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(54) **SHALLOW LOUDSPEAKER WITH SLOTTED MAGNET STRUCTURE.**

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Abstract of JP-A-60-68799

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Description

This invention relates to electrodynamic transducers and more specifically to a novel configuration of the magnet structure and diaphragm which permits a shallower transducer to be realized than is permitted by prior art designs.

Various shallow and flat diaphragm designs are known. There are, for example, the designs illustrated by the following U.S. Patents: 1,766,612; 2,498,825; 2,858,377; 3,153,463; 4,379,951; 4,385,210; 4,508,941; and, 4,520,237. This listing is only intended as illustrative of the prior art and specifically is not intended as a representation that no closer prior art exists to the claimed invention. Although the listed prior art generally illustrates what are believed to be the shallowest transducer designs available with existing technology, the illustrated designs suffer from the weakness that the transducer must be designed with space between the diaphragm and magnet assembly when the voice coil is unexcited so that no collisions occur between the diaphragm and magnet assembly when the voice coil is excited. For example, in a transducer whose design is intended to provide a .6 inch (1.5 cm) peak to peak excursion, a space of at least .3 inch (.75 cm) must be provided between the diaphragm and adjacent surfaces of the magnet assembly when the voice coil is unexcited. Of course, collisions between the diaphragm and magnet assembly must be avoided to prevent the audible distortion which accompanies such collisions.

It is an object of the present invention to provide an electrodynamic transducer structure in which it is not necessary to provide space between the diaphragm and magnet structure in the direction in which excursion of the diaphragm occurs.

JP-A-60/68799 discloses a loudspeaker structure with two poles defining between them an air gap, and a voice coil connected to the diaphragm. This has been taken as the basis for the preamble of claim 1.

The essential features of the invention are set out in claim 1.

In a preferred embodiment of the invention, the first pole is an inner, or core, pole and the second pole is an outer pole, or shell. The air gap has a generally cylindrical configuration. The voice coil has a generally cylindrical configuration for displacement axially within the air gap. The openings are provided in the outer pole.

Illustratively, the diaphragm comprises an opening having an inner sidewall, and the ribs are secured at their radially outer extents to the inner sidewall, the diaphragm is generally planar, and the inner sidewall is right circular cylindrical.

Further, illustratively, the air gap and voice coil are generally right circular cylindrical in configura-

tion.

According to the illustrative embodiment, the openings in the outer pole are generally slot-shaped.

The openings are elongated in the direction of the air gap and voice coil axes and narrow in a direction transverse to the air gap and voice coil axes. Also according to the illustrative embodiment, the ribs are elongated in the direction of the air gap and voice coil axes and narrow in a direction transverse to the air gap and voice coil axes.

According to the illustrative embodiment, the means for coupling the voice coil to the diaphragm further comprises a voice coil form for supporting the voice coil in the air gap. The ribs are secured at their radially inner extents to the voice coil form.

The invention may best be understood by referring to the following description and accompanying drawings which illustrate the invention. In the drawings:

Fig. 1 illustrates an exploded fragmentary perspective view of an electrodynamic transducer constructed according to the present invention; and

Fig. 2 illustrates a fragmentary sectional side elevational view of the electrodynamic transducer of Fig. 1, taken generally along section lines 2-2 of Fig. 1.

Referring to both figures, the transducer includes a back plate 10 which can be constructed from any suitable material such as a metal or filled or unfilled resin. Back plate 10 extends outward from the transducer components illustrated in the figures and typically supports the outer perimeter (not shown) of the diaphragm 12 of the transducer by some suitable configuration which is not the subject of this invention. An outer pole, or shell, 14 is mounted, such as by a suitable adhesive, on back plate 10. Shell 14 is constructed from a material which has a high magnetic permeability, a ferromagnetic material. Shell 14 defines within it a generally right circular cylindrical space 17, open at the top 16. Slots 18 extend along the length of the sidewall 20 of shell 14 from its floor 22 to its upper lip 24. Slots 18 are elongated in the direction of the axis 26 of the right circular cylindrical space and narrow in the circumferential direction.

