MAGNETIC ASSEMBLY FOR LOUDSPEAKER

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ABSTRACT

A loudspeaker having a cup-shaped outer pole piece and an inner pole piece which is telescoped within it and separated from it both axially and radially to provide a cup-shaped space between the two. In the space the opposed surfaces of the pole pieces is a cup-shaped insert of permanently magnetic material in the form of magnetic particles suspended in an inert binder. The inert binder is preferably formed of elastomeric material such as synthetic rubber or resilient plastic with a snug or slightly interfering fit so that the elements may simply be pressed together to assemble them. The permanently magnetic material is magnetized during fabrication, prior to, or following, assembly, being polarized so that the surfaces presented to the two pole pieces are of opposite polarity. The invention resides in part in the method used in assembling the parts together. In one aspect of the invention the magnetic insert is of composite construction using adjacent portions of magnetic material polarized at right angles. In another aspect of the invention the insert includes an annulus which is formed of a bar of elastomeric material bent in a circular shape incident to assembly.

25 Claims, 13 Drawing Figures
MAGNETIC ASSEMBLY FOR LOUDSPEAKER

Because of the high degree of competition which exists in the manufacture of loudspeakers, particularly in the smaller sizes, and the emphasis which is placed upon low per-unit cost, loudspeakers available on the commercial market for use in the usual radio or television set have notably poor fidelity. Efficiency is low because of low level of flux density in the air gap in which the voice coil moves. This in turn is due to inner-outer magnetic coupling between the parts and designs which tolerate a high level of leakage flux. The most common design includes outer and inner pole pieces with the magnetism being derived entirely from a cylindrical permanently magnetic pellet which acts as a stabilizer for the inner pole piece at a location which is remote from the air gap. In order to fit the parts together while keeping the losses at the joints at an acceptable level and to clamp them permanently in position, care must be employed both in fabrication and in assembly, adding to the cost.

It is, accordingly, an object of the present invention to provide a magnetic assembly for a loudspeaker which is highly efficient, producing high flux densities in the gap, which makes efficient use of the permanently magnetic material and the material of the pole pieces so that the flux is concentrated in the gap with minimum leakage. It is a related object to provide a magnetic assembly for a loudspeaker in which the permanently magnetic material is concentrated in the region of the gap to create a short magnetic path and with substantially no leakage in the portions of the structure which are remote from the gap.

It is still another object of the invention to provide a magnetic assembly for a loudspeaker in which the component elements may be inexpensively manufactured without adherence to close tolerances and which may be easily and quickly assembled simply by pressing the parts together with assurance of minimum reluctance at all points in the magnetic path. It is a more specific object to provide a magnetic assembly for a loudspeaker in which the permanently magnetic element is in the form of a resilient insert which is made tightly fitting so that when the parts are forcibly pressed together, internal expansive forces are developed causing the permanent magnet to be pressed into intimate contact with the surfaces of the pole pieces, taking up any geometrical or surface irregularities, and at the same time providing a high degree of frictional retention so that no other fastening means need be used.

It is yet another object of the present invention to provide a method or procedure for manufacturing and assembling a loudspeaker which is not limited to a particular design configuration but which is adaptable to a wide range of specific designs, characterized by the advantage of a better fit to above and which leads itself to high speed automatic production.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIG. 1 is a vertical section taken through loudspeaker magnetic assembly constructed in accordance with the present invention.

FIG. 1a is a transverse section taken along the line 1a—1a in FIG. 1.

FIG. 2 is an exploded view of the structure shown in FIG. 1 showing the manner in which the parts are telescopically assembled.

FIG. 3 is a fragmentary section, similar to FIG. 1, but showing an insert of composite construction.

FIG. 3a is similar to FIG. 3 but shows use of a disk covering the entire area of the outer pole piece.

FIG. 4 shows the manner in which the annular portion of the magnet in FIG. 3 and 3a may be rolled out of a bar of magnetized stock.

FIG. 5 is a sectional diagram showing the permanently magnetic material being molded in situ.

FIG. 6 is a vertical section similar to FIG. 1 but showing a modified form of the present invention.

