



(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:  
15.11.2006 Bulletin 2006/46

(51) Int Cl.:  
B22C 9/10 (2006.01)

(21) Application number: 05425320.8

(22) Date of filing: 13.05.2005

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

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(54) Foundry cores and method for manufacturing the same

(57) The present invention relates to foundry cores and a method for manufacturing the same.

Particularly, the present invention relates to a hollow foundry core (1) comprising a plurality of half-cores (1a,

1b, 1c) being assembled by means of sealing elements (4a, 4b, 4c) for providing a core (1), said half-cores (1a, 1b, 1c) and said sealing elements (4a, 4b, 4c) being provided with a pressed mixture of sand and a binder.

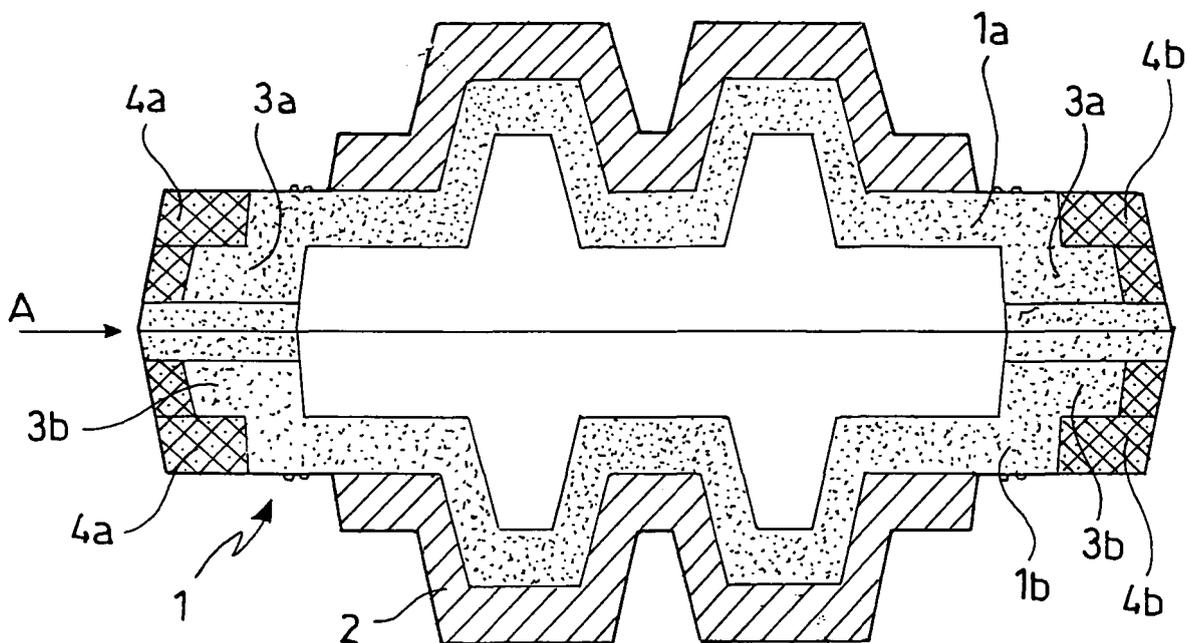


FIG.1

## Description

**[0001]** The present invention relates to foundry cores and a method for manufacturing the same.

**[0002]** The technology for casting weld metals in sand moulds (the so-called "foundry sand") is widely known and used for manufacturing articles of various types and sizes, such as either motor or car transmission system components, hydraulic componentry, parts of machines of different types, etc. Many of these articles have either undercut elements or inside cavities requiring the use, inside the sand mould, of cores reproducing the voids of the piece to be manufactured. These cores are generally manufactured from sand and suitable binders, such as amino resins. Besides reproducing the empty spaces of the piece to be manufactured as noted, the cores generally comprise either projecting or oversized parts at the ends thereof providing the so-called "core prints", which allow the core to be supported in the proper position for casting, by resting on the sand mould in some points in which there is no interference with the piece mould. At the end of the casting and after the piece has been solidified, both the sand mould and the sand core are eliminated by the mechanical action (vibrations, etc.), thus leaving the piece substantially clean. However, the parts deriving from the process, such as fins and casting gates, will have to be removed from the piece. The fins are particularly a problem in complex-shape pieces, in which two or more half-cores require to be coupled with one another which reproduce the complexity of the piece voids, once assembled. The assembly of these half-cores for providing a so-called core assembly is difficult and does not usually cause a snug fit, such that, during the casting step, the fin formation in the junction points is practically unavoidable. Moreover, the removal of the fins from the solidified piece requires expensive mechanical processing.

