March 21, 1950 D. H. CUNNINGHAM 2,501,031

MAGNETIC FIELD STRUCTURE FOR DYNAMIC LOUDSPEAKERS AND THE LIKE

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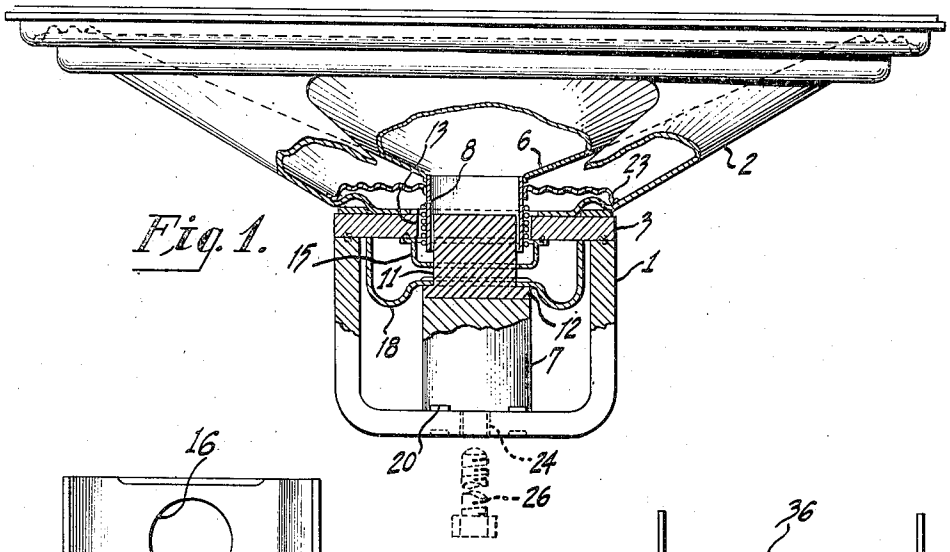


Fig. 1.

Fig. 1a.

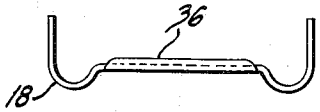


Fig. 1b.

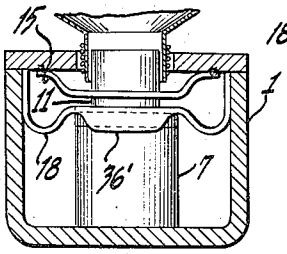


Fig. 4.

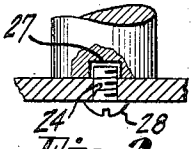


Fig. 2a.

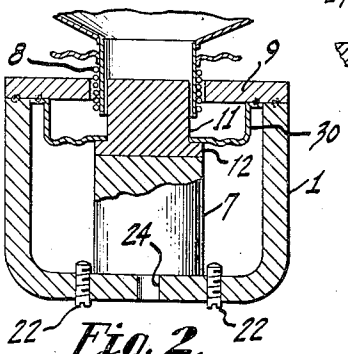


Fig. 2.

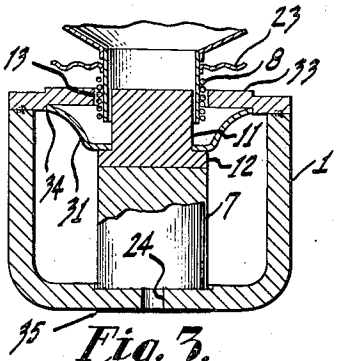


Fig. 3.

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MAGNETIC FIELD STRUCTURE FOR DYNAMIC LOUD-SPEAKERS AND THE LIKE

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Application November 30, 1945, Serial No. 632,064

6 Claims. (Cl. 179—115.5)

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This invention relates to loudspeakers and more particularly to an improved assembly for a permanent magnet dynamic loudspeaker.

An object of the invention is to provide a new and improved method and means of assembly of magnetic elements of a loudspeaker.

More particularly it is an object of the invention to provide improved and simplified means for holding the elements of a permanent magnet loudspeaker together in desired operating relation.

