Aug. 3, 1943. R. W. CARLISLE ET AL 2,325,590

EARPHONE

Filed May 11, 1940 2 Sheets-Sheet 1

Fig. 1

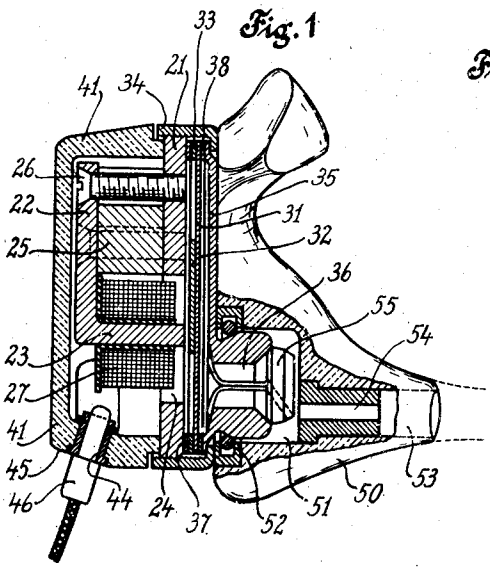


Fig. 2

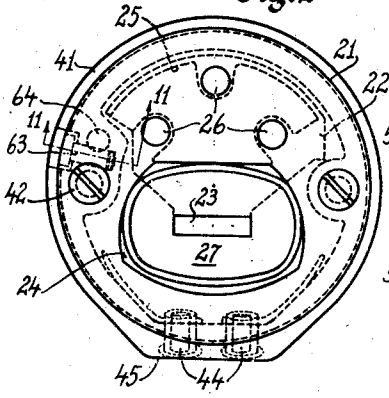


Fig. 7

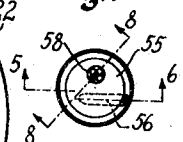


Fig. 5

Fig. 8

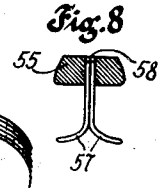


Fig. 4

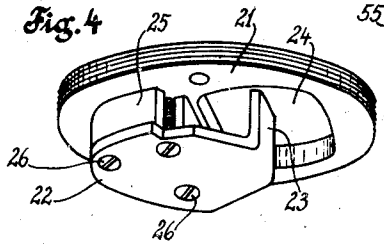


Fig. 6

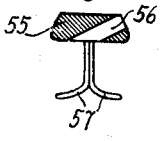
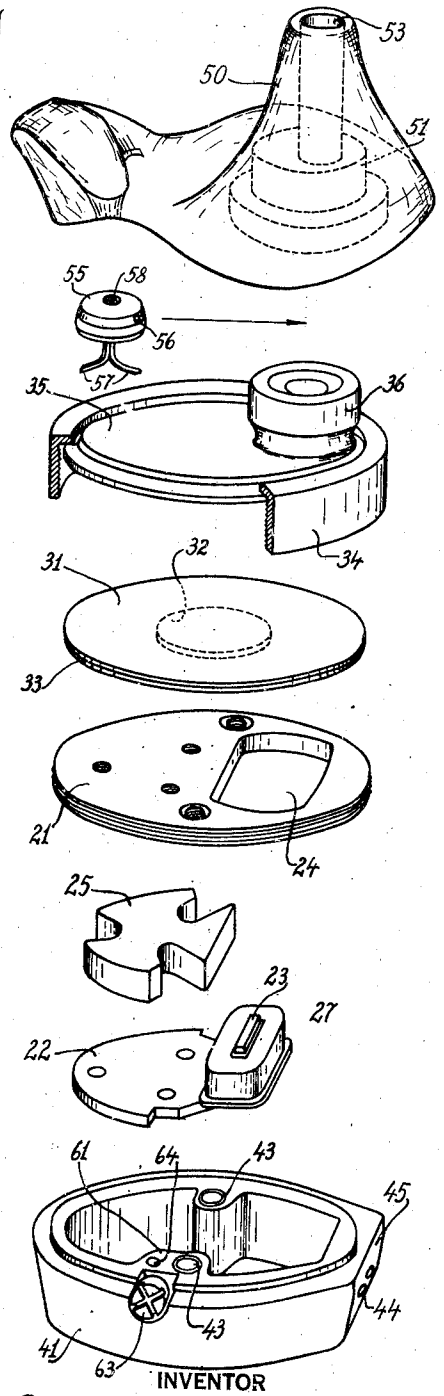


