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(54) **Multi-ferrite magnetic system for loudspeaker**

(57) The invention contemplates a new multi-ferrite magnetic system for loudspeaker drive units, where the metal areas located on the outside periphery of the metal pole piece and the top plate are defined by about the periphery of the ferrite elements.
The system is non limitatively a "flower-like" shaped magnet system with the "petals" following the diameter

of solid magnetic discs. The system built as the best mode uses ceramic ferrite discs, but rare earth magnets could also be used along with the same benefits and advantages.

That loudspeaker magnet system retains the advantages of a multi-ferrite system whilst improving its performance and efficiency and at the same time reducing cost and improving productivity.

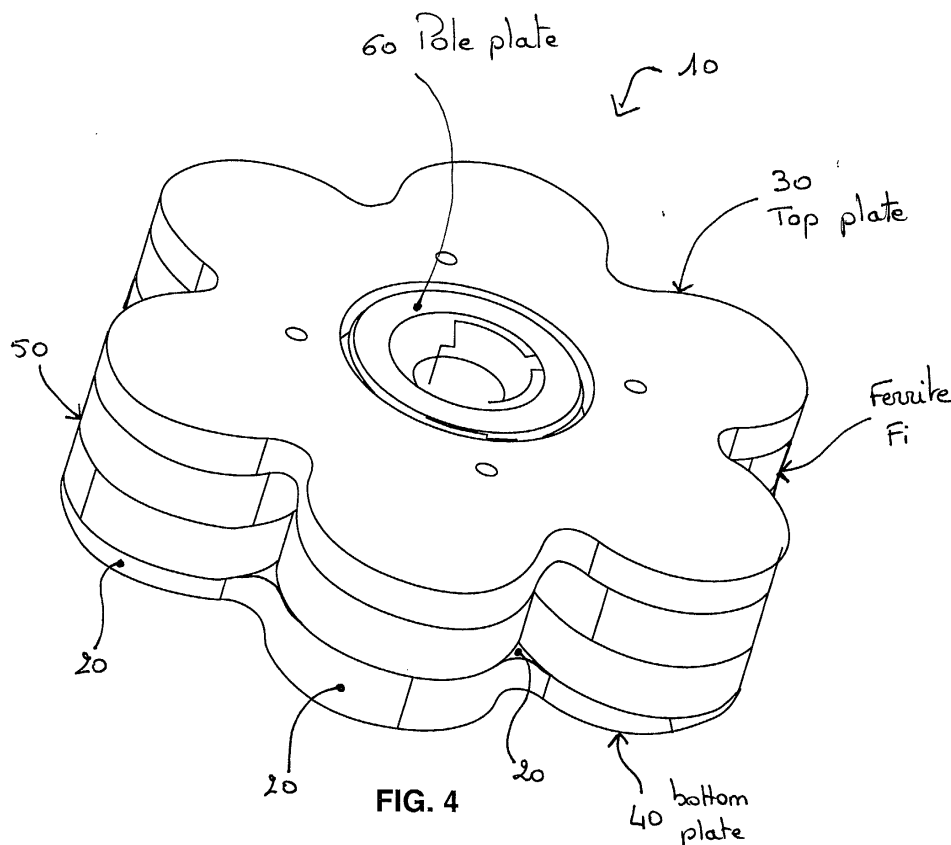


FIG. 4

Description

Technical Field of the Invention:

[0001] This invention relates to an improved multi-element magnetic system for loudspeaker drive units

Prior art:

[0002] The magnetic motor of a loudspeaker usually consists of a metal pole piece, a top plate and in-between the ferrite magnet. For very large diameter motor systems, structural problems result from the large surfaces involved, which if not perfectly flat reduce the effective bonding strength between the pieces.

[0003] Solid ferrite discs are bonded around a specially shaped pole piece and top plate. The solid discs improve magnetic efficiency and increase bonding strength. The shaped pole plate and top plate are designed to minimise flux linkage and therefore loss between the two plates, concentrating more of the magnetic strength into the gap where the voice coil is situated.

[0004] The existing system answers the problem of power compression under the dust cap and the practical constraints of obtaining a flat gluing surface over a large single magnetic disc.

Fig. 1 shows a typical magnetic motor system of a loudspeaker drive unit. A ferrite magnetic ring is sandwiched between two metal plates so that the magnetic force is concentrated across the voice coil gap.

Fig. 2 is a cross-sectional view of Fig. 1.

