United States Patent [19]

Collinson

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[54] **ELECTRO-ACOUSTIC TRANSDUCERS**

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[73] Assignee: **The Rank Organisation Limited,** London, England

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[21] Appl. No.: **364,486**

[52] **U.S. Cl.** ..... **179/115.5 PV,** 179/179

[51] **Int. Cl.** **H04r 9/04**

[58] **Field of Search** ..... 179/115.5 PV, 115.5 R, 179/111 R, 178, 179, 181 R, 181 F

[56] **References Cited**

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Primary Examiner—Kathleen H. Claffy
Assistant Examiner—Thomas L. Kundert
Attorney, Agent, or Firm—Brisebois & Kruger

[57] **ABSTRACT**

A transducer assembly for a flat diaphragm transducer of the type having a non-magnetic diaphragm with a conductor in the form of spaced parallel strips on one face with a cooperating magnet structure comprising a plurality of elongate alternate magnetic poles, which can be readily assembled by unskilled labour is disclosed. The transducer assembly comprises two polygonal frames having inwardly directed flanges and peripheral upstanding flanges. The inwardly directed flanges serve to define the spacing between the magnet structure and the diaphragm when two such frames are assembled with the diaphragm therebetween and the magnet structures located by the upstanding peripheral flanges of the frame members which flanges project away from one another. The two frame members are clamped along at least two sides in correspondence with the inwardly directed flanges, and the clamping means also holds the magnet structures and a perforated backing plate onto the frame members.

12 Claims, 8 Drawing Figures

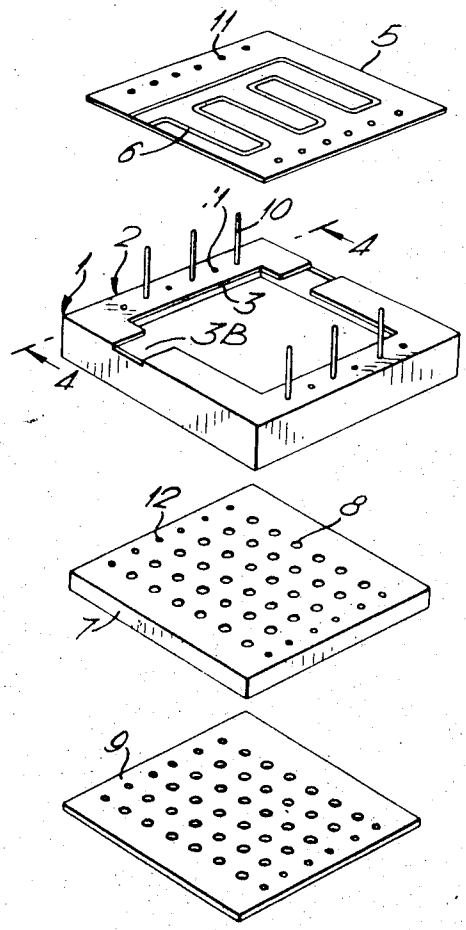


Fig. 1.

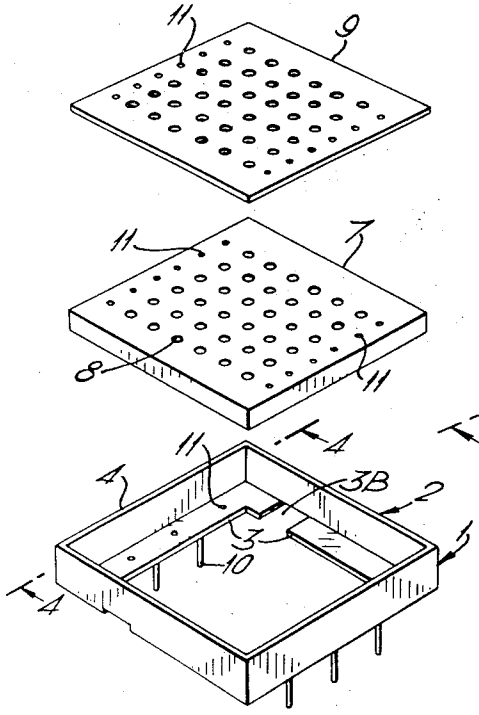


Fig. 2.

