

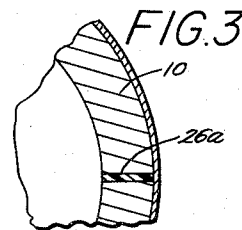
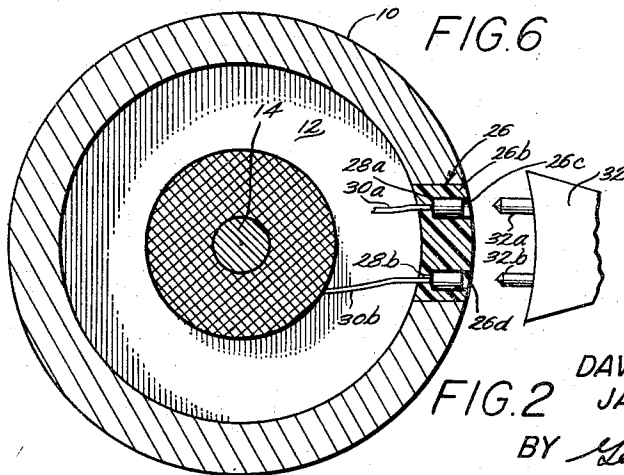
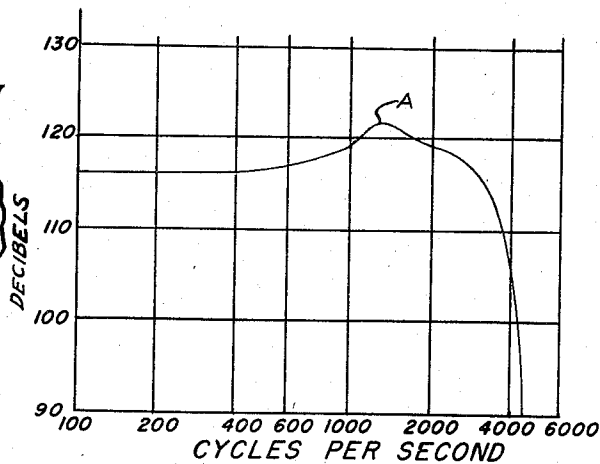
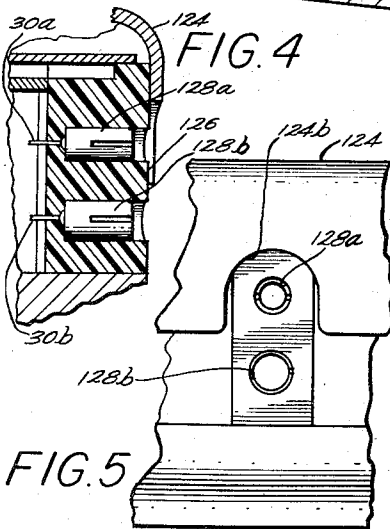
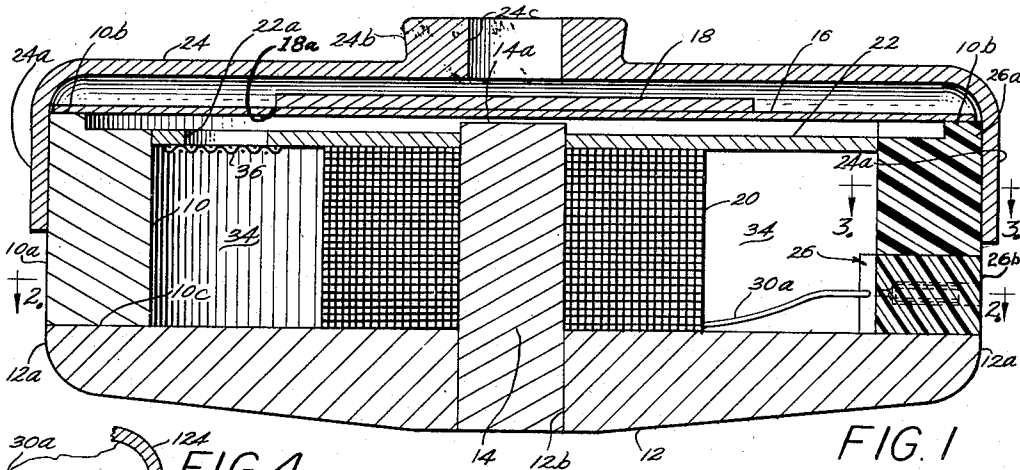
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HEARING AID RECEIVER

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HEARING AID RECEIVER

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6 Claims. (Cl. 179—115)

The present invention relates to a hearing aid receiver characterized by small size and good electrical and mechanical characteristics.

