



(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.01.2004 Bulletin 2004/03

(51) Int Cl.7: H04R 9/06

(21) Application number: 02291719.9

(22) Date of filing: 09.07.2002

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
IE IT LI LU MC NL PT SE SK TR
Designated Extension States:
AL LT LV MK RO SI

(74) Representative: Richebourg, Michel François
Cabinet Michel Richebourg,
"Le Clos du Golf",
69, rue Saint-Simon
42000 Saint Etienne (FR)

(71) Applicant: FOCAL JMLab
42003 Saint-Etienne Cedex 01 (FR)

(72) Inventor: Baker, Dominic, c/o Focal-JMLab
42003 Sainte-Etienne C-dex 01 (FR)

Remarks:

A request for correction of the description and claim 6 has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) Magnetic system for a moving coil loudspeaker

(57) This invention relates to a magnetic motor system for a loudspeaker drive unit characterized in that it uses a central magnetic system surrounded by a second magnetic element 'focus ring'.

The magnet system of the invention may preferably use a combination of Samarium Cobalt and Neodymium magnetic elements, and the invention namely covers the said focus ring in a magnetic system comprising a

Samarium Cobalt element for the principle magnetic circuit, surrounded by a focus ring of Neodymium.

In the best mode of the invention so far, reference 2 is the SmCo principle magnetic element. Reference 3 is the pole-plate. Reference 4 is the top-plate. In this non limitative example the magnetic elements are "C" shaped to facilitate passing the connection from the voice coil to the tweeter connections.

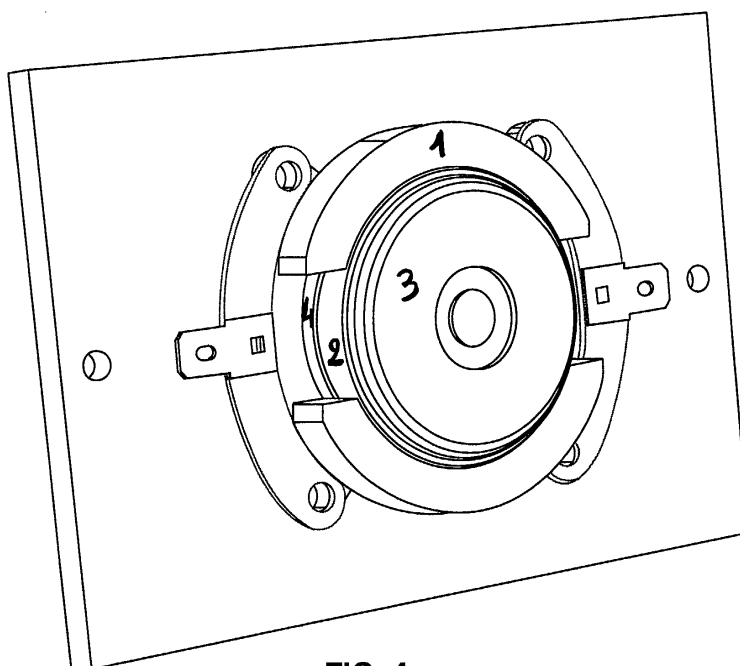


FIG. 4

Description

Technical Field of the Invention:

[0001] The present invention relates to moving coil loudspeakers, and more specifically to a magnetic motor system for a loudspeaker drive unit.

[0002] As is well known, a loudspeaker mainly consists of a magnetic motor system and a moving diaphragm supported by a suspension system. The magnetic motor system normally comprises a 'T' shaped pole-plate and a flat top-plate washer in-between which is located the magnetic medium. The magnetic flux flows across the gap between the pole and the hole in the top-plate washer.

Prior art:

[0003] It is known to use rare earth magnet assemblies in loudspeakers. B

[0004] Rare earth magnets have been used due to their high maximum energy product (BH max). In general, a rare earth NdFeB magnet is around 10 times more powerful than a ceramic ferrite magnet of the same volume. At the same time, a NdFeB magnet is around 10 times the cost of a ceramic ferrite for the same volume. The result is that for the same cost it is possible to achieve the same magnet strength, but with a large size saving. It is worth noting that this reduction in size makes the metal top-plate and pole-plate smaller and therefore cheaper to manufacture as well as the increased demand for NdFeB magnets driving the commercial price downwards.

[0005] There are two main examples of existing rare earth magnet assemblies used in loudspeakers. The most common type is shown on Figure 1. This is the most common form of rare earth magnet system typically used as the motor element for tweeters. A disc of Neodymium 1 is bonded with a steel cup 2 and the top-plate 3 bonded to this to form the magnetic circuit.

