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Cragg et al.

[11] **3,781,492**

[45] **Dec. 25, 1973**

[54] **HEADSET**

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[21] Appl. No.: **290,905**

[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **H04m 1/05,** H04r 1/28
[58] **Field of Search** .... 179/156 A, 121 D, 179/180

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Attorney—C. Cornell Remsen, Jr. et al.

[57] **ABSTRACT**

A headset includes a main housing containing a miniature demountable earphone, a microphone pre-amp and a snap-on earpiece. The housing is connected to one end of an adjustable boom having a pressure gradient microphone at the other end. The microphone has a piezoelectric disc transducer mounted midway from either end of a cylindrical housing and perpendicular thereto, the cylinder halves being separate acoustic resonators of predetermined frequency to provide an upper limit of operation.

20 Claims, 9 Drawing Figures

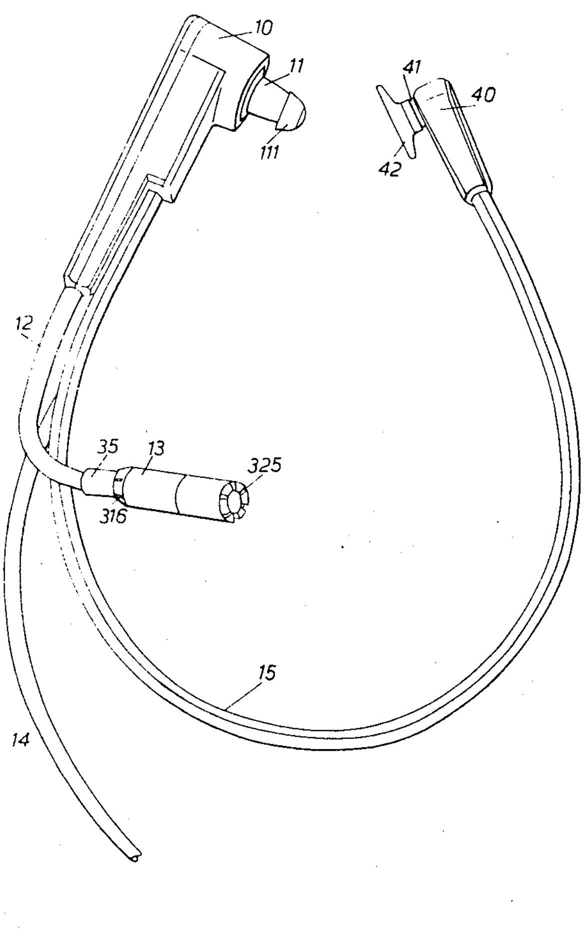
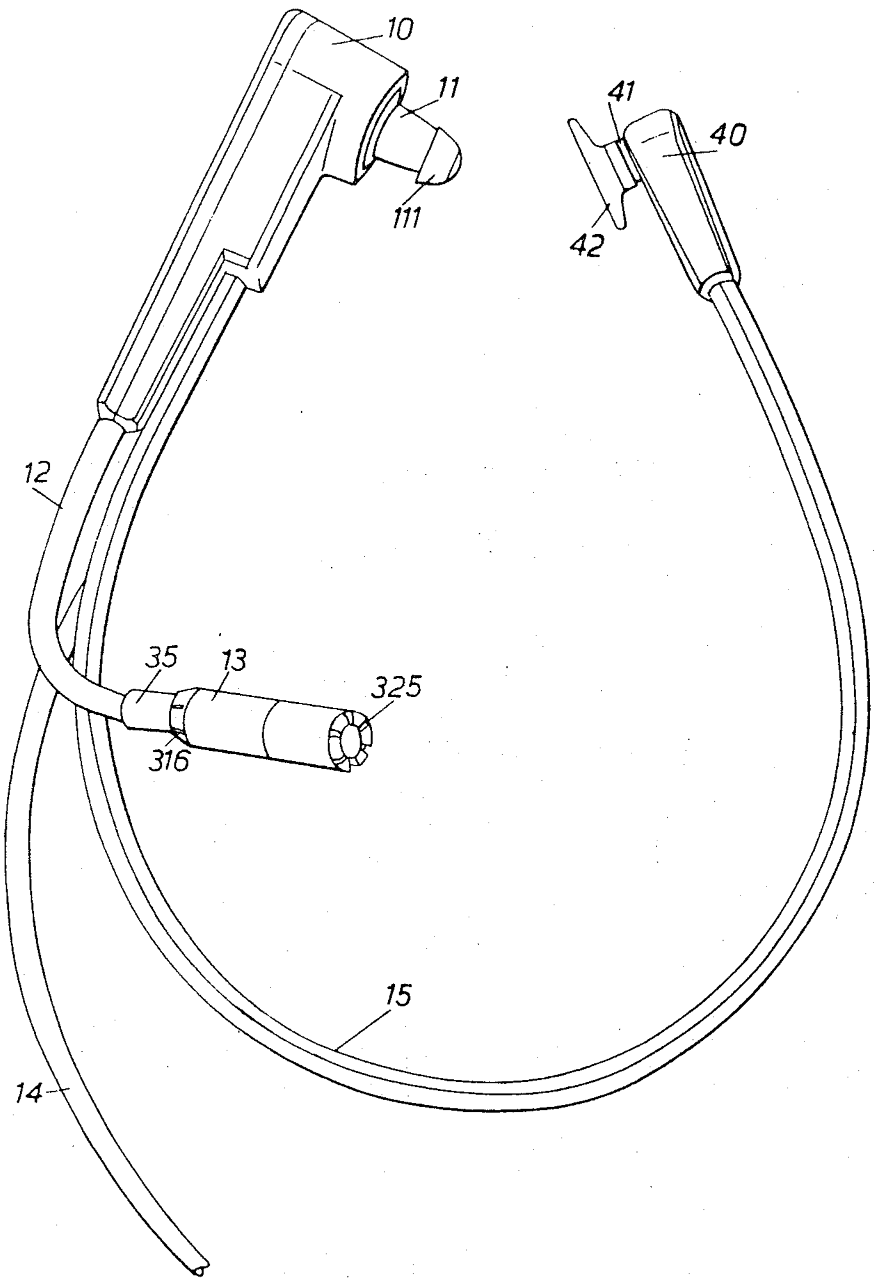


