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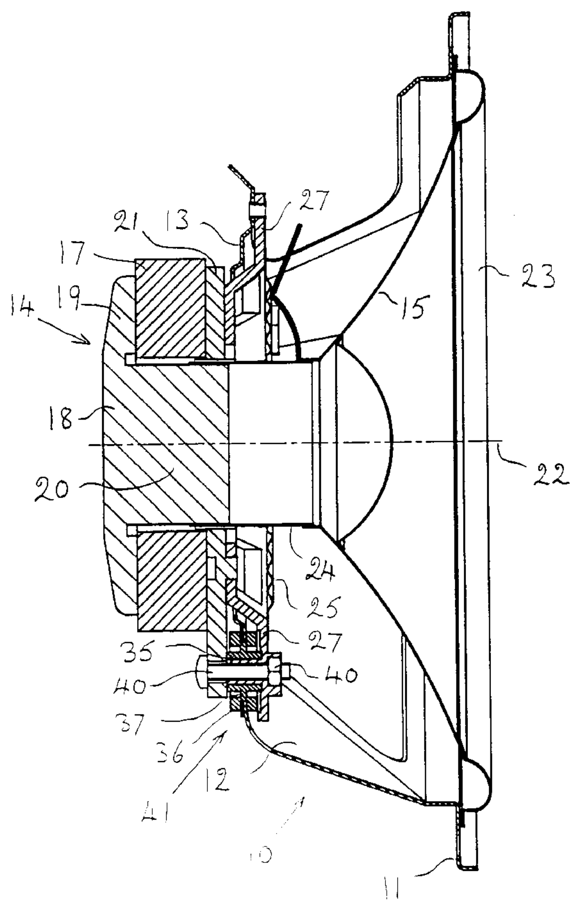
(54) Magnetic drive system for loudspeaker.

(57) A loudspeaker construction is disclosed in which a conical diaphragm (15) is caused to generate and radiate sound by means of interaction between a drive coil on a coil former (24) secured to the neck of the diaphragm and a magnet assembly (14) secured to a chassis (10) of the loudspeaker. Electrical energisation of the drive coil produces a drive force acting on the drive coil to move the diaphragm. In order to reduce or prevent radiation of sound from a front ring (11) of the chassis and from a baffle board on which the chassis is mounted arising from reaction to the drive force acting on the magnet assembly, the magnet assembly is mechanically isolated or de-coupled from the chassis. This is accomplished by securing the magnet assembly to the chassis by means of resilient mountings (41) to reduce or prevent transmission of reaction force from the magnet assembly to the chassis.



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This invention relates to loudspeaker drive units for sound reproduction and in particular to a construction of magnetic drive system for such loudspeaker drive units.

Loudspeaker drive units include a sound radiating diaphragm, commonly of conical form, which is caused to vibrate by a drive system to generate the radiated sound waves. The mouth of the diaphragm is mounted by means of a compliant surround to a chassis of the loudspeaker drive unit to permit axial movement of the cone relative to the chassis. Usually the drive system comprises a magnet assembly rigidly mounted on the chassis of the loudspeaker drive unit. The magnet assembly includes an annular air gap in a magnetic path such that there is magnetic flux across the air gap. The diaphragm carries a cylindrical coil which is located concentrically with the annular air gap and at least a part of the length of the coil is within the annular air gap and is electromagnetically coupled with the magnetic flux in the annular air gap. Electric current is passed through the coil and hence a force is generated which causes the diaphragm to move away from its rest position. Accordingly if the current in the coil is a waveform representing sound signals, the diaphragm will be driven to move in a manner such as to reproduce those sound signals. It will be appreciated that when the diaphragm is driven in this manner the movement of the diaphragm causes pressure variations in the air adjacent thereto and this requires a substantial magnitude of power to be input to the coil of the loudspeaker drive unit in order to drive the diaphragm to produce the required magnitude of sound level. Also, the diaphragm has a finite mass which, although it is low, requires significant magnitude of force to overcome the inertia of the mass of the diaphragm. As a result, when an electric current is passed through the coil to produce a force to drive the diaphragm the magnet assembly is subjected to an equal and opposite re-action force