Fig. 3



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EARPHONE

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Fig. 13

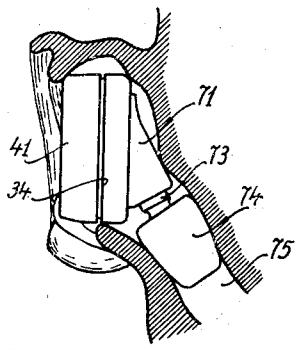


Fig. 14

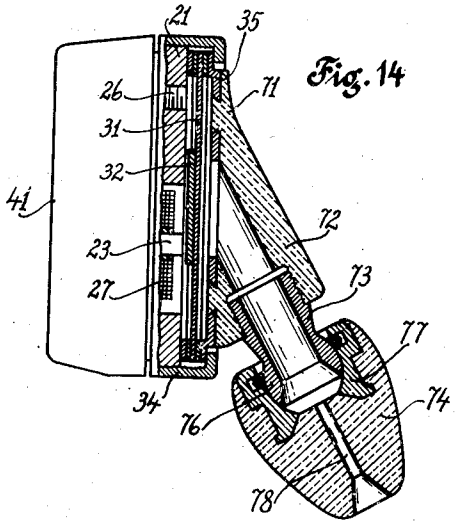


Fig. 16

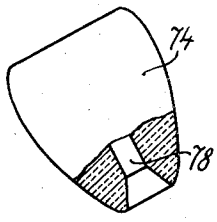


Fig. 17

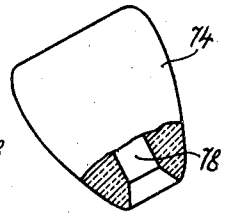


Fig. 15

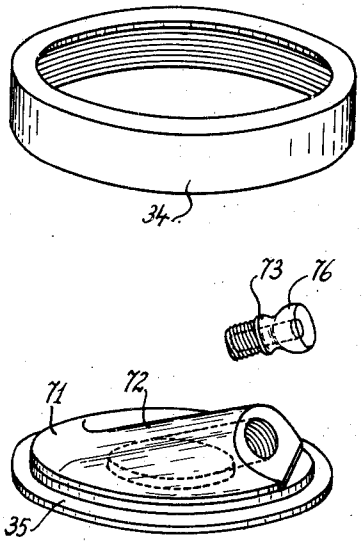


Fig. 10

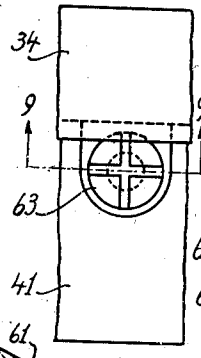


Fig. 11

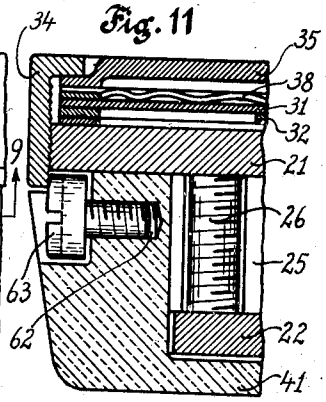


Fig. 12

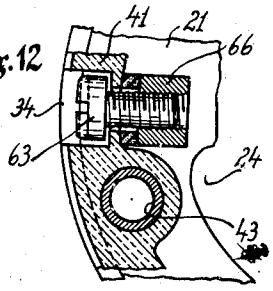
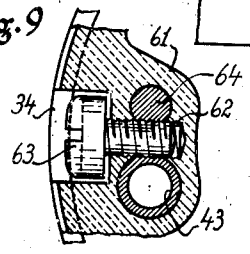


Fig. 9



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UNITED STATES PATENT OFFICE

2,325,590

EARPHONE

Richard W. Carlisle, Elmsford, and Alfred J. Mastropole, New York, N. Y., assignors to Sonotone Corporation, Elmsford, N. Y., a corporation of New York

Application May 11, 1940, Serial No. 334,678

8 Claims. (Cl. 179—107)

This invention relates to earphones, and particularly to midget size earphones of the type used by deafened persons, small enough to be worn and held within the ear of the user.

Among the objects of the invention is an improved midget earphone combining within an extremely small structure various features which simplify its manufacture, assembly and accurate adjustment in an efficient operating condition essential for producing with such small unit the relatively large volume of relatively high quality output required from a satisfactory hearing aid; and improved methods and arrangements for selectively controlling and adjusting the output characteristics of such earphone so as to fit best the needs of the user.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawings in which

Fig. 1 is a vertical cross-sectional view through a midget earphone illustrating one form of the invention as it is held within the ear of the user;

Fig. 2 is an elevational view of the receiver without its cap;

Fig. 3 is an exploded view of the principal elements of the earphone;

Fig. 4 is a perspective view of the assembled elements of the magnetic driving structure of the earphone;

Figs. 5 and 6 are cross-sectional views along line 5—6 of Fig. 7 of two interchangeable tone control units for the earphone;

Fig. 7 is a top view of the tone control unit;