**[0003]** There are two main techniques for manufacturing the sand cores.

**[0004]** The first technique provides the formation of solid cores by pressing a mixture of sand and amino resins as binders.

**[0005]** However, the thus formed solid core is very heavy, especially with large size pieces, thus requiring large and bulky core prints to be manufactured, with a subsequent waste of material. The amount of sand used further causes the costs to increase, particularly in terms of material handling. Since the mixture contains a certain amount of amino resins, a problem also exists which is connected with the release of the toxic gases in the environment which are emitted by these resins both during the formation of the core and the casting of the metal, and throughout the following cooling step.

**[0006]** A further disadvantage of the solid sand cores is the relative core rigidity, which does not allow to second the casting shrinkage during the cooling, with the possible formation of cracks in the metallic piece.

**[0007]** A further problem is connected with the difficul-

ties in flogging, an operation that requires a considerable energy in order to crumble the core solid body.

**[0008]** These problems are partially solved by the second method used for manufacturing foundry cores, known as the "shell moulding".

**[0009]** This technique provides the manufacturing of a metal mould reproducing the impression either of a half-core or the whole core. The metal mould is placed inside a core box either made of steel or cast iron and then brought at a high temperature (about 300-350°C, for example either by means of resistances or naked-flame heating). A mixture of sand and amino resins, which crosslink and embed the sand by binding the latter due to the high temperature of the metal mould surface, is blown against the metal mould surface. When the process has been completed, the exceeding sand-resin mixture is drawn away (and thus recovered) and the core is extracted.

**[0010]** Thereby, hollow cores are obtained characterized by a thin shell having a low weight but a non-uniform thickness, which is capable in any case of providing high-accuracy castings.

**[0011]** Yet, this technique does not solve, rather exacerbates some problems already existing with solid cores.

**[0012]** Particularly, the massive use of amino resins causes considerable environmental and health problems to workers, both because of the harmful gases emitted while the process is being carried out, and the considerable difficulties and disposal costs of the toxic residues.

**[0013]** Furthermore, the thus manufactured core has a relatively high brittleness, which prevents the use thereof for large-sized pieces.

**[0014]** Even in this case, the non-uniformity of thickness has a negative influence on the casting shrinkages while being solidified, with the result that the formation of cracks is not completely excluded.

**[0015]** Finally, the "shell moulding" method is very expensive.

**[0016]** Therefore, the problem at the heart of the present invention is to provide a foundry core which overcomes the above-mentioned drawbacks.

**[0017]** This problem is solved by a foundry core and a method for manufacturing the same as outlined in the annexed claims.

**[0018]** Further characteristics and advantages of the present invention will be better understood from the description of some exemplary embodiments, which is given hereinbelow by way of indicative and non-limiting example, with reference to the following figures:

Fig. 1 shows a side sectional view of a foundry core according to the present invention;

Fig. 2 shows a view according to direction A from Fig. 1;

Fig. 3 shows the view from Fig. 2 in a different embodiment of the invention;

Fig. 4 shows a sectional perspective view of a core box according to the method of the present invention;

Fig. 5 shows a sectional perspective view of a different embodiment of a foundry core in accordance with the invention; .

Fig. 6 shows a sectional perspective view of a detail from Fig. 5 according to a further embodiment;

Fig. 7 shows a sectional view of a different foundry core in accordance with the invention;

Fig. 8 shows a sectional perspective view of a core box according to the method of the present invention, for manufacturing a core of highly complex shape.