Still other objects and advantages of the invention will be apparent from the following specification. The present invention is in the nature of an improvement over the structure shown and claimed in my U. S. Patent No. 2,312,238 of February 23, 1943. The features of novelty which I believe to be characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its fundamental principles and as to its particular embodiments will best be understood by reference to the specification and accompanying drawings in which:

Figure 1 is a view in side elevation, partly in section, of a loudspeaker magnet structure embodying the invention,

Figures 1*a* and 1*b* are plan and side elevation views, respectively, of an element of the speaker of Figure 1, shown slightly enlarged,

Figure 2 is a side elevation view, partly in section, of a loudspeaker magnet system embodying a modified form of the invention,

Figure 2*a* is a fragmentary side elevation view, partly in section, of a portion of the yoke and magnet system of Figure 2 showing a modified form thereof,

Figure 3 is a side elevation view, partly in section, of a loudspeaker magnet system embodying a modified form of the invention, and

Figure 4 is a side elevation view of a loudspeaker magnet system embodying a modified form of the invention.

In the various figures like reference numerals represent like parts.

Referring now more particularly to Figure 1, the invention is illustrated by means of a speaker unit adapted for use with a frusto-conical diaphragm 2, circular or elliptical in contour. A paramagnetic field structure comprising a U-shaped field yoke 1 of ferromagnetic material such as cold rolled steel or other paramagnetic material is provided with an annular pole piece or yoke plate 3 of similar material fastened to the open end of the field yoke 1 preferably by

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means of projection welding. Within the yoke 1 is a permanent magnet 7 of high retentivity preferably centrally located and of Alnico V, composed of the following elements, aluminum 8%, nickel 14%, cobalt 24%, copper 3%, and iron. For further information on this magnetic material, attention is called to proceedings IRE, October 1943, pages 437–440 by W. E. Ruder. This magnetic material is extremely hard, cannot be drilled or tapped, at least by ordinary means. These magnets are made in long rods and sliced up into the desired short lengths or are molded. The upper and lower polar faces of the magnet 7 are ground flat and lie in parallel planes. The base or lower face of the magnet rests upon a coined flat surface of the bottom of the yoke 1, the surface being stamped flat and smooth by a smooth circular die in a coining operation. A soft iron or mild steel inner pole piece 11 is located upon the upper polar ground face of magnet 7 and the cylindrical upper end of this pole piece cooperates with a circular opening 13 in yoke plate 3 in forming an annular air gap.

For the purpose of accurately centering the pole piece 11 with respect to the opening 13 a sheet metal centering disc 15, preferably of brass, is permanently secured to the yoke plate 3 as by welding and is provided with a circular opening 16 (Fig. 1*a*) concentrically disposed with respect to opening 13 in the yoke plate. An annular air gap is formed in which is disposed a cylindrical voice coil structure 8 attached to the small end of a frusto-conical diaphragm 6 and centered by means of a resilient centering disc 23, in turn attached to a metal housing 2. While a symmetrical U-shaped yoke and centrally located magnet has been shown, a one-sided arrangement, such as shown in Figure 9 of patent to Serge 2,029,282, January 28, 1936, may be used.

For the purpose of firmly holding the magnetic elements 1, 7 and 11 together in operating assembled relation, a resilient clamping member, preferably of phosphor-bronze, hard brass or other stiff nonmagnetic sheet material, is used. This member, shown in greater detail in Figures 1*a* and 1*b*, is made compressible over a wide range of axial movement, and sufficiently stiff to hold the upper and lower polar faces of the magnet firmly between the lower ground surface of pole piece 11 and the coined surface, respectively, on the bottom of the yoke 1. Ordinarily the friction between the adjacent plane surfaces would prevent lateral shifting, but to positively assure against undue shifting, in case the speaker is dropped, it is preferred in some cases that posi-

tive limiting means be provided. Lugs 20, for example three or four, are extruded on the yoke spaced around the base of the magnet to limit possible shifting to a small amount, the radial spacing or clearance of the lugs being sufficient to allow for manufacturing tolerances in the diameter of the magnet.