FIG.1



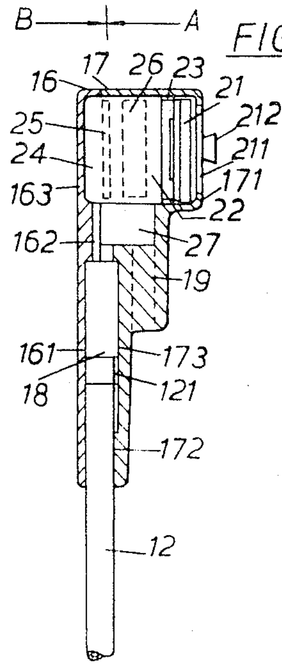


FIG.2.

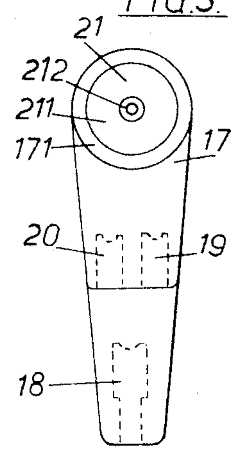


FIG.3.

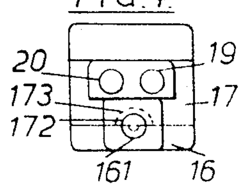


FIG.4.

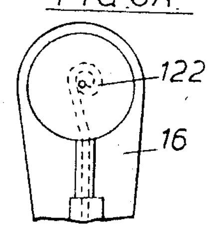


FIG.5A.

