United States Patent [19]

Parker

[11] **3,763,334**

[45] **Oct. 2, 1973**

[54] **MAGNET ASSEMBLY**

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[22] Filed: **Jan. 21, 1972**

[21] Appl. No.: **219,718**

[52] **U.S. Cl.** ..... **179/115.5 R**

[51] **Int. Cl.** **H04r 9/06**

[58] **Field of Search** ..... 179/115.5 R, 115.5 PC, 179/117, 119 R, 179; 335/231, 302

[56] **References Cited**

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[57] **ABSTRACT**

A permanent magnet assembly adapted for use in a loudspeaker, particularly one having a low-flux density permanent magnet, comprising a one-piece return path element having two ring-shaped concentric segments, between which is fitted a ring-shaped, radially oriented permanent magnet. The two concentric segments of the return path are open at the axial top portion thereof and are joined at the lower axial portion thereof by a bridge member which is circumferentially divided except for a small portion thereof. The radially inward segment of the return path has an upper axial portion which is wider than the remaining portion of the segment to concentrate the magnetic flux at the air gap. A centrally disposed pole piece fits within the return path-permanent magnet assembly to complete the magnetic circuit of the permanent magnet loudspeaker.

4 Claims, 4 Drawing Figures

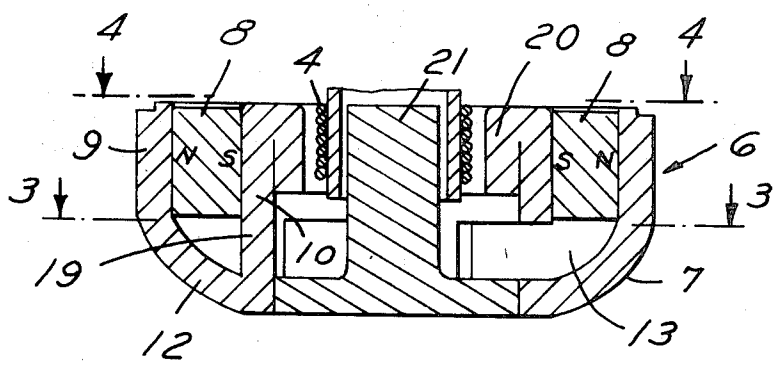


FIG. 1

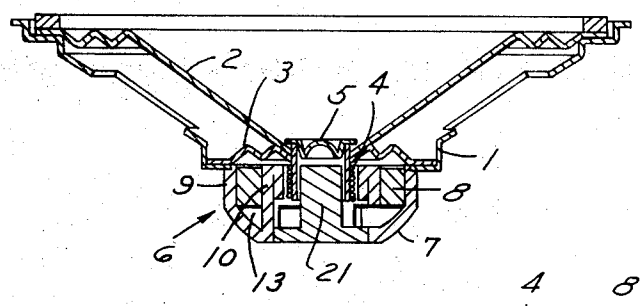


FIG. 2

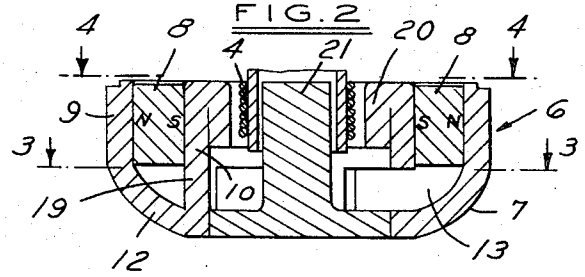


FIG. 3

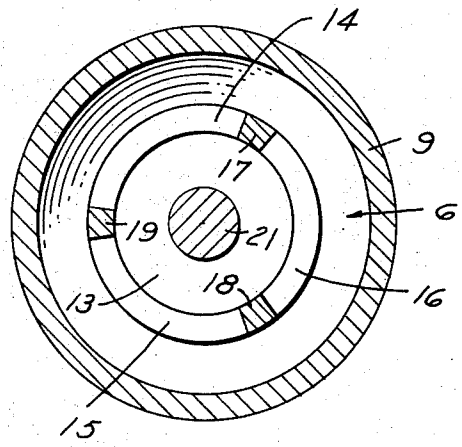
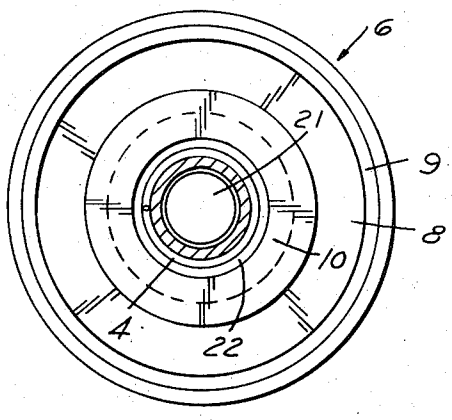


FIG. 4



MAGNET ASSEMBLY

This invention relates to a magnet assembly for use in a permanent magnet loudspeaker, and more specifically to a magnet assembly useful in a loudspeaker with a low-flux density permanent magnet.