Fig. 3 shows a currently used multi ferrite system. There are considerable losses or magnetic "short-circuits" due to the flux linkage between the top and bottom metal plates. This flux linkage limits the magnetic strength in the magnetic voice coil gap.

[0005] With the existing system there are disadvantages including large size, high weight, inefficient use of the magnetic elements and as a result of this a low magnetic field in the gap. In addition production is long and costly due to the nature of the metal parts and their design.

[0006] A more compact and powerful system was needed to facilitate emplacement and provide a more economical solution without degrading performance. Production build also needed to be simplified and productivity improved.

[0007] There was clearly a need for the development of a loudspeaker magnet system that retained the advantages of a multi-ferrite system whilst improving its performance and efficiency and at the same time reducing cost and improving productivity.

[0008] This apparently was not regarded as feasible in the industry, despite the need.

Summary of the Invention :

[0009] A system was designed using a specially shaped pole piece and top plate along with solid disc magnets to reduce to an absolute minimum the losses caused by the flux linkage between the top plate and pole piece.

[0010] This was achieved by reducing the metal areas located on the outside periphery of the metal pole piece and the top plate.

[0011] The invention therefore contemplates a new multi-ferrite magnetic system 10 for loudspeaker drive units, where the metal areas located on the outside periphery of the metal pole piece 60 (bottom plate 40) and the top plate 30 are defined by about the periphery 50 of the ferrite elements F_i ($F_1, F_2, \dots$). Cf. Fig. 5.

[0012] On fig. 4, which shows a non limitative system 10 of the invention, the metal areas located on the outside periphery 20 of the metal pole piece 60 (bottom plate 40) and of the top plate 30 are defined by about the periphery 50 of the ferrite elements.

[0013] By "about the periphery", it is meant here that the said metal areas 20 broadly follow the shape of the periphery 50 of each of the ferrite elements F_i , that is, the periphery of the plates is obtained by a very slight (and possibly tiny) widening of the periphery 50 of the ferrite elements, or is obtained by defining areas 20 of metal plate between two adjacent ferrite elements F_i (such as F_1, F_2 on fig. 5) which can be of any shape, such as semi-circular, triangular, squared, polygonal, or geometrically complex like an ellipsoidal shape or any similar shape, or any combination of such shapes, of various shapes 1, 2, 3, 4 of fig. 5) provided the said areas 20 are as small as possible.

[0014] Possible, but non limitative shapes are represented on Fig. 5.

[0015] Fig. 5 shows the area between two adjacent ferrite elements and a few possible shapes for the periphery of the plates.

[0016] The invention also contemplates a process for manufacturing the said new multi-ferrite element and the corresponding tool, since it proved necessary to optimise the manufacturing by developing a complex tool to cold forge and then stamp the pole piece and a stamping tool for the top plate so that the metal pieces could be industrially produced at an economical cost.

[0017] The skilled man will appreciate that it is possible to manufacture the new element according to the invention, without using the said tool and process, though this represents the best mode for industrial reasons.

It is likely that the cost was one of the main reasons for the industry having not even attempted to find a solution to the above mentioned drawbacks, along with the engineering problems that were likely to surge.

[0018] Actually, one of the principle difficulties encountered when developing the new form of magnet system was to achieve the form of the pole piece by a combination of cold forging and then stamping. This allows this complex form to be efficiently and commercially produced. It was not self-evident to achieve that result, nor to even think that it might be.

[0019] One of the merits of the inventor is to have overcome the corresponding prejudice.

Detailed description of the Invention :

[0020] According to the invention, the multiple magnetic elements are ring type ceramic ferrite magnets arranged around a circular pole and top plates.

[0021] The best mode of the invention relates to a multi-ferrite magnetic system 10 which features a top plate 30 and a bottom plate 40 whose periphery is closely following the diameter or periphery 50 of solid magnetic discs or cylinders F_i circularly arranged around the pole plate 60, the said periphery of the plates being slightly beyond the said diameter of the ferrite discs, from the center of the system outwards, and forming periphery-connecting areas 20 between each diameter of ferrite element F_n , F_{n+1} , the said areas being as small as possible, thus forming a flower-like shaped magnet system.

[0022] Effectively the system is a "flower-like" shaped magnet system with the "petals" following the diameter of solid magnetic discs. The system built as the best mode and intended for commercial use uses ceramic ferrite discs F_i , but rare earth magnets could also be used along with the same benefits and advantages. Fig. 4 shows a non-limitative, but best mode achievement, of the said Power Flower™ system of the present invention, with cut-away metalwork and solid disc magnetic elements.

