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HEARING AID DEVICE

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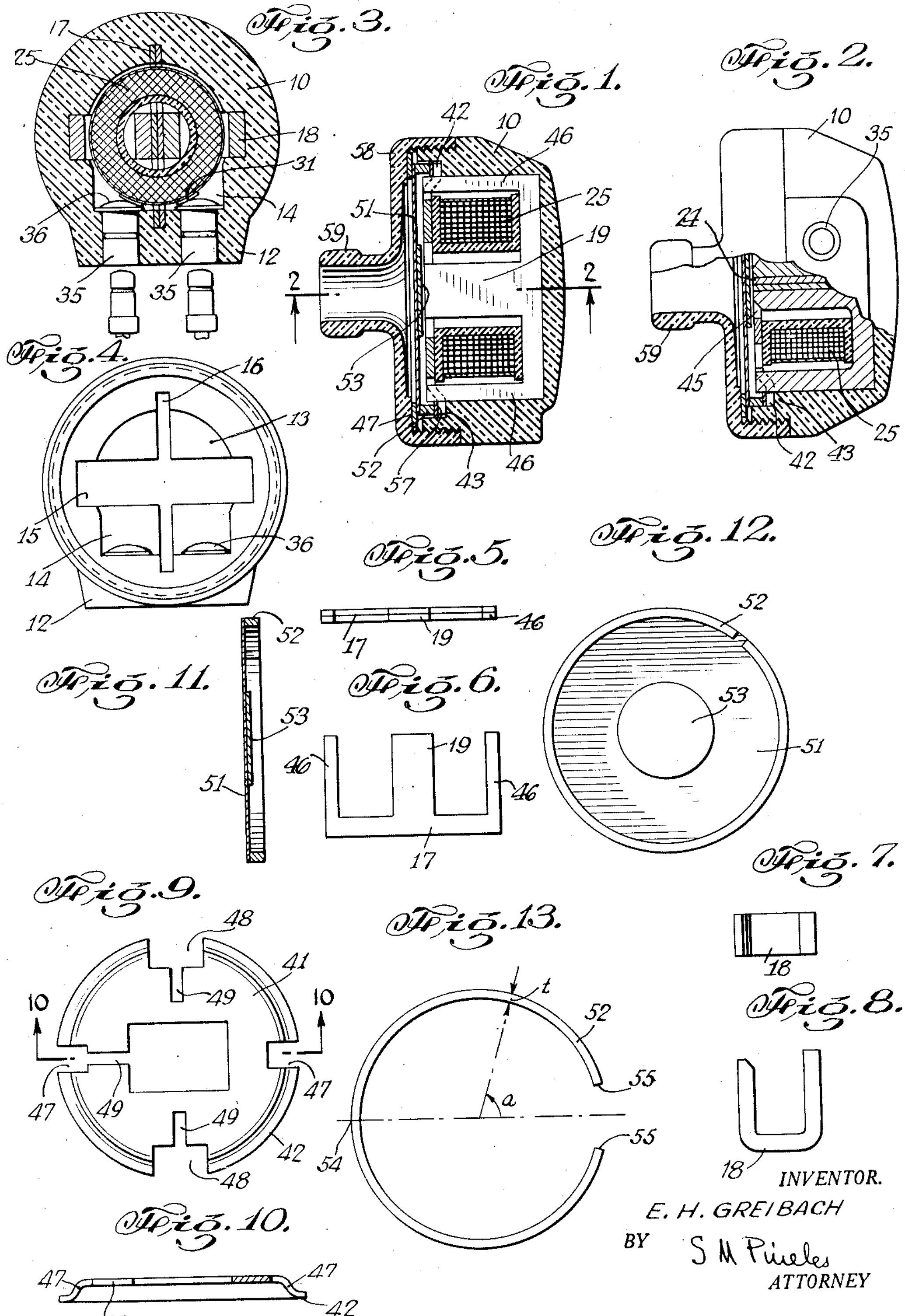

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HEARING-AID DEVICE

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4 Claims. (Cl. 179—181)

This application is a division of my copending application Serial No. 556,158 filed August 10, 1931, now Patent No. 1,973,410, dated Sept. 11, 1934.