[0006] It is simple, cost effective and capable of producing a high magnetic field strength.

[0007] An improved version of this is shown in Figure 2. This represents an improvement of the construction for a Neodymium magnet system, using a second Neodymium disc 4 bonded to the top of the top-plate 3 to concentrate the magnetic field into the voice coil gap.

[0008] The second Neodymium disc 4 helps push the magnetic field into the gap to increase field strength.

[0009] Both of these systems share a common disadvantage however. Neodymium in the grades typically used for loudspeakers, N35, has a low Curie temperature. The Curie temperature is the temperature at which the parallel alignment of elementary magnetic moments completely disappears and the material is no longer able to hold magnetization. For common grades of Neodymium, the Curie temperature is around 300°C, limiting a stable operating temperature in air to 80°C. There are

some special grades available, but even these are only workable up to 120-150°C.

[0010] A simple test on an existing Neodymium driven tweeter revealed a working temperature measured at the rear surface of the motor cup of just over 100°C after 15 min of a bandwidth limited pink noise signal at 0.75 watts. This clearly indicates the need for an improved temperature performance especially in high-end systems and considering the very high power levels experienced in modern home cinema and car systems.

[0011] A common construction for a ring type ceramic ferrite (ferrite rings 5, 6) magnet system is represented on Figure 3. The second ferrite 5 bonded to the pole-plate 7 pushes back stray magnetic field back into the part and an improvement in magnetic force in the voice coil gap is obtained.

Summary of the Invention :

[0012] This invention relates to a magnetic motor system for a loudspeaker drive unit characterized in that it uses a central magnetic system surrounded by a second magnetic element 'focus ring'.

[0013] More specifically, in one non-limitative embodiment, which is the best mode of the invention as of today, the magnet system of the invention uses a combination of Samarium Cobalt and Neodymium magnetic elements, although the use of this particular combination is non limitative as the function of the magnetic geometry is applicable to all magnetic materials.

[0014] In another aspect, the invention covers a specific geometry for the magnetic motor system characterized by the presence of a magnetic focusing ring surrounding at least partially the central principle magnetic element.

[0015] Still in another aspect of the invention, the application covers the said focus ring in a magnetic system comprising a Samarium Cobalt element for the principle magnetic circuit, surrounded by a focus ring of Neodymium.

Detailed description of the Invention:

[0016] The rare earth material Samarium Cobalt exists in two alloys: SmCo5 and Sm2Co17. The Sm2Co17 alloy offers several advantages over the SmCo5 type: it exhibits superior temperature characteristics along with higher maximum energy product (BHmax, MGOe). The Curie temperature for Sm2Co17 is around 800°C, allowing a stable operating temperature of 300-350°C.

[0017] There are two disadvantages to Samarium Cobalt. Firstly it is around twice the price of Neodymium that is already an expensive material. Secondly, it has a lower maximum energy product (BHmax, MGOe), around 75% of that of Neodymium. However, for high performance products, SmCo magnets have a far greater corrosion resistance than NdFeB magnets, so longevity is greatly enhanced.

[0018] These two serious drawbacks probably explain why no attempt has ever been made for commercially using Samarium Cobalt as a component of a magnetic system for use in a loudspeaker.

[0019] The inventive merit of the inventor is first to have overcome this prejudice which pre-existed, against the use of Samarium Cobalt and to have more generally thought of the use of an hybrid type magnetic motor system.

[0020] Another merit is to have designed a magnetic system using Samarium Cobalt in such a way that the obtained magnetic system shows only advantages and no disadvantages, or no disadvantages of such a disastrous magnitude as would have been anticipated from the use of Samarium Cobalt.

[0021] Namely, the invention provides a complex magnetic system which remains compact enough to be used in a loudspeaker, that is another definite requisite.

[0022] The system effectively uses the maximum possible energy from the costly Samarium Cobalt material focusing it into the magnetic gap.

[0023] The system developed according to the invention uses, in a preferred but non limitative embodiment, a Samarium Cobalt element for the principle magnetic circuit, surrounded by a focus ring of Neodymium.

[0024] The result is a magnetic system that produces a higher magnetic field than that of the simple Neodymium system, with in addition the advantages of Samarium Cobalt, i.e. stable magnetic field at elevated temperatures.

[0025] The skilled man will appreciate easily that this result could not be anticipated, since the expectation would rather have been to get a lower magnetic field than the simple Neodymium, and additionally there was no certainty to keep the known advantages of the simple Samarium Cobalt while evading most of its drawbacks.