Permanent magnet speakers of the type using a low flux density magnet conventionally contain a permanent magnet circuit made up of an axially oriented and/or magnetized ring-shaped magnet with separate return path elements across the axial upper and lower portions thereof and a centrally disposed iron or steel pole piece. With such a speaker design, the return path element contacts a relatively large area of one pole of the magnet but presents a small surface at the air gap. This arrangement permits a high degree of concentration of the relatively low magnet flux density at the air gap. The problem, however, is that there is considerable flux loss out the side of the magnet. Thus, such an arrangement is relatively inefficient, only about 50 percent of the magnet flux being useful in the air gap. In addition, this flux leakage may interfere with the operation of other nearby components or devices when used, for example, in television sets or in cars.

The present invention has as its principal object a magnetic circuit design for a loudspeaker utilizing relatively low-flux permanent magnets which provides substantially greater efficiency and less flux leakage than designs heretofore known. An additional object of this invention is to provide a magnet assembly for a speaker which does not require close physical tolerances in the magnet.

It is still an additional object of this invention to provide a magnetic circuit for a loudspeaker which permits the use of a smaller permanent magnet, and thereby a smaller speaker, to obtain equivalent loudspeaker performance.

The foregoing and other objects of the invention are achieved in a permanent magnet assembly comprising a radially oriented ring-shaped permanent magnet and a one-piece return path element having two concentric ring-shaped segments open at the top axial portion thereof and joined at the bottom axial portion thereof by a bridge member which is circumferentially divided except for a small portion thereof. The permanent magnet fits within, and is in magnetic circuit relationship with, the two concentric segments of the return path element. The radially inward ring-shaped segment of the return path element has a top axial portion of enlarged thickness in order to concentrate the magnetic flux at the air gap. A centrally disposed pole piece or core is located concentrically within the inner ring-shaped segment of the return path element to complete the magnetic circuit. As used in the specification and claims, "ring-shaped" is intended to include magnet or return-path shapes containing a central cavity or hole surrounded by a closed magnet or return-path structure.

The invention will be more clearly understood from the following description, taken in connection with the accompanying drawing in which

FIG. 1 is a cross-sectional view of a loudspeaker incorporating a permanent magnet assembly illustrating an embodiment of the invention,

FIG. 2 is an enlarged view of the permanent magnet assembly of FIG. 1,

FIG. 3 is a cross-sectional view of the loudspeaker shown in FIG. 2 along the lines 3—3 of FIG. 2, and

FIG. 4 is a plan view of the permanent magnet assembly along the lines 4—4 of FIG. 2.

Referring to the drawings, the loudspeaker comprises a supporting frame or basket 1, at the other outer edge of which is supported a frustoconical diaphragm 2. A flexible spider 3 is secured at its outer periphery to basket 1. A voice coil 4 is wound on a voice coil form 5 and is coupled to diaphragm 2. This portion of the loudspeaker construction is of conventional design and forms no part of the present invention.

The permanent magnet assembly of the invention is identified in the drawings by the numeral 6. The permanent magnet assembly 6 comprises an integral or one-piece return element 7 and radially oriented ring-shaped permanent magnet 8 fitting within and in magnetic circuit contact with the return path element 7. The return path element has two concentric ring-shaped segments — a radially outward segment 9 and a radially inward segment 10, both extending the axial length of the permanent magnet and in contact with one of the poles thereof. The upper portion of the return path element is open to facilitate insertion of permanent magnet 8. The concentric segments are bridged at their lower extremity by a bridging member 12, extending from, and to, the lower extremity of each of the magnet-return path contacting surfaces. Bridging member 12 is spaced below and away from the lower axial surface of permanent magnet 8 to provide an air space 13 to prevent local edge circuits in the magnetic assembly. Bridging member 12 is divided except for a small portion thereof by removal of a circumferential portion except for several small connecting strips. In the drawing this is illustrated as three identical circumferentially cutaway portions 14, 15, and 16, and three identical metallic connecting strips, 17, 18, and 19, spaced equidistant from each other around the circumference of the portion of the bridging member adjacent the magnet-return path contacting surface. These three connecting strips, 17, 18, and 19, make the return path element an integral component and yet are sufficiently small so that they do not short-circuit the flow of magnetic flux through the circuit of the magnet assembly. A small amount of magnetic flux is lost in the saturation of these metallic strips, but the amount is not great.