Fig. 8 is a cross-sectional view along line 8—8 of Fig. 7 of a similar interchangeable control element;

Fig. 9 is a sectional view along line 9—9 of Fig. 10 of an arrangement for locking the earphone cap in its adjusted position;

Figs. 10 and 11 are elevational and sectional views, respectively, of the locking arrangement of Fig. 9;

Fig. 12 is a view similar to Fig. 9 of a modified form of locking arrangement;

Fig. 13 is an exterior view of another form of an earphone of the invention and a horizontal section of the adjacent portions of the ear in which it is held;

Fig. 14 is a horizontal sectional view of the earphone of Fig. 13;

Fig. 15 is an exploded view of the cap elements of Fig. 14; and

Figs. 16 and 17 are views of two interchangeable tone control units for the earphone of Fig. 13.

Most of the deafened are very sensitive and seek to conceal their hearing impairment. Accordingly, a satisfactory hearing aid device for supplying the deafened person with the sound energy required to overcome his handicap must be suitable for comfortable and inconspicuous wear and simple and foolproof in operation so as to free the user from physical as well as mental strains. All the elements of the device must not only be small and light in weight, but must be able to respond at high efficiency to all important speech frequencies and they must operate satisfactorily under all conditions of use, without special attention and frequent reconditioning.

Many efforts have been made in the past to make the hearing aid midget earphones worn in the ear of the user as small, as comfortable and as efficient as possible so as to meet the foregoing requirements.

It was also long known that the hearing deficiencies of different individuals vary over the range of audible sound frequencies, and that it is very important to make it possible to selectively control the frequency response of earphones in accordance with the individual needs of each user.

The earphone of the invention is of much simpler construction than similar prior earphones, and embodies various desirable novel features which make it possible to more accurately manufacture, assemble and adjust such earphone, and to reduce its overall size without decreasing its output and quality.

The invention also provides novel methods and arrangements for selectively controlling the frequency characteristics of the earphone output so that it fits best the needs of the user.

The various features of the invention will be more readily understood from the description of an exemplification thereof in the form of the midget earphone shown in Figs. 1 to 4 which is designed to serve as a part of a hearing aid in which the receiver winding may be traversed by a D. C. current component in addition to the speech frequency current oscillations used for its operation.

The earphone is of the electromagnetic type and has an electromagnetic driving structure formed of an outer pole plate 21 to which is secured a parallel inner pole plate 22 having an angularly bent pole arm 23 projecting into the opening 24 of the pole plate 21, and a permanent magnet block 25 is held suitably clamped be-

tween the parallel portions of the pole plates 21, 22, as by three screws 26 extending through notches provided in the periphery of the block 25.

The permanent magnet block 25 has flat parallel walls against which the two parallel pole plates 21, 22 are clamped and is made of good-quality permanently-magnetizable material. Permanent magnet blocks made of powdered Alnico material, which is sintered in the molded shape shown in the drawings, are used in the practical construction of such earphones. On the pole arm 23 of the pole plate 22 is mounted the actuating-winding coil 27 of the electromagnetic driving structure.

The hole 24 of the outer pole plate 21 is made large enough to enable the insertion of the coil 27 into its place on the pole arm 23 after the assemby of the magnetic driving structure shown in Fig. 4 has been completed. This is important in the manufacture of such midget earphones because it makes it possible to sand off or grind to an even flat aligned surface level the pole face of the pole arm 23 and the adjacent face of the outer pole plate 21, and to blow out the chips caused by this operation before the coil is inserted. In addition, coils may be easily exchanged and replaced without disturbing the aligned magnetic driving structure.

The flat surface of the outer pole plate 21 serves as an aligning support for the vibratory diaphragm structure 31. The diaphragm structure 31 is formed of a flat spring metal plate to which is secured, as by soldering, a flat central magnetic armature portion 32 and a flat peripheral stiffening ring 33, which are so arranged that by aligning the periphery of the diaphragm 31 on the outer pole plate 21 the pole face of the armature 32 will be symmetrically aligned parallel and opposite to the pole faces of the pole arm 23 and the pole plate 21 and will enable accurate adjustment of the magnetic gap between the pole faces of the vibrating structure so formed. As shown in Fig. 1, the armature 32 bridges the magnetic path between the pole faces of the pole arm 23 and the aligned adjacent portion of the pole plate 21, which are spaced from the parallel pole face of the armature 32 by accurately adjusted gaps.

The aligning member formed by the outer pole plate 21 serves also as the clamping junction for clamping the armature diaphragm 31 in its accurately spaced and aligned position opposite the electromagnetic driving structure. As shown, the outer plate 21 has a threaded circular periphery which is engaged by an inwardly threaded cylindrical clamping ring 34 of the cap plate 35 so as to clamp the periphery of the diaphragm 31 in its aligned position and provide between its exterior surface and the cap plate 35 an acoustic chamber. The cap plate 35 has a projecting knob or tip 35 forming a sound outlet passage to the exterior. The cap 35 and its clamping ring 34 may be made of one piece, or, as shown, of two parts so as to make it possible to adjust the angular position of the cap plate 35. The armature is accurately spaced by a spacer ring 37 of the required thickness.