FIG. 7 is a vertical section showing a still further modification including use of an axial extension on the inner pole piece.
or surface irregularity. This not only insures a highly efficient, low reluctance, magnetic joint, but sufficient frictional force is developed, against the outer wall 33 of the inner pole piece, so that the bottom wall 52 of the insert is snugly contained between the bottom walls 24,34 of the pole pieces. During assembly, when the inner pole piece 30 and insert 50 are being pressed into place, a force F is applied to the inner pole piece, stressing the material 52 of the bottom wall of the insert until the point of solid bottoming is achieved. Where the insert is slightly oversized, the pole pieces, and particularly the outer pole piece, may be formed with rounded or slightly tapering entry way surfaces, a matter well within the skill of the art.

It is one of the features of the present invention that the magnetic insert 50, when magnetized in a suitable jig prior to insertion, the jig providing surfaces which correspond to the surfaces of the pole pieces and which are similarly polarized. Typically the material is saturated by application of flux at a density on the order of 10,000 gauss or more. Alternatively, the insert may be magnetized after assembly with the pole pieces. In the latter event it is preferred to apply magnetizing flux after the two pole pieces have been seated together with the insert 50 between them but before the collar 40 is positioned into place. This tends to insure that the applied magnetizing flux is substantially all usefully employed in overcoming the coercivity of the magnetic insert without loss of the flux by reason of the shunting effect of the collar and relatively narrow air gap 43. Nonetheless, if desired, the magnetic assembly may be magnetized with the collar 40 in place simply by employing a quantity of flux which is sufficiently great as to overcome the shunting effect of the collar, particularly where the level is high enough to induce saturation in the collar.

As an alternate to using a permanently magnetized insert 50 of monolithic construction the insert may be made up of two separate pieces. As shown in FIG. 3 the insert, indicated at 50a, may be made up of an annular portion 51a, which may be formed by extrusion, and a disk shaped, complimentary portion 52a. The annulus preferably extends the length of the outer pole piece, while the disk has an area corresponding to the area of the inner pole piece. The annulus is polarized radially while the disk is polarized axially, i.e., at right angles thereto. If desired, the disk 52a may be dimensioned to occupy the entire bottom portion of the outer pole piece as shown at 52b in FIG. 3a. The portions 51a, 52a, may both be resilient or, if desired, the disk-shaped portion 52a may be made of hard magnetic material, for example, with a ceramic binder, which, incident to assembly, is simply dropped into the outer cup prior to the inner pole piece and magnetic insert being pressed into place.

Where a separate annulus 51a of elastomeric material is used, as disclosed in FIG. 4, the annulus is preferably formed of a straight bar of material having a thickness on the order of the radial dimension r and which is permanently magnetized in the thickness dimension, which is then bent, end to end, into circular shape as shown in FIG. 4, so as to be radially polarized for pressing into position between the outer and inner pole pieces.

As a still further option, in practicing the present invention, the magnetic insert 50 may be molded in situ. Thus, as shown in FIG. 5, the outer pole piece 20 may be suitably secured in a socket 60 while the inner pole piece 30 is held in desired position by a chuck 61. The permanently magnetic material, in liquid or molten form, is discharged into the space between the two pole pieces via suitable nozzles 62 to a level which closely approaches the region of the air gap.

Where the permanently magnetic body, indicated at 50b, is molded, or cast in situ, it is not necessary for an elastomeric binder to be used and the binder, in such case, may be formed of any desired plastic material which is of viscous consistency when mixed, so as to hold the particles of magnetic material in place, and which is capable of prompt hardening into a solid mass, either with or without presence of heat to facilitate the reaction. Where the permanent magnetic is formed in situ, any suitable magnetic charging jig may be used to apply flux between the pole pieces 20, 30 while the material is still soft and incident to changing to the hardened condition.