If desired, holes may be provided in place of the lugs and thread cutting drive screws inserted, as shown in Figure 2. After the magnet has been assembled into the position shown, the screws 22 are driven upward above the surface of the yoke into limiting position around the base of the magnet. With this modification, the assembly is easier in that there are no obstructions such as the lugs over which to slide the magnet lower face. Another advantage is that provisions, such as other holes, may be made for the use of a larger diameter magnet for larger power output.

In assembling the magnet element into the yoke assembly, Figure 1, elements 1 and 3 of which have previously been welded together along with centering means 15 as a unit assembly, the pole piece 11 with spring clamp 18 resting upon the shoulder 12 are inserted centrally into position. Fingers of an arbor press are inserted and exert pressure upward against the spring clamp 18 permitting lifting the pole piece 11 a short distance above the position shown. The magnet may then be laterally inserted over the lugs into the operating position shown. When the pressure is removed, the spring 18 exerts considerable pressure axially against the shoulder 12 forcing the polar plane surfaces into tight contact and holding the elements 7 and 11 together against the bottom flat coined surface of the yoke 1.

A hole 24 (Figure 1) is provided to facilitate forming the yoke symmetrically and for holding the yoke members 1 and 3 in proper position during assembly for welding, and for coining the flat surface adjacent 24. It is found useful as an alternative to compress the spring 18 for purposes of assembly or removal of the magnet, particularly by a service man. A rod may be inserted through the hole 24 prior to assembly of magnet 7, upward against the bottom face of pole piece 11 with sufficient force to compress the spring 18 while inserting the magnet. The magnet is then inserted an amount sufficient for it to maintain the spring in a compressed position, whereupon the rod is then removed and the magnet inserted further to the position shown in the drawing. In removing the magnet the rod is forced upward against the lower polar face of the magnet sufficiently to raise the face above the level of the lugs. The hole 24 may be threaded, as shown in dotted lines, and a threaded tool 26 inserted to bear against either the magnet or the pole piece 11, as the case may be, with sufficient mechanical advantage to compress the spring clamp. Referring to Figures 1*a* and 1*b*, the longitudinal edges of the clamp alongside the opening 8 are bent upwardly at a desired angle to reinforce the clamp weakened by opening 8.

Referring to Figure 2*a*, in the case of molded magnets, it is possible to cast a central bore or depression, as shown at 27, and the yoke opening 24 may be threaded, as above described re Figure 1, to receive a machine screw 28 that projects part way into the bore 27 to function as lateral limiting means instead of using the screws 22 (Fig. 2) or lugs 20 (Fig. 1). With a single central limiting means, different diameter magnets may be used interchangeably. A long threaded tool or bolt, as in Figure 1, may be inserted through hole 24 during assembly to initially compress the spring clamp while sliding the magnet into place.

Referring again to Figure 2, there is shown a centering cup-shape disc 30 made of resilient material such as hard brass or phosphor-bronze sheet material for the purpose of performing also the clamping functions of member 18 in Figure 1, as shown and claimed in the application of F. J. Harbaugh, Serial No. 632,065, filed concurrently herewith. The disc is preferably corrugated concentrically to increase its axial range of compressibility. It is made sufficiently rigid radially to maintain the pole piece centered in the opening in pole plate 3, and stiff enough axially to exert sufficient pressure upon the shoulder 12 to hold the magnet 7 firmly between the pole piece 11 and bottom of the yoke 1. The upper edge of the cup-shaped disc 30 is preferably welded to the under surface of the pole plate 3, after which the central opening is counterbored accurately concentric to the opening in plate 3.

Referring to Figure 3, a dished centering member 31, similar in function and material to member 30 (Fig. 2) is formed with a central opening centered relative to pole plate 33 by means of an offset shoulder 34 extruded in concentric relation to the opening 13. The element 31 if of the same diameter as the depression 34, fits snugly therein and is removable. It is more rigid radially than the form shown in Figure 2, but has less axial movement in compression or expansion. Instead of lugs for limiting lateral displacement of the base of the magnet, a slight circular depression 35, preferably concentric relative to reference hole 24, is formed by the coining operation above mentioned as being made by a die under pressure to provide a flat surface in uniform contact area with the lower polar face of the magnet. The depression is just deep enough to limit lateral displacement of the magnet under the condition of high pressure exerted by the axially stiff clamping means 31. It is easier to slide the magnet into place in the depression than in the case of the raised lugs.