This invention relates to telephone receivers and has particular relation to features of construction of a small midget type telephone receiver used in connection with hearing-aid devices which efficiently reproduces sound, is small and convenient to carry inconspicuously on the person, is mechanically strong and resistant to continuous handling by the user, and is economic and simple in manufacture, assembly and repair.

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 drawing wherein

Fig. 1 is a vertical sectional view through a completely assembled receiver telephone embodying the invention;

Fig. 2 is a partially sectional view of the complete receiver along line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view through the receiver casing and the assembled parts;

Fig. 4 is a top view of the open casing of the receiver telephone before the parts are assembled therein;

Figs. 5 and 6 are top and side views, respectively, of the soft iron core of the receiver;

Figs. 7 and 8 are top and side views, respectively, of the permanent magnet cores used in the receiver;

Fig. 9 is a top view of the pole plate of the receiver;

Fig. 10 is a cross sectional view through the pole plate along line 10—10 of Fig. 9;

Fig. 11 is a vertical sectional view through the diaphragm of the receiver;

Fig. 12 is an elevational view of the diaphragm; and

Fig. 13 is an elevational view of the tension ring of the diaphragm in its untensioned condition.

Hearing-aids must be suitable for inconspicuous wear and easy in handling by people having impaired hearing. This makes it necessary to make the receiver of a small size. At the same time the receiver must properly reproduce the sound that is to be imparted to the ear. Difficulties are thus presented in placing within a minute space available for the receiver the material and elements necessary to produce the sound in the ear of the wearer and to produce it in accordance with the sound input following faithfully its continuous variations.

My invention provides a midget telephone receiver of special construction assuring easy assembly and manufacture, and efficient sound reproduction, in a unit of small size and suitable for inconspicuous wear. It comprises a casing 10 of insulating material, such as of molded phenolic condensation substance, having an annular shape, only .875 inch in diameter, and is provided at one side of its tapered wall with a projecting terminal ledge portion 12. The interior of the casing has formed therein a hollow cylindrical chamber 13 merging into a rectangular extension 14 opposite the ledge portion 12. The sides and the bottom of the chamber 13 are further provided with a wide groove 15 and a relatively narrow groove 16 for mounting the elements of the magnetic system of the receiver.

The magnetic system comprises a plurality of E-shaped soft iron laminiations 17, in the instance illustrated, two laminations, as shown in detail in Figs. 5 and 6; and a pair of U-shaped permanent magnets 18, of highly retentive material, such as cobalt steel or the like, shown in detail in Figs. 7 and 8. The soft iron laminations are assembled side by side and inserted in the narrow slot 16 of the casing as shown in Fig. 3, and the two permanent magnets 18 are assembled in a direction perpendicular to the soft iron core on both sides of the center piece 19 of the soft iron laminations, as shown in Fig. 3. The arms 20 of the U-shaped permanent magnets leaning against the center portion of the soft iron core are somewhat shorter than the outer arms 21 and are beveled on the inner side at 22. When so assembled, as shown in Figs. 1, 2, and 3, the soft iron and the permanently magnetized core members constitute a magnetic system which has a center pole formed by the soft iron center pieces 19 of the laminations 17 and the arms 20 of the permanent magnets 18. By beveling off the sides of the permanent magnet arms 20, the flux of the permanent magnet core members 20 is forced through the pole area of the soft iron core members 19, thereby causing the permanent flux produced by the permanent magnets 18 and the flux produced by induction in the soft iron cores 17 to intimately intermingle at the pole surface 24.

Within the circular space between the magnet core arms is mounted an inducing coil 25 having two contact strips 31 of springy sheet metal, such as phosphor bronze.

In the ledge portion of the casing are mounted two contact bushings 35, in the form of hollow metallic sleeves with rounded heads 36, which are engaged by the contact strips 31 of the coil 25.