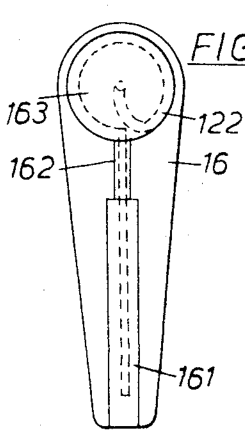


FIG.5

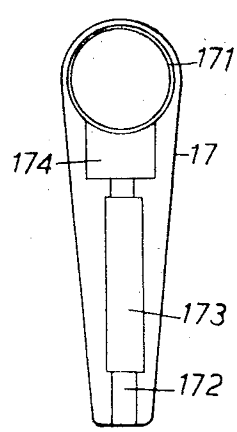
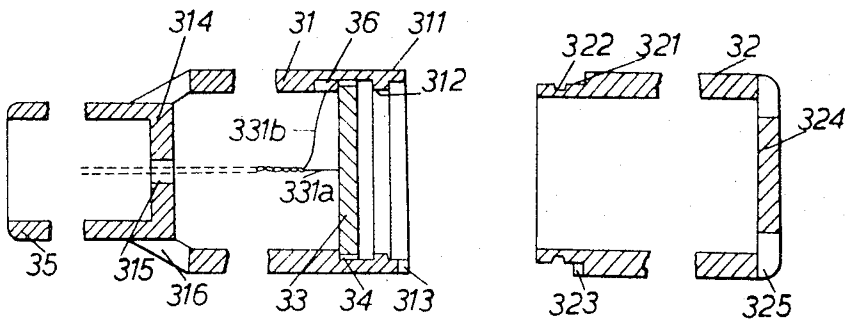


FIG.6.

FIG.7


314
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331b
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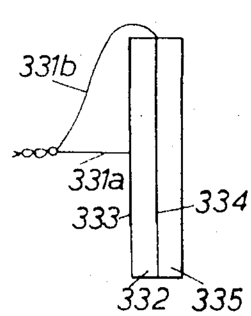
325

FIG.8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331a
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HEADSET

This invention relates to headsets for use by telephone operators or other persons using communications systems in a handsfree manner.

SUMMARY OF THE INVENTION

The invention provides a pressure gradient microphone for a communications headset, including a housing of molded plastics formed as a hollow cylinder with both ends apertured for the ingress of sound but otherwise substantially closed and a piezoelectric disc transducer element inside the housing with its major surfaces normal to the longitudinal axis of the housing, in which the disc is mounted halfway along the cylinder by an endless ring seal between its edge and the adjacent inside surface of the housing, and in which the apertured cylinder halves on each side of the disc are acoustic resonators at a predetermined frequency to provide an upper limit of the microphone output at said frequency.

According to the invention there is also provided a communication's headset having a microphone at the outer end of a boom, in which the microphone is as described in the previous paragraph, in which the boom is a tube carrying the microphone cable inside it, in which the longitudinal axis of the boom towards its outer end is coincident with the longitudinal axis of the microphone housing, and in which the boom and microphone configuration is such that when the apertured cylinder end of the microphone furthest from the boom is positioned in front of one corner of the user's mouth then the apertured cylinder end of the microphone adjacent the boom is displaced away from the user's mouth.

The invention further provides a communications headset having an insert type earphone and a microphone, and adapted to be worn by pressure against both sides of the user's head exerted via an under-the-chin band; in which one end of the under-the-chin band is attached to a main housing which contains the insert earphone, the housing and under-the-chin band being adapted, together with an earpiece, to position the insert earphone acoustic outlet opposite the user's ear canal; in which a tube associated with the microphone has one end attached to the main housing and is adapted to extend adjustably around the user's face towards his mouth; and in which the headset cable for connection to the earphone and microphone has one end attached to the main housing.

According to the invention there is still further provided a communications headset, in which a one-piece boom carries a microphone at its lower end, in which the upper portion of the boom is slidable up and down in a tubular cavity in a main housing, and in which a cable from the microphone is carried within the boom up into the main housing where it is led radially into a cylindrical cavity whose axis is perpendicular to the tubular cavity holding the upper end of the boom and out of said cylindrical cavity on its axis, the arrangement being such that when the boom is pushed in the upper end of the microphone cable moves into the cylindrical cavity and is accommodated around its periphery.

