Sept. 19, 1967 E. PLESS 3,342,953

ELECTRO-ACOUSTIC TRANSDUCER

Filed Oct. 11, 1963

Fig. 1

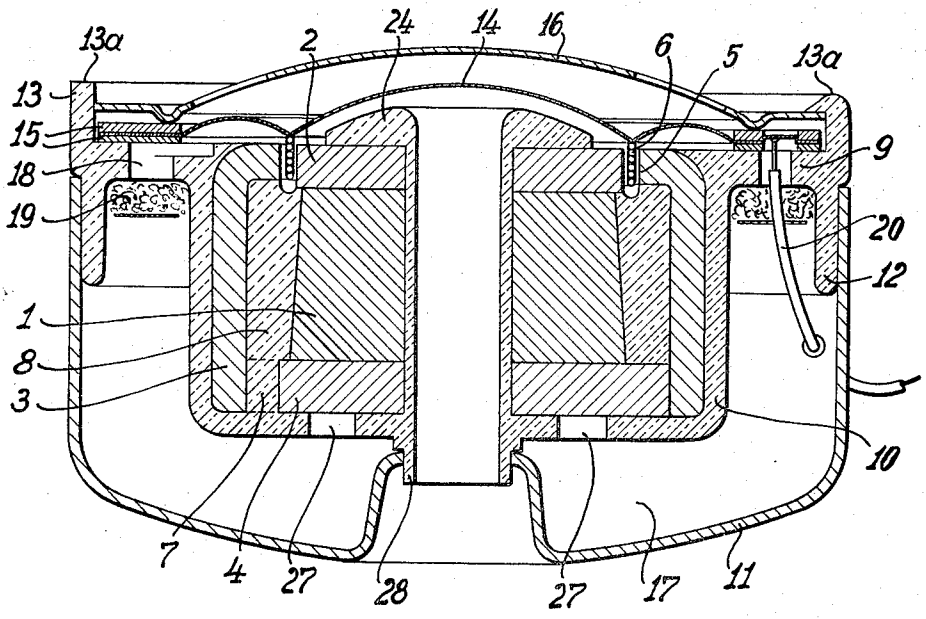
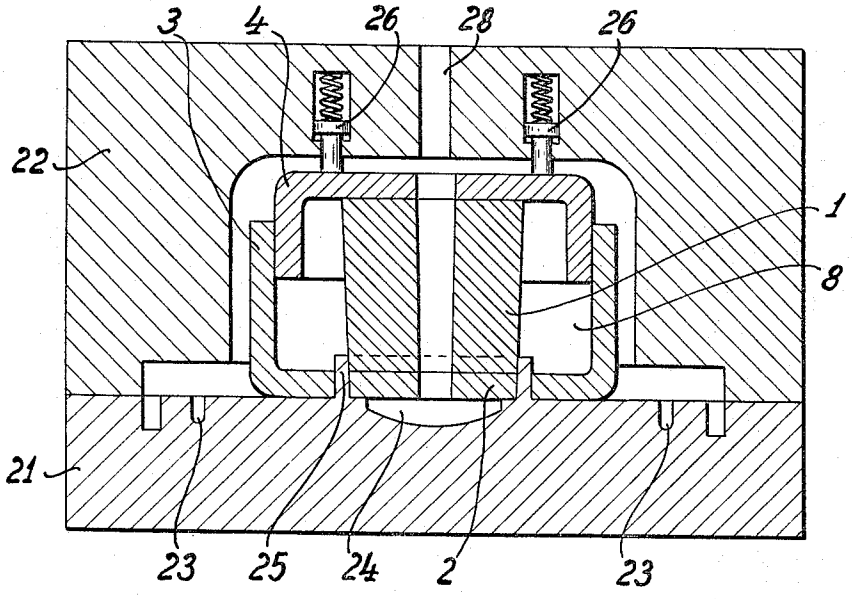


Fig. 2



INVENTOR.

ERNST PLESS

BY

ATTORNEY

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ELECTRO-ACOUSTIC TRANSDUCER

Ernst Pless, Vienna, Austria, assignor to Akustische u. Kino-Gerate Gesellschaft m.b.H., Vienna, Austria

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With the increasing spread of high-grade electro-acoustic transmitting installations, the demand for electro-acoustic transducers has increased to such an extent that they now constitute mass-produced articles which can be competitive only if they are manufactured by highly efficient processes while preserving the quality.

For this reason the manual work required for assembling the components of the transducer has been minimized at least in part. To this end it has been attempted to injection-mold material in and around a plurality of transducer parts and/or to make these parts preferably of thermoplastic materials or of metals which flow under pressure, such as aluminum.

A magnetic loudspeaker which has thus been made is described, e.g., in the Austrian patent specification No. 218,090. In this loudspeaker at least the diaphragm frame is made by injection molding and is secured to the magnet system by the material which has penetrated through openings in the adjacent part of the magnet system, said material forming a sleevelike extension, which ensures the centric position of the iron core and of the air gap.