With the bushings so mounted in place within the casing and the soft iron and permanent magnet members assembled in their grooves within the casing, the inducing coil 25 may be mounted in its place by merely pushing it into the circular space of the casing, the two contact strips 31 of the coil automatically establishing a reliable electrical conducting connection between the ends of the coil and the two bushing sleeves 35 so that by inserting the plugs into the bushing sleeves a positive contact with the coil may be established. This permits quick detachable connection and disconnection of the connecting cord to the diminutive telephone, and provides a simple assembly of the magnetic and electrical parts within the casing.

Over the assembled magnet and coil structure is placed a pole plate 41 of soft iron, the edges 42 of the pole plate being depressed to rest against the inner edge 43 of the casing walls. The pole plate has a central rectangular opening larger than the pole face 24 of the central core member so as to leave a gap 45 between the inner edges of the opening and the edges of the pole face 24 of the central core of the magnet system. The periphery of the pole plate is provided with rectangular cutouts 47, 48 conforming in outline to the cross section of the outer arms of the magnet members so that the flux from the outer soft iron core members and permanent magnet members may enter into the pole plate and pass therealong to the central main gap 45 over which the plugs have then to cross towards the central core member of the magnet system. The junctions between the outer ends of the soft iron core arms 46 with the adjacent portions of the pole plate around the cutouts 47 form slight gaps so as to constitute points of relatively high reluctance preventing excessive flow of shunting flux between the inner and outer pole ends of the permanent magnets 18 by way from the central arm of the permanent magnet through the adjacent soft iron core members 19, then through said soft iron core members to the outer arms 46 thereof, and then through the body of the pole plate to the outer arms of the permanent magnet member. By making the junction between the ends of the outer soft iron core members with the pole plate 41, at the cutouts 47, of sufficiently high magnetic reluctance, this shunt flux may be reduced to the proper value. The radial slot in the pole plate prevents eddy currents.

Above the pole plate is mounted the diaphragm unit 50 comprising a thin circular resilient sheet 51, of phosphor bronze or sheet steel, for instance, which is held under uniform circumferential tension by a tension ring 52 shown in detail in Figs. 11 to 13. At the center the resilient diaphragm 51 carries a soft iron armature 53 in the form of a circular disk which has its back surface soldered or otherwise joined to the underside of the diaphragm 51. In order to give the diaphragm the correct tension while securing a structure of utmost simplicity and easy to manufacture, the tension ring is made of a body of steel or similar material of larger diameter than the diameter of the diaphragm, the tension ring for the diaphragm shown in Figs. 11 and 12 being, for instance, shown in its normal condition in Fig. 13. A part of the ring periphery is cut out so that when the edges of the ring shown in Fig. 13 are brought close to each other, the ring assumes the form in which it is seen in Fig. 12. In making the diaphragm unit, the ring is compressed to the proper diameter and placed in a fixture having a depression equal to the height of the ring and a diameter equal to the diameter of the diaphragm 51. The diaphragm 51 is then placed over the ring and soldered at its edge to the ring so that, after the soldering, the ring with the diaphragm may be taken out of the fixture, the ring 52 trying to return to its normal position as shown in Fig. 13 and thus stretching the diaphragm skin 51 in all directions. The fixture for soldering the diaphragm 51 to the ring 52 may be combined with the fixture for soldering the armature 53 to the diaphragm, the fixture having simply in the center another depression for housing the diaphragm 53, the two soldering operations being performed together.

If the spring ring has a uniform thickness, the radial tension of the diaphragm 51 will not be quite uniform in the different radial directions. In order to secure uniform stretching in all directions, the ring is made with a thickness which decreases uniformly from the center point of the ring at 54 towards its two ends 55. The correct thickness of the ring to secure uniform tension in the diaphragm can be determined from the formula

$$t=c\left(\sin^2\frac{a}{2}\right)^{1/3}$$

where "t" is the thickness at a point of the periphery under the angle "a" and "c" is the thickness of the ring at the center portion 54. The height of the spring ring 52 is so chosen that when mounted in place, as shown in Figs. 1 and 2, the armature 53 is spaced a short distance above the pole face 24 so that it is free to swing up and down. To secure the proper spacing of the armature 53 from the pole face 24, one or more washers 57 may be inserted between the outer edge of the pole plate 41 and the bottom side of the tension ring 52. The assembly of the receiver unit is completed by placing a second washer 47 over the top edge of the diaphragm 51 and screwing over it a cover member 58 having a peripheral portion screwed over the threaded outer wall of the casing 10. The cover 58 may be made of metal, such as aluminum, and it conforms to the outer contours of the casing 10. The central portion of the cover 58 forms a small sound chamber in front of the diaphragm, and has an upwardly projecting perforated nipple 59 at the center of the cover. This nipple may be either directly placed in the ear or have another rubber nipple fitting the ear clamped over it so as to cause the column of air impelled by the movement of the diaphragm 51 to act directly on the ear canal.