A spring ring 38 transversely bent into a wavy shape is clamped between the rim of the cover plate 35 and the rim of the armature diaphragm 31 so as to hold all operating parts clamped in their adjusted position.

In the earphone receiver assembly described above, the pole plate 21, which, as shown is a very solid rigid part, serves thus as an aligning member which makes it easy to align on its opposite sides the elements of the electromagnetic vibrating system and the acoustic chamber, and to maintain with a minimum of effort and care the accurate magnetic gap spacing and efficient operating conditions essential for producing with a tiny unit fitting within the ear of the person the relatively large sound output of good quality that is required from a satisfactory hearing aid earphone.

The earphone has also a casing shell member 41 which, in distinction from prior earphone designs, does not perform any functions, except to serve as enclosure for the parts of the magnetic structure mounted on the inner side of the aligning pole plate 21, the casing being held clamped thereto by flat head screws 42 held in inwardly threaded bushings 43 of the casing 41.

This arrangement makes it possible to mold the casing shell 41 of a relatively cheap synthetic resin material. Since the casing shell 41 is not used as a reference element for aligning the various parts of the vibrating system and the acoustic chamber, inaccuracies in molding or warpage will not in any way affect the accurate adjustment of the operating elements of the earphone.

The winding ends of the actuating coil 27 are connected to two terminal bushings 44 which extend through a slanted side wall portion 45 of the casing shell 41 at an angle to the generally flat parallel main walls of the earphone structure, so that when the cord plugs 46 of the connecting cord are inserted in the terminal bushing 44, the outwardly projecting plug portions shall not interfere with the insertion of the earphone into the space within the outer ear.

By mounting all the elements of the earphone, which cooperate in translating the electric oscillations delivered to the earphone into sound energy delivered to the ear of the user, on the opposite sides of a flat solid aligning plate, all operating parts may be made of simple shape and easily machined to accurate dimensions, thereby enabling easy assembly and accurate adjustment of all parts in their efficient operating positions.

The aligning plate 21 which is used as a common level for all operating parts, serves also as the support of the housing shell 41 which is so secured thereto that warpage or any inaccuracies in its dimensions cannot affect the adjustment of the operating parts.

As shown in the drawings, the sound outlet knob 36 projecting from the cover plate 35 is offset from the center and is shaped to clamp the earphone to an ear tip 50 molded to fit the outer ear of the user. The ear tip 50 has a cavity 51 for receiving the outlet knob 36 of the earphone which is held clamped therein by a snap fastener ring 52 retained in a collar insert embedded in the molded body of the ear tip 50. A sound passage 53 extending through the projecting portion of the ear tip registers with and fits into the mouth of the ear canal so that the sound generated in the acoustic chamber of the ear phone will be transmitted through the knob passage 36 and the ear tip passage 53 to the ear canal of the user.

In the drawings is shown an ear tip 50 molded to fit a very small size ear and, as shown, the diameter of the earphone is confined within the circumference of the flat ear tip surface facing it.

The size of such midget earphones presents

the following problem: Deafened persons are very anxious that the earphone shall be as small as possible and that it should not be noticeable. In order to meet these requirements, the diameter of the earphone must be kept down if possible so that it should fit within the lobe of a very small ear of a young person. In addition, it is desirable that the earphone should lie as flush within the lobe of the ear as feasible. This in turn requires that it should not be thicker than about $\frac{3}{16}$ of an inch.

The receiver of the invention meets these requirements. Its outer diameter is only .7 of an inch. As shown in the drawings, the midget earphone is thicker than the coil principally by the thickness of the inner pole plate **22** and the armature **32**. Accordingly, the thickness of the midget cannot be substantially reduced without reducing the size of the coil.

Since, as explained hereinabove, the earphone shown in the drawings is designed for use in hearing aids which send a D. C. current component through the earphone coil **27**, a considerable heat is evolved in the coil and the coil of the dimensions shown is just about adequate to take care of such heating effect.

The midget earphones of the invention of the type shown in the drawings may be made considerably thinner if they are designed for use only in hearing aids which do not send a direct current component through the receiver coil **27**. The thickness of a receiver designed for such use could be reduced by at least $\frac{1}{16}$ of an inch so that its overall thickness would be $\frac{1}{16}$ of an inch less than that shown.