[0026] The focus ring system uses a Samarium Cobalt magnetic element and the principle magnet. A ring of Neodymium focuses or forces any spurious flux back towards the magnetic gap to maximize performance whilst remaining separate and therefore less sensitive to the high operating temperature in the center of the magnetic structure and around the voice coil.

[0027] The focus ring allows the maximum force to be concentrated into the magnetic gap from the Samarium Cobalt element. The focus ring uses a high power Neodymium magnet that is separated from the main magnetic system. As already stated, Neodymium is not suitable for the high operating temperatures experienced. This physical separation allows the system to be operated at high temperatures without affecting the magnetic performance as the Neodymium element remains well within its safe temperature operating range.

[0028] A non limitative representation of the system of the invention is shown in Figure 4.

[0029] Figure 5, which consists of Fig. 5A and Fig. 5B, shows a simulation of a simple Neodymium system (prior art).

[0030] Fig. 5A shows the Flux Density in the magnetic gap, vs. the distance to the said gap, with an usable average density of 1.6 Tesla.

[0031] Fig. 5B shows a representation of the Flux lines.

[0032] Figure 6, which consists of Fig. 6A and Fig. 6B, shows a simulation of a simple Samarium Cobalt system.

[0033] Fig. 6A shows the Flux Density in the magnetic gap, vs. the distance to the said gap, with an usable average density of only 1.5 Tesla.

[0034] Fig. 6B shows a representation of the Flux lines.

[0035] Figure 7, which consists of Fig. 7A and Fig. 7B, shows a simulation of the hybrid system of the invention, Samarium Cobalt / Neodymium system.

[0036] Fig. 7A shows the Flux Density in the magnetic gap, vs. the distance to the said gap, with an usable average density of 1.7 Tesla, what is surprising since it is superior to the density of simple Neodymium (1.6 Tesla) though it would have been expected a lower value, due to the lower density of the simple Samarium Cobalt (1.5 Tesla).

[0037] Fig. 7B shows a representation of the Flux lines.

[0038] On figure 4, which is the best mode of the invention so far, reference 2 is the SmCo principle magnetic element. Reference 3 is the pole-plate. Reference 4 is the top-plate. In this example the magnetic elements are "C" shaped to facilitate passing the connection from the voice coil to the tweeter connections. This shaping is obviously not limitative.

[0039] On figure 5B, reference 1 is the pole-plate, reference 2 is the top-plate, reference 3 is the simple magnetic Neodymium element. The magnet gap is situated between the pole-plate 1 and the top-plate 2.

[0040] On figure 6B, reference 1 is the pole-plate, reference 2 is the top-plate, reference 3 is the simple Samarium Cobalt magnetic element.

[0041] On figure 7 (invention) reference 1 is the pole-plate, reference 2 is the top-plate, reference 3 is the Samarium Cobalt principle magnetic element and reference 4 is the Neodymium focus ring element.

[0042] The Neodymium element to the right creates a second magnetic ring which so to say sends the magnetic energy back (at least partially) to the core of the system (while on fig 5B and 6B this energy escapes to the right and is totally lost).

Conclusion

[0043] The system although more costly in terms of materials and its more complex construction, has two significant advantages: the ability to provide a stable magnetic force at elevated operating temperatures and a further improved magnetic force when compared to a simple Neodymium based system. Of course this arrangement of a magnetic focus ring around the magnet-

ic system can be applied to all types of magnetic material to provide a range of qualities not found in conventional systems. For example, a Neodymium system with a Neodymium focus ring showed a very high magnetic field strength in the gap of 1.8 Tesla.

[0044] As indicated above, the invention covers the incorporation in a magnetic motor system for a loudspeaker drive unit, the said magnetic motor comprising a central principle magnetic element, of a further focus ring, magnetic in nature, surrounding at least partially the said central magnet, for the purpose of concentrating the magnetic flux to the maximum into the core of the device, with minimum magnetic losses.

[0045] In one preferred embodiment, the central magnetic element is made of Samarium Cobalt and the said focus ring is made of Neodymium.

[0046] However, these magnetic elements can be chosen among the usual magnetic materials used for loudspeakers, such as simple

Neodymium,

NdFeB - all grades

SmCo - all grades

Ceramic Ferrite - all grades

Alnico - all grades

[0047] The present invention also covers the loudspeaker drive unit containing at least one such magnetic motor system as described above, and the loudspeakers comprising at least one such drive unit.

[0048] The invention also encompasses all the options that will be apparent to the skilled man in the light of his common knowledge, optionally complemented by a few routine tests.

Claims

1. Magnetic motor system for a loudspeaker drive unit **characterized in that** it uses a central magnetic system surrounded by a second magnetic element or magnetic 'focus ring'.