It is difficult in practice to make efficient small telephones of the midget type with magnetic systems composed only of permanent magnets because excessively long magnets are required to provide the necessary flux conditions at the armature. It is likewise difficult in practice to make such midget telephones with soft iron shunts because a relatively larger magnet is necessary in order to produce a sufficient permanent magnetic field to provide for the shunt flux as well as for the main actuating flux at the armature. This difficulty is overcome by the construction of my invention as shown in Figs. 1, 2, and 3.

A permanent flux is produced by the arms of the permanent magnet, and at the same time a soft iron shunt is provided for the induced alternating flux without loss of too much permanent flux by the shunt. A high degree of operativeness of the receiver is obtained by securing thorough intermingling of the permanent flux and the superposed induced alternating fluxes at the armature gap **45** through the use of a common pole surface on the end of the central soft iron core member **19**. The same is true of the fluxes coming through the outer arms of the permanent magnet and soft iron core members, these fluxes again combining and intermingling in the pole plate. By proper provision of high reluctance junctions, in the form of gaps **47** between the outer arm ends **46** of the soft iron core and the adjoining cutouts **47** of the soft iron pole piece **41**, excess diversion of the permanent flux from the main armature gap **45** is avoided, while at the same time a soft iron path of relatively low reluctance is provided through the soft iron core **17** for the alternating fluxes induced by coil **25**.

The features of the invention described above are susceptible of many modifications that will suggest themselves to those skilled in the art.

I claim:

1. In a wearable hearing-aid device, an electromagnetic sound reproducing vibrating mechanism having a magnetic system for actuating an armature, an armature diaphragm unit comprising a diaphragm of thin resilient metal, a split ring of resilient metal integrally united to the periphery of said diaphragm, and an armature integrally united to the center of said diaphragm adapted to be actuated by said magnetic system, said split ring being compressed from an originally larger diameter and exerting under the action of its internal forces radial forces maintaining said diaphragm in a radially tensioned condition.

2. In a hearing-aid midget telephone receiver having a magnetic system for actuating an armature, an armature diaphragm unit comprising a diaphragm of thin resilient metal, a split ring of resilient metal integrally united to the periphery of said diaphragm, and an armature integrally united to the center of said diaphragm adapted to be actuated by said magnetic system, said split ring being compressed from an originally larger diameter and having a thickness decreasing from its center towards its ends so that under the action of the forces exercised by said ring in its tendency to return to its original position said diaphragm is substantially uniformly tensioned in all radial directions by said ring.

3. In a hearing-aid telephone receiver having a magnetic system for actuating an armature, an armature diaphragm unit comprising a diaphragm of resilient metal having a thickness of less than 5 mils, and preferably of the order of 2 mils, a split ring of resilient metal integrally united to the periphery of said diaphragm, and an armature integrally united to the center of said diaphragm adapted to be actuated by said magnetic system, said split ring being compressed from an originally larger diameter and exerting under the action of its inner forces radial forces maintaining said diaphragm in a radially tensioned condition.

4. The method of producing a tensioned diaphragm unit for a telephone receiver or the like, which comprises producing a flat, split ring member of resilient spring metal lacking a small segmental portion to form a complete ring and resiliently resisting distortion of its shape, externally compressing said ring member to form a ring of smaller diameter tending to return to its original shape, integrally uniting said compressed ring to a metal foil diaphragm while simultaneously uniting an armature to the center of said diaphragm, and then releasing said ring from the external compression for radially tensioning the portion of said diaphragm between the armature and the ring.

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