[0023] The top-plate and pole-plate (with bottom plate) pieces are achieved using a cold forging and stamping process. Being a flat metal piece, the top-plate is stamped out of sheet steel using a cold tool. The pole plate, being more complex, is first cold forged from a steel 'mushroom' as a circular pole-plate. It is subsequently passed to a second stamping operation to achieve the flower form.

[0024] The design is an originally complex form of magnet system designed to optimise the use of multiple magnet elements.

[0025] The Power Flower™ magnetic system of the invention is compact and efficient providing considerable cost savings over the traditional multi-ferrite magnet system.

[0026] This does represent a definite and useful advance compared to the traditional multi-ferrite type system.

[0027] The first commercial use of this system is expected to be, non imitatively, a high power in-car sub-woofer.

[0028] 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. Multi-ferrite magnetic system 10 for loudspeaker drive units, comprising a metal pole piece 60, a top plate 30 and in-between the ferrite magnet F_i , **characterized in that** the metal areas located on the outside periphery 20 of the metal pole piece (bottom plate 40) and of the top plate 30 are defined by about the periphery 50 of the ferrite elements F_i .
2. Multi-ferrite magnetic system 10 according to claim 1, **characterized in that** the periphery 20 of the said plates 30, 40 is obtained by a very slight widening of the periphery 50 of the ferrite elements F_i (F_1 , F_2).
3. Multi-ferrite magnetic system according to claim 1, **characterized in that** the periphery 20 of the said plates 30, 40 is obtained by defining areas of metal plate between two adjacent ferrite elements F_i (F_1 , F_2) which can be chosen among the following: semi-circular, triangular, squared, polygonal, or geometrically complex like an ellipsoidal shape, or any combination of such shapes, provided the said areas are as small as possible.
4. Multi-ferrite magnetic system according to any one of claims 1 to 3 **characterized in that** it is of a ring type ceramic ferrite magnets F_i arranged around a circular pole 60, 40 (bottom plate) and top plate 30.
5. Multi-ferrite magnetic system according to any one of claims 1 to 4 **characterized in that** the system 10 has top plate 30 and bottom plate 40 whose periphery is closely following the diameter or periphery 50 of solid magnetic discs or cylinders F_i arranged circularly around the pole plate 60, the said periphery being slightly beyond the said diameter, from the center of the system outwards, and forming periphery-connecting areas 20 between each diameter of ferrite element F_n , F_{n+1} , the said areas being as small as possible, thus forming a flower-like shaped magnet system.
6. Multi-ferrite magnetic system according to any one of claims 1 to 5 **characterized in that** it uses ceramic ferrite discs or rare earth magnets.
7. Process for manufacturing a multi-ferrite element according to any one of claims 1 to 6, **characterized in that** it comprises the following steps:

- to cold forge and then stamp the pole piece and
- to stamp tool the top plate

8. Process according to claim 7 characterized in that

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- the top-plate is stamped out of sheet steel using a cold tool;
- the pole is first cold forged from a steel 'mush-room' as a circular pole-plate and is subsequently passed to a second stamping operation to achieve the flower form.

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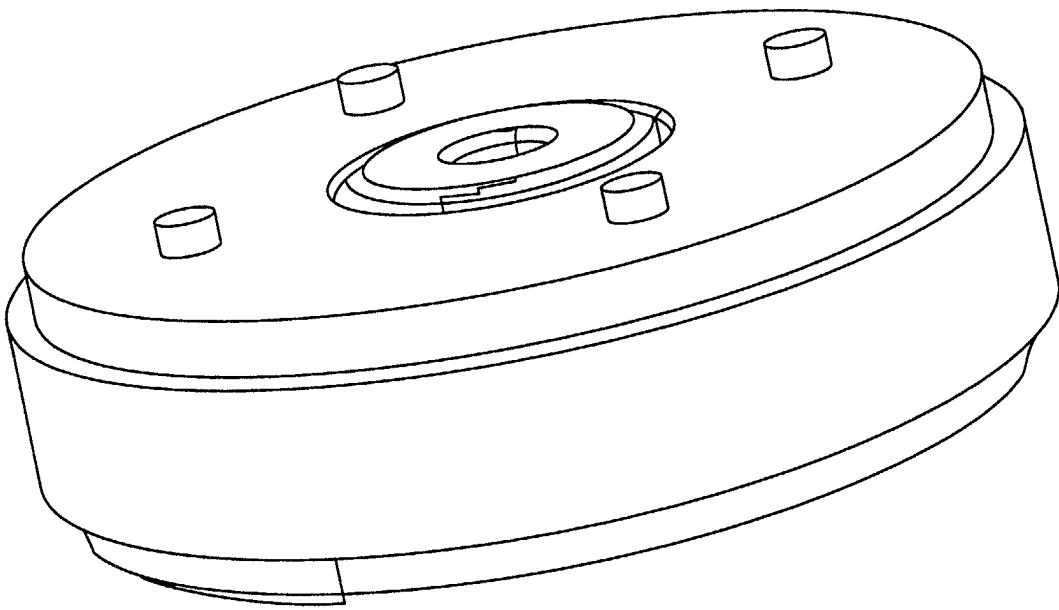


