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.
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 6½ 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 analogous 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 sinus, 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 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 traumatic, 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 traumatication 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 ear tip 6 (and of course, ear tip 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 ear tip 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 sea 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 assemble 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 ear tip 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 ear tip, 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 ear tip 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 ear tip 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 ear tip 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 sub-
stantially 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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