**[0019]** With reference to the above-mentioned Figs. 1 and 2, the foundry core according to the present invention, which has been generally indicated with numeral 1, is hollow and consists of two half-cores 1a and 1b being coupled with each other.

**[0020]** The metallic casting the cavity of which is formed due to the core 1 has been indicated with 2.

**[0021]** The shape of the foundry core 1 is, in the drawing, merely exemplary and obviously depends on the cavity shape of the piece 13 which is intended to be manufactured.

**[0022]** The core 1 is provided with connecting portions 3a, 3b at the ends thereof, having a double-step profile. These connecting portions 3a, 3b are assembled by means of sealing elements 4a, 4b wrapping the latter. Both the half-cores 1a, 1b and the sealing elements 4a, 4b are provided in a mixture of sand and a suitable binder. Typically, said binder will be an ammino resin of the type employed as a binder in foundry cores. The amounts of binder will generally range between 2% and 10% by dry weight.

**[0023]** Thereby, a substantially monolithic hollow core is obtained.

**[0024]** As shown in Fig. 2, the coupling between the first half-core 1a and the second half-core 1b is carried out by means of a shape-coupling between two complementary step profiles. Thereby, an efficient seam seal is obtained, which minimizes the infiltration of the weld metal, while casting. Conversely, the weld metal infiltration would cause irreparable defects in casting.

**[0025]** The core 1 comprises a vent hole 5 located in at least one end, either for the leakage of steam or gas being generated by the binding resin while casting. However, this vent hole 5 can be also omitted if the amount of binder is low.

**[0026]** According to the embodiment such as shown in Fig. 3, the coupling between the first half-core 1a and the second half-core 1b can be conventionally carried out by bonding, by arranging a suitable adhesive layer either along the faying surface between the two half-cores or in suitable recesses situated on some contact points between the half-cores. The adhesive will be of the type usually employed in these applications, such as a vinyl glue. In this case, the sealing element 4a, 4b will be omitted.

**[0027]** It should be noted that the connecting portions 3a, 3b being assembled with the sealing element 4a, 4b

also function as core prints.

**[0028]** The cores 1 according to the invention can be prepared according to conventional methods which provide the use of core boxes consisting of two half-boxes into which the impression of the half-core 1a, 1b to be manufactured is inserted. The mixture of sand and binder is blown under pressure in the boxes in the presence of suitable gaseous substances which trigger the resin crosslinking. The half-core is thus removed from the core box and then coupled with a second half-core obtained in the same manner. The assembly of the half-cores 1a, 1b is thus introduced into the same core box in which the sand will be blown for manufacturing the sealing element 4a, 4b. Obviously, this core box will comprise an impression reproducing the shape of the assembly of the half-cores 1a, 1b and sealing element 4a, 4b; therefore, in substance, the shape either of the whole core 1 or the core portion which is intended to be manufactured.

**[0029]** Advantageously, the cores 1 according to the invention may be manufactured by a method which provides the use of a core box as shown in Fig. 4. The core box 8, consisting of two half-core boxes 8a, 8b, comprises both the impressions 9, 10 for the half-cores 1a, 1b (in the example from Fig. 1, 2, and 4, two half-cores) and the impression 11 for the final core 1, resulting from the coupling of the half-cores with the sealing element 4a, 4b (the sectional view only shows a sealing element 4a being located at one of the two ends of the core 1).

**[0030]** Suitable ducts 12', 12", 12''' allow the introduction of the sand-binder mixture under pressure (the so-called "blowing"). Obviously, the duct or ducts for blowing the sealing element 4a, 4b will be set at the cavities being left empty after the half-cores 1a, 1b have been placed in the impression 11.

**[0031]** For certain applications, a preferred embodiment of the invention provides that said ducts 12', 12", 12''' end with suitable nozzles (not shown). Particularly, it is advantageous that the duct 12''' for blowing the sealing element ends with a nozzle. Advantageously, a plurality of ducts 12 being provided with nozzles (not shown) along the profile of the cavity inside which the core is formed can be provided for complex pieces (see Fig. 8). For complex pieces such as the one shown in Fig. 8, it can be further advantageous to preset a suitable housing (which can be seen from the drawing as a blind hole in the half-core 1a and a through hole in the half-core 1b) for a stiffening rod 14 in the half-cores 1a, 1b. Said stiffening rod 14 will be set upon introducing the half-cores 1a, 1b into the impression 11, before the blowing forming the finished core 1 has been carried out.