In common constructions of loudspeaker drive unit the chassis of the speaker is in the form of a generally conical basket comprising a front annular flange and a number of legs, extending rearwardly and inwardly from the flange, to which the magnet assembly is rigidly secured. The mouth of the conical diaphragm is mounted by a compliant surround to the front annular flange of the chassis and this front flange forms a mounting means for the loudspeaker drive unit. In order to provide the required acoustic characteristic of a loudspeaker, the loudspeaker drive unit is mounted on a baffle board forming a wall of a box or cabinet. A circular aperture is provided in the baffle board and the front chassis flange is secured to the board surrounding the aperture with the remainder of the chassis and the magnet assembly of the loudspeaker drive unit extending into the interior of the box. When the coil of the loudspeaker drive unit is energised to vibrate the diaphragm to generate sound radiation the equal and opposite re-action forces to which the magnet structure is subjected are transmitted through the chassis to the baffle board and as a consequence there is a tendency for the baffle board to vibrate and radiate sound. As a result the overall sound produced by the loudspeaker drive unit when mounted on the baffle board of the box comprises the combination of the sound radiated by the diaphragm together with any sound radiated by the chassis flange and the baffle board due to vibration thereof resulting from the reaction forces acting on the magnet assembly.

High quality reproduction of sound requires that the relationship between the magnitude of the electrical input drive signal and the magnitude of the level of sound output is as linear as possible and is represented by a smooth curve as a function of frequency. However the effect of the radiation of sound due to the re-action forces is to distort this smooth curve and to result in distortion of the reproduced sound. To overcome this distortion in reproduction it has been proposed to mount the front flange of the loudspeaker drive unit chassis to the baffle board by means of resilient or compliant mountings. However in order to obtain the required coupling of the diaphragm with the surrounding air it is required that the mouth of the diaphragm is sealed to the baffle board in a manner which prevents leakage of air between the mouth of the diaphragm and the baffle board. Accordingly if the loudspeaker drive unit is mounted by means of resilient or compliant mountings it is necessary to provide a compliant sealing ring to seal between the front of the chassis and the baffle board. While this method may enable the chassis of the loudspeaker drive unit to be mechanically isolated from the baffle board so that any sound radiation from the baffle board due to reaction forces acting on the magnet assembly is eliminated or reduced the front flange of the chassis itself presents a significant sound radiating surface which can radiate sound which will interfere with that radiated by the diaphragm and result in distortion of the reproduced sound.

According to the invention a loudspeaker drive unit comprises a chassis; a magnet assembly including an annular air gap, magnetic flux being generated in the air gap by a magnet; a diaphragm having a periphery thereof secured by compliant means to the chassis; a drive coil secured to the diaphragm and located in the magnetic flux of the air gap so that passage of electric current through the drive coil generates a drive force acting between the magnet assembly and the diaphragm to cause the diaphragm to vibrate; and wherein the magnetic structure is mechanically isolated or de-coupled from the chassis to prevent or reduce transmission to the chassis of re-action force arising from said drive force.

An embodiment of the invention will now be described by way of example with reference to the drawing which shows a central cross section through a loudspeaker drive unit.

Referring to the drawing, a chassis 10 of a loudspeaker drive unit comprises a front annular flange 11 from which legs 12 extend rearwardly and inwardly. The rear ends of the legs 12 are joined by a rear member in the form of an annular plate 13. The chassis may be of cast construction but is conveniently pressed from sheet metal. preferably three legs 12 equiangularly spaced on the flange 11 are provided but if desired a larger number of legs may be provided. A magnet assembly 14 is secured to the annular plate 13. The magnet assembly 14 comprises an annular magnet 17, a first pole element 18 having a circular flange 19 magnetically coupled to one pole face of the magnet 17 and a cylindrical centre pole 20 extending from the flange 19 through the magnet 17 and a second pole element comprising a front plate 21 magnetically coupled to the other pole face of the magnet 17. The front plate 21 is of annular form with a central aperture therein of greater diameter than the diameter of the centre pole 20. The centre pole 20 extends through the aperture in the front plate 21 to define, between them, an annular air gap concentric with a centre line 22. The larger diameter front edge of the conical diaphragm 15 is secured to the front flange 11 of the chassis 10 by means of a compliant surround 23. A cylindrical coil former 24 is secured to the rear smaller diameter of the conical diaphragm 15. The coil former 24 carries a drive coil for the conical diaphragm. The inner diameter of the coil former 24 is slightly larger than the diameter of the centre pole 20 and the outer diameter of the drive coil on the coil former is slightly smaller than the diameter of the aperture in the front plate 21. The coil former extends rearwardly from the diaphragm 15 through the air gap between the centre pole 20 and the front plate 21 such that the drive coil is located in the region of the air gap and is subjected to magnetic flux generated by the magnet 17 in the air gap. Centering means 25 is secured to the coil former 24 to maintain the coil former, and the drive coil carried thereby, concentric relative to the centre line 22 of the annular air gap. The centering means may comprise, as shown in the drawing, an annular sheet formed with concentric corrugations therein whereby the conical diaphragm 15 is free to move in an axial direction on the compliant mounting ring 23 relative to the chassis 10 while being maintained concentric relative to the axis 22. An outer edge of the centering means 25 is secured to a surface of an annular member 27 which is attached to the magnet assembly 14.