FIG. 1

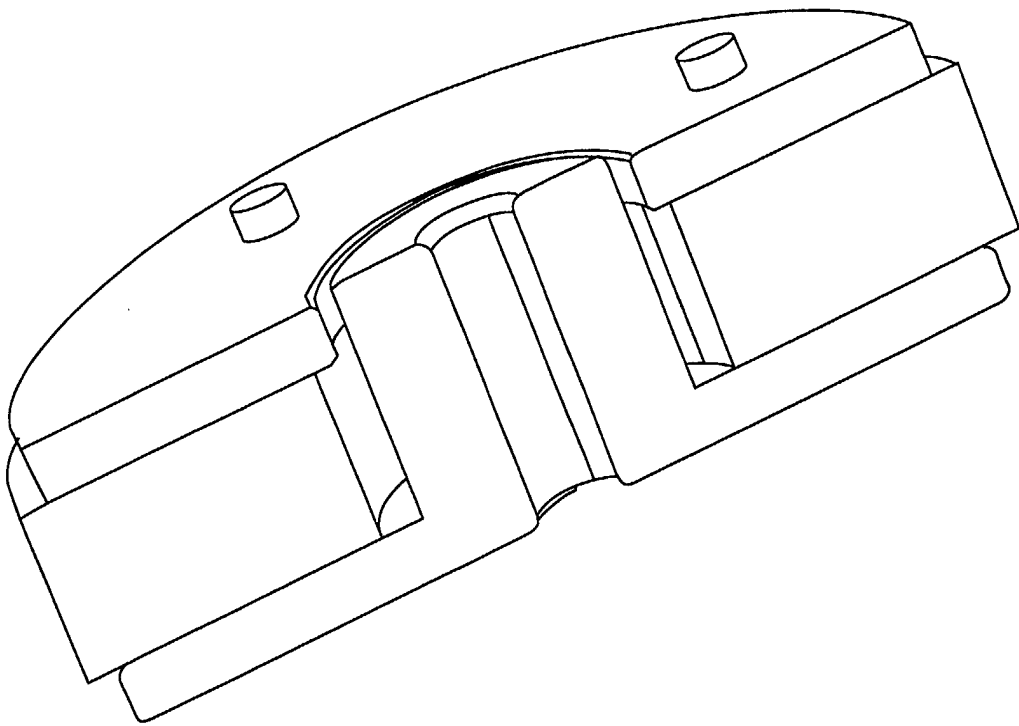


FIG. 2