By making the permanent magnet block with notches, it is automatically positioned in its proper place between the pole plates **21**, **22** and the shanks of their clamping screws **26** when assembled. In addition, this arrangement provides a large cross-sectional area for the magnetic path between the two pole plates having a sufficiently low magnetic reluctance to assure efficient operation of the receiver without necessitating special magnetic shunt paths for the alternating magnetic flux.

The coercive magnetic force of the permanent magnetic material used in the earphone is large enough to supply the required permanent magnet flux if its total thickness or its effective length between the pole plates is made as little as $\frac{1}{16}$ of an inch. Such construction would require a very short magnetic air gap of less than three thousandths of an inch between the armature and the core structure. If it is desired to operate such receivers with a larger air gap of the order of three to five thousandths of an inch, it is better to use a permanent magnet block **25** having an effective length or thickness of $\frac{1}{8}$ of an inch between the pole plates **21**, **22**.

The design features of the earphone described above eliminate disturbing effects of temperature changes on the adjustment of its cooperating elements that are otherwise encountered in such earphones. The response of the earphones may be regulated by using armature diaphragm structures of different resonant frequencies.

Thus, an earphone shown in the drawings having an armature **32** approximately .030 inch thick will resonate around 1100 cycles; one having an armature approximately .022 inch thick will resonate around 1500 cycles; and one having an armature approximately .015 inch will resonate around 1800 cycles.

Midget receivers operating with such resonant frequencies have a frequency range extending substantially 50% higher than the resonant frequency. By using a somewhat stiffer diaphragm **31** and an armature .012 thick, the resonant frequency may be raised to approximately 2500 cycles and higher, at a slight loss of sensitivity.

The same result may be accomplished by magnetizing the permanent magnet **25** less strongly. Where an increase in low frequency output is desired, the permanent magnet **25** is magnetized to less than full value. If it is desired to damp the mechanical resonance of the armature diaphragm and to extend the high frequency range, the thickness of the acoustic cavity between the armature diaphragm **31** and the cap plate **35** should be kept down to approximately .012 to .015 inch. In some cases, additional damping may be provided by placing a piece of cotton in the cavity **51** of the ear tip **50** in order to attenuate the resonance peaks, or to adjust the output on high signals to a critical level that will not be uncomfortable to the user.

Because of its acoustic propagation characteristics, the air in the knob outlet passage **36** acts as an inertance and has the effect of slightly attenuating frequencies above about 4000 cycles. This effect is desirable since the frequency band above 4000 cycles contains more noise than useful signals. If the acoustic cavity between the diaphragm **31** and the cap **35** is made too large, the air therein acts as a compliance which accentuates the effects of the inertance of the knob outlet passage and increases the attenuation of the high frequencies.

If the audiometric measurement of the user indicates that the diminution of the high frequency output is desirable, or if the user is particularly sensitive to distortion in the high frequency range, it is desirable to control the attenuation of the high frequency output. As shown in Figs. 1 to 3, such control of the high frequency output may be supplied by attaching to the outer end of the knob outlet duct **36** an outlet duct extension in the form of a washer-like plug member **55** provided with a relatively elongated hole **56** of small cross section.

As shown in Figs. 5 to 8, the tone control washer **55** is made very flat so as to occupy only a portion of the cavity **51** of the ear tip **50**. The hole **56** is arranged to extend diagonally through the flat body of the washer **55** so that its inertance effect is increased, and to assure that the outlet end of the hole **56** opening into the cavity **51** of the ear tip shall not be clogged by a piece of cotton placed therein. Such acoustic control plug **55** having a hole about .020 in diameter will reduce the output by about six decibels at 4000 cycles and will hardly have any effect at 1000 cycles and below.

By using a set of acoustic control washer plugs or duct extensions **55**, designed for detachable coupling to the outer end of the outlet knob of the acoustic chamber of the earphone, each having a hole **56** of different diameter, as shown in Figs. 5 and 6, the frequency characteristics or the tone of the output of a midget earphone may be adjusted in accordance with the needs of the user. Simple interchangeable attachment is made possible by providing each duct extension **55** with a spring projection **57** formed of two doubled-over thin wires anchored in a hole **58** of the washer, the free ends of the springs being bent outwardly to engage the inner edge of the outlet duct **36** and hold it clamped therein. As shown in Fig. 1, the sound outlet duct **36** of the

cover wall 35 has at its outer end an outwardly facing non-planar, tapered, seating surface interfitting with the complementary seating surface formed on the inward end of the duct extension washer 55; and the surface of the inner end of the outlet duct 36 is slightly tapered to receive the ends of the retainer springs 57 of the duct extensions 55, without increasing the height of the acoustic chamber of the earphone.

Instead of employing a set of duct extensions 55, of different acoustic inertance characteristics for selectively fitting the output characteristics of the earphone in accordance with the needs of the user, the control washer may be made with a very small hole 56 having an inertance effect required in extreme cases, which is then adjusted in accordance with the needs of the user, by successively enlarging it, by a set of graduated reamers or drills.