**[0032]** The method of the invention starts with the formation of the first two (or more, according to the cases) half-cores 1a, 1b by introducing the sand-binder mixture from their respective nozzles 12; 12', 12". Then, the core box is open, the half-cores 1a, 1b are arranged in the proper position inside the impression 11 for the core 1, thus obviously leaving the space which will be taken by the sealing element 4a, 4b empty; the core box is then

closed again. At this point, the blowing of the sand-binder mixture will be carried out either simultaneously through all the nozzles 12, 12', 12", 12"', or even only through one of them according to the cases, thus allowing the final core 1 and the half-cores 1a, 1b for the next core to be formed at the same time. The thus obtained core 1 will be removed and the half-cores manufactured will be arranged inside the impression 11. The method will be thus repeated, and so on.

**[0033]** Therefore, according to the method of the invention, the processing time can be optimised, thus manufacturing with a single simultaneous blowing both the hollow core being assembled with the sealing element and the half-cores for the next manufacturing.

**[0034]** According to the embodiment of the cores 1 as shown in Fig. 5, the two half-cores 1a, 1b (by way of example, they relate to the manufacturing of a pipeline cavity) comprise their respective connecting portions 3a, 3b being obtained with a step in the core thickness from the outer surface and with a raking riser, such that, after being coupled with each other, they make a groove running along the whole seam between the two half-cores 1a, 1b. The mixture of sand and binder forming the sealing element 4a, 4b is blown in these grooves.

**[0035]** The advantage of this embodiment is that the sealing element 4a, 4b, besides providing a substantially monolithic hollow core, seals the junction and avoids the casting infiltration while casting. The final metallic piece will further have a better finishing, because no seam will be left on the surface:

**[0036]** The embodiment from Fig. 6 is substantially similar to the one from Fig. 5, apart from the fact that it comprises a toothed profile ribbing 6 along the joining surface between the connecting portions 3a, 3b of the half-cores 1a, 1b, on a first connecting portion 3a engaging with a groove 7 of a complementary shape, being provided in the second connecting portion 3b. Thereby, the coupling between the two half-cores 1a, 1b is more accurate and stable.

**[0037]** In Fig. 7 a further embodiment of the core 1 of the invention is shown. The core 1, for manufacturing the cavity for a T-shaped hydraulic pipe fitting 13, consists of three half-cores 1a, 1b, 1c being assembled by means of sealing elements 4a, 4b, 4c wrapping the connecting portions 3a, 3b, 3c of the half-cores.

**[0038]** Also the cores from Figs. 5, 6, and 7 can be prepared in accordance with the method described above.

**[0039]** Similarly, core assemblies of highly complex moulds (for example, the crankcases) can be manufactured by assembling several hollow cores by the method of the invention so as to provide a monolithic core assembly.

**[0040]** The hollow cores of the invention have several advantages compared to the ones of the background art of the invention.

**[0041]** First of all, the foundry cores of the invention have a low weight, compared to the solid cores, thus

allowing smaller core prints to be used. The amount of sand-binder mixture is reduced by 50%, with a consequent reduction in costs and, in the case of use of resins as binders, less environmental impact.

5 **[0042]** The hollow cores of the invention further are characterized by a higher flexibility which aids in the casting shrinkages, thus minimizing the formation of cracks.

**[0043]** The casting quality is improved even compared to the cores obtained by the "shell moulding" method. In fact, hollow cores can be obtained with a uniform wall thickness by the method of the invention, because the shape of the cores solely depends on the shape of the impression used in the core box. On the other hand, a non-homogeneous thickness, in which the parts being thicker or less thick are randomly arranged, are obtained by the "shell moulding" method. A uniform wall thickness is important in order to have a uniform shrinkage of the casting.