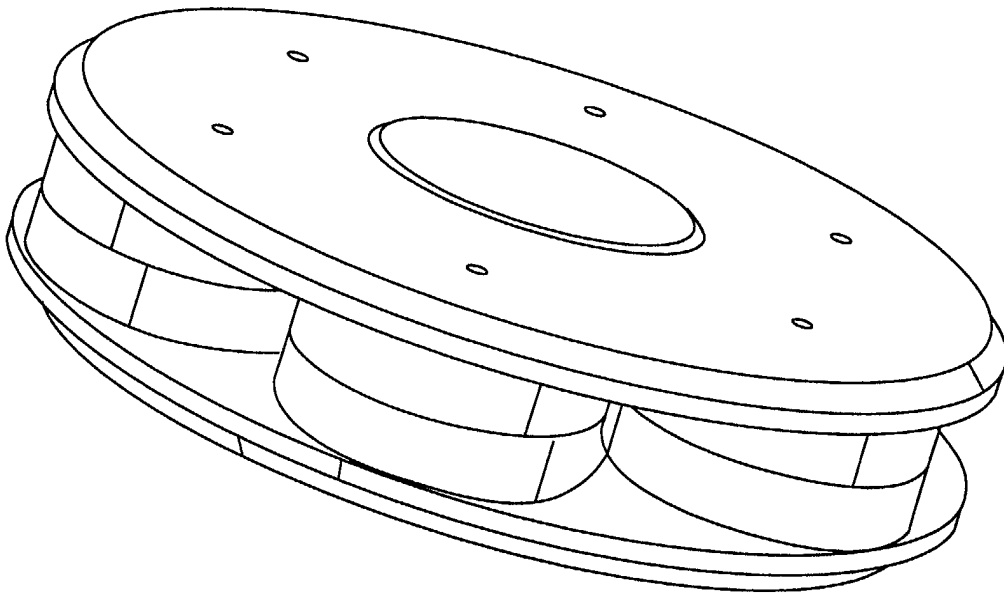
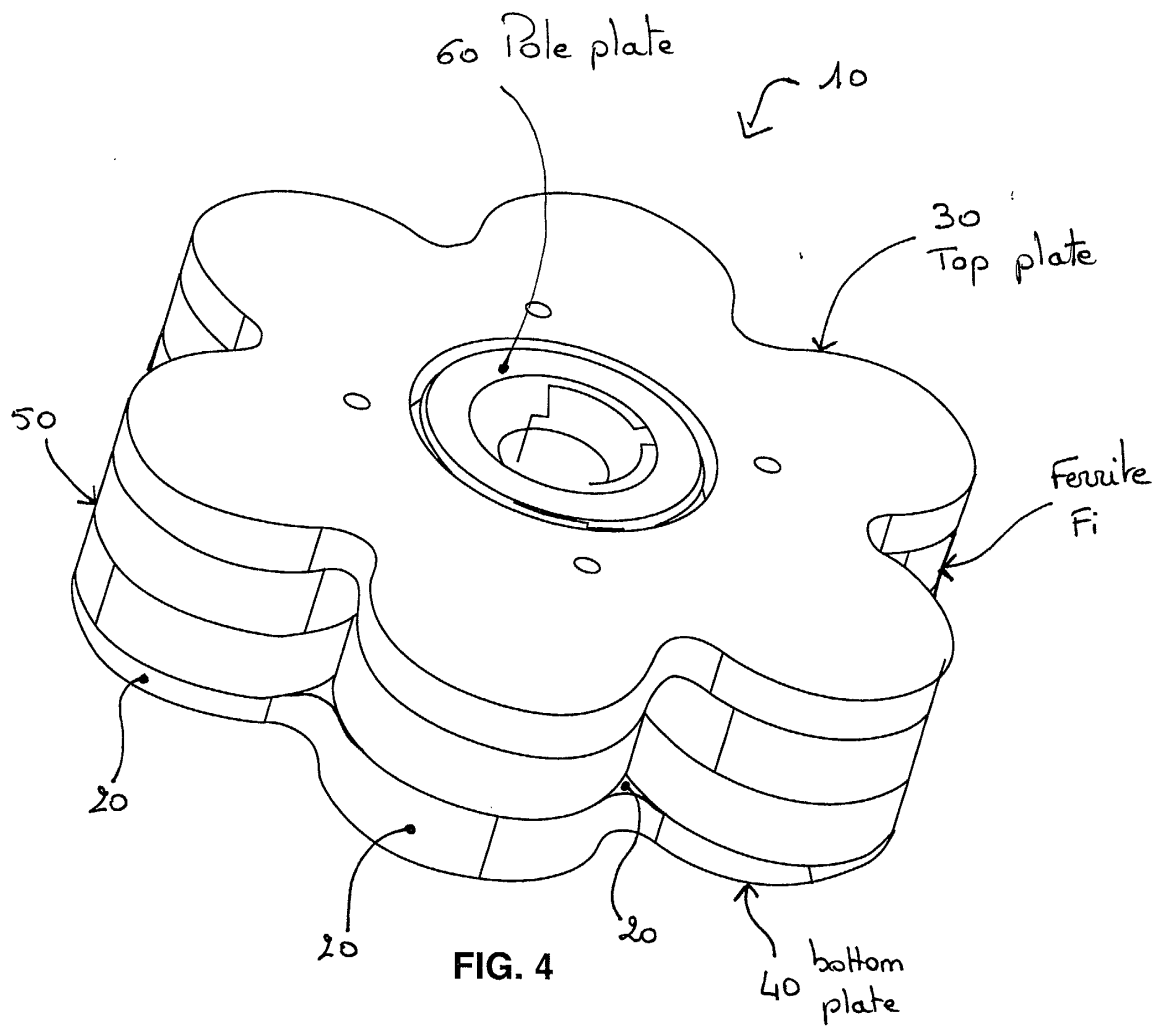