It is one of the features of the present invention that the permanently magnetic material not only extends to the vicinity of the air gap but that it is formed of a cross sectional thickness which has a maximum value in the region of the gap. Thus, referring to FIG. 6 of the drawings, there is shown a modified form of the invention including an outer pole piece 70 which is of cup shape and in which the cup is tapered or flaring to provide a progressively greater radius in the direction of the air gap, the tapered portion being indicated at 71. The inner pole piece 75 in this embodiment is also tapered, at its bottom end, as shown at 76. The intervening space is substantially fully occupied by the magnetic insert 80. Because of the tapering dimension, the thickness of the magnetic insert is at a minimum in the region 81 along the axis, as indicated by the dimension t1 and is a maximum adjacent the air gap as indicated by the dimension t2, with a progressive increase in the cross section in between. The insert 80 is magnetized from face to face previously discussed in connection with FIG. 3.

The arrangement shown in FIG. 6 makes efficient use of the permanently magnetic material since the thickest section, which is the source of the greatest amount of flux, is most closely adjacent the air gap. The invention is noted in relation to the tapering of the outer pole piece, but, if desired, the inner pole piece 75 may be flared outwardly, toward the bottom, to provide similar increase of cross section in the magnetizing space. It will be apparent that in the latter event the magnetic insert, if elastic, will have to be assembled over the inner pole piece before final assembly into the outer pole piece. The amount of taper of the outer pole piece is subject to variation which is preferably not so great as to defeat the self-retention feature. It will be understood, however, that the invention is not limited to self-retention and that a thin layer of cement may be applied to some or all of the engaged surfaces in order to assist friction in holding the assembly firmly together.

A still further embodiment is shown in FIG. 7 where the outer pole piece 90 is made up of two members, a wall portion 91 and a permeable end cap 92 which permits stacked assembly from the rear rather than the front of the structure. The inner pole piece 93 is of limited axial length, defining a cup-shaped airspace which is occupied by a cup-shaped permanently magnetic insert 95. It is one of the features of the invention that the inner pole piece has a cylindrical permeable member 100 telescoped within it and serving as an extension to conduct flux from the member 93 to the air gap indicated at 101. The other side of the air gap is defined by a collar 102 which extends radially inward from the edge of the outer cup and which may, as shown, be formed integrally with the outer cup piece. A slightly modified form is shown in FIG. 7a. Here the lip indicated at 102a is turned outward instead of inward to permit space for a supplementary annular strip of magnetic material 95b, axially polarized as shown, which not only adds to the flux in the gap but which reduces leakage flux between the poles.

The invention discussed above may be practiced in still further modified form using the configuration shown in FIGS. 8, 8a, and 8b. Here the outer pole piece, indicated at 110, is of flat "pancake" configuration and the inner pole piece indicated at 111 has a portion which is of cylindrical shape leading to the air gap as well as a partial flange 112 which extends radially outward toward the side wall of the outer electrode but which stops short of it by an amount indicated at z. The structure is enclosed by a collar 115 of permeable material having an outer edge 116 which is pressed into place within the lip of the outer pole piece 110 and which has an inwardly turned portion 117 which, with the pole piece 111, defines an air gap 118. In accordance with the invention an insert of permanently magnetic material is interposed between all of the opposed surfaces of the inner and outer pole pieces. The permanently magnetic material thus occupies three separate regions, the front space 121, the peripheral space 122 and the
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back space 123. The insert is polarized as shown in FIG. 8a with surfaces of one polarity in contact with the inner pole piece thereby directing substantially all of the flux into the air gap with substantially no internal or external leakage fields.

The structure of FIG. 8 includes an annular spacing collar or insert 125 of soft steel of the like which is telescoped inside of the outer pole piece and which is of constant width to provide a positive bottoming seat for the collar 115 in addition to augmenting the cross section of metal available to induce flux. Such an inserted collar may be used in the preceding embodiments, for example, inside of the wall 21 of the pole piece 20 to provide a seat for the outer edge of collar 40. The structure of FIG. 8 may be slightly modified, if desired, by forming the inner pole piece of the cup 114 into the center of a washer 112. By turning the lip 117 outwardly the permanently magnetic material may be extended radially inward.