Alternatively, the outlet passage 53 of the molded ear tip 50 may be used for adjustably controlling the frequency or tone of the earphone output. To this end, the ear tip passage 53 is provided with an inner portion 54 forming a hole of reduced cross section which is so proportioned as to have an acoustic inertance effect required in extreme cases. The tone of the earphone output is then adjusted in accordance with the needs of different users by successively enlarging the narrow hole 54, for instance, by a set of graduated reamers or drills. As another alternative, the portion of the ear tip 50 surrounding its narrow tone control hole 54 may be made in the form of an interchangeably mounted insert plug, of metal, for instance, so as to enable adjustment of the tone in accordance with the needs of the user, by inserting into the ear tip passage 53 one of a set of insert plugs having tone control holes 54 of different graduated cross sections.

The earphones of the type shown may be used either in hearing aids in which its actuating coil is traversed by a direct-current component, or in which the coil is traversed only by alternating current. Because of the small size of the earphone, maintenance of the gap spacing between the armature and adjacent pole faces in a critically adjusted position is of controlling importance. In some cases, it may be very important to maintain the acoustic cavity in between the diaphragm and the cap critically adjusted. The magnetic gap may be critically adjusted by placing a spring washer, such as spring washer 38, between the diaphragm 31 and the pole plate 21, and one or more thin flat washers, such as washer 37, of the predetermined desired thickness between the cap wall 35 and the diaphragm 31 of the acoustic chamber. Thereupon, the cap rim 34 is turned against the pressure of the spring washer until the gap is adjusted in the operating position in which it meets best the needs of the user. If critical adjustment of the acoustic cavity is desired, the spring washer is placed between the diaphragm and the cap wall, while one or more thin washers of predetermined thickness are placed between the pole plate 21 and the diaphragm 31, and the cap rim 34 is turned to critically adjust the acoustic cavity.

In order to assure that the earphone remains in the critically adjusted position, it is provided with an arrangement for locking it in the adjusted position.

As shown in Figs. 9 to 11, the side wall of the casing 41 is provided with an inward protrusion 61 having an inwardly threaded hole 62 in which is mounted a locking screw 63, the head of which is located and arranged to engage the inwardly facing edge portion of the clamping collar 34 of the earphone cap 35. The cap collar 34 may be locked in the adjusted position of the cap by turning the locking screw 63 outwardly until it engages and clamps the cap collar or rim 34 against rotation. By turning the locking screw 63 inwardly, the cap collar 34 is released from its locking engagement, whereupon it may be turned to adjust either the gap or the acoustic chamber, whereupon it is again locked in the adjusted position by turning the locking screw 63 outwardly. The head of the locking screw 63 is provided with cross grooves to permit its being turned by a screw driver and its outer surface is slightly curved to facilitate its locking engagement with the inner edge of the cap rim 34.

As shown in Fig. 9, a firm anchorage of the adjusting screw within the thin wall of the casing 41 is provided by forming the molded wall protrusion 61 adjacent the molded protrusion of the bushing insert 43, and embedding in the protrusion 61 a metal pin insert 64 close to the bushing insert 43 to assure that their outer surfaces form parts of the threaded hole 62 of the locking screw 63.

In Fig. 12 is shown an alternative form in which the locking screw 63 is held in an inwardly threaded hole of a metallic projection 66 extending from the overlying pole plate 21. The metallic projection 66 may be formed either as part of the pole plate 21 or may be suitably secured thereto, as by fusing or welding.

Instead of supporting the earphone on a molded ear tip fitting and held within the outer ear, such midget earphones may be held directly within the cavity of the ear between the tragus and the anti-tragus, in the way shown in Fig. 13.

As shown in Figs. 13 to 15, in order to provide a tight sound passage between the acoustic chamber of the earphone and the mouth of the ear canal, the earphone is provided with a receiver cap 71 having an angularly projecting sound outlet duct portion 73 to which is connected by a self-adjustable junction a small ear tip duct 74 fitting and engaging the entrance portion of the ear canal 75.

In the form shown, the earphone cap 71 has a molded protruding portion 72 in which is held, as by threads, the outlet duct 73, which is of metal and forms a swivel stud having a ball-shaped end portion 76 fitting into a spherical seating surface of a swivel socket ring 77 embedded in the molded body of the ear tip duct 74.

As shown, the swivel socket ring 77 of the ear tip duct 74 is provided with a snap fastener ring so that when it is inserted on the swivel stud 76 it is retained in a self-adjustable position on its ball, so as to complete a substantially tight sound passage from the earphone outlet duct 73 through the ear tip duct 74 into the ear canal 75.