A right circular cylindrical ferromagnet 28 and a high magnetic permeability, right circular cylindrical slug 30 are stacked on the floor 22 of shell 14 to form the inner, or core, pole 31 of a yoke 32 with shell 14. A right circular cylindrical air gap 34 coaxial with space 17 and core pole 31 is thus formed.

Diaphragm 12 includes an inner circular opening 36 defined by a right circular cylindrical wall 38 having a radius larger than the radius of shell 14 so that diaphragm 12 will slide down around the shell

14. Several ribs 40 extend radially inward from wall 38 and join the outer sidewall of a right circular cylindrical voice coil form 42. The dimensions of ribs 40 and voice coil form 42 are such that the ribs 40 move freely without contact in slots 18 and voice coil form 42 and the voice coil 44 which is provided on the radially inner surface 46 thereof move freely without contact in air gap 34.

It will be appreciated with reference to Fig. 2 that the entire excursion of diaphragm 12 between its peak limits T and B is below the level of lip 24 of shell 14. Thus, the object is achieved of providing a transducer structure wherein space between the diaphragm 12 and magnet structure 14, 28, 30 in the direction in which excursion of the diaphragm 12 occurs is eliminated.

Claims

1. An electrodynamic transducer comprising a magnet structure (32) including first and second poles (14,30) defining between themselves an air gap (34), a diaphragm (12), a voice coil (44), and means (40) for coupling the voice coil (44) to the diaphragm (12), characterized in that openings (18) are provided in at least one of the poles, the openings (18) extending substantially parallel with the air gap (34) and the direction of motion of the voice coil (44) in the air gap, and wherein the means (40) for coupling the voice coil (44) to the diaphragm (12) comprises ribs (40) extending transversely across the air gap and securing the voice coil to the diaphragm.
2. The apparatus of claim 1 wherein the first and second poles comprise an inner pole (30) and an outer pole (14), respectively, the voice coil (44) having a substantially cylindrical configuration, and the air gap (34) having a substantially cylindrical configuration, the ribs (40) extending substantially radially of the axes of the voice coil (44) and air gap between the voice coil and diaphragm (12).
3. The apparatus of claim 2 wherein the openings are in the outer pole (14) and are in the shape of slots (18) which are elongated in the direction of the air gap and voice coil axes and narrow in a direction transverse to the air gap and voice coil axes.
4. The apparatus of claim 3 wherein the ribs (40) are elongated in the direction of the air gap (34) and voice coil (44) axes and narrow in a direction transverse to the air gap and voice coil axes.

5. The apparatus of any one of claims 2 to 4 wherein the means for coupling the voice coil (44) to the diaphragm (12) further comprises a voice coil form (42) for supporting the voice coil in the air gap, the ribs being secured at their radially inner ends to the voice coil form.
6. The apparatus of any one of claims 2 to 5, wherein the air gap (34) and voice coil (44) are substantially right circular cylindrical.
7. The apparatus of any one of claims 2 to 6 wherein the diaphragm (12) comprises an opening having an inner sidewall (38) and the ribs (40) are secured at their radially outer ends to the inner sidewall.
8. The apparatus of claim 7, wherein the inner sidewall (38) of the opening in the diaphragm (12) is substantially cylindrical.
9. The apparatus of claim 8, wherein the inner sidewall (38) of the opening in the diaphragm (12) is substantially right circular cylindrical.
10. The apparatus of any one of claims 1 to 9, wherein the diaphragm (12) is substantially planar.