**[0044]** Instead, higher thicknesses in points in which a higher strength is required and lower thicknesses in the critical points for the final flogging could be required for certain applications. Even in this case, the possibility of obtaining the desired thickness in a predetermined manner and not randomly is a sure advantage of the method of the invention.

20 **[0045]** The cores of the invention, unlike the ones obtained according to the "shell moulding" method, can be also used for large-sized hollow pieces. In these cases, the hollow core can be provided with inside stiffening ribs in order to avoid that it may collapse.

**[0046]** The minimum diameter which the hollow core may have according to the invention will be about 30 mm, which thing means that these cores can be used for a really wide range of casting products.

35 **[0047]** In the case of complex shapes, the core assembly assembled by the method of the invention, providing a second blowing in order to provide the sealing element, brings to a higher accuracy and quality of the casting, thus eliminating the fin formation.

40 **[0048]** The core flogging, which is carried out after the casting has been solidified as said above, is made simpler, due to the lower strength of the hollow core compared to the solid core.

**[0049]** In order to further aid in the core flogging, it is a further object of the present invention a flogging method comprising the following steps:

- a) wetting the core being inserted into the solidified casting;
- 50 b) reducing the temperature below 0°C until the water is frozen;
- c) increasing the temperature until the ice is melted;
- d) subjecting the casting to the flogging.

55 **[0050]** The core impregnation with water and the subsequent freezing cause the formation of flaws and cracks which can make the core more capable of being disintegrated, after having increased the temperature again.

**[0051]** In one preferred embodiment of the present invention, the hollow cores 1 are provided in a mixture of sand and cement. The cement is present in the mixture in amounts ranging between 3% and 35% by dry weight.

**[0052]** The cement acts as a binder, the action of which is generated by adding either water or other additives. The water will be added in amounts ranging between 2% and 15% by weight.

**[0053]** Alternatively, clay can be employed as a binder, preferably bentonite. The amount of clay will preferably range between 3% and 40% by dry weight. Even in this case, the binding action will be generated by adding water in the amounts mentioned above.

**[0054]** According to a further embodiment, a mixture of sand, cement and clay will be used, in which the sand is 60-95% by dry weight.

**[0055]** Preferably, after the core has been formed, the latter will be subjected to the drying process. Thereby, the core strength increases, which can suffer much higher pressures. Therefore, the core drying process is particularly recommended for casting either large-sized or complex-shaped pieces.

**[0056]** Advantageously, the drying process will reduce the emission of vapours, particularly steam, in the metal casting step and therefore it will allow pieces with less porosities and thus a high quality to be obtained.

**[0057]** The core can be further painted, in order to increase the shelf life thereof. Thereby, the slag inclusion problem is also solved, i.e. the weld metal inclusions in the core surface which, after the casting has been solidified, cause a surface contaminated by the sand to form on the piece and which reduce the strength thereof and, by increasing the porosity, cause defects which will become evident in the following steps of the mechanical processing.

**[0058]** The advantages in the use of a sand-concrete and/or clay mixture for manufacturing the cores are obvious.

**[0059]** First of all, the use of organic binders (amino resins) causing considerable pollution problems is completely eliminated.

**[0060]** Moreover, the manufacturing and disposal costs are reduced.

**[0061]** It is understood that only some particular embodiments of the foundry core and the method for manufacturing the same which are the object of the present invention have been described, to which those skilled in the art will be able to carry out all those modifications required for adapting the latter to particular applications, without however departing from the scope of protection of the present invention.

**[0062]** For example, it is understood that solid foundry cores with the sand-concrete mixture of the invention can be also manufactured.