I prefer to employ barium or strontium ferrite power compounded to about one micron size in accordance with the publications identified as IEEE Transactions on Magnetics at volume MAG-4, No. 2, of June 1968 and No. 3 of September 1968, respectively entitled On the Magnetic Properties of Fine-Milled Barium and Strontium Ferrite by Richter et al. and Permanent Magnet Materials by Becker et al. Such publications, and the references there cited, are included herein by reference. The physical and magnetic properties of ferrite materials in an elastomeric binder are set forth in publication DMS—MB entitled Platform Permanent Magnets published by the Dielectric Material and Systems Division of the 3M Company of St. Paul, Minnesota, also included by references.

The invention is not limited to particular compositions of permanently magnetic particles or use of particular substances as a binder for such particles. Elastomeric plastic binder materials may be of several different kinds, for example, those which may be converted to a viscous liquid by application of heat with subsequent addition of the particles to form a uniform mix, preferably with application of pressure, and those in which the original substance is in the form of a viscous liquid and in which a catalyst is employed to produce hardening after the magnetic particles have been added. In a typical case the magnetic particles may, in the final product, occupy from 70 to 98 percent of the volume of the finished product.

Where the permanently magnetized inserts are individually and separately formed, they may be molded in a molding machine capable of applying a pressure on the order of 20 tons per square inch and similar to the equipment used for molding powdered iron or the material may be cast as a slurry using commercially available casting equipment. Upon being formed or during the process of hardening the inserts may be subjected to a high level of magnetic flux from commercially available magnetic charging equipment such as sold by Indiana General Corporation having charging electrodes which are shaped to conform for close magnetic coupling, to the pole pieces of a charging jig having surfaces which correspond to the opposed surfaces of the outer and inner speaker pole pieces. Where the magnetic charging is accomplished with the inserts in place, a charging device may be used having pole pieces which are formed to provide close magnetic coupling to the edges, or lips, 25, 35 respectively, of the outer and inner pole pieces, 20, 30. It is to be noted that in the case of magnets having an elastomeric binder neither the mold, where the inserts are formed or the magnetic jig in which they are magnetized, if magnetized prior to assembly, need be accurately shaped, since the inserts, being resiliently deformable, accommodate themselves to all minor variations of geometry, including slightly out-of-round, and all minor surface irregularities. Similarly, where the magnets are formed of elastomeric bar stock (FIG. 4) the dimensions of the bar need not be highly precise.

As stated herein, steel is a preferred material for the outer and inner pole pieces since conventionally available mild steel, for example, hot-rolled steel of the type 1010 is easily formed into cup shape by drawing operation and is adequately permeable. The thickness of the pole section is largely a matter of designer's choice. On the one hand it is desired to use steel of a thin gauge in order to reduce cost and weight but on the other hand the thickness can be sufficiently great to avoid saturation. The thickness may be supplemented where desired by a laminar insert such as shown at 125 in FIG. 8. It is to be understood that the term "steel" as used here includes any structural material having a ductility and permeability which is normally associated with mild steel.

The term "permanently magnetic particles" as used herein refers to particles of ferrite or any similar material capable of exhibiting a high degree of coercivity following magnetization by an externally applied magnetic field.

In the discussion it has been assumed that the pole pieces are all of circular section, that is, of cylindrical or conical shape; however, it will be apparent to one skilled in the art that the cup-shaped electrodes may be formed of square configuration, provided only that suitable adapters are used to conduct the flux to a circular air gap.

For convenience the term "molded" has been applied herein to the permanently magnetized insert, and it is intended that this term generally cover inserts which are formed by molding, casting, extruding, or otherwise shaping, either separately prior to installation, or in situ, and regardless of whether the insert is resilient or non-resilient.

It is seen that the construction is well adapted for mechanized assembly and that automated means may be provided for pressing together the parts shown in FIG. 2. Where the permanently magnetic element is in the form of an annulus, as in FIG. 3, and where it is desired to form the annulus by bending a bar of elastomeric material magnetized in the thickness dimension, it is well within the skill of the art to provide automated means for bending and holding the magnetic insert for pressing into place.