Additional parts and operations are required, however, for the final assembly of the magnet system of such a transducer.

Besides, precise dimensions must be adhered to because that plastic part which serves for centering and partly fixing the permanent magnet has also fitting surfaces.

A plurality of other dynamic sound transducers have been disclosed, which comprise also fillers, preferably of plastic, which serve for connecting the parts of the magnet system and which fill the entire interior of the transducer and may form, together with the diaphragm frame, a unit made in one operation.

This involves a superfluous waste of material because it is not necessary to fill all cavities. In these known arrangements, the outside surfaces of the magnet system remain free and must be protected from external influences by the provision of a separate coat of paint or another surface treatment.

The transducer according to the invention does not have these disadvantages. Only a minimum amount of plastic or the like is used for its manufacture. The transducer according to the invention is extremely robust. This is of special significance particularly for microphones. All these advantages do not involve a sacrifice of quality, which is even increased by the structure according to the invention.

The invention relates particularly to electro-acoustic transducers which comprise a magnet system having an annular air gap and including a permanent magnet, which is axially or concentrically disposed, and a body, made preferably by an injection-molding or pressure-casting process from a metal which flows under pressure or from a plastic, particularly from a thermoplastic material, serves for fixing and centering. The transducer according to the invention is characterized in that the injection-molded or pressure-cast material fills entirely at least one free space provided in the magnet system in or around a core member preferably formed by said permanent magnet and the magnet system is surrounded by the same material also on the outside and the resulting integral body has extensions in the shape of discs, rings or the like, which serve for the fixation of a diaphragm, a centering spider, a diaphragm frame, a protective housing or the like.

In a preferred embodiment of the invention, the core member of a magnetic circuit defines at least two spaces in the magnetic circuit and at least one of said spaces is substantially free of said injection-molded or pressure-cast material. This may be effected by injection-molding or pressure-casting said material to surround said magnetic circuit and to fill only one of said spaces so as to hold said parts together as a unit.

To facilitate the assembly with the diaphragm, cover, etc., the extensions in the form of discs, rings or of other formations on the integral body are provided with register marks, fitting pins or the like.

Another advantage afforded by the invention resides in that only those surfaces must be machined which are contiguous and through which the magnetic flux is transmitted, as well as the surfaces defining the annular air gap, of course, whereas all other surfaces do not require machining because they are coated or covered or the cavities defined by them are filled.

The invention includes also the apparatus for manufacturing the transducer according to the invention. This apparatus consists essentially of a flat base and a substantially pot-shaped top. The plane of division between the top and base may lie approximately in the plane of the front pole piece.

Further advantages and features of the transducer according to the invention will become apparent from the following specification with reference to the accompanying drawing, in which FIG. 1 is a transverse sectional view showing a dynamic microphone embodying the invention and FIG. 2 in a sectional view showing the device for manufacturing the transducer.

FIG. 1 is a sectional view showing an electrodynamic microphone according to the invention. It comprises a permanent magnet **1**, which has in this case an axial through bore, through which the rear face of the diaphragm can also be exposed to sound. In a loudspeaker, such a bore is only required for venting the space behind the diaphragm if the latter forms a closed surface. The substantially cylindrical permanent magnet **1** is adjoined at one end by the front pole piece **2** and on the other end by the rear pole piece **4**. The magnetic circuit is closed by the pot-shaped member **3** and the air gap **5**, in which the coil **6** is movably arranged. The rear pole piece **4** has at least one bore **7**, through which the filler material can enter into the cavity **8** surrounding the permanent magnet **1**. With the exception of the environment of the air gap and of the openings **27**, the entire magnet system is almost completely covered by the filler material **10**. The openings **27** are formed by the resilient cores **26** shown in FIG. 2. A rimmed disc-shaped extension **9** provided in the plane of the front pole piece **2** has a rim portion **12** for the attachment of an outer pot and has another rim portion **13**, which together with the top surface of the flange **9** forms a dish, which receives the diaphragm **14** with its stiffening rings **15** and the protective cover **16** consisting preferably of plastic. The protruding rim portion **13***a* is partly or entirely beaded over by hot-forming, as is shown on the right in FIG. 1.

The outer pot **11** is not intended in general to provide for a protection of the microphone because such a protection would not be required for a transducer embodying the invention. The outer pot **11** is provided for acoustic purposes in order to enable the formation of an acoustic impedance element required for modifying the properties of the microphone. However, the outer pot **11** may form an essential part of the housing. To couple the cavity **17** defined by the outer pot to the thin or shallow

air cushion disposed behind the diaphragm, the flange **9** is formed with one or more bores **18**, behind which damping material **19** may be secured to provide a frictional acoustic resistance. One or two of these bores may serve for the passage of the lead wires **20** to the moving coil. The neck **28** may extend through the outer pot **11** to vent the thin or shallow air chambers behind the diaphragm so as to give the microphone a cardioid directional characteristic.