## Claims

1. A hollow foundry core (1) comprising a plurality of half-cores (1a, 1b, 1c) being assembled by means of sealing elements (4a, 4b, 4c) for providing a core (1), said half-cores (1a, 1b, 1c) and said sealing elements (4a, 4b, 4c) being provided with a pressed mixture of sand and a binder.
2. The foundry core according to claim 1, wherein the amount of binder ranges between 2% and 10% by dry weight.
3. The foundry core according to claim 1 or 2, wherein said core (1) is substantially monolithic.
4. The foundry core according to any of the claims 1 to 3, comprising at least one vent hole (5) for the leakage of steam or gas.
5. The foundry core according to any of the claims 1 to 4, wherein the assembly of said half-cores (1a, 1b, 1c) is carried out by bonding rather than by means of said sealing elements (4a, 4b, 4c).
6. The foundry core according any of the claims 1 to 5, wherein the coupling between said half-cores (1a, 1b) is carried out by means of a shape-coupling between two complementary step profiles.
7. The foundry cores according to any of the claims 1 to 6, wherein said half-cores (1a, 1b) comprise connecting portions (3a, 3b) being obtained with a step in the half-core thickness from the outer surface, so as to make a groove intended to house said sealing elements (4a, 4b) along the whole seam, after they have been coupled with each other.
8. The foundry core according to any of the claims 1 to 7, wherein a ribbing (6) is located on a first connecting portion (3a) and a groove (7) of a complementary shape is located on a second connecting portion (3b), along the joining surface between the connecting portions (3a, 3b) of said half-cores (1a, 1b).
9. The foundry core according to any of the claims 1 to 8, having predetermined wall thicknesses according to the requirements of use.
10. The foundry core according to claim 9, wherein said wall thicknesses are higher in points in which a higher mechanical strength is required and lower in points of a difficult flogging.
11. The foundry core according to any claim 1 to 10, said binder being concrete and/or clay.
12. The foundry core according to claim 11, wherein the

- amount of sand ranges between 60% and 95% by dry weight.
- 13.** The foundry core according to claim 11, wherein said binder is cement, said cement ranging in amounts between 3% and 35% by dry weight. 5
- 14.** The foundry core according to claim 11 or 12, wherein said clay ranges in amounts between 3% and 40% by dry weight. 10
- 15.** The foundry core according to any of the claims 11, 12 or 14, wherein said clay is bentonite.
- 16.** The foundry core according to any of the claims 11 to 15, further comprising water in order to generate the binding action, said water preferably ranging between 2% and 15% by weight. 15
- 17.** The foundry core according to any of the claims 11 to 16, said core being dried and preferably painted before being used. 20
- 18.** A method for preparing foundry cores according to any of the claims 1 to 17, comprising the steps of: 25
- (a) providing a core box (8) comprising two half-core boxes (8a, 8b) comprising the impressions (9, 10) for the half-cores (1a, 1b) and the impression (11) for the core (1) resulting from the coupling of said half-cores (1a, 1b) with sealing elements (4a, 4b); said core box (8) further comprising a plurality of ducts (12, 12, 12, 12) for introducing the sand-binder mixture into suitable points of said impressions (9, 10, 11); 30
- (b) introducing the sand-binder mixture under pressure through said ducts (12, 12, 12, 12) so as to simultaneously form said half-cores (1a, 1b) and said core (1); 35
- (c) removing the finished core (1) from the impression (11) and transferring the half-cores (1a, 1b) being simultaneously formed in a suitable position in the impression (11) for the final core (1); 40
- (d) repeating the operations of steps (b) and (d). 45
- 19.** The method according to claim 18, wherein at least one of said ducts (12, 12, 12, 12) ends with a nozzle.
- 20.** The method for casting weld metals in moulds, comprising a step of introducing into said mould a foundry core (1) as outlined in any of the claims 1 to 17. 50
- 21.** The method according to claim 20, comprising a flogging step for the metallic piece, said flogging step comprising the following steps: 55
- (i) wetting said core (1) being inserted into said
- metallic piece;
- (ii) reducing the temperature below 0°C until the water is frozen;
- (iii) increasing the temperature until the ice is melted;
- (iv) subjecting the metallic piece to the flogging.
- 22.** The foundry core which can be obtained from a mixture of sand and a binder, said binder being cement and/or clay.