The inner radial segment 10 of the return path is turned back upon itself to form a portion 20 of enlarged thickness to concentrate the magnetic flux in the air gap. The axial height of the permanent magnet should normally be several times the height of the air gap — three times in the case of barium ferrite permanent magnets. This ratio allows the concentration to boost magnetic density to the 10,000 kilogauss level. A solid steel inner pole or core 21 is press-fitted within the return path-magnet assembly to complete the magnetic circuit and create air gap 22 for coils 4 of the speaker.

The ring-shaped permanent magnets useful in the invention may be made of virtually any permanent magnet material, including, for example, barium or strontium ferrites, cobalt-rare earth magnets of the Co_5Sm type, alnico or fine particle elongated single-domain magnets or iron or iron-cobalt alloys. Because the lowest flux density magnetic materials are the ferrites, the invention is singularly useful with ferrite magnets. However, it can also be used to advantage with other low-flux density permanent magnets of the aforementioned type. It is preferable that the magnets be aniso-

tropic, having a principal direction of magnetization in the radial plane, i.e., oriented along a path from the center of the ring-shaped magnets to their outer extremity. An illustration of a so-oriented anisotropic magnet and a method of orienting and compacting elongated single-domain magnets along a radial path is disclosed in U.S. Pat. No. 3,250,831.

A number of advantages result from the design of the magnetic assembly of the invention. A structure of very low magnetic radiation is obtained and therefore can be used for applications where it has not previously been considered appropriate, as for example in color television sets and in cars. In addition, essentially all of the magnetic flux is useful at the air gap. It is estimated that a magnet of approximately 6 oz. weight will give the same level of performance previously obtained with a 10 oz. magnet in a 1 inch voice coil system. The radial depth of the magnet need be only slightly longer than present conventional ceramic speaker magnets—about one-fourth inch. The tolerances on the outer and inner diameter of the magnet could be large because the tolerances are provided by the concentric segments of the one-piece return path element. It is considerably less expensive to provide close tolerances in a steel return path component than it is in a permanent magnet that is very difficult to machine or grind. In addition, the permanent magnet requires no attachment in the magnetic circuit. It is simply dropped into the pocket formed by the two concentric segments of the return path assembly.

An additional advantage is that two or three performance levels can be provided with a given voice coil size by simply changing the axial height of the permanent magnet ring. This is not possible with previous designs where flux considerations are controlled by the width of the permanent magnet and cannot therefore conveniently be adjusted. This can considerably reduce costs in making speaker magnet assemblies by a reduction in the tooling involved and in changing the dimensions of both the magnet and the steel parts in conventional plate designs in use today.

I claim:

1. A peranent magnet assembly adapted for use in a loudspeaker comprising

a radially oriented ring-shaped permanent magnet,

a return path element having two concentric-ring-shaped segments open at the top axial portion thereof and joined at the lower axial portion thereof by a bridge member which is circumferentially divided except for a small portion thereof, the radially inward ring-shaped segment having a top axial portion of enlarged thickness,

the permanent magnet fitting within, and in physical contact with, the two concentric segments of the return path element.

2. In a permanent magnet loudspeaker, a permanent magnet assembly comprising

a radially oriented ring-shaped permanent magnet,

a return path element having two concentric ring-shaped segments open at the top axial portion thereof and joined at the bottom axial portion thereof by a bridge member which is circumferentially divided except for a small portion thereof, the radially inward ring-shaped segment having a top axial portion of enlarged thickness,

the permanent magnet fitting within, and in magnetic circuit contact with, the two concentric segments of the return path element,

a pole piece located concentrically within the radially inward ring-shaped segment of the return path element, said pole piece being in contact with said radially inward ring-shaped segment at a lower axial portion thereof and being spaced from said inner ring-shaped segment at the upper axial portion thereof to form an air gap.

3. The permanent magnet assembly of claim **1** in which the return path element is integral and the concentric ring-shaped segments of the return path element are joined at the bottom axial portion thereof by a bridge member which is circumferentially divided except for a plurality of thin connecting strips.

4. The permanent magnet assembly of claim **1** in which the permanent magnet is a ferrite.

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