When the coil of the drive unit is energised with a waveform representing sounds to be reproduced a force is generated by the inter-action of electrical current in the drive coil and the magnetic flux in the air gap which drives the conical diaphragm to move such as to radiate sound. The force acting on the diaphragm produces an equal and opposite re-action force acting on the magnet assembly 14 which tends to be transmitted through the chassis to the front flange of the chassis and to any baffle board on which the drive unit is mounted. This transmitted force tends to cause the front flange of the drive unit chassis and the baffle board to vibrate and to radiate sound which interferes with sound radiated by the conical diaphragm and as a result causes distortion of the reproduced sound. In order to prevent or at least reduce this distortion of the reproduced sound due to the re-action force acting on the magnet assembly, the magnet assembly 14 is mounted on the chassis 10 in such a manner that the magnet assembly is mechanically isolated or decoupled from the chassis 10. The mechanical isolation or de-coupling of the magnet assembly 14 from the chassis 10 is achieved by means of resilient mountings 41, only one of which is illustrated in the drawing, for the magnet assembly. Each mounting 41 comprises a resilient bush member located in an aperture in the rear plate 13. The resilient bush member comprises an inner tubular element 35 and an outer annular element 36 interconnected by a web 37. The outer annular element 36 has an annular groove in the periphery thereof to receive the edge of the plate 13. A rigid tubular member 38 extends through the inner tubular element 35. As shown in the drawing, the tubular member 38 is carried by the member 27. The front plate 21 of the magnet assembly extends out to the locations of the mountings 41 and is secured to the tubular members 38 by screws 39 and nuts 40. Thus the outer annular element of the resilient bush members is held by the plate 13 and the inner tubular element 35 is secured to the front plate 21 by means of the tubular spigot 38 engaging in the tubular element 35 and by the tubular spigot 38 being secured to the front plate 21 by the screws 39 and nuts 40. For ease of assembly the nuts 40 are held captive in recesses in the member 27. Accordingly it will be appreciated that the magnet assembly 14 is resiliently connected to the chassis by means of the webs 37 of the resilient bush members. The webs permit movement of the magnet assembly relative to the chassis 10 in the direction of the axis 22 and it is in this direction that vibration of the magnet assembly due to the re-action forces will occur. Therefore the resilient bush members mechanically isolate or de-couple the magnet assembly from the chassis 10 in respect of vibration of the magnet assembly resulting from re-action forces when the diaphragm 15 is driven. However the webs of the bush members resist movement of the magnet assembly in directions transverse to the axis 22 and hence the axis 22 of the magnet assembly and the air gap therein is maintained substantially concentric with the axis of the chassis 10 regardless of the orientation of the loudspeaker drive unit.

It is preferred to secure the magnetic assembly to the chassis by means of three resilient bush members 41 and to locate the resilient bush members in the rear member 13 adjacent to the legs 12.

While in general the low frequency diaphragm is of conical form, the diaphragm may be of other forms as may be desired. For example, the diaphragm may be planar with the periphery thereof mounted by compliant means to a chassis of the drive unit and the drive coil secured to a central region of the diaphragm.