In the above discussion, mention has been made of the use of ferrite in an elastomeric binder as a preferred material and the fact that such material may be magnetized in the cold state after forming. Since the particles are randomly oriented, only those particles which have a component of direction along the axis of the applied magnetism will be permanently magnetized, nevertheless high levels of residual magnetism combined with high coercivity can be achieved. Higher levels of residual magnetism may be obtained using the same magnetizing flux density by orienting the particles physically along the same direction, which can be achieved by orienting the magnetizing flux while the body of magnetic material is still in the molten or plastic state and prior to fusing into an integral mass. Thus it may be clear that the present invention is equally applicable to the use of either "un-oriented" or "oriented" ferrite mixes.

In the above discussion, mention has been made of the importance of snug fit between the elastomeric insert and the presented walls of the pole pieces and the fact that this condition can be achieved by having the radial thickness of the inserted annulus of magnetic material of slightly greater dimension than the receiving space between the poles for forceable insertion as discussed in connection with FIG. 2. Further in accordance with the present invention, it is proposed that the annulus, for ease of assembly, be slightly understere in the radial thickness direction for ease of assembly, with axial pressure being applied to the end surfaces of the insert incident to assembly to cause the insert, by reason of volumetric compression, to swell radially for intimate all-over contact with the presented pole surfaces. This aspect of the invention may be easily understood in connection with the structure shown in FIG. 7 where the insert occupies the entire length of the outer pole piece. In accordance with this aspect of the invention the elastomeric insert 95, upon insertion, may have a normal radial thickness which is slightly less than the available radial space so that it slips easily into place prior to applying the end cap 92. The insert is, however, dimensioned so as to have a normal axial length which is greater than the final length so that, when the cap is applied and powerfully pressed into its seated position, endwise stress is applied to the insert causing
the insert to flow or swell radially to bring the annular faces thereof into intimate contact with the annular pole pieces. With the end cap held under pressure the flanges thereof may be spot welded to the outer pole piece 91 to maintain the pressurized condition during the life of the loudspeaker. It is found that this not only improves the efficiency of the magnetic joints at the pole pieces but that it also brings the magnetic particles in the insert into closer proximity with one another thereby to increase the magnetic efficiency of the insert itself.

In the other embodiments disclosed herein which are "front loading," the insert in the unstressed state, may also be made slightly undersized in the radial dimension for easy assembly and slightly oversized in the axial direction so that when the enclosing collar is applied and pressed into seated position, such collar applies endwise force to the insert causing it to swell radially into contact with the faces of the poles.

In those structures, exemplified by FIG. 1, where the magnetic annulus of elastomeric materials falls short of extending the entire axial length of the space within the outer pole piece, the "air space" may be occupied by an annulus of inert, i.e., non-magnetic material such as dense plastic capable of transmitting pressure from the collar to the body of magnetic material for swelling of the latter when the collar is forcibly pressed into its final position. The insert annular insert may be made of non-compressible elastomeric material, if desired; in any event it acts as a means for transmitting force applied to the collar over the presented end faces of the magnetic insert. This annular pressurizing procedure is particularly applicable where elastomeric magnetic bodies are used having a binder which has a relatively low durometer rating, in other words, which is sensibly resilient; say in the nature of synthetic rubber.

When using this procedure, the enclosing collar may be bottomed on a laminar insert such as that shown at 125 in FIG. 8. For holding the collar in its final position spot welding may be used or the collar may be frictionally retained in the outer pole piece to block and maintain the magnet thereafter in volumetric compression.

I claim as invention:
1. A loudspeaker magnetic assembly, the combination comprising an outer pole piece of hollow cup shape formed of sheet steel, an inner pole piece of hollow cup shape formed of sheet steel, the inner pole piece being nested in the outer to provide opposed edges radially spaced from one another, an annular steel collar radially extending from the edge of at least one of the cups toward the edge of the other to provide a radial air gap for a voice coil, the inner pole piece being spaced from the outer axially as well as radially so that the opposed surfaces thereon define a cup-shaped space between them, a molded cup-shaped insert of permanently magnetic material having surfaces in intimate contact with the opposed surfaces of the pole pieces to form a magnetic circuit of low reluctance for concentration of flux in the air gap, the inner and outer surfaces of the insert being permanently magnetized with opposite polarity.