By providing a plurality of ear tip ducts 74 of different exterior dimensions, in the way shown in Figs. 16 and 17, but all designed for interchangeable self-adjustable clamping engagement with the swivel end of the earphone outlet duct 73, the same earphone may be fitted to ears of different sizes without requiring laborious and expensive molded ear tips of the type shown in Fig. 1, while assuring substantially the same degree of acoustic coupling between the acoustic cavity of the earphone and the ear canal. By providing sets of such interchangeably detachable swivel-type ear tip ducts 74 having sound

passages 78 of different cross sections, they may also be used instead of the washers 55 for controlling the tone or the frequency response of the earphone.

Alternatively, all ear tip ducts 74 may be provided with a passage of such small cross section as to provide for the most extreme cases requiring such type of tone control. The tone of the earphone output is then adjusted in accordance with the needs of different users by enlarging the passage 78 of the ear tip duct 74, for instance, by a graduated set of drills or reamers.

The exemplifications of the novel features of the invention described above which simplify and at the same time make possible much more accurate manufacture, assembly and critical adjustment of midget earphones for hearing aids and the like, and to modify their output characteristics so as to fit best the needs of the user, will suggest to those skilled in the art many other modifications thereof. It is accordingly desired that the appended claims be construed broadly and that they shall not be limited to the specific details shown and described in connection with the exemplifications thereof.

We claim:

1. In an earphone designed to be small enough for carrying in the ear of the user, an electromagnetic vibratory structure comprising a substantially rigid plate-like aligning member having a circular periphery and an opening in the interior thereof; a magnetic core structure clamped in a predetermined aligned position to one side of said aligning member and having a pole projection extending into said opening; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position by the periphery of the other side of said aligning member, said diaphragm having a magnetic armature portion driven by said core structure and held in a vibratory condition opposite said pole projection at a predetermined small gap spacing therefrom; and cap means having a cap wall including a cap outlet duct overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim held in detachable interlocking engagement with the periphery of said aligning member and holding clamped thereto said diaphragm and said cap wall; and a casing portion held in a position in which it encloses said core structure and is prevented from affecting the adjusted relation of the elements of the magnetic structure secured to said aligning member; and locking means including a locking screw mounted in a part of the earphone structure surrounding the pole projection and having an outer surface shaped so that upon turning it on its threads it will interlockingly engage or release an interior edge portion of said cap rim.

2. In an earphone designed to be small enough for carrying in the ear of the user, an electromagnetic vibrating structure comprising a substantially rigid plate-like aligning member having a circular periphery and an opening in the interior thereof; a magnetic core structure clamped in a predetermined aligned position to one side of said aligning member and having a pole projection extending into said opening; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position by the periphery of the other side of said aligning member, said diaphragm having a magnetic armature portion driven by said core structure and held in a vibratory condition opposite said pole projection at a predetermined small gap spacing therefrom; and cap means having a cap wall including a cap outlet duct overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim held in detachable interlocking engagement with the periphery of said aligning member and holding clamped thereto said diaphragm and said cap wall; and a casing portion held in a position in which it encloses said core structure and is prevented from affecting the adjusted relation of the elements of the magnetic structure secured to said aligning member; and locking means including a locking screw mounted in a part of the earphone structure surrounding the pole projection and having an outer surface shaped so that upon turning it on its threads it will interlockingly engage or release an interior edge portion of said cap rim projecting beyond the periphery of said aligning member.

3. In an earphone designed to be small enough for carrying in the ear of the user, an electroacoustic transducer structure including a casing portion having a rear wall and a side wall enclosing a part of said transducer structure and an aligning portion having a circular aligning periphery; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position relatively to said aligning periphery; cap means having a cap wall including a cap outlet duct overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim detachably engaging and overlapping said aligning periphery and holding clamped thereto said diaphragm and said cap wall; and locking means including a locking screw mounted in a part of the transducer structure surrounded by said casing portion and having an outer surface shaped so that upon turning it on its threads it will interlockingly engage or release an interior edge portion of said cap rim.

4. In an earphone designed to be small enough for carrying in the ear of the user, an electroacoustic transducer structure including a casing portion having a rear wall and a side wall enclosing a part of said transducer structure and an aligning portion having a circular aligning periphery; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position relatively to said aligning periphery; cap means having a cap wall including a cap outlet duct overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim detachably engaging and overlapping said aligning periphery and holding clamped thereto said diaphragm and said cap wall; and locking means including a locking screw mounted in a part of the transducer structure surrounded by said casing portion and having an outer surface shaped so that upon turning it on its threads it will interlockingly engage or release an interior edge portion of said cap rim, said locking screw being held in a wall portion of said casing portion.