Hearing aid receivers are required to produce relatively high level sound in the ear passages of the wearer. However, considerations of appearance as well as comfort, require that such receivers be light in weight and small in size. It is accordingly highly desirable in a hearing aid receiver to provide a structure in which the materials are employed in the most effective manner possible consistent with effective operation.

In accordance with the present invention the hearing aid receiver consists of an annular axially polarized permanent magnet which serves to impart a D.-C. bias to the magnetic field while at the same time functioning as part of the A.-C. flux path and the case of the receiver. Since the magnet itself serves as part of the case—and the remainder of the case is defined by operative parts of the receiver—no separate housing with the incident weight and bulk is required. The bottom of the magnet is closed by a magnetic disc which forms the bottom of the case and at its center supports a magnetic pole piece which reaches up to points adjacent the open end of the permanent magnet. The diaphragm bridges the open end of the permanent magnet and thus extends to a position closely adjacent to the central pole piece. The voice coil encircles the pole piece and its connections to the external driving circuits are obtained through a terminal block forming an integral part of the permanent magnet and having its exposed face flush with the outer face of the magnet to form a smooth case. This terminal block is located in a circumferentially extending gap in the magnet which spans the entire cross-section of the magnet to interrupt the electrical circuit the magnet otherwise forms about the coil.

The present invention further contemplates the use of a circular magnetic disc disposed over the center of the diaphragm to serve the dual function of permitting a very thin and hence limber diaphragm without magnetic saturation and weighting the diaphragm at the most effective position to lower the resonant frequency as desired.

Further in accordance with the present invention the sharpness of the resonant peak is reduced by providing an apertured wall between the annular cavity formed by the magnet and the coil and the space beneath the diaphragm. The aperture is spanned by a cloth web which serves as a damper to resist air flow therethrough.

It is, therefore, a general object of the present invention to provide an improved hearing aid receiver.

More specifically, it is an object of the present invention to provide an improved hearing aid receiver in which the magnetic structure itself defines the outer casing.

Further it is an object of the present invention to provide an improved hearing aid receiver wherein the permanent magnet defines the outer casing and in which terminal connections are provided as an integral part

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of the magnet without prejudice to its effective operation as a magnet.

It is a further object of the present invention to provide an improved hearing aid receiver in which the resonant peak is comparatively broad in frequency and small in amount.

Still another object of the present invention is to provide a unipolar receiver for hearing aids wherein the permanent biasing magnet extends about the voice coil without interfering with the operation thereof.

Additionally it is an object of the present invention to provide an improved hearing aid receiver having features of construction, combination and arrangement whereby it efficiently utilizes the magnetic parts to impart vibration to the diaphragm as well as to form the casing, is of simple construction, operates effectively over the desired frequency range, and accommodates a relatively high impedance voice coil.

Still another object of the present invention is to provide an improved hearing aid receiver in which a magnetic disc is provided at the center of the diaphragm without creating undesired noise or buzzing in the receiver.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and mode of operation, will best be understood by reference to the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a greatly enlarged view in axial cross-section of a hearing aid receiver constructed in accordance with the present invention;

Fig. 2 is a view through axis 2—2, Fig. 1, to a smaller scale and showing the connecting plug in detached relation to the socket formed by the receiver;

Fig. 3 is a fragmentary view to a smaller scale through axis 3—3, Fig. 1;

Fig. 4 is a fragmentary view like Fig. 1 but showing an alternative arrangement of the socket for the connecting plug;

Fig. 5 is a fragmentary side elevational view of the apparatus of Fig. 4; and

Fig. 6 is a frequency response curve showing the characteristics of a receiver similar to that of Fig. 1 constructed in accordance with the present invention.

Referring now to Fig. 1, there is shown at 10 an annular permanent magnet. This magnet has its bottom edge closed by the disc 12 which is of soft magnetic material and at its edge 12a mates with the outer face 10a of the magnet 10 to form a neat attractive outer appearance. The disc 12 has a cylindrical bore 12b at its center portion, which bore receives the pole piece 14 which extends towards the open end of the annular magnet 10 as shown. In an actual unit for hearing aid use, the diameter of magnet 10 may be about $\frac{3}{4}$ inch and the length about $\frac{1}{8}$ inch.