Referring to Figure 4, the assembly is similar in structure to Figure 1 except that the lugs 20 are eliminated and the upturned reinforcing sides 36 along the spring clamp 18 are made wider and turned downwardly, extending below the level of the bottom face of pole piece 11. The clamping spring arms also extend below the bottom face of the pole piece around the top of the magnet, and together with the reinforcing sides, limit any lateral displacement of the magnet.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted within the scope of the present invention and within the scope of the claims which follow. While the invention has been illustrated in connection with a permanent magnet speaker, it will be found to have patentable utility with a field winding speaker.

I claim as my invention:

1. A dynamic loudspeaker, comprising in combination a permanent magnet having upper and lower plane polar faces, a field structure therefor comprising a yoke plate secured to a field yoke and having a circular opening, a cylindrical pole piece located upon the upper polar face of said magnet and forming within said opening an annular air gap, means for retaining said yoke plate and pole piece in uniformly spaced operating relation, and spring means disposed between

said yoke plate and pole piece, said spring means being biased to exert substantial pressure against said pole piece thereby to hold said magnet between said pole piece and said field yoke.

2. The invention as set forth in claim 1 wherein said field yoke is provided with limiting means to prevent accidental lateral displacement of said magnet.

3. The invention as set forth in claim 1 wherein said spring means comprises a sheet metal element with upwardly bent ends bearing against said yoke plate and having an opening concentric with said first named opening, said pole piece having a shoulder in contact with said spring means and against which said spring means is biased.

4. In a dynamic loudspeaker, a field yoke, a permanent magnet having upper and lower polar faces centrally located upon said yoke, a pole piece disposed on the upper face of said magnet, a yoke plate fastened upon the ends of said field yoke and provided with an opening surrounding said pole piece and forming therewith an operating air gap, spring clamping means disposed between said yoke plate and said pole piece and exerting a downward pressure against said pole piece thereby to force said pole piece against said magnet and said magnet against said field yoke, and centering means secured to said yoke plate against lateral movement and provided with a central opening through which said pole piece is disposed for maintaining said pole piece concentric within said opening in the pole plate.

5. In a dynamic loudspeaker, a field yoke of magnetic material, a yoke plate permanently attached to the ends of said field yoke and provided with a centrally disposed opening, a permanent magnet having upper and lower pole faces, said lower face of said magnet being centrally disposed on said field yoke, a pole piece having a lower surface disposed upon said upper pole face of said magnet and extending into said centrally disposed opening, elongated spring biasing means of non-magnetic material having upturned ends engaging said yoke plate and provided with a central opening concentric with said yoke plate opening, said pole piece being disposed within said spring biasing means opening and having an annular shoulder against which said spring biasing means exerts a force in the direction of said magnet for holding said pole piece, said magnet and said yoke in operative, assembled relation, and centering means of non-magnetic material disposed between said yoke plate and said spring biasing means, said centering means having an opening concentric with said yoke plate opening and through which said pole piece is disposed in closely fitting relation for maintaining said pole piece in uniform, spaced relation to said yoke plate thereby to form an air gap therebetween.

6. In a sound transducer, a field structure of magnetic material comprising a U-shape yoke and yoke plate secured to the ends of said yoke, said plate being provided with a circular opening, a permanent magnet disposed on said yoke in operative magnetic relation therewith, a pole piece for said magnet having a shoulder and a cylindrical portion extending into said opening in spaced relation to said yoke plate thereby forming an air gap therebetween, a nonmagnetic centering element secured to said plate and provided with a circular opening closely surrounding said cylindrical portion in spaced relation to said shoulder and in concentric relation with said first named opening, and spring means engaging said yoke plate and said shoulder, and being biased against said shoulder for holding said pole piece against said magnet and said magnet against said yoke.

DAVID H. CUNNINGHAM.

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