2. Magnetic motor system according to claim 1, **characterized in that** the said magnet system uses a combination of Samarium Cobalt and Neodymium magnetic elements.

3. Magnetic motor system according to claim 1 or 2, **characterized by** the magnetic focusing ring surrounding at least partially the central principle magnetic element .

4. Magnetic motor system according to any one of claims 2 or 3, **characterized by** the presence of said focus ring in a magnetic system comprising a Samarium Cobalt element for the principle magnetic circuit, surrounded by a focus ring of Neodymium.

5. Magnetic motor system according to any one of

claims 1 to 4, **characterized in that** the said focus ring , in particular the high power Neodymium magnet, is physically separated from the main magnetic system.

6. Magnetic motor system according according to any one of claims 1 to 5, **characterized in that** the magnetic elements are "C " shaped.

7. Magnetic motor system according to any one of claims 1 to 6, **characterized in that** a magnet gap is situated between the pole-plate 1 and the top-plate 2.

8. Magnetic motor system according to any one of claims 1 to 6, **characterized in that** the said magnetic elements can be chosen among:

- the simple Neodymium,
- NdFeB - all grades
- SmCo - all grades
- Ceramic Ferrite - all grades
- Alnico - all grades

9. Loudspeaker drive unit **characterized in that** it contains at least one magnetic motor system according to anyone of claims 1 to 8.