The upper end 14a of the pole piece 14 terminates just short of the face 10b of the magnet 10. The diaphragm 16 is of magnetic flexible material and bridges the open end of the magnet 10 and extends to a closely spaced position in relation to the end 14a of the pole piece 14 as shown. At its center portion the diaphragm 16 receives a circular weight 18 of magnetic material as described in detail hereafter.

The voice coil 20 surrounds the pole piece 14 and seats at its bottom end on the disc 12 and its top end receives the apertured cover 22 as described in detail hereafter.

The upper end of the magnet 10 and the diaphragm assembly are protected by the cover 24 which at its skirt portions 24a is snugly received on the magnet 10 and

hence held in position. At its center the cover 24 has a protruding boss 24b which fits into the ear piece of the wearer to sustain the receiver on the ear piece. The boss 24b has a central opening 24c through which sound from the moving diaphragm 16 is transmitted to the passage of the ear piece and thence to the ear drum of the wearer.

The unit of Figs. 1 and 2 defines a single flux path which serves both as an A.-C. flux path and a D.-C. flux path. The A.-C. flux path carries the flux associated with the M. M. F. due to current flow in coil 20. This path may be traced from the pole piece 14 which extends through the turns of coil 20, to the diaphragm 16 and the weight 18 where the flux extends radially outwardly; axially downwardly through the permanent magnet 10; and radially inwardly to the base of pole piece 14 through the disc 12. It will be apparent that the action of this flux is to create an alternating flux component between the face 14a and the center of the diaphragm 16 and hence to exert mechanical forces on the diaphragm causing it to vibrate in response to the alternating current flow.

The D.-C. flux is due to the magnetization of the permanent magnet 10. The magnet is magnetized in the axial direction. That is, the upper face 10b is one pole and the lower face 10c is the opposite pole. Flux association with the action of this magnet follows the same path as the A.-C. flux described above. That is, it passes radially inwardly through the disc 12 to the central pole piece 14; axially upwardly through the pole piece 14; across the gap from face 14a to the diaphragm 16 and weight 18; and radially outwardly to the face 10b of the magnet 10. It will thus be apparent that the effect of the magnet 10 is to provide a D.-C. flux across the gap between face 14a and diaphragm 16 and weight 18. This flux is of such magnitude as to insure against M. M. F. from coil 20 causing a reversal of magnetic polarity between face 14a and the diaphragm 16.

It will be observed that the coil 20 is entirely surrounded by the magnet 10. However, the magnet has a circumferential gap which spans its entire cross section and receives the insulating spacer generally indicated at 26, Fig. 1. In the form of the structure shown in Figs. 1-3 this gap has two parts. One part, which receives spacer part 26a, is of relatively small circumferential extent and is located adjacent the diaphragm 16. This part interrupts the electrical circuit otherwise defined by the magnet about the coil. The lower part of the gap receives the insulating spacer part, 26b, and is of greater circumferential extent to form an insulating terminal support for the socket terminals 28a and 28b, Fig. 2. As shown, these socket terminals are embedded in the portion 26b of the spacer 26 and receive the wires 30a and 30b which extend to the coil 20. The socket terminals are actually received in cylindrical openings 26c and 26d which extend to the outer margin of the spacer to define bores into which the prongs 32a and 32b of the connecting plug 32 extend.

It will be noted that the portions 26a and 26b of the insulating member 26 mutilate the magnetic uniformity of the permanent magnet 10. This does not, however, significantly alter the magnetic characteristics of the receiver or its operation. This is due in part to the fact that the portion 26a of the spacer is narrow and is adjacent the diaphragm 16 and in part by reason of the natural effect of diaphragm 16 and the weight 18 of causing a circumferentially uniform pattern of magnetic flux flow adjacent pole piece 14 even though the flux flow is somewhat non-uniform at the periphery. However, in the interest of obtaining maximum magnetic energy of the magnet 10 in relation to its size, it is desirable to minimize the circumferential extent of the portion 26b of the spacer 26.

In the alternative construction of Figs. 4 and 5, the gap in the magnet 10 is of uniform circumferential extent

to receive the spacer 126 of uniform thickness. In this case, the sockets 128a and 128b are vertically spaced and the cover 124 is provided with a cutout portion 124b to provide access to the terminal block 126. In this construction it is likewise desirable to minimize the circumferential extent of the spacer 126 in the interest of obtaining maximum magnetic energy in relation to the diameter of the permanent magnet.