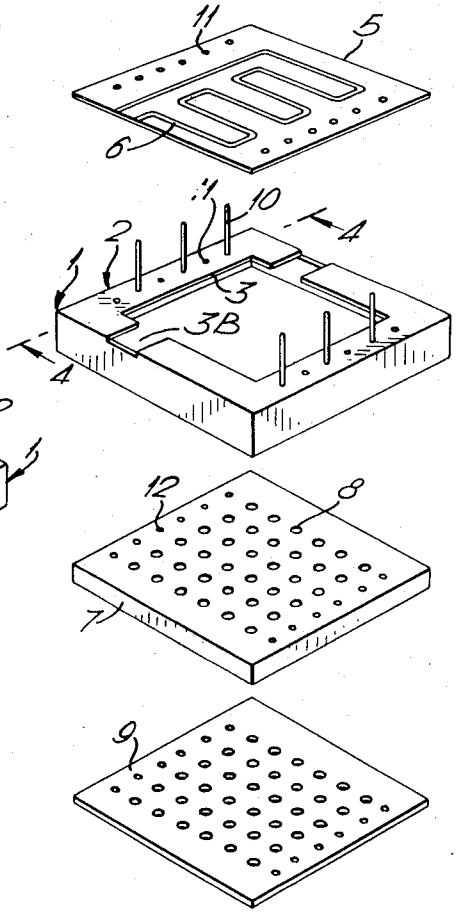


Fig. 3.

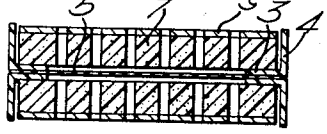


Fig. 4.

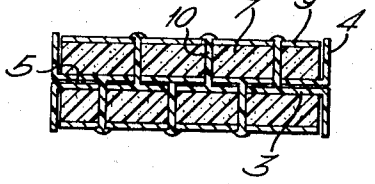


Fig. 5.

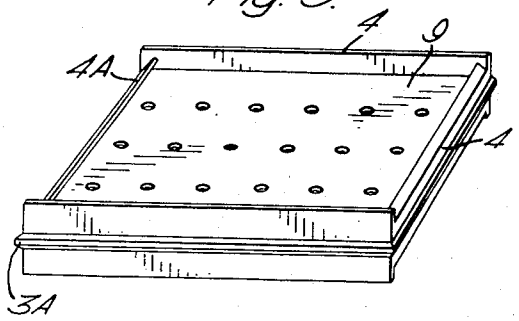


Fig. 6.

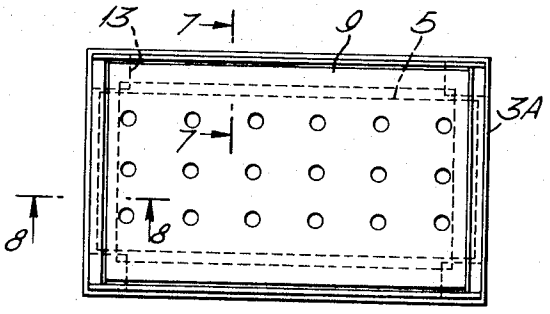


Fig. 7.

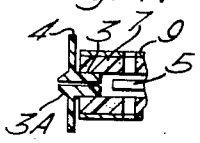
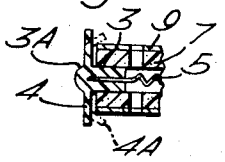


Fig. 8.



ELECTRO-ACOUSTIC TRANSDUCERS

The subject of this invention is a transducer and is a development of the invention which is the subject of patent application Ser. No. 251,388 to Willis et al., filed May 8, 1972.