FIG. 2 is a sectional view showing an apparatus for manufacturing the transducer according to the invention. The representation is only diagrammatic and nonessential details have been omitted.

The apparatus consists essentially of a mold for injection-molding or casting, comprising a base **21** and a top **22**. The mold base is substantially flat and formed only with few recesses, for instance, for fitting pins **23** and for the mushroom-shaped portion **24**, which is the assembled microphone defines the thin air chamber behind the diaphragm and holds the front pole piece **2** in centric position. The recess for the mushroom-shaped portion **24** is bordered by a circular ring member **25**, which ensures that the space for the air gap is left free and which is also required for centering the permanent magnet **1**, the platelike pole piece **2** and the pot-shaped member **3**. The microphone shown in the apparatus has an omnidirectional rather than a unidirectional pattern. In such a microphone, the diaphragm is not exposed to sound from the rear of the transducer. For this reason, the bore in the permanent magnet **1** may be entirely filled with filler material and the cavity **8** around the permanet magnet may be utilized for acoustic purposes.

The mold top **22** is formed with the filling opening **28**. Because the mold is not closely contiguous with the system, the filling mass encloses the entire system also on the outside and leaves free only those portions to which other parts of the transducer, such as the diaphragm and its holder and, if desired, the diaphragm frame of loudspeakers, are secured. Alternatively, the loudspeaker frame may be made in a known manner simultaneously with the envelope of filler of the magnet system.

From the following description of the injection-molding operation and its preparation it is apparent how simple the transducer according to the invention can be manufactured.

The front pole piece **2** is first placed onto the mold base and the magnet **1** is inserted. The mold having the ring **25** which provides for the air gap thus determines at the same time the position of the essential parts of the magnet system because this ring **25** determines also the final position of the pot-shaped member **3**. The entire system is now assembled in correct position. Now the mold top **22** is applied, which is obviously provided with fitting surfaces or fitting pins interengaging with the base to hold the two parts in the correct relative position. During the same operation, resilient pins **26** force the two pole pieces against the magnet **1** so that the same is in snug engagement with the front pole piece **2** and the inside surface of the rear pole piece **4**.

Whereas only microphones have been described by way of example, it is obvious that the invention includes not only microphones but also loudspeakers and earphones. It is applicable wherever a system consisting of a plurality of parts is to be joined to form an integral body.

Compared to the previously usual joints made, for instance, with screws, rivets, adhesive, etc., this mode of connection has the special advantage in electro-acoustic transducers that all surfaces which do not constitute fitting surfaces need not be machined and the covering with the filler material provides nevertheless a smooth, attractive surface, which may be additionally provided with various projections, extensions or the like for any desired purpose so that, for instance, one and the same transducer may be incorporated in housings of different shapes without need for making a new mold. The covering made preferably from thermoplastic material protects the entire system to a high degree from climatic influences.

It is understood that the invention relates also to the novel magnet system units for electro-acoustic transducers and to processes for the manufacture of such units.

What is claimed is:

1. In an electro-acoustic transducer, a magnetic system including an axially elongated annular permanent magnet, a pair of annular pole pieces having substantially flat portions engaged with the respective axially opposite ends of said annular permanent magnet and defining therewith an axial passage, and a substantially cylindrical magnetic yoke embracing said permanent magnet and said pole pieces and having one end engaging the radially outer periphery of one pole piece and having a radially inwardly extending portion at its opposite end radially spaced from the radially outer periphery of the other pole piece to define an annular air gap coaxial with said axial passage; a moving coil positioned in and displaceable axially of the air gap; and a body of moldable material at least partially filling said axial passage and extending axially outwardly of said pole pieces and radially over at least a portion of the outer surfaces thereof, said body of material extending completely over the outer surface of said one pole piece and laterally over the entire outer surface of said substantially cylindrical magnetic yoke to form means uniting said permanent magnet, said pole pieces and said magnetic yoke into a substantially unitary structure defining a closed magnetic circuit except for said annular air gap, the portion of said body of material in said axial passage and extending over the outer surfaces of said pole pieces acting in the nature of double-headed rivet anchoring said pole pieces to said permanent magnet.

2. In an electro-acoustic transducer, as claimed in claim **1**, said one pole piece being cup-shaped and including a cylindrical rim having a radially outer surface engaged with the radially inner surface of said magnetic yoke.

3. In an electro-acoustic transducer, as claimed in claim **1**, in which the radially inner surface of said magnetic yoke is spaced radially from the radially outer surface of said permanent magnet to define an annular space; said one pole piece having an aperture therethrough communicating with said annular space and said body of material filling said aperture and said annular space.

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KATHLEEN H. CLAFFY, *Primary Examiner.*

A. McGILL, *Assistant Examiner.*