ear canal tissues. While this permits some stress to be exerted transverse to the axis of rotation, and along it, the usual movement of the stethoscope is not in such directions as would produce these types of stress, and, further, the ear canals are less vulnerable thereto.

BRIEF DESCRIPtION OF THE DRAWING

FIG. 1 is a diagram for use in explaining the principles of the present invention, as applied to a typical stethoscope-use situation;

FIG. 2 is a diametral sectional view of a stethoscope eartip according to the invention, the section corresponding to the plane of the section A of FIG. 3, and the proportions of the Figure being 6⅔ times those of an actual example of the eartip;

FIGS. 3 and 4 are opposing end elevations of the eartip of FIG. 2; and

FIG. 5 is a side elevation thereof, the proportions of FIGS. 3, 4 and 5 being about twice those of an actual example of the eartip; and

FIGS. 6 and 7 are views analagous to those of FIGS. 2 and 3 respectively, but of a second form of the invention, wherein a ball and socket arrangement provides eartip rotatability, and

FIGS. 8 and 9 are views analogous to that of FIG. 6 but of additional forms of the invention.

In FIG. 1, reference numeral 1 denotes a section through the head of a human user of a stethoscope denoted generally by reference numeral 2. The section is to be supposed to more or less bisect the ear canals 3 and 4 of the user's head. For simplicity, the canals are also deemed to be substantially coaxial right cylinders, the common axis of which is the X axis of the XYZ coordinate system diagrammed between the ear canals.

Stethoscope 2 has ear tips 5 and 6 in place in canals 3 and 4. The tips terminate rigid sound tubes 7 and 8, which are normally biased toward each other by a suitable U-shaped leaf spring 9, the ends of which terminate in fittings 10 and 11 or the like which fix the lower ends of tubes 7 and 8 to the ends of the spring 9. Fittings 10 and 11 connect the upper ends of flexible sound tubes 12 and 13 to the lower ends of tubes 7 and 8.

At their lower ends, tubes 12 and 13 are interconnected by a fitting 14 to one end of sound tube 16. A sound pick-up 17 terminates the other end of tube 16. In use, sound intercepted by pick-up 17 is conducted through tube 16 to fitting 14, whence it passes to sound tubes 7 and 8 via sound tubes 12 and 13, eventually being emitted into the ear canals 3 and 4 through tips 5 and 6.

As thus far described, FIG. 1 will be recognized as depicting the usual configuration of stethoscope and user. The actual geometry of the anatomy of the human head is somewhat more elaborate, for instance, the ear canal is actually a bit sinous, varies in diameter along its length, and has an effective axis diverging downwardly from the X axis. However, for the purposes of the present invention, the illustrated geometry is sufficiently accurate.

In any event, from the time the user dons the stethoscope, the stethoscope in general undergoes a good deal of bodily motion. However, this occurs with tips 5 and 6 rather solidly fixed in place. Thus, the normal condition of spring 9 is to hold the tips much closer together than illustrated, so that to don the stethoscope, the user has to spread the tubes 7 and 8 apart, and the tips are a quite snug fit in the ear canal. As a result, there is a rather substantial spring force trying to push the tips deeper into the ear canals, and a rather substantial frictional force between the circumferential surface of the eartips and the ear canal tissue in contact therewith.

The user normally grasps the stethoscope at about the pickup 17, which gives him a very substantial leverage on all axes passing through the locations of the eartips. As the ear canal tissue is quite delicate, it is evident that such leverage can easily be used to the detriment of such tissue. As it happens, this tissue is most vulnerable to the most likely application of that leverage, which is to move the stethoscope in such sense as to deflect the tubes 7 and 8 about the x axis, for example, in the sense of the arc C which lies in the YZ plane (the Z-axis, of course, is normal to the section plane represented by reference numeral 1, but had to be shown in perspective in order to be sufficiently visualizable).

To put it another way, the stethoscope is, in effect, fixed to the ear canal tissue. In comparison to the ear tissue, the stethoscope structure between fitting 14 and the tips is quite rigid, so that if the ear tips move when the rigid structure is moved, the ear tissue distorts to allow such motion. As the tissue is delicate, the distortion is likely to be tramatic, causing temporary discomfort, at least, and not infrequently, an actual lesion of the tissue, especially if the trauma is recurrent, due to frequent use of the stethoscope. It will be noted that stresses along the X axis are much less likely to be traumatic, at least when it comes to causing lesions. The reason for this is that the ear canal converges, so that some of the force due to spring 9 is absorbed by com-

pression of the outer layers of tissue against inner, more solid tissue. However, forces tangential to the inner surface of the ear canal tends to peel the outer layers from the more solid tissue. As the stethoscope user is generally in a position such that his explorations with pick-up **17** almost invariably lead to deflection of the tubes **7** and **8** about the X axis, it is evident that the user almost continuously acts in a way inviting traumatization of the ear canal tissue.