In the specification of the aforesaid patent application, there is described an audio transducer incorporating a diaphragm carrying on one face at least an electric current conductor consisting of a number of spaced parallel conductor portions and a fixed magnet unit incorporating a perforated backing plate bearing a magnet presenting a plurality of magnetic poles in strip form arranged in a selected pattern of polarity and opposite the gaps between the parallel portions of the conductor on the diaphragm so as to produce a magnetic field in the plane of the diaphragm and orthogonal to the conductor.

It is an object of the present development to provide a construction of such a transducer which is easily assembled by semi-skilled labour, provides the requisite spacing of the parts and is completely rigid.

According to the present invention an audio transducer comprises two frame members each in the form of a closed polygon having an inwardly directed flange extending around at least part of the periphery thereof and a further flange forming an upstanding wall extending around the periphery thereof, at least one non-metallic diaphragm carrying a metallic conductor formed as a plurality of spaced, parallel, series connected strips located between and separating the frame members which are disposed with the upstanding walls projecting away from one another, two fixed magnet structures, each resting on the said inwardly directed flanges within the upstanding wall of respective frame elements and each having a plurality of parallel spaced elongated magnet poles facing the diaphragm aligned with the spaces between the strips of conductor with adjacent poles being of opposite polarity, and a perforated metallic backing sheet in contact with the face of the magnet remote from the diaphragm, and means holding all the said components of the transducer clamped together along at least two sides of the said frame members.

Two treble diaphragms and a full range diaphragm interposed between them may be provided between the frame elements.

The magnet may consist of a perforated sheet of plastomagnetic material or of individual strips of plastomagnetic material as defined. The perforated sheet or the individual strips may be formed of stacked laminations.

The magnet and the backing sheet associated with each frame element may be fastened to one another by adhesive.

Each frame element may be formed with pins projecting from selected co-planar flanges towards and penetrating the other frame element the corresponding co-planar flanges of which are formed with holes penetrated by the pins, the backing sheets and it may be the magnets also being formed with similarly located holes for passage of the pins, the projecting ends of which are deformed to form rivet heads holding the one frame element with its magnet unit to the other frame element with its magnet unit with the diaphragm clamped between the frame elements.

The diaphragm may be similarly perforated for passage of the pins.

Alternatively the tips of at least two opposite upstanding walls of each element may be inwardly bent over the outer surface of the associated magnet unit to hold the magnet unit in place, the heels of the angle bars of the two frame elements, i.e. the outside corners where the flanges meet, being fastened to one another with the diaphragm held between the two elements.

The frame elements may be of thermoplastics material, e.g., polystyrene, the pins or the walls being deformed following the application of heat. Similarly the two frame elements may be heat sealed to one another. To facilitate heat sealing the co-planar flanges of the angle bars may extend rearwardly beyond the heels of the bars so that the extended portions may be heated and fused together without distorting the adjacent portions of the frame elements.

The backing sheets may be of mild steel and may be cadmium plated.

The diaphragm may be of a non-metallic material such as Melinex.

The conductor strip on the diaphragm may be of aluminium and the ends may be located adjacent to one another at one edge of the diaphragm so as to be readily engageable by a connecting plug, gaps being provided in the co-planar flanges to receive the plug during assembly of the components of the transducer and to retain the plug after the frame elements are fastened to one another.

Practical embodiments of the invention are illustrated in the accompanying drawings in which FIG. **1** is an exploded view of what may for convenience be considered the upper frame element and its associated magnet and backing sheet of one form of transducer assembly and FIG. **2** is an exploded view of what may for convenience be referred to as the lower frame element with its associated magnet and backing sheet of the said transducer assembly including the diaphragm, FIG. **3** is a section through the centre of the assembled transducer which is the subject of FIGS. **1** and **2**, and FIG. **4** is a section through the assembled transducer at the position marked **4—4** in FIGS. **1** and **2** showing how the pins lock the two frame elements and their associated components to one another; FIG. **5** is a perspective view showing another form of transducer assembly, FIG. **6** is a plan view of the transducer of FIG. **5**, FIG. **7** is a section through the line **7—7** in FIG. **6** before the frame elements are heat sealed together, and FIG. **8** is a section through the line **8—8** in FIG. **6** showing the tips of the upstanding flanges bent over the magnet units and the frame elements heat sealed to one another to hold all the components in rigid clamped relationship.