Patentansprüche

1. Elektrodynamischer Wandler mit einer Magnetanordnung (32), die erste und zweite Pole (14, 30) enthält, welche zwischen sich einen Luftspalt (34), ein Diaphragma (12), eine Lautsprecherspule (44) und Mittel (40) zum Koppeln der Lautsprecherspule (44) mit dem Diaphragma (12) festlegen, dadurch gekennzeichnet, daß Öffnungen (18) in mindestens einem der Pole vorgesehen sind, wobei die Öffnungen (18) sich im wesentlichen parallel mit dem Luftspalt (34) und der Bewegungsrichtung der Lautsprecherspule (44) in dem Luftspalt erstrecken, und wobei die Mittel (40) zum Koppeln der Lautsprecherspule (44) mit dem Diaphragma (12) Stege (40) umfassen, die transvers quer durch den Luftspalt verlaufen und die Lautsprecherspule an dem Diaphragma befestigen.
2. Vorrichtung nach Anspruch 1, wobei die ersten und zweiten Pole einen inneren Pol (30) bzw. einen äußeren Pol (14) umfassen, wobei die Lautsprecherspule (44) im wesentlichen eine zylindrische Konfiguration aufweist, der Luftspalt (34) eine im wesentlichen zylindrische Konfiguration aufweist und die Stege (40) im wesentlichen radial zu den Achsen der Laut-

sprecherspule (44) und dem Luftspalt zwischen der Lautsprecherspule und dem Diaphragma (12) verlaufen.

3. Vorrichtung nach Anspruch 2, wobei die Öffnungen sich in dem äußeren Pol (14) befinden und die Form von Einschnitten (18) aufweisen, welche in die Richtung der Luftspalt- und der Lautsprecherspulenachse gestreckt und schmal in einer Richtung quer zu der Luftspalt- und der Lautsprecherspulenachse sind. 5 10
4. Vorrichtung nach Anspruch 3, wobei die Stege (40) in Richtung der Luftspalt- (34) und der Lautsprecherspulenachse (44) gestreckt und schmal in einer Richtung quer zu der Luftspalt- und der Lautsprecherspulenachse sind. 15
5. Vorrichtung nach einem der Ansprüche 2 bis 4, wobei die Mittel zum Koppeln der Lautsprecherspule (44) mit dem Diaphragma (12) ferner einen Lautsprecherspulenkörper (42) zum Tragen der Lautsprecherspule in dem Luftspalt aufweisen, wobei die Stege an ihren radialen inneren Enden an dem Lautsprecherspulenkörper befestigt sind. 20 25
6. Vorrichtung nach einem der Ansprüche 2 bis 5, wobei der Luftspalt (34) und die Lautsprecherspule (44) im wesentlichen gerade kreiszylindrisch sind. 30
7. Vorrichtung nach einem der Ansprüche 2 bis 6, wobei das Diaphragma (12) eine Öffnung umfaßt, die eine innere Seitenwand (38) aufweist und die Stege (40) mit ihren radial äußeren Enden an der inneren Seitenwand befestigt sind. 35
8. Vorrichtung nach Anspruch 7, wobei die innere Seitenwand (38) der Öffnung in dem Diaphragma (12) im wesentlichen zylindrisch ist. 40
9. Vorrichtung nach Anspruch 8, wobei die innere Seitenwand (38) der Öffnung in dem Diaphragma (12) im wesentlichen gerade kreiszylindrisch ist. 45
10. Vorrichtung nach einem der Ansprüche 1 bis 9, wobei das Diaphragma (12) im wesentlichen planar ist. 50

Revendications

1. Transducteur électrodynamique, comprenant une structure d'aimant (32), comportant une première et une seconde pièces polaires (14, 30) délimitant entre elles un entrefer (34), une 55

membrane (12), une bobine mobile (44) et des moyens (40) servant à accoupler la bobine mobile (44) à la membrane (12), caractérisé en ce que des ouvertures (18) sont ménagées dans au moins l'une des pièces polaires, ces ouvertures (18) s'étendant d'une manière pratiquement parallèle à l'entrefer (34) et à la direction de déplacement de la bobine mobile (44) dans l'entrefer, et en ce que les moyens (40) servant à accoupler la bobine mobile (44) à la membrane (12) comprennent des nervures (40) s'étendant transversalement d'un côté à l'autre de l'entrefer et rendant la pièce mobile solidaire de la membrane.