Hereinbefore, the chassis of the loudspeaker drive unit has been described as a unitary structure with the magnet assembly mounted thereon by means of resilient mountings secured to the magnet assembly and to the plate 13. However if desired the chassis may comprise two parts which are connected together but mechanically isolated or decoupled from one another by resilient mounting means. One part of the chassis includes the front flange and the other part of the chassis comprises a sub-chassis which includes the rear member. The front flange may have legs extending rearwardly and the rear member may have legs extending forwardly and connection between the two parts of the chassis may be effected by resilient mounting means secured to corresponding pairs of legs of the chassis and sub-chassis. With a two part chassis in which resilient connections are provided between front and rear parts, the magnet assembly may be rigidly secured to the rear sub-chassis.

Claims

1. A loudspeaker drive unit comprising a chassis; a magnet assembly including an annular air gap, magnetic flux being generated in the air gap by a magnet; a diaphragm having a periphery thereof secured by compliant means to the chassis; a drive coil secured to the diaphragm and located in the magnetic flux of the air gap so that passage of electric current through the drive coil generates a drive force acting between the magnet assembly and the diaphragm to cause the diaphragm to vibrate; and wherein the magnet assembly is mechanically isolated or de-coupled from the chassis to prevent or reduce transmission to the chassis of re-action force arising from said drive force.

2. A loudspeaker drive unit as claimed in claim 1 wherein the mechanical isolation or de-coupling of the magnet assembly from the chassis is effected by resilient mountings securing the magnet assembly to the chassis.

3. A loudspeaker drive unit as claimed in claim 2 wherein the resilient mountings are effective to permit relative movement between the magnet assembly and the chassis in a direction aligned with the direction in which the reaction force acts on the magnet assembly and are effective to restrain relative displacement of the magnet assembly and the chassis in directions transverse to the direction of action of the re-action force.

4. A loudspeaker drive unit as claimed in claim 2 or 3 in which the chassis comprises a front annular member to which the diaphragm is secured by the compliant means; a rear member; a plurality of legs connecting the rear member to the front member; a plurality of resilient mountings secured to the rear member; and the magnet assembly includes a front plate surrounding the air gap and defining an outer boundary of the annular air gap; and including means securing the front plate to said resilient mountings.

5. A loudspeaker drive unit as claimed in claim 4 wherein the resilient mountings are located in the rear member respectively one adjacent each leg of the chassis.