The permanent magnet 10 is preferably constructed of a magnetic material having a high value of stored energy and effective in a short squat shape. The copper-nickel-cobalt alloy known as Cunico is a material of this kind as it has high coercive force and low residual magnetization. In addition, this material has relatively good machineability. Another material which can be used is a copper-nickel-iron alloy known as Cunife. This material has been found suitable even though its ideal shape is somewhat longer and less squat than the shape of magnet 10. The pole piece 14, the diaphragm 16, and the weight 18, should be of a soft magnetic material having a high saturation flux density. The material known as Permendur has been found effective for this purpose as it has flux density at saturation in excess of 20,000 gauss.

The annular chamber 34, Fig. 1 forms a part of the acoustical system and hence influences the operation of the diaphragm 16. The stiffness of the diaphragm, the combined mass of the diaphragm 16 and the weight 18, and the size of this chamber determine the frequency of the resonant peak A, Fig. 6. The weight 18 serves to reduce this frequency value below the value in its absence. Also, this weight serves to increase the cross section of the diaphragm 16 adjacent the pole piece 14 where the flux density is high and the tendency towards saturation is most pronounced. The marginal portions of the diaphragm can accordingly be made thin and flexible.

The weight 18 is affixed to the center of the diaphragm 16 by spot welding or similar means. The bottom face of this weight has a flat or even a convex configuration so that it does not interfere with the vibrations of the diaphragm 16. In addition, the margin 18a of the weight 18 is carefully machined at its lower edge to remove any burr or roughness, so that there is no tendency for the margin of the weight 18 to contact the diaphragm in any manner tending to create noise. By thus providing a centrally supported magnetic weight with smooth margins which does not have a burr tending to contact the diaphragm, the buzzing which may otherwise be created by the weight 18 is eliminated.

The sharpness and magnitude of the resonant peak A is reduced by the cap 22 which extends over the annular space 34 as shown. This cap is of plastic or similar material and has a circular opening 22a providing communication between the space immediately below diaphragm 16 and the annular space 34. The cloth web 36 bridges the opening 22a so as to oppose the flow of air between the cavity 34 and the space immediately beneath the diaphragm 16. The cloth 36 accordingly acts as a damper and increases the effective resistance of the resonant mechanism. As a consequence the resonant peak is reduced in magnitude and broadened in frequency. This is a desirable objective in most hearing aid receiver designs. However, if a sharper resonant peak is desired, the damping cloth can be omitted.

It has been found that air trapped in space 34 tends to impart stiffness to the diaphragm 16. The smaller this space becomes, the more pronounced the stiffness which is imparted to the diaphragm. However, considerations of overall size dictate the use of a coil 20 which fills the maximum possible proportion spaced between pole 14 and magnet 10. It is accordingly necessary to strike a compromise between the desired lack of effective stiffness in diaphragm 16 and the overall size of the unit. When this compromise is made, however, the acoustic output of the receiver in relation to its size is large.

The complete seal provided by the cup-shaped housing defined by the magnet 10 in conjunction with the bottom disc 12 also prevents the discharge of sound from beneath diaphragm 16. This prevents feedback with the incident undesirable distortion and howling.

The receiver construction described herein has been found highly effective in providing an effective receiver of small size and weight, largely because the magnetic parts themselves form the case and because the design gives highly efficient utilization of the component parts. In addition, the coil 20 can be made of somewhat higher impedance than the coils of current hearing aid receivers. This is particularly advantageous inasmuch as it is possible to use the receiver without a transformer in a transistor type hearing aid, thereby eliminating the space and weight attendant the use of the transformer otherwise required.

If desired, the web 36, described above as made of cloth, may be fine mesh wire screen or other material which resists the free passage of air and thus serves as a damping medium. Also, while only a simple opening 22a is shown, the cap 22 may have a plurality of such openings in accordance with the desired degree of resistance to air flow between the annular chamber 34 and the space beneath diaphragm 16.

While we have shown and described specific embodiments of the present invention it will, of course, be understood that various modifications and alternative constructions may be made without departing from the spirit and scope thereof. We, therefore, intend by the appended claims to cover all modifications and alternative constructions falling within their true spirit and scope.