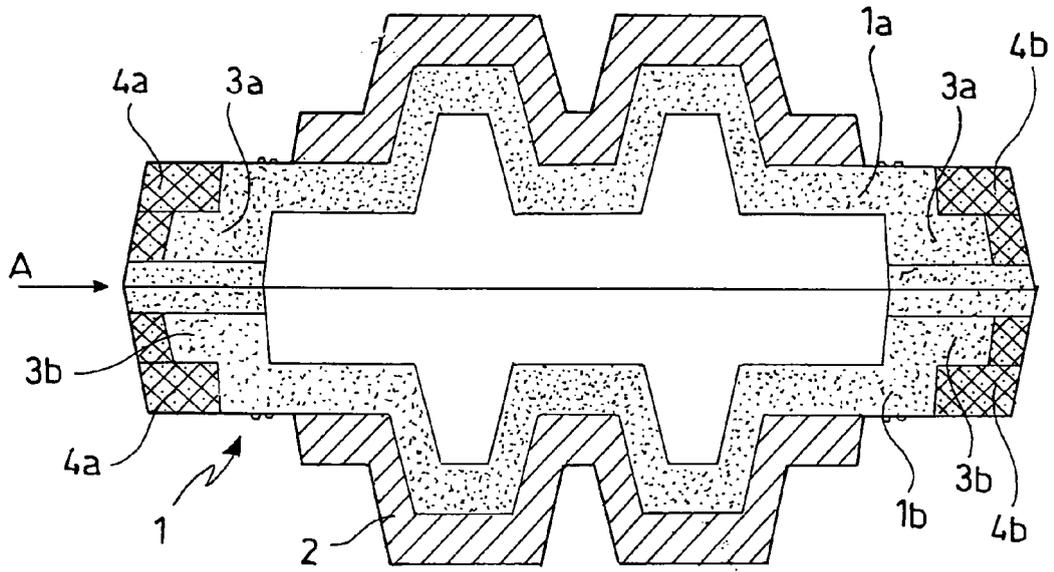


FIG. 1

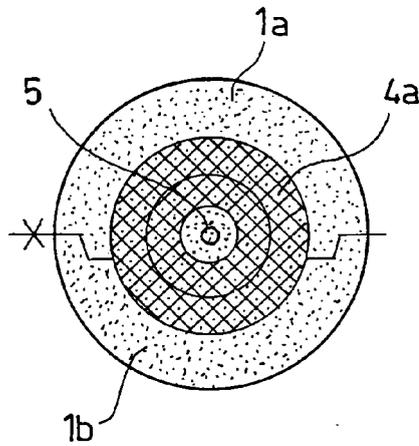


FIG. 2

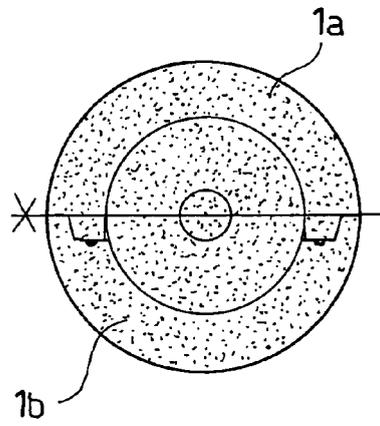


FIG. 3