BRIEF DESCRIPTION OF THE DRAWINGS

A communications headset according to the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 shows a front view of the headset;

FIG. 2 shows a longitudinal section view of the main housing of the headset, also showing the earphone and the upper portion of the microphone boom;

FIGS. 3 and 4 show a side view and an underneath view respectively of the main housing;

FIG. 5 shows a side view, in the direction of the arrow A on FIG. 2, of the cover part of the main housing and indicates the microphone cable when the microphone boom is in the fully retracted position, and FIG. 5A shows again the top part of the main housing cover in order to indicate the position of the microphone cable when the microphone boom is in the fully extended position;

FIG. 6 shows a side view, in the direction of arrow B on FIG. 2, of the casing part of the main housing;

FIG. 7 shows a longitudinal section view of the casing and cap portions of the microphone housing, enlarged with respect to FIG. 1; and

FIG. 8 shows the construction of the piezoelectric disc transducer element incorporated in the microphone, enlarged with respect to FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, the headset includes a main housing **10** which locates against one side of the user's head. A detachable earpiece **11** clips onto the acoustic outlet nipple of an insert earphone contained in the housing **10**. A boom tube **12** extends from the lower end of the housing **10** and is adjustably adapted to extend around the user's face towards his mouth. At the outer end of the boom **12** is a microphone **13**. The headset cable **14** for connection to the earphone and microphone has one end attached to the housing **10** from where it can hang freely to a dress clip when the headset is in use. One end of an under-the-chin band **15** is attached to the main housing **10**. The headset is adapted to be worn by pressure exerted against both sides of the user's head via the band **15**; the housing **10** and the band **15** being adapted, together with the earpiece **11**, to position the insert earphone acoustic outlet opposite the user's ear canal.

Referring now to FIGS. **2** to **6**, the main housing is a two-part plastics molding comprising a cover portion **16** on the back of a casing portion **17**. The cover **16** and casing **17** are held together in any convenient manner, preferably by undercutting one of the parts to form a male portion so that it snap fits into the other part forming a female portion with an adhesive to complete the fixing. The microphone boom **12**, headset cable **14**, and under-the-chin band **15** are attached to the main housing by extending into three parallel tubular cavities **18,19,20** respectively in a lower portion of the housing, and the earphone **21** is in an upper portion of the housing at the front of a tubular cavity **22** whose axis is perpendicular to the three tubular cavities in the lower portion.

The insert earphone **21** is a magnetic diaphragm electro-acoustic transducer of the miniature "button" type as used with hearing aids. As shown in FIGS. **2** and **3** it is located at the front of the housing cavity **22** by a lip 171 of the casing over the otherwise exposed front cover 211 of the earphone 21 with the acoustic outlet nipple 212 at the center protruding in front of the casing lip 171. As shown in FIG. 2 the earphone 21 is without its usual back cover, a ring 23 with a disc (not shown) behind it holding it and providing an air volume behind the earphone diaphragm. The earphone 21, ring 23 and disc are assembled into the casing 17 from the rear. In one alternative arrangement a complete earphone (i.e. with its back cover) is used, inserted into the casing 17 from the front of the cavity 22 and held in place by a turned-over lip which could be broken to enable the earphone to be replaced complete if necessary. As already described with reference to FIG. 1, the detachable earpiece 11 clips directly onto the outlet nipple 212 of the earphone 21. As shown in FIG. 1, the earpiece 11 has a small diameter end portion 111 to enable a fit against the user's ear canal. In an alternative arrangement, the earpiece could have a larger diameter end portion to fit the outer ear; some people will find this more pleasant to use and it also provides a good seal.

As already described, the microphone boom 12 is a one piece plastics tube whose upper portion is located in the tubular cavity 18 in the main housing. The cavity 18 is formed by a groove 161 in the cover 16 whose constant diameter is a sliding fit around the boom tube 12, and a cooperating groove in the back of the casing 17 which consists of a lower portion 172 of the same diameter as the groove 161 and an upper portion 173 of greater diameter. Inserted in the top of the tube 12 is a stem having a top portion of the same diameter as the tube 12 except for a radial projection 121 (see FIG. 2) which is a sliding fit in the increased diameter groove 173. Thus the boom tube 12 is slidable up and down in the cavity 18 over a distance equal to the length of the groove portion 173 less the length of the radial projection 121 i.e. about two centimeters. Also the boom tube is rotatable around its own axis through an angle determined by the distance around the periphery of the groove 173 less the thickness of the radial projection 121, i.e. about 150 degrees. This angle of rotation is sufficient for the microphone to be put forward of whichever ear the headset main casing is mounted on, and together with the 2 centimeters range for extension and retraction enables the microphone to be positioned by any user just in front of the corner of the lips.