In the drawings **1** denotes frame elements each consisting of a number of angle bars **2** disposed in the form of a closed polygon, in the illustrated construction a quadrilateral, one flange **3** of each angle bar **2** being co-planar with a flange **3** of each other angle bar **2** and the other flanges **4** forming an upstanding wall. **5** denotes a diaphragm of non-metallic material carrying a metallic conductor **6** in the form of a strip having spaced parallel portions. **7** denotes magnets formed with perforations **8** and so magnetized as to provide the effect of a plurality of strip magnets, adjacent strips being of opposite polarity, the magnets **7** being formed of plastomagnetic material consisting of magnetic particles em-

bedded in a matrix of non-magnetic material and 9 denotes perforated metallic backing sheets in contact with the rear faces of the magnets 7 and serving the dual purpose of mechanical supports for the magnets and low reluctance paths for the magnetic flux of the magnets. The perforations in the sheet 9 are arranged to register with the perforations 8 in the magnet 7 when the magnet 7 and the sheet 9 are placed together to form a magnet unit.

Referring particularly to FIGS. 1 and 2, 10 denotes pins projecting outwardly from the co-planar flanges 3, said flanges being formed with holes 11, the pins 10 and the holes 11 being so located that when the upper frame element is applied to the lower frame element the pins 10 of the one frame element penetrate the holes 11 in the other frame element. The diaphragm 5, the magnet 7 and the sheet 9 are also formed with holes 12 so spaced that these holes can be penetrated by both sets of pins 10 on the upper and the lower frame elements. FIG. 4 shows how the pins 10 in the lower frame element penetrate the co-planar flanges 3, the magnet 7 and the sheet 9 of the upper frame element and the pins 10 of the upper frame element penetrate the diaphragm 5, the magnet 7 and the sheet 9 of the lower frame element, the protruding tips of the pins being heat-deformed to function as rivet heads preventing withdrawal of the two frame elements with their contained components from one another so that the assembly remains a rigid unit.

In the construction of FIGS. 5, 6, 7 and 8 the two frame elements are assembled the same as in the construction of FIGS. 1 to 4 but in this case the tips 4A of one pair of opposite upstanding flanges 4 are heated and bent inwardly so that they engage the outer faces of the sheets 9 thus retaining the magnet units within the respective frame elements, also, the projecting heels 3A of the angle bars are heat fused to one another to hold the two frame elements to one another with the diaphragm 5 gripped between them. It will be observed that in this embodiment the diaphragm is gripped at two opposite edges only and is free along the other two opposite edges. This greatly reduces artificial damping of the diaphragm. As a safeguard against the accidental entry of the free edges of the diaphragm into the open gap between the co-planar flanges 3 adjacent to the free edges of the diaphragm (see FIG. 6) corner pegs 13 are fitted into the said open gaps and project a short distance inwardly beyond the said flanges 3.

In the construction illustrated in FIGS. 1 to 4 the plug 14 providing an electrical connection to the ends of the conductor 6 may be attached to the diaphragm 5 to provide an electrical connection to the conductor 6 before the diaphragm 5 is placed in position, the plug resting in the gap 3B in the co-planar flanges 3. It will be understood of course that if desired the conductor 6 may be arranged to project beyond the confines of the frame elements 1 so that a separate external connection may be made to the conductor 6. The construction of FIGS. 5 to 7 may similarly accommodate an internal plug or an external plug if desired.