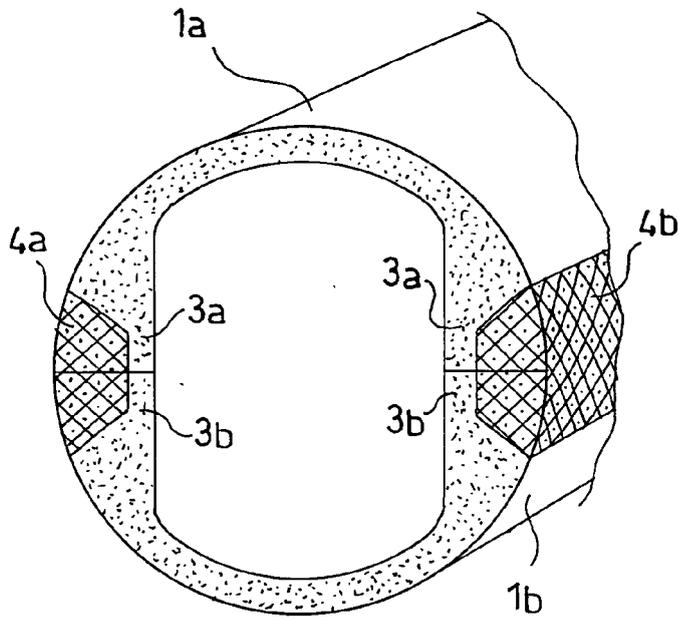


FIG. 5

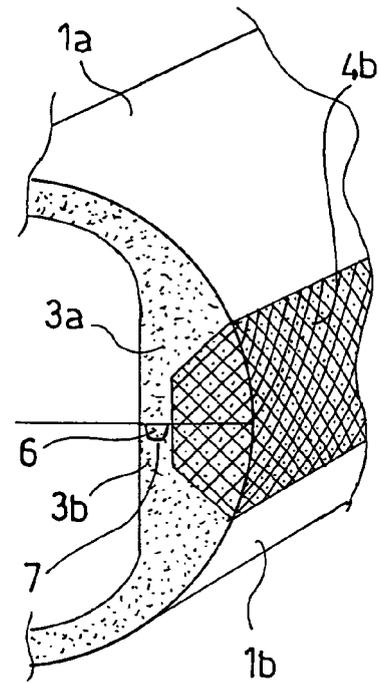


FIG. 6

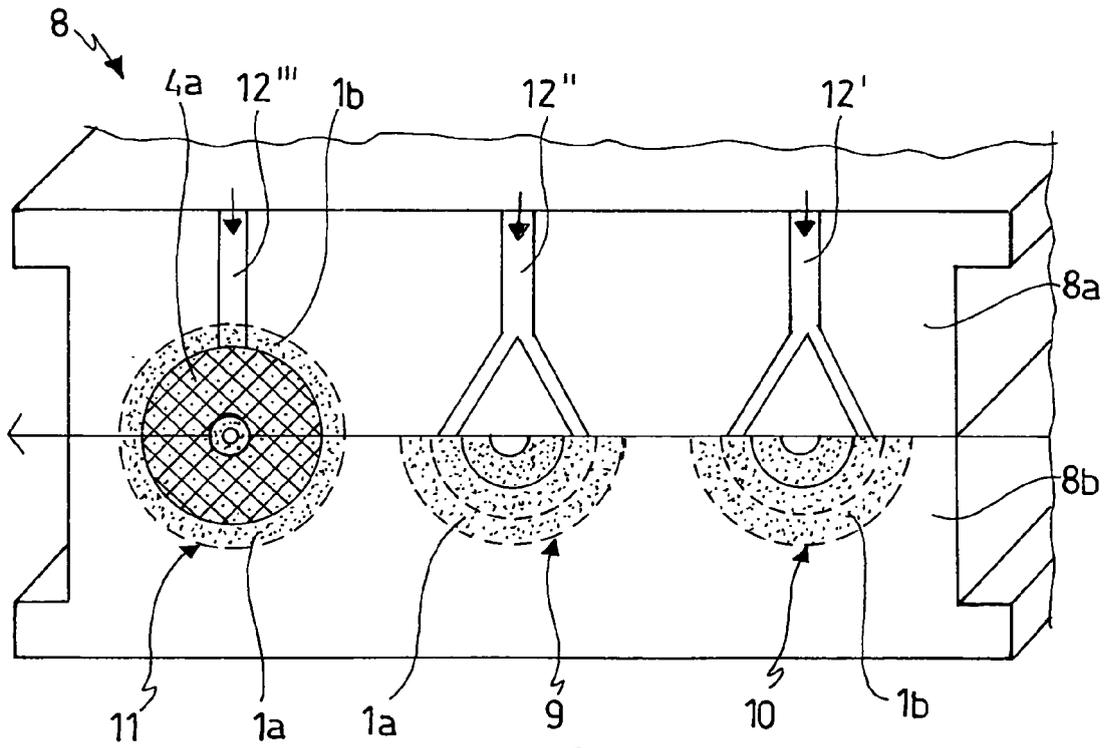


FIG. 4