5. In an arrangement for fitting a hearing aid including an earphone small enough for carrying in the ear of the user so as to compensate for his individual hearing impairment; said earphone comprising an electroacoustic transducer structure including a casing portion enclosing a part of said transducer structure and an aligning portion having a circular aligning periphery; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position relatively to said aligning periphery; a cap structure having a cap wall overlying said diaphragm to confine therebetween an acoustic chamber, and

a cap rim detachably engaging and overlapping said aligning periphery and holding clamped thereto said diaphragm and said cap wall; said cap wall having integrally formed thereon an outwardly projecting sound outlet duct having at its outer end a non-planar seating surface facing outwardly in the general direction of the duct passage; and a set of a plurality of outlet duct extensions, each duct extension having a complementary seating surface sealingly interfitting with the outwardly facing seating surface of said duct portion and junction means for detachably joining it to the end of said cap outlet duct, and different duct extensions of said set having a different internal cross section for enabling controllable adjustment of the frequency characteristics of the earphone output in accordance with the needs of the user; each of said duct extensions being designed to form part of a hollow ear tip member shaped and arranged to fit into the ear canal and to provide a substantially air-tight sound passage from said acoustic chamber to the ear canal.

6. In an arrangement for fitting a hearing aid including an earphone small enough for carrying in the ear of the user so as to compensate for his individual hearing impairment: said earphone comprising an electroacoustic transducer structure including a casing portion enclosing a part of said transducer structure and an aligning portion having a circular aligning periphery; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position relatively to said aligning periphery; a cap structure having a cap wall overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim detachably engaging and overlapping said aligning periphery and holding clamped thereto said diaphragm and said cap wall; said cap wall having integrally formed thereon an outwardly projecting sound outlet duct having at its outer end a non-planar seating surface facing outwardly in the general direction of the duct passage; and an outlet duct extension having a complementary seating surface sealingly interfitting with the outwardly facing seating surface of said duct portion and junction means for detachably joining it to the end of said cap outlet duct, said duct extension being designed to form part of a hollow ear tip member shaped and arranged to fit into the ear canal and to provide a substantially air-tight sound passage from said acoustic chamber to the ear canal.

7. In an arrangement for fitting a hearing aid including an earphone small enough for carrying in the ear of the user so as to compensate for his individual hearing impairment: said earphone comprising an electroacoustic transducer structure including a casing portion enclosing a part of said transducer structure and an aligning portion having a circular aligning periphery; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position relatively to said aligning periphery; a cap structure having a cap wall overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim detachably engaging and overlapping said aligning periphery and holding clamped thereto said diaphragm and said cap wall; said cap wall having integrally formed thereon an outwardly projecting sound outlet duct having at its outer end a non-planar seating surface facing outwardly in the general direction of the duct passage; and a set of a plurality of outlet duct extensions, each duct extension having a complementary seating surface sealingly interfitting with the outwardly facing seating surface of said duct portion and junction means for detachably joining it to the end of said cap outlet duct, and different duct extensions of said set having a different internal cross section for enabling controllable adjustment of the frequency characteristics of the earphone output in accordance with the needs of the user; each of said duct extensions being designed to form part of a hollow ear tip member shaped and arranged to fit into the ear canal and to provide a substantially air-tight sound passage from said acoustic chamber to the ear canal; said junction means and the seating surfaces of said sound outlet duct and said duct extensions being so shaped and arranged as to constitute a self-aligning universal joint junction enabling self-aligning adjustment of each of the outlet duct extensions in different angular positions relatively to the sound outlet duct.

8. In an arrangement for fitting a hearing aid including an earphone small enough for carrying in the ear of the user so as to compensate for his individual hearing impairment: said earphone comprising an electroacoustic transducer structure including a casing portion enclosing a part of said transducer structure and an aligning portion having a circular aligning periphery; a vibratory diaphragm having a periphery supported in a predeterminedly aligned position relatively to said aligning periphery; a cap structure having a cap wall overlying said diaphragm to confine therebetween an acoustic chamber, and a cap rim detachably engaging and overlapping said aligning periphery and holding clamped thereto said diaphragm and said cap wall; said cap wall having integrally formed thereon an outwardly projecting sound outlet duct having at its outer end a non-planar seating surface facing outwardly in the general direction of the duct passage; and an outlet duct extension having a complementary seating surface sealingly interfitting with the outwardly facing seating surface of said duct portion and junction means for detachably joining it to the end of said cap outlet duct, said duct extension being designed to form part of a hollow ear tip member shaped and arranged to fit into the ear canal and to provide a substantially air-tight sound passage from said acoustic chamber to the ear canal; said junction means and the seating surfaces of said sound outlet duct and said duct extension being so shaped and arranged as to constitute a self-aligning universal joint junction enabling self-aligning adjustment of said outlet duct extension in different angular positions relatively to the sound outlet duct.

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