My solution to this problem is to provide a rotatable connection between the ear tips **5** and **6**, and the tubes **7** and **8**, wherein each of such connections has at least one axis of rotation and that axis is along the X-axis, in practice, slightly skewed therefrom, for, as pointed out before, the effective axis of the actual ear canal diverges somewhat from the X-axis.

In FIG. **2**, the eartip **6** (and of course, eartip **5**) is shown to be a sleeve **19** having fixed thereto a collar **20**. The inner volume of the sleeve is right cylindrical, over which volume flange **21** of the sleeve extends to define an aperture **22**. From flange **21** projects a flange **23** which fits into a corresponding slot in the end of collar **20**, with the flared central aperture **24** registering at its narrower side with the aperture **22**. Typically, sleeve **19** would consist of metal or other rigid material, whereas collar **20** would consist of a soft material, in particular, neoprene. The sleeve **19** and collar **20** for all practical purposes must define a single, integral member, so preferably they are bonded together by vulcanization or other means which will both hold the two together and hermetically seal the collar **20** to the flange **21**, continuously around the periphery of aperture **22**.

As will be seen from FIG. **2**, collar **20** flares outwardly through an angle of 180° to terminate in a portion **25** thereof, of reduced thickness. The proportions of FIG. **2** are to exact scale of an actual example of an eartip according to the invention. However, the basic desiderata are that the largest diameter of collar **20** is just large enough to create a hermetic seal between the tissue of the ear canal surrounding portion **25**, and the portion **25**. The configuration shown in FIG. **2**, with a neoprene flange, allows the cross-section of collar **20** to be circular and still seal the ear canal, which is actually somewhat elliptical in cross-section. A material harder than neoprene could be used if the collar were given elliptical cross-section. Generally speaking, the harder the material of collar **20**, the more nearly it must conform to the actual ear canal contour. As this is not conducive to manufacturing economy, or to ease of use, it is preferable to use soft enough material in order to achieve a single size and configuration which will suit all ear canals.

Received within sleeve **19**, is a sleeve **26**. Sleeve **26** is right-cylindrical in outer contour and fits the inner volume of sleeve **19** as closely as possible, without filling it so closely as to prevent sleeve **26** from rotating freely in sleeve **19**.

Sleeve **26** has a flange **27**, analogous to flange **21**, the former defining an aperture **28** which registers with aperture **21**. Unlike flange **21**, the surface of flange **27**, next adjacent flange **21**, has a smooth flat finish mating with a similar finish on the surface of flange **21** next adjacent flange **27**. As will be seen from FIG. **2**, sleeve **26** is a substantially perfect fit except at a flange **29** of the left end of sleeve **19**. The flange **29** does not exist until after the sleeve **26** has been inserted in sleeve **19** during manufacturing. After such insertion, the end of sleeve **19** is swaged over as shown, allowing a slight clearance between flange **29** and the left end of sleeve **26**, in order to assure that the latter can continue to be freely rotatable in sleeve **19**.

The fit between sleeve **19** and sleeve **26** need not be especially close in order to prevent sound transmission through the slight annular clearance between the inner surface of sleeve **19** and the outer surface of sleeve **26**, because when the tips are in place in the ears, spring **9** forces the end surface of each flange **27** to seat on the adjacent surface of the corresponding flange **21**, thereby creating a substantially airtight seal between the flanges.

Sleeve **26** is provided internally with a set of threads for receiving the threaded end **18** of the sound tube **8**, the bore **32** of which is to register with aperture **28**. To assembly the tip **6** to the tube **8**, a suitable tool is inserted through hole **30** in sleeve **19** into hole **31** in sleeve **26** so that the sleeve **26** can be screwed tightly on end **18**. Sleeve **26** should be tightly secured to end **18** in order to assure that no sound is transmitted via the interstices between the threads, as well as to assure that the eartip will not work loose from tube **8**.

The sleeve **26** could be threaded on step **18** before being assembled to sleeve **19**, in which case flange **29** would have to be formed after the tip is in place on tube **8**. It this instance, sleeve **26** could be formed as an integral part of the end of tube **8**. However, these variants, while within the scope of the invention, have their drawbacks. For instance, it would be most inconvenient to the user if he had to replace an eartip, as he is not likely to be prepared to perform the swaging step. With the FIG. **2** embodiment, however, it is not difficult for the user to screw on a new eartip while blocking rotation between the sleeves **19** and **26** by means of the end of a common paper clip, say.