FIG. 3



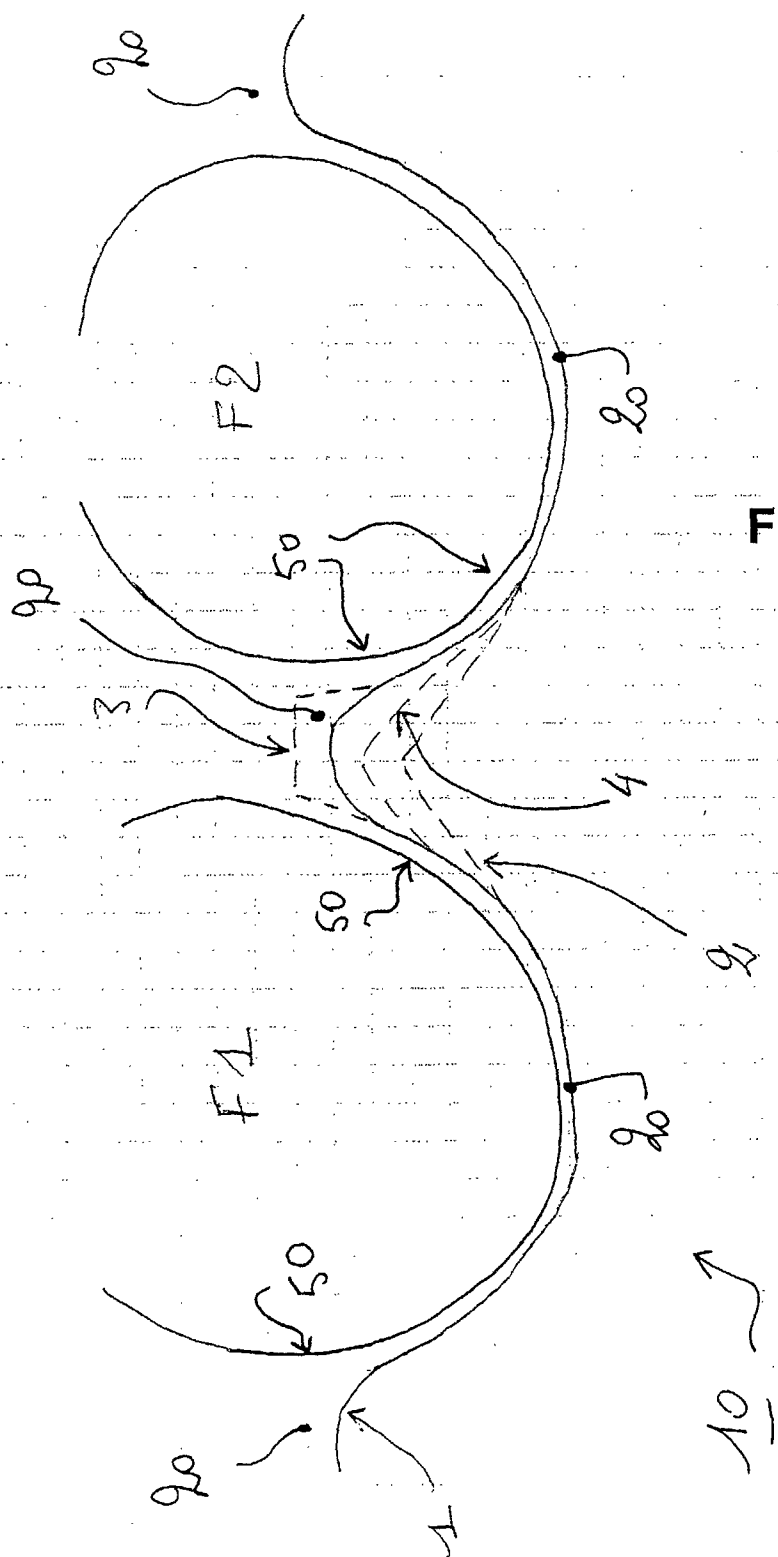


FIG. 5



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 02 29 1718

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	EP 0 921 707 A (SEAS FABRIKKER AS) 9 June 1999 (1999-06-09) * column 3, line 44 - column 5, line 18; figures 9-12 * -----	1-4,6	H04R9/00 H04R9/02 H04R9/06 H01F7/02
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H04R H01F
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 17 March 2003	Examiner Lindberg, P
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			

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

EP 02 29 1718

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The members are as contained in the European Patent Office EDP file on
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17-03-2003

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