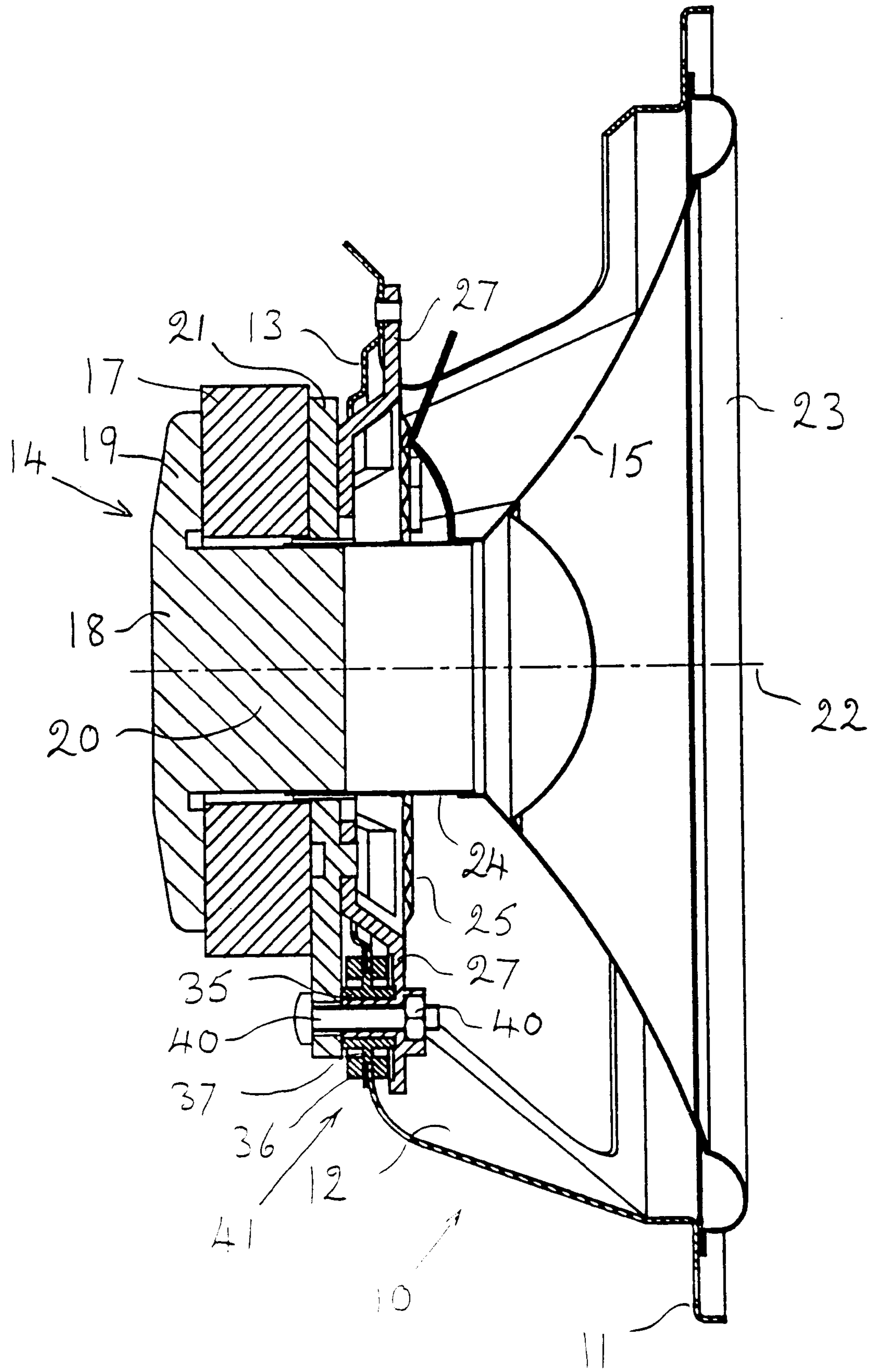
6. A loudspeaker drive unit as claimed in claim 2 or 3 in which the chassis comprises a front annular member to which the diaphragm is secured by the compliant means; in which the magnet assembly is secured to a rear sub-chassis member and in which the rear sub-chassis member is connected to the chassis by resilient means effective to mechanically isolate or de-couple the magnet assembly and rear sub-chassis member from the chassis.

7. A loudspeaker drive unit as claimed in claim 6 wherein the chassis includes first legs extending rearwardly; the rear sub-chassis member includes second legs corresponding to said first legs and extending forwardly; and in which the resilient means is secured to corresponding first and second legs.

8. A loudspeaker drive unit as claimed in any one of claims 2 to 7 wherein each resilient mounting comprises an inner element; an outer annular element extending around the inner element and a resilient web interconnecting the inner and outer elements.

9. A loudspeaker drive unit constructed and arranged to operate substantially as hereinbefore described with reference to the drawing.

10. A loudspeaker including a box and a loudspeaker drive unit as claimed in any preceding claim; said loudspeaker drive unit being mounted on a wall of the box by a rigid connection between the chassis of the drive unit and the wall of the box.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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 4950

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 667 568 (LIEBSCHER) * column 1, line 70 - column 2, line 28; figure 3 *	1-6,9,10	H04R9/06 H04R9/02 H04R1/28
X	EP-A-0 158 978 (QUAAS J.) * page 12, line 8 - line 30; figure 8 *	1,9,10	
X	GB-A-2 001 827 (SONY CORPORATION) * page 1, line 27 - page 2, line 23; figures *	1,9,10	
A	DE-A-3 841 946 (PIONEER ELECTRONIC CORP.) * column 1, line 35 - column 254; figure 1 *	1,9,10	
A	FR-A-2 625 639 (KOBUS) * page 1, line 34 - page 3, line 6; figures *	1,9,10	
A	DE-A-3 705 724 (PIONEER ELECTRONIC CORPOR.) * column 1, line 61 - column 2, line 65; figures 1-5 *	1,9,10	
	-----		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H04R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 JULY 1992	GASTALDI G.L.

CATEGORY OF CITED DOCUMENTS

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