A microphone cable 122 (see FIGS. 5 and 5A) from the microphone 13 is carried within the boom tube 12 into the cavity 18 in the main housing from where it is led through the groove 162 in the cover 16 radially into a cylindrical cavity 24 (see FIG. 2) which is coaxial with and the same diameter as the cavity 22 at the front of which the earphone 21 is located. The cavity 24 is formed between a recess 163 in the cover 16 and a plate 25 located in the back of the cavity 22, and the microphone cable 122 is led out of the cavity 24 on its axis through a hole in the center of the plate 25. In an alternative construction, where the earphone 21 inserted into the casing 17 from the front, the plate 25 can be formed integrally with the back of the casing 17.

In the fully retracted position of the boom 12, as shown in FIG. 5, the microphone cable 122 goes up and then right around the periphery of the cavity 24. When the boom 12 is pulled down to its extended position, the cable 122 is pulled through the guide groove 162 in the cover 16 and comes to the dashed line position shown on FIG. 5A. When the boom 12 is pushed back again the cable spiral automatically expands. In this way 2 centimeters of cable is accommodated in a small space without becoming tangled.

It will now be appreciated that the main reason for the arrangement which limits the rotative movement of the boom 12 to less than one full turn (in fact 150° as previously described) is to prevent continuous turning of the boom 12 which would eventually break the microphone cable 122. Without this limitation, continuous turning could occur by the user turning the boom 12 forward to get it in front of his mouth when putting on the headset, then turning further forward to remove the headset, then all the way round (instead of back) when next putting the headset on.

The microphone on the end of the boom 12 will now be described in detail with respect to FIGS. 1 and 7. The microphone housing is formed as a hollow cylinder of circular cross-section. The housing is divided transversely with respect to the longitudinal axis of the cylinder into two open ended parts, a casing 31 and a cap 32. The casing 31 has a portion 311 near its open end having its wall thickness reduced from the inside and a circular rib 312 projecting inwardly therefrom. The cap 32 has a portion 321 near its open end having its wall thickness reduced from the outside and a circular groove 322 in its outer surface. The casing 31 and cap 32 snap fit together by the cap portion 321 projecting into the casing portion 311 with the groove 322 fitting over the rib 312, and are keyed by a peg 323 on the cap 32 fitting in a recess 313 in the casing 31. The reduced end portion 321 of the cap 32 is shorter than the reduced end portion 311 of the casing 31 thus providing a groove in the inside surface of the housing in which a piezoelectric disc transducer element 33 is located with its major surfaces normal to the longitudinal axis of the housing.

On assembly, before fitting the cap 32 onto the casing 31, the transducer element 33 is mounted in the casing 31 by an edge encircling thin filler 34 of soft rubber or rubber like material which seals the element 33 to the adjacent inside surface of the cylinder. The seal 34 does not apply rigid edge clamping to the element 33 so providing good attenuation of mechanical vibrations between the housing and the element 33. Electrical connection wires 331*a*, 331*b* from the element 33 are led through a hole 315 in the wall 314 which closes the casing part 31 of the microphone housing into a tubular extension 35 integral with the wall 314 and hence to the microphone cable in the boom tube 12 which fits into the tubular extension 35. The wire 331*a* extends from the center of the back of the element 33 and the wire 331*b* extends from the edge of the element 33 through a notch 36 in the inside surface of the casing 31 adjacent the element 33.

The tubular extension 35 is of smaller section than the casing 31 and six sound ingress apertures 316 are provided in the sloping portion of the casing end wall 314 outside the tubular extension. Six sound ingress apertures 325 are also provided on the periphery of the wall 324 which closes the cap part 32 of the microphone housing. The cylinder end walls 314 and 324 are equidistant from the element 33. The microphone housing cylinder has a length (between the end walls 314 and 324) of about 32 millimeters and a diameter of about 9 millimeters, and the element 33 has a diameter of about 7 millimeters and a thickness of about 1 millimeter. The apertured cylinder half on each side of the element 33 forms an acoustic resonator at 4,000 Hz to provide an upper limit of the microphone output at this frequency.