The construction of the invention provides the advantages of easy assembly without requiring a high degree of skill because the necessary spacing of the magnets and the diaphragm is provided by the thickness of the co-planar flanges 3, these flanges being made of the required thickness to provide the desired degree of spacing. The construction also provides a completely rigid unit able to resist quite rough treatment.

I claim:

1. In an audio transducer of the type comprising:
- a non-magnetic diaphragm with a conductor on at least one face thereof, the conductor being formed as a plurality of elongate, parallel, series connected strips,
- a magnet structure presenting a plurality of elongate magnetic poles aligned with the spaces between the parallel strips of said conductor, adjacent poles having opposite polarity whereby the magnetic field produced thereby extends substantially parallel to the plane of the diaphragm and orthogonal to the direction of said strips of said conductor where it intersects said conductor, and
- a perforated metallic backing plate in contact with the face of said magnet structure remote from said diaphragm,
- the improvement wherein:
  - there are two individual magnet structures one on each side of said diaphragm each having a respective perforated metal backing plate,
  - a frame structure comprising two frame members in the form of respective closed polygons, said frame members having inwardly directed flanges defining the separation between said diaphragm and said two magnet structures, and further upstanding flanges defining an upstanding wall extending around the periphery of said frame members, said upstanding wall having a height at least as great as the combined thickness of the associated said magnet structure and backing plate, and
  - means clamping said two frame members together along at least two of said inwardly directed flanges with said diaphragm therebetween, said clamping means also holding said magnet structures and said backing plates on said frame members.

2. The transducer of claim 1 wherein there are a plurality of different diaphragms interposed between said frame members.

3. The transducer of claim 1 wherein said magnet structures each incorporate a perforated sheet of plasto-magnetic material, that is a material consisting of magnetic particles embedded in a matrix of non-magnetic material.

4. The transducer of claim 1, wherein said magnet structures include a plurality of individual strips of plasto-magnetic material, that is a material consisting of magnetic particles embedded in a matrix upon magnetic material.

5. The transducer of claim 3 wherein said magnet structures are formed of stacked laminations of plasto-magnetic material.

6. The transducer of claim 4 wherein said magnet structures are formed of stacked laminations of plasto-magnetic material.

7. The transducer of claim 1 wherein said magnet structures and said backing sheets associated with each frame member are secured to one another by adhesive.

8. The transducer of claim 1 wherein said at least two inwardly directed flanges are formed with pins projecting therefrom in a direction away from said upstanding wall flanges, and holes interspersed between said pins

whereby two said frame members can be interconnected by passing said pins through said associated holes in said at least two inwardly directed flanges, the ends of said pins being deformed to form rivet heads holding the two frame members and their associated magnet structures to one another with said diaphragm clamped between said frame members.

9. The transducer of claim **1** wherein the free edges of at least two opposite upstanding flanges of each said frame member are inwardly bent over the outer surface of said associated magnet structure to hold said magnet structure in place, and

means fastening the edges of adjacent faces of two frame members together with said diaphragm held between said two members.

10. The transducer of claim **9** wherein said frame members are formed of a thermoplastics material with an outwardly projecting lip coplanar with said at least two inwardly directed flanges, said lips being heated and fused together without distorting the adjacent portions of said frame members which are thereby heat sealed to one another.

11. The transducer of claim **1,** wherein at least one of said inwardly directed flanges of each said frame member is provided with gaps in corresponding positions to define, when said two frame members are located together, an opening to receive a plug for connecting the two ends of said conductor strip on said diaphragm to a source of electrical supply when said transducer is assembled.

12. The audio transducer of claim **1,** wherein said frame members are constructed from a plurality of angle section frame elements joined at the ends thereof to form the corners of said frame members.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,833,771 Dated September 3, 1974

Inventor(s) JOHN DUNN COLLINSON

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

May 26, 1972 Great Britain . . . 24960/72

Signed and sealed this 8th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.