2. In a loudspeaker magnetic assembly, the combination comprising an outer pole piece of hollow cup shape formed of sheet steel, an inner pole piece formed of steel and nested in the outer pole piece to provide opposed edges radially spaced from one another, an annular steel collar radially extending from the edge of at least one of the pole pieces toward the edge of the other to provide a radial air gap for a voice coil, the inner pole piece being spaced from the outer axially as well as radially so that the opposed surfaces thereof define a cup-shaped space between them, and a molded cup-shaped insert of permanently magnetic material having intimate surface contact with the opposed surfaces of the pole pieces so as to define a magnetic circuit of low reluctance for concentration of flux in the air gap, the inner and outer surfaces of the insert being permanently magnetized with opposite polarity.

3. The combination as claimed in claim 2 in which the insert is in the form of permanently magnetic particles suspended in a body of inert elastomeric material dimensioned to fit the opposed surfaces of the pole pieces.

4. The combination as claimed in claim 3 in which the insert is dimensionally slightly oversized to provide a press fit with the opposed surfaces of the pole pieces for development of internal pressure in the insert so that the insert is self-accommodating to any geometric or surface irregularities of the opposed surfaces.

5. The combination as claimed in claim 2 in which the wall of the cup-shaped insert has a thickness which is greater than the bottom of the cup-shaped insert.

6. The combination as claimed in claim 2 in which the wall thickness of the insert increases progressively in the direction of the air gap.

7. The combination as claimed in claim 2 in which the molded insert is molded in situ.

8. The combination as claimed in claim 2 in which a basket is provided formed integrally with the cup-shaped outer pole piece as an extension of the edge of the cup.

9. The method of forming a loudspeaker magnetic assembly, having an outer cup-shaped pole piece and an inner pole piece dimensioned to provide an annular space between them, which consists of separately forming an insert consisting of particles of permanently magnetic material suspended in a body of inert elastomeric material of annular shape in which the radial thickness is slightly greater than the radial dimension of the annular space, and then telescoping the insert and pole pieces into assembled relation with a press fit so that the insert develops internal pressure to insure accommodating itself to geometric or surface irregularities of the pole pieces thereby to achieve minimum reluctance at the contacting surfaces.

10. The method covered in claim 9 which includes the additional steps of applying magnetic charging flux to the pole pieces for charging the insert and then telescoping into the outer pole piece a collar of permeable material to define a narrow annular air gap.

11. The method of making a loudspeaker magnetic assembly having cup-shaped inner ad outer pole pieces providing opposed edges to define an air gap and with the inner pole piece being smaller than the outer both radially and axially, which comprises molding a cup-shaped insert formed of permanently magnetic particles suspended in a body of inert elastomeric material with the insert having a bottom which conforms to the opposed end surfaces of the pole pieces and a side wall which conforms to the opposed wall surfaces of the pole pieces but with the side wall being radially thicker than the radial spacing between the opposed wall surfaces, and telescoping the pole pieces and insert together with a press fit to the point of bottoming thereby to insure intimate all over contact between the surfaces of the insert and the opposed surfaces of the pole pieces.

12. The method of making a loudspeaker magnetic assembly using a cup-shaped inner and outer pole pieces providing opposed edges to define an air gap and with the inner pole pieces being smaller than the outer both radially and axially, which comprises forming a molten mass of material made up of permanently magnetic particles suspended in an inert hardenable binder, temporarily fixing the inner pole piece in a position telescoped within the outer pole piece but with the bottom and side walls spaced therefrom to form a cup-shaped space between them, pouring the molten material into the cup-shaped space to form a magnetic insert and permitting the same to harden in situ to secure the pole pieces mechanically to one another, and applying magnetism between the pole pieces incident to hardening for polarization of the permanently magnetic particles with the insert having one plurality at the surface which mates with one of the pole pieces and having the opposite plurality at the surface which mates with the other pole pieces.