2. Transducteur suivant la revendication 1, dans lequel les première et seconde pièces polaires consistent respectivement en une pièce polaire intérieure (30) et une pièce polaire extérieure (14), la bobine mobile (44) ayant une configuration pratiquement cylindrique et l'entrefer (34) ayant aussi une configuration pratiquement cylindrique, tandis que les nervures (40) s'étendent d'une manière pratiquement radiale vis-à-vis des axes de la bobine mobile (44) et de l'entrefer entre cette bobine mobile et la membrane (12).
3. Transducteur suivant la revendication 2, dans lequel les ouvertures sont ménagées dans la pièce polaire extérieure (14) et ont la forme de fentes (18) qui sont allongées dans la direction des axes de l'entrefer et de la bobine mobile et étroites dans une direction transversale vis-à-vis de ces axes de l'entrefer et de la bobine mobile.
4. Transducteur suivant la revendication 3, dans lequel les nervures (40) sont allongées dans la direction des axes de l'entrefer (34) et de la bobine mobile (44) et étroites dans une direction transversale vis-à-vis de ces axes de l'entrefer et de la bobine mobile.
5. Transducteur suivant l'une quelconque des revendications 2 à 4, dans lequel les moyens servant à l'accouplement de la bobine mobile (44) à la membrane (12) comprennent en outre un guide de bobine mobile (42) servant à soutenir la bobine mobile dans l'entrefer, les nervures étant solidaires de ce guide de bobine mobile à leurs extrémités radialement intérieures.
6. Transducteur suivant l'une quelconque des revendications 2 à 5, dans lequel l'entrefer (34) et la bobine mobile (44) sont pratiquement cylindriques à section droite circulaire.

7. Transducteur suivant l'une quelconque des revendications 2 à 6, dans lequel la membrane (12) comporte une ouverture présentant une paroi latérale intérieure (38) et les nervures (40) sont solidaires de cette paroi latérale intérieure à leurs extrémités radialement extérieures. 5
8. Transducteur suivant la revendication 7, dans lequel la paroi latérale intérieure (38) de l'ouverture ménagée dans la membrane (12) est pratiquement cylindrique. 10
9. Transducteur suivant la revendication 8, dans lequel la paroi latérale intérieure (38) de l'ouverture de la membrane (12) est pratiquement cylindrique à section droite circulaire. 15
10. Transducteur suivant l'une quelconque des revendications 1 à 9, dans lequel la membrane (12) est pratiquement plane. 20