10. Loudspeaker **characterized in that** it comprises at least one drive unit according to claim 9.

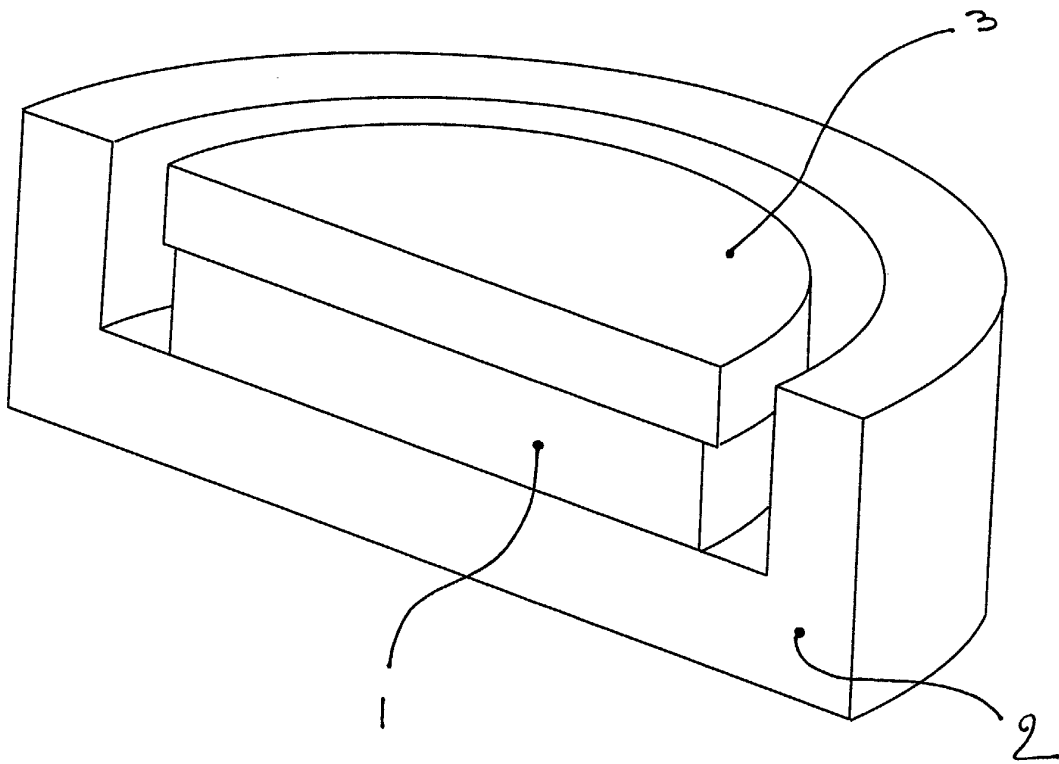


FIG. 1

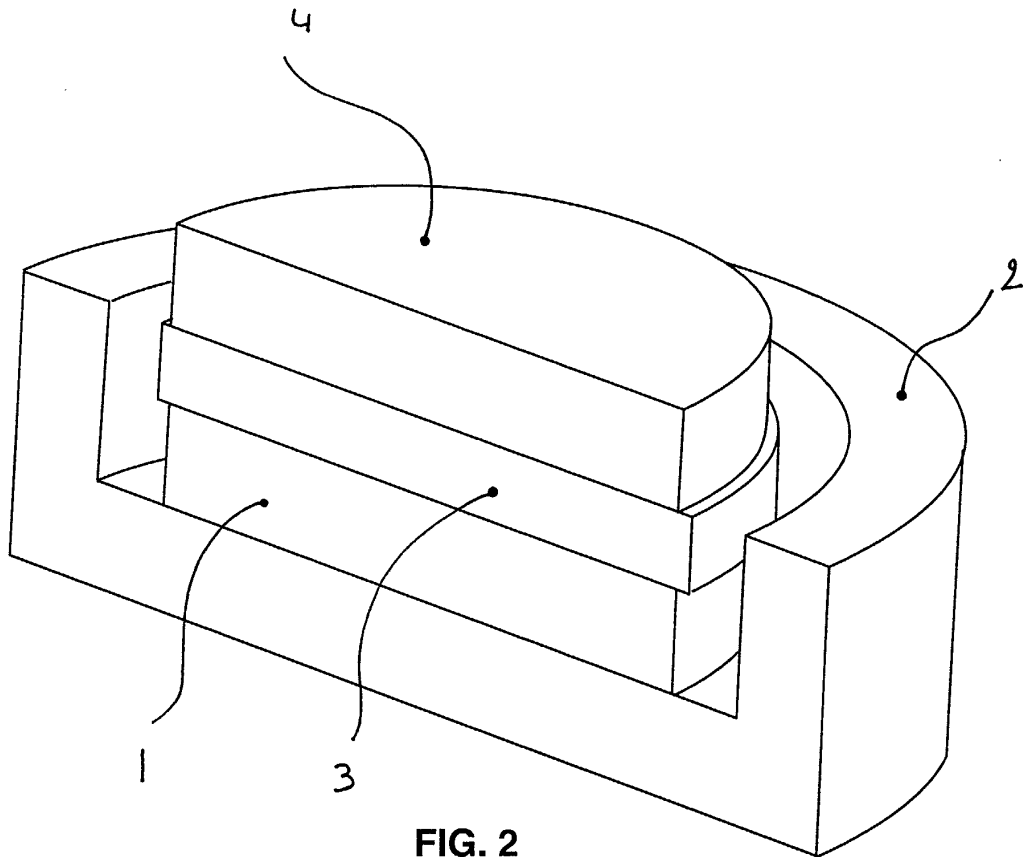


FIG. 2

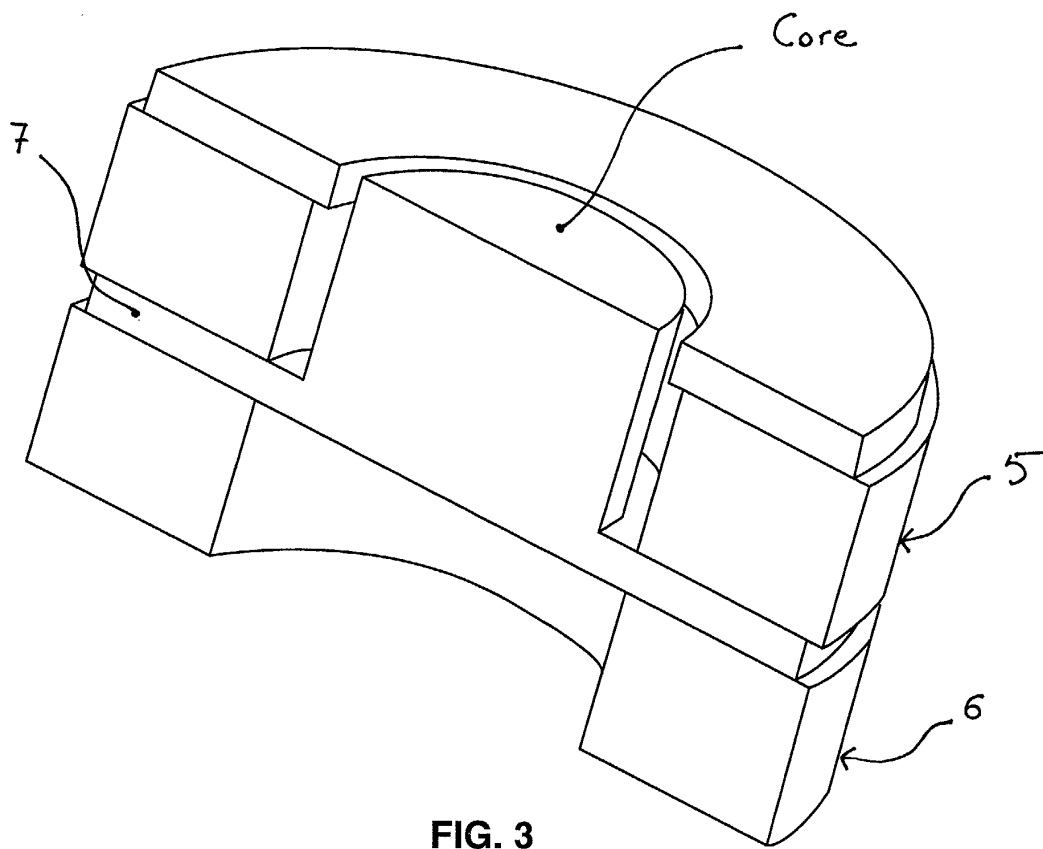


FIG. 3

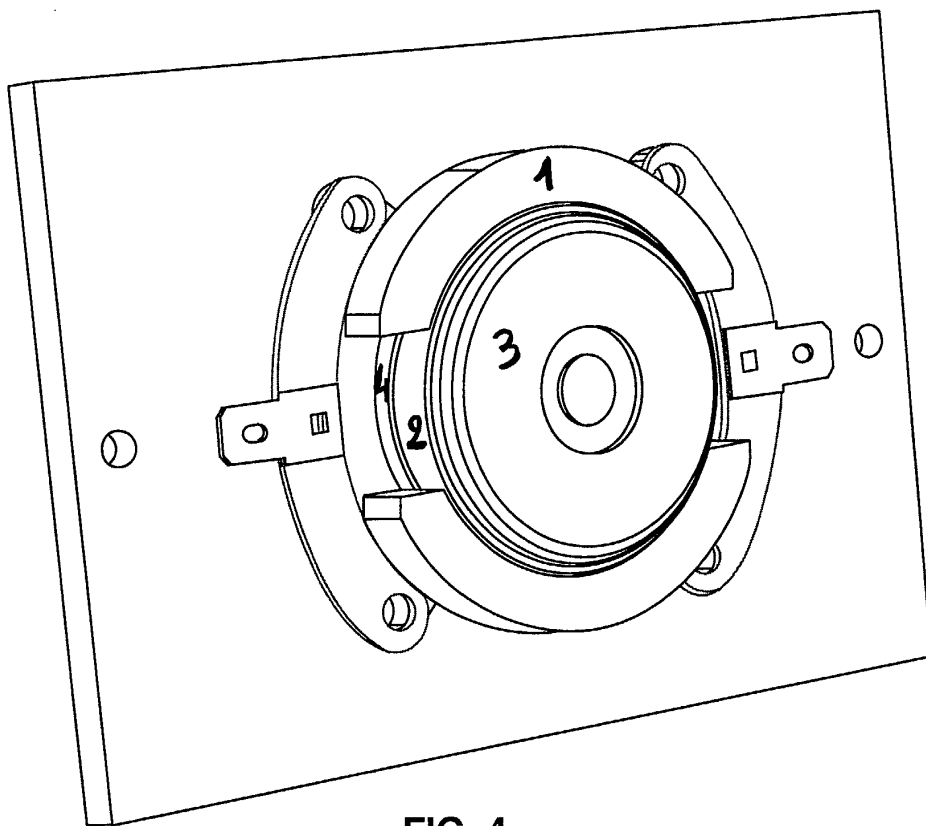


FIG. 4

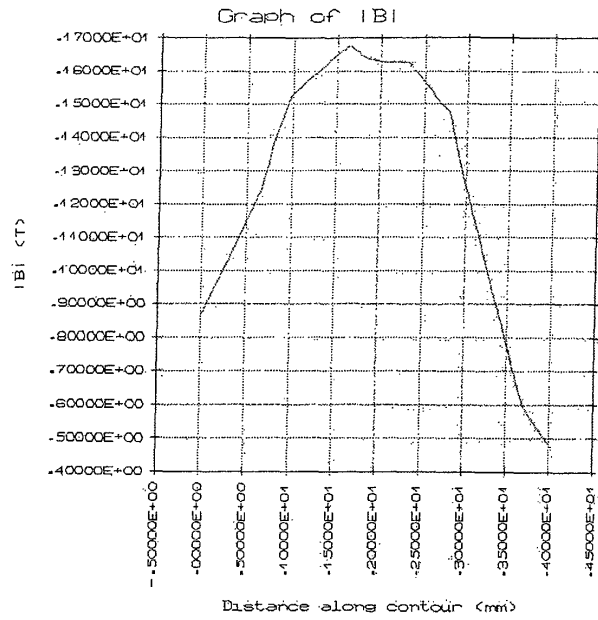


Fig 5A