The transducer element 33 will now be described in more detail with reference to FIG. 8. A thin disc 332 of piezoelectric ceramic material (lead-zirconate-titanate) has electrodes 333 and 334 applied as by evaporation (or by painting) to the major surfaces thereof. The material of the electrodes 333 and 334 is typically gold, nichrome or silver and in intimate contact with the disc surface. After application of the electrodes, the disc is polarized by subjection to a voltage via the electrodes of the order of 25KV per cm through the thickness of the disc, so that a voltage difference will appear between the electrodes when the disc is stretched radially.

The electrodes 333 and 334 cover the whole of the respective major surface of the disc almost to the periphery thereof, and the disc is mechanically bonded and electrically connected face to face with a thin flexible metal disc 335 typically of aluminum, brass or nickel iron, e.g. Permalloy D, about equal in thickness to the piezoeletric disc 332 and having an acoustic stiffness equal to the acoustic stiffness of the disc 332. The latter disc 332 is as thin as can conveniently be made, about 0.002 inches to 0.0025 inches. The lead wire 331*a* is attached to the electrode 333 at the face of the ceramic disc 332, and the lead wire 311b is attached to the edge of metal disc 335 and the electrode 334.

The composite disc 332, 335 together with electrodes 333 and 334 and lead wires 331*a* and 333*b*, constitute the piezoelectric disc transducer element 33 of the microphone 13.

Referring back to FIG. 1, the longitudinal axis of the boom 12 towards its outer end is coincident with the longitudinal axis of the microphone 13, and thus the boom and microphone confirguration is such that when the cylinder end of the microphone furthest from the boom (with apertures 325) is positioned in front of one corner of the user's mouth then the cylinder end of the microphone adjacent the boom (with apertures 316) is displaced sideways away from the user's mouth.

The microphone 13 is equally open to speech sounds at the two sets of apertures 325 and 316, so it is responsive to the pressure gradient between the two sets of apertures and the transducer element 33 is driven by the pressure difference between its two faces. Sound waves arriving at some distance greater than 1 foot due to ambient noise produce very little pressure difference across the element 33 at frequencies where the wavelength is large compared to the distance between back and front surfaces i.e. for all frequencies up to about 5,000 Hz. However with the apertures 325 very near the lips, the microphone is in the region of spherical wave propagation from the mouth and the well known bass boost effect comes into operation whereby the pressure gradient increases with decreasing frequency below 5,000 Hz. That is to say that the user's speech sounds are boosted compared to far sounds and so the microphone is noise cancelling. The element 33 should have its first resonant mode in the upper range of the speech band, between 3,500 Hz and 6,000 Hz to give a smooth response over the whole speech band.

Since the microphone 13 is used very near the mouth, normal air blasts of speech will tend to produce turbulent flow round the cylinder housing. The noises of turbulence, "blasting" are greatly reduced by the provision of open celled plastics foam, e.g. of polyurethane, (not shown) behind the apertures in the cylinder halves on each side of the element 33. This added acoustic resistance has a two fold effect: firstly it reduces the unidirectional air flow impinging directly on the element, and secondly it reduces the sharp edges which generate turbulence.

Referring now back to FIG. 2, the microphone cable which is led through the center of the plate 25 is connected to a pre-amplifier 26 (shown in dotted outline), constructed as a printed circuit board disc on which components are mounted and located in the cavity 22 behind the earphone 21. The piezoelectric transducer microphone 13 is a high impedance device, and the purpose of having the pre-amplifier 26 in the headset main housing is to raise the microphone output signals to a level such that they are not subject to undue interference along the headset cable 14. At the other end of the headset cable the pre-amplifier output is fed into another amplifier the output of which will match the microphone to the characteristics of the communication circuit to which the headset is connected, e.g. an operator's circuit in a telephone exchange.