In an actual example of an eartip according to the invention, collar **20** consisted of neoprene, and sleeves **19** and **26** consisted essentially of aluminum and thermoplastic acetyl resin, respectively.

In the form of the invention shown in FIG. **6**, a ball **33** and socket **34** provide eartip rotatability. Socket **34** corresponds to sleeve **19**, and has a collar **35** corresponding to collar **20**, and extending continuously around the periphery of the socket. In order to take advantage of the universal rotatability of the ball **33**, socket **34** is provided with a circular aperture **36**, somewhat larger in diameter than the sound transmitting aperture **37** through ball **33**. Likewise, socket **34** has a circular aperture **38** somewhat large in diameter than sound tube **8** which projects through aperture **38** into ball **33**, to which it is fixed by any suitable means (not shown), with its bore **32** communicating with aperture **37**.

FIG. **7** shows the collar **35** as being somewhat oblong, in order to illustrate the possibility of providing a better fit to the contour of the human ear canal. However, the collar **35** may be circular, as in the case of its counterpart collar **20**.

It is to be observed that the collar **35** (and collar **20**) by its very form provides a certain amount of flexibility, and so widens the range of materials that may be used

for the collars, including those materials whose intrinsic flexibility is not in itself enough to be entirely comfortable if plugged into the ear canal firmly enough to seal the canal. A similar result is obtained in the form shown in FIG. 8, where a doughnut like tip 39 is provided, which is hollow, as shown at 40, and may have a filling of air or liquid. Here, the thinness of the doughnut wall together with the intrinsic flexibility of the wall material (rubber, plastic, or the like), provides for a comfortable seal of the ear canal. Reference numeral 41, denotes the rotatable coupling between doughnut 39 and sound tube 8.

FIG. 9 is similar to FIG. 8 except that a solid doughnut 42 is contemplated. In this case, the material of doughnut 42 must be sufficiently intrinsically resilient to provide a comfortable seal of the ear canal. Finally, it is also within the scope of the invention to provide an exact fit of the eartip to the ear canal, over sufficient length of the latter that the canal is adequately sealed without substantially distorting the canal, in which case the eartip may be made of quite rigid material such as bakelite.

Having set forth my invention as required by 35 USC 112, I claim:

1. A stethoscope including first, second, and third tubes, first and second eartips, and a pickup;

said first eartip being on one end of said first tube, said second eartip being on one end of said second tube, and said pickup being on one end of said third tube;

the other ends of said tubes being joined together for transmission of sound from said pickup to said eartips;

said first and second tubes having flexible portions, and said stethoscope having means biasing said one ends thereof toward each other for causing the said tips to be closer together than intra-aural distance, except when in place in a user's ears;

said first eartip having a passageway therethrough communicating with the passageway of said first tube and opening into the canal of a user's ear when said tip is in place in said ear;

said first eartip being externally constructed to substantially seal said canal, when in place, as aforesaid, and said stethoscope having mounting means mounting said eartip rotatably and sealingly said one end of said first tube for rotation with respect to said one end while in place in said canal, and on an axis approximately the same as that of said canal;

said second eartip being the same as said first eartip, and being mounted on said one end of said second tube, in the same way;

said mounting means being a first sleeve fixed to one end of said first tube, and said eartip including a second sleeve rotatably fitting the outside of said first sleeve, but being restrained from movement axially of said first sleeve;

said first sleeve having fastening means removably fastening it to said one end of said first tube, said fastening means being of the type requiring access to the exterior of said first sleeve, and said second sleeve having a hole in the side thereof for providing such access.

2. The stethoscope of claim 1, wherein said eartip has an annular flexible collar projecting therefrom transverse to the effective axis of said canal and said mounting means provides for rotation of said eartip on an axis transverse to the direction of projection of said collar.

3. The stethoscope of claim 1, wherein said fastening means includes threads on said first tube and threads inside said first sleeve engageable with the former said threads by rotation of said second sleeve with respect to said first sleeve; said first sleeve having a tool-engageable element located for allowing access thereto via said hole.

4. The stethoscope of claim 3, wherein said second sleeve has an annular flexible collar projecting radially therefrom.

5. The stethoscope of claim 3, wherein said tool-engageable element is a hole in the side of said first sleeve.

6. The stethoscope of claim 5, wherein said second sleeve has an annular flexible collar projecting radially therefrom.

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