In the appended claims, the circular weight 18 is described as having a smooth margin adjacent the thin magnetic disc. Normally these circular weights are stamped from a sheet of magnetic material. By a smooth margin is meant one from which all burrs and protrusions, resulting from the fabrication of the piece, have been carefully removed.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A receiver for a hearing aid comprising in combination: an annular axially magnetized permanent magnet having a circumferentially extending gap spanning its entire cross-section; a magnetic disc bridging one end of the permanent magnet and having a central pole piece extending within the confines of the permanent magnet to a point slightly short of the other end of the permanent magnet; a thin magnetic disc bridging the opposite end of the permanent magnet and carrying a magnetic disc of smaller radius at its center in registration with the pole piece; a voice coil encircling the pole piece; a non-conducting insert disposed in the gap and at its outer margin conforming to the shape of the magnet to define a smooth housing in conjunction therewith; and sockets embedded in the insert and connected to the coil to receive the connecting plug to the hearing aid.

2. A receiver for a hearing aid comprising in combination: an annular axially magnetized permanent magnet having a circumferentially extending gap spanning its entire cross-section; a magnetic disc bridging one end of the permanent magnet and having a central pole piece extending within the confines of the permanent magnet to a point slightly short of the other end of the permanent magnet; a thin magnetic disc bridging the opposite end of the permanent magnet and carrying a magnetic disc of smaller size at its center and in registration with the pole piece; a voice coil encircling the pole piece; a non-conducting insert disposed in the gap and at its outer margin conforming to the shape of the magnet to define a smooth housing in conjunction therewith; sockets embedded in the insert and connected to the coil to receive the connecting plug of a hearing aid; an apertured cover bridging the space between the magnet and the pole piece and located adjacent said other end of the magnet; and

a cloth damper extending over the aperture of said cover to resist air flow therethrough.

3. A receiver for a hearing aid comprising in combination: an annular axially magnetized permanent magnet having a circumferentially extending gap spanning its entire cross-section, the gap being of substantially uniform circumferential extent at all points; a magnetic disc bridging one end of the permanent magnet and having a central pole piece extending within the confines of the permanent magnet to a point slightly short of said other end of the permanent magnet; a thin magnetic disc bridging the opposite end of the permanent magnet; a voice coil encircling the pole piece; a non-conducting insert disposed in the gap and at its outer margin conforming to the shape of the magnet to define a smooth housing in conjunction therewith; and vertically spaced sockets connected to the voice coil embedded in the insert to receive the connecting plug of the hearing aid.

4. A receiver for a hearing aid comprising in combination: an annular axially magnetized permanent magnet having a circumferentially extending gap spanning its entire cross-section, the gap being of small circumferential extent near one end of the magnet and of larger circumferential extent elsewhere; a magnetic disc bridging the other end of the permanent magnet and having a central pole piece extending within the confines of the permanent magnet to a point slightly short of said one end of the permanent magnet; a thin magnetic disc bridging the one end of the permanent magnet; a voice coil encircling the pole piece; a non-conducting insert disposed in the gap and at its outer end conforming to the shape of the magnet to define a smooth housing in conjunction therewith; and sockets to receive the connecting plug of the hearing aid embedded in the insert in the region of larger circumferential extent and connected to the voice coil.

5. A receiver for a hearing aid comprising in combination: an annular axially magnetized permanent magnet; a magnetic disc bridging one end of the permanent magnet and having a central pole piece extending within the confines of the permanent magnet to a point slightly short of said other end of the permanent magnet; a thin magnetic disc bridging the opposite end of the permanent magnet; a voice coil encircling the pole piece; and a magnetic disc of smaller size than the thin magnetic disc anchored to the center of the thin magnetic disc on the side opposite the central pole piece, said last disc having a margin which bears against the thin magnetic disc to an extent determined by the flexure of the thin magnetic disc under sound vibration, said margin being of smooth conformation free from burr.

6. A receiver for a hearing aid comprising in combination: an annular axially magnetized permanent magnet; a magnetic disc bridging one end of the permanent magnet and having a central pole piece extending within the confines of the permanent magnet to a point slightly short of said other end of the permanent magnet; a thin magnetic disc bridging the opposite end of the permanent magnet and carrying a magnetic disc of smaller radius at its center in registration with the pole piece; a voice coil encircling the pole piece; a relatively large air chamber in communication with the thin magnetic disc; and damping means between the relatively large air chamber and said thin magnetic disc.

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