The headset cable 14 enters the main housing through the tubular cavity 19 in the casing 17 in front of the groove 173 forming part of the tubular cavity 18 which holds the microphone boom 12. The top of the cable 14 has a grommet arranged to snap fit into the casing 17 by a bayonet action. The headset cable contains five wires; two to supply input signals to the earphone 21, two to take the microphone output signals from the pre-amplifier 26, and one to carry the necessary power supply for the pre-amplifier 26. Connection of these five wires from the earphone 21 and preamplifier 26 is made in the cavity 27, between the cavities 19 and 22, provided by a recess 174 (see FIG. 6) in the casing 17. A terminal block for this purpose can be provided by five connector pins insert molded into the casing 17 and projecting into the cavity 27.

The under-the-chin band 15 is a plastics tube having one end inserted into the hole 20 in the casing 17 by the side of the hole 19 holding the top end of the headset cable. The other end of the tube 15 fits into a plastics molded holder 40 (see FIG. 1) having a peg 41 on which a face pad 42 is retained. The tube 15 is shaped so that it opens out when worn and exerts sufficient pressure to hold the earpiece 11 into the ear on one side of the user's head and the face pad 42 to the bony part of the face in front of the ear on the other side of the user's head.

As an alternative to the face pad 42 an earpiece similar to the earpiece 11 can be retained on the peg 41 of the holder 40. Such an earpiece will hold the headset more securely to the head than the face pad 42 and may be preferred by some users; in this case coaxial holes through the holder 40 and the earpiece will maintain the ability of the user to listen to his surroundings while using the headset. Otherwise, the headset can be provided with a double earphone configuration. In this case the holder 40 will be replaced by a differently shaped molding adapted to hold the second earphone, which will also be of the insert type with an earpiece similar to the earpiece 11 clipped directly onto its outlet nipple, and the wires to this second earphone will be retained inside the tube 15.

The first mentioned end of the under-the-chin band **15** is simply stuck by adhesive into the hole **20** so that it is at the correct angle with respect to the housing **10** for when it is worn. An alternative fixing for the under-the-chin band **15**, which can be employed with the single earphone version of the headset, is to provide a snap fitting arrangement between the band **15** and the hole **20** (with means for keying them at the correct angle) so that the user can detach the band **15** at will. In the absence of the band **15** convenient use as a handset is enabled simply by holding the housing **10** to one side of the head with the earpiece **11** in the ear.

It is to be understood that the foregoing description of specific examples of this invention is made by way of example only and is not to be considered as a limitation on its scope.

We claim:

1. A pressure gradient microphone for a communications headset, including a housing of molded plastic formed as a hollow cylinder with both ends apertured for the ingress of sound but otherwise substantially closed and a piezoelectric disc transducer element inside the housing with its major surfaces normal to the longitudinal axis of the housing, in which the disc is mounted halfway along the cylinder by an endless ring seal between its edge and the adjacent inside surface of the housing, and in which the apertured cylinder halves on each side of the disc are acoustic resonators at a predetermined frequency to provide an upper limit of the microphone output at said frequency.

2. A microphone as claimed in claim **1**, and in which the ring seal is of rubber or a rubber-like material such as not to apply rigid edge clamping to the disc.

3. A microphone as claimed in claim **1**, and in which the cylinder halves on each side of the disc contain open celled plastic foam to provide acoustic resistance.

4. A microphone as claimed in claim **1**, and in which the transducer element comprises a piezoelectric disc with an electrode on each major surface thereof, and a second disc of equal acoustic stiffness attached face to face with the piezoelectric disc.

5. A microphone as claimed in claim **4**, and in which the second disc is a flexible metal disc.

6. A microphone as claimed in claim **1**, in which the housing is divided transversely with respect to the longitudinal axis of the cylinder into two open ended parts, a casing and a cap, which snap fit together, in which the ring seal secures the disc to the casing part at its open end, and in which electrical connection wires from the disc are led out of the housing through the casing part.

7. A microphone as claimed in claim **6**, in which a portion of the cap part near its open end having its wall thickness reduced from the outside projects into a portion of the casing part near its open end having its wall thickness reduced from the inside, and in which the reduced end portion of the cap part is shorter than the reduced end portion of the casing part thus providing a groove in the inside surface of the housing in which the disc is located.