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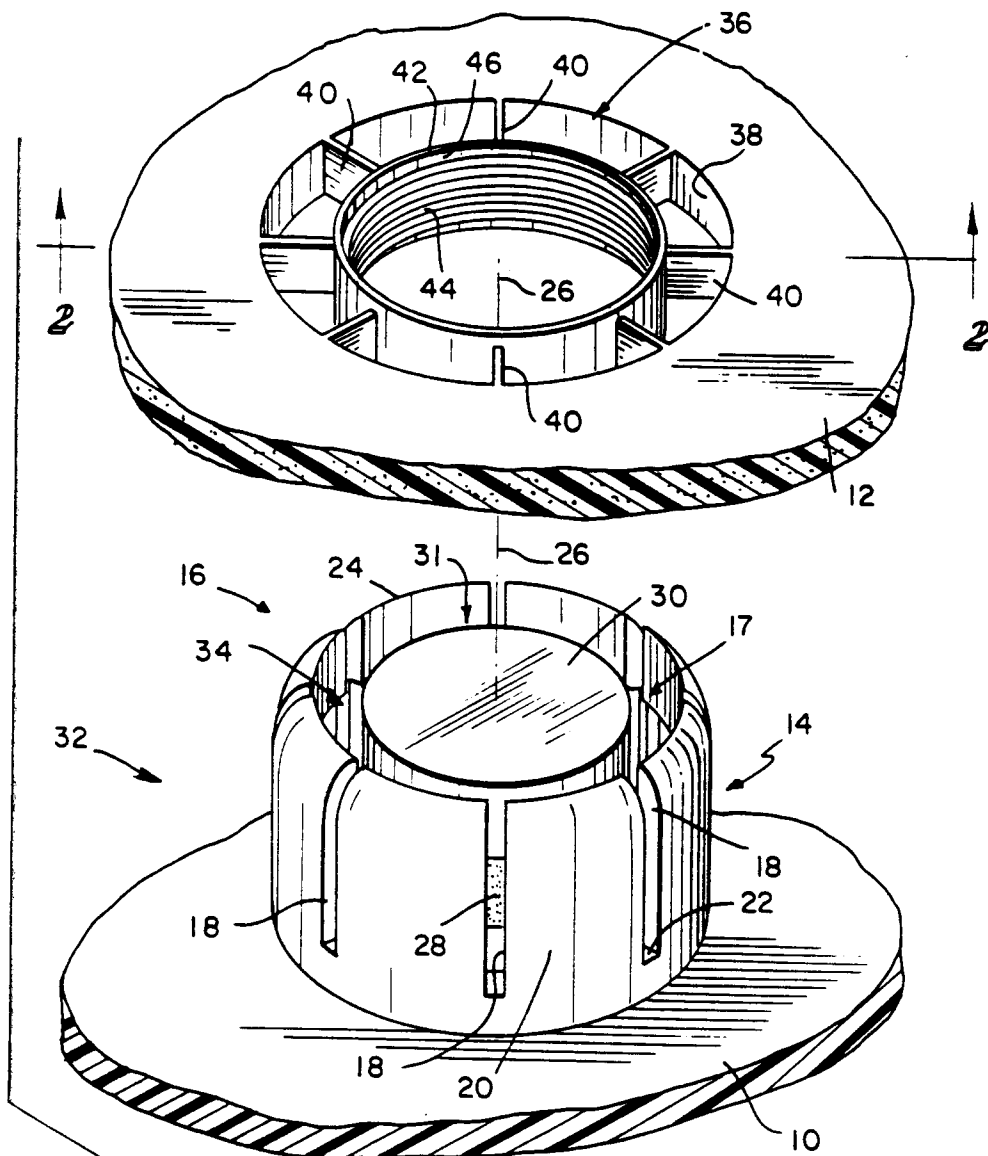


FIG 1

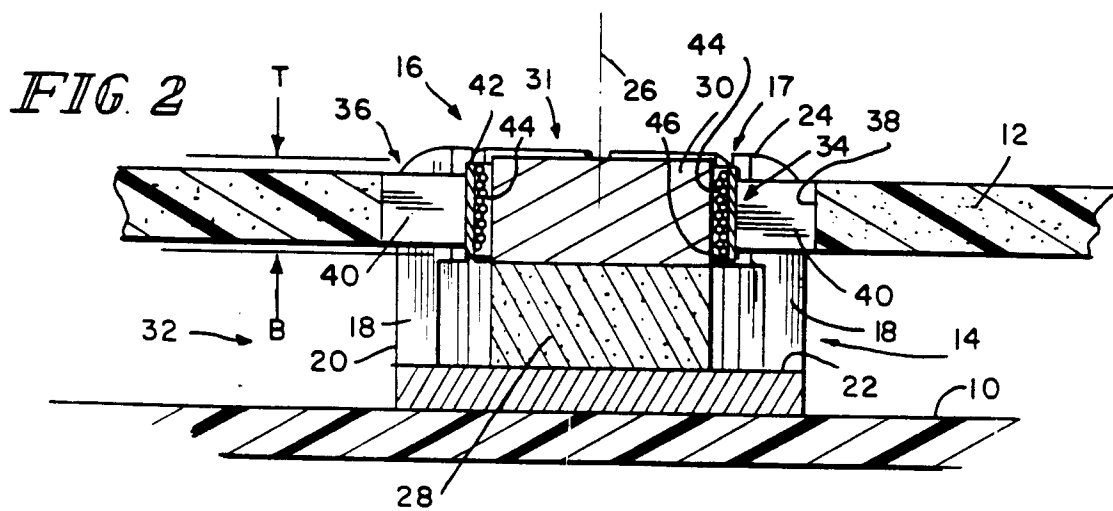


FIG 2