FIG 5 : Prior art

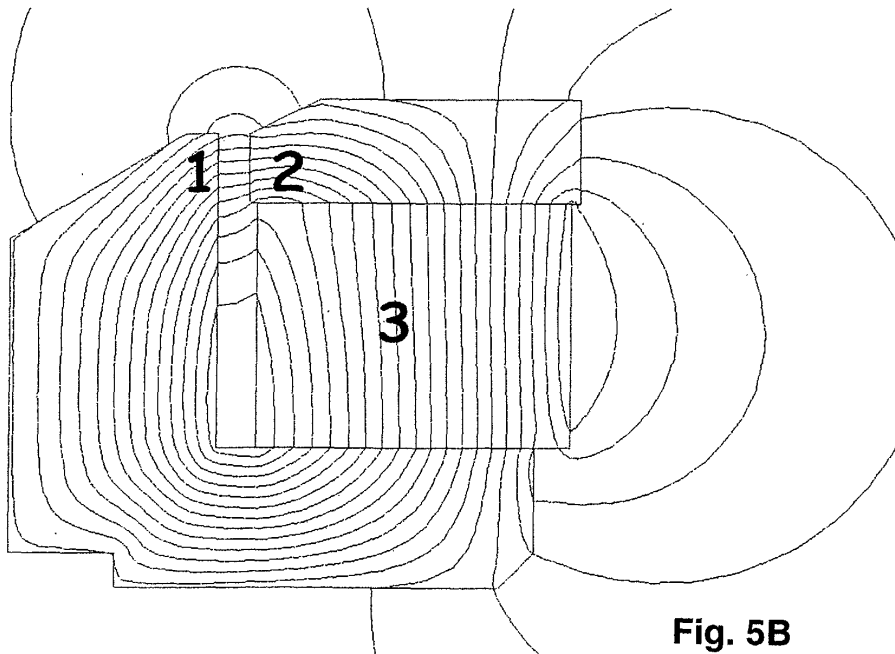


Fig. 5B

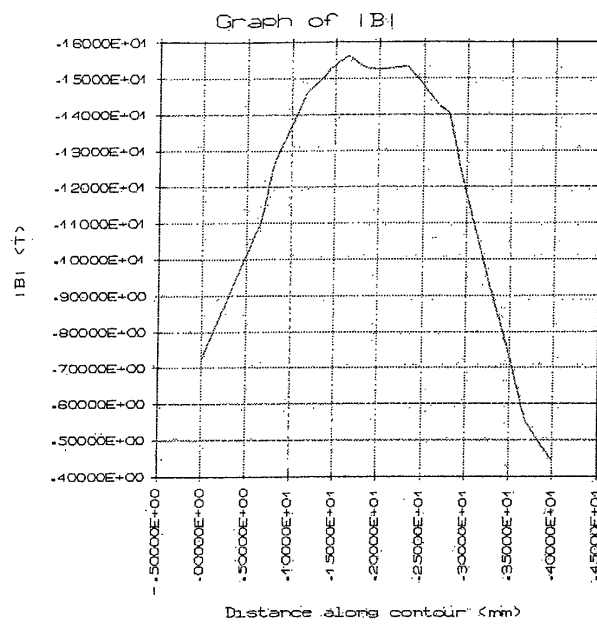


Fig 6A

FIG 6 : Prior art

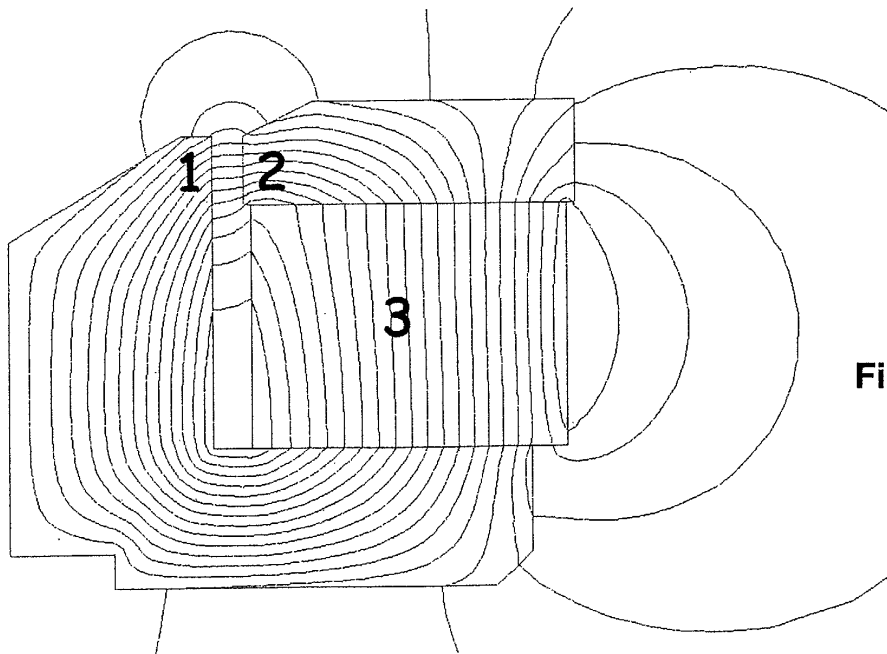


Fig. 6B

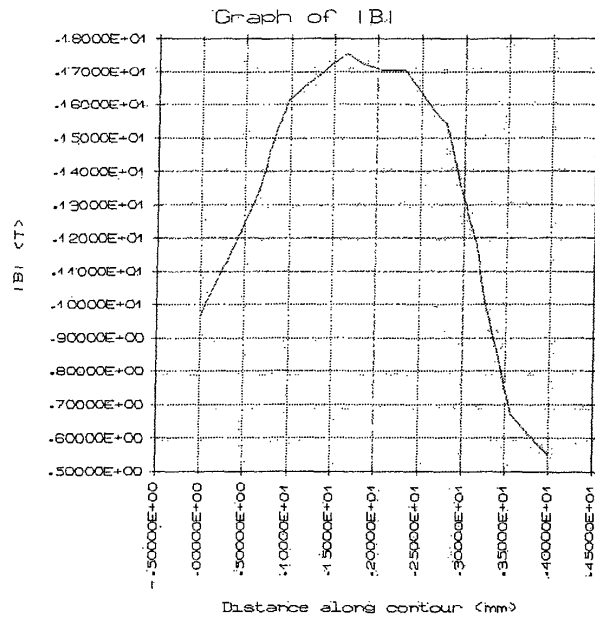


Fig 7A

FIG 7 : invention

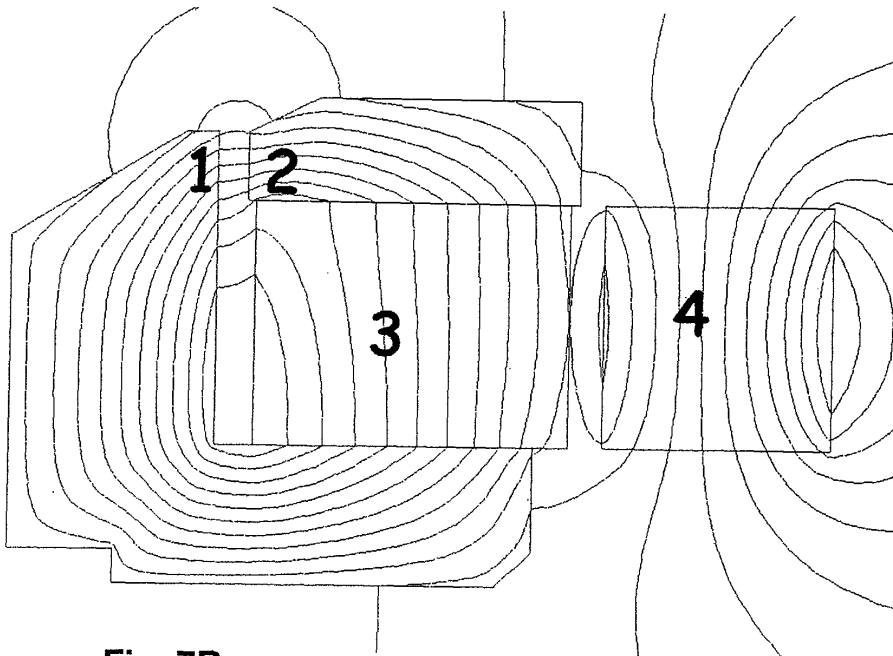


Fig. 7B



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 29 1719

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.7)
X	US 5 835 612 A (AZAMI KAZUO ET AL) 10 November 1998 (1998-11-10) * column 3, line 21 - column 4, line 26; figures 2,6,7 *	1-10	H04R9/06
X	US 5 687 248 A (CHIANG DAR-MING ET AL) 11 November 1997 (1997-11-11) * column 3, line 23 - line 65; figure 1 *	1-10	H04R
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Place of search MUNICH			Examiner Lindberg, P
Date of completion of the search 20 March 2003			
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 29 1719

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-03-2003

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5835612	A	10-11-1998	JP 9238395 A	09-09-1997

US 5687248	A	11-11-1997	NONE	