8. A communications headset having a pressure gradient microphone at the outer end of a boom, in which the boom is a tube carrying the microphone cable inside it, in which the longitudinal axis of the boom towards its outer end is coincident with the longitudinal axis of the microphone housing, and in which the boom and microphone configuration is such that when the apertured cylinder end of the microphone furthest from the boom is positioned in front of one corner of the user's mouth, then the apertured cylinder end of the microphone adjacent the boom is displaced away from the user's mouth.

9. A communications headset as claimed in claim **8**, in which the boom and microphone are held together by the outer end of the boom tube fitting into an integral tubular extension from the closed end of the casing part of the microphone housing, in which the electrical connection wires of the microphone are led through a hole in the casing closed end into the tubular extension and hence to the microphone cable in the boom tube, and in which the tubular extension is of smaller section than the casing part of the housing with sound ingress apertures being provided in the casing closed end outside the tubular extension.

10. A communications headset having an insert type earphone and a microphone, and adapted to be worn by pressure against both sides of the user's head exerted via an under-the-chin band; in which one end of the under-the-chin band is attached to a main housing which contains the insert earphone, the housing and under-the-chin band being adapted, together with an earpiece, to position the insert earphone acoustic outlet opposite the user's ear canal; in which a tube associated with the microphone has one end attached to the main housing and is adapted to extend adjustably around the user's face towards his mouth; and in which the headset cable for connection to the earphone and microphone has one end attached to the main housing.

11. A headset as claimed in claim **10**, in which the under-the-chin band, microphone tube and headset cable are attached to the main housing by extending into three tubular cavities in a lower portion of the housing, and in which the earphone is in an upper portion of the housing at the front of a tubular cavity whose axis is perpendicular to the microphone tube cavity in the lower portion.

12. A headset as claimed in claim **11**, in which the microphone tube is a one-piece boom carrying the microphone at its lower end near the user's mouth, in which the upper portion of the boom is slidable up and down in its tubular cavity in the main housing, and in which a cable from the microphone is carried within the boom up into the main housing where it is led radially into a cylindrical cavity whose axis perpendicular to the tubular cavity holding the upper end of the boom and out of said cylindrical cavity on its axis, the arrangement being such that when the boom is pushed in the upper end of the microphone cable moves into the cylindrical cavity and is accommodated around its periphery.

13. A headset as claimed in claim **12**, and in which the upper portion of the boom and the main housing tubular cavity in which it is accommodated are adapted to allow the boom to be rotated around its own axis through less than one full turn.

14. A headset as claimed in claim **13**, in which the upper portion of the boom has a radial projection at its top end, and in which the tubular cavity holding the upper portion of the boom has a portion extending for part of its length with a sector of diameter greater than the boom to accommodate said radial extension at the top of the boom, the length and the sector size of said portion being adapted together with said radial extension to limit the sliding and rotative movements respectively of the boom.

15. A headset as claimed in claim 12, in which the main housing is a two-part molded plastic comprising a cover portion on the back of a casing portion, in which the tubular cavity holding the upper portion of the microphone boom is formed by a groove in the back of the casing and a cooperating groove in the cover, and in which the cylindrical cavity accommodating the upper end of the microphone cable is partly formed by a recess in the cover.

16. A headset as claimed in claim 15, and in which the cylindrical cavity accommodating the upper end of the microphone cable is coaxial with the tubular cavity at the front of which the insert earphone is located.

17. A headset as claimed in claim 16, and in which a microphone preamplifier is housed behind the insert earphone.

18. A headset as claimed in claim 15, and in which the two tubular cavities in the main housing into which extend the under-the-chin band and headset cable respectively are side by side in a separate plane from the tubular cavity holding the upper portion of the microphone boom.

19. A headset as claimed in claim 10, and in which the under-the-chin band is detachably attached to the main housing so that use as a handset is enabled by the removal of the under-the-chin band.

20. A communications headset comprising a one-piece boom which mounts a microphone at its lower end, wherein the upper portion of the boom is slidable up and down in a tubular cavity in a main housing, and a cable from the microphone is carried within the boom up into the main housing where it is led radially into a cylindrical cavity whose axis is perpendicular to the tubular cavity holding the upper end of the boom and out of said cylindrical cavity on its axis, whereby when the boom is pushed in, the upper end of the microphone cable moves into the cylindrical cavity and is accommodated around its periphery.

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