13. The method as claimed in claim 12 which includes the step of inserting between the presented edges of the pole pieces an annular ring of permeable material dimensioned to...
have a press fit with one of the pole pieces and to define an annular air gap with respect to the other.

14. In a loudspeaker magnetic assembly, the combination comprising an outer pole piece of hollow cup shape formed of sheet steel, an inner pole piece of hollow cup shape formed of sheet steel, the inner pole piece being nested in the outer to provide opposed edges radially spaced from one another and being smaller than the outer pole piece both axially and radially to define a cup-shaped space between them, a molded cup-shaped insert of permanently magnetic particles in an inert binder occupying the space and in intimate contact with the opposed surfaces of the pole pieces, the insert being so magnetized that the surfaces thereof which contact the respective surfaces of the pole pieces are of opposite polarity, and an annular ring of permeable material having a press fit with the edge of one of the pole pieces and extending radially into the vicinity of the other to define an annular air gap for receiving a voice coil.

15. The combination as claimed in claim 14 in which the ring has an integral axially extending portion adjacent the air gap.

16. In a loudspeaker magnetic assembly, the combination comprising an outer pole piece of hollow cup shape formed of sheet steel, an inner pole piece of hollow cup shape formed of sheet steel, the inner pole piece being nested in the outer and shorter in length, the inner pole piece being spaced from the outer axially as well as radially so that the opposed surfaces define a cup-shaped space between them, a molded cup-shaped insert of permanently magnetic material having surfaces of opposite plurality in intimate contact with the respective opposed surfaces of the pole pieces, said inner pole piece having an extension of cylindrical shape telescoped within it and extending axially therefrom to present an edge which is opposite the edge of the outer pole piece to define an annular air gap with the latter for reception of a voice coil.

17. In a loudspeaker magnetic assembly, the combination comprising an outer pole piece of hollow cup shape formed of sheet steel, an inner pole piece of cylindrical shape also of steel and having a diameter and axial length which is less than the outer pole piece so that when the inner pole piece is telescoped into the outer one to provide an annular air gap, there is defined, between the pole pieces, an end space and an annular wall space, a disk of permanently magnetic material dimensioned to substantially occupy the end space, and an annulus of permanently magnetic material dimensioned to occupy the wall space, the annulus being formed of permanently magnetic particles suspended in a body of elastomeric material and dimensioned to provide a press fit into the annular wall space for not only accommodating geometric surface irregularities but for holding the inner pole piece in intimate axial engagement with respect to the disk.

18. The combination as claimed in claim 17 in which the annulus of permanently magnetic material is polarized in the radial direction and the disc of permanently magnetic material is polarized in the axial direction.

19. The combination as claimed in claim 17 in which the annulus of permanently magnetic material extends the axial depth of the outer pole piece and in which the disc of permanently magnetic material has an area which corresponds to the area of the inner pole piece and a thickness which corresponds to the thickness of the end space.

20. In a loudspeaker magnetic assembly, the combination comprising an outer pole piece of hollow cup shape formed of sheet steel, an inner pole piece formed of steel and nested in the outer pole piece to provide opposed edges radially spaced from one another, an annular steel collar radially extending from the edge of the outer pole piece to a position spaced from the edge of the inner pole piece to provide a radial air gap for a voice coil, the inner pole piece being spaced from the outer axially as well as radially so that the opposed surfaces thereon with the collar seated in position define an annular space between them having a predetermined axial length and radial thickness, the annular space being occupied by an annular magnetic insert of elastomeric material having a normal radial thickness which is slightly less than the thickness of the space and having a normal axial length which is slightly greater than the length of the space, said collar having a press fit with the outer pole piece so that when the collar is pressed into seated position axial force is applied to the end surfaces of the insert causing the insert to swell radially into intimate contact with the presented faces of the inner and outer pole pieces.
25. The combination as claimed in claim 24 in which an inert non-compressible spacer is interposed between the collar and the presented end surface of the insert for transmitting compressive force from the collar to the insert, the spacer being of annular shape conforming substantially to the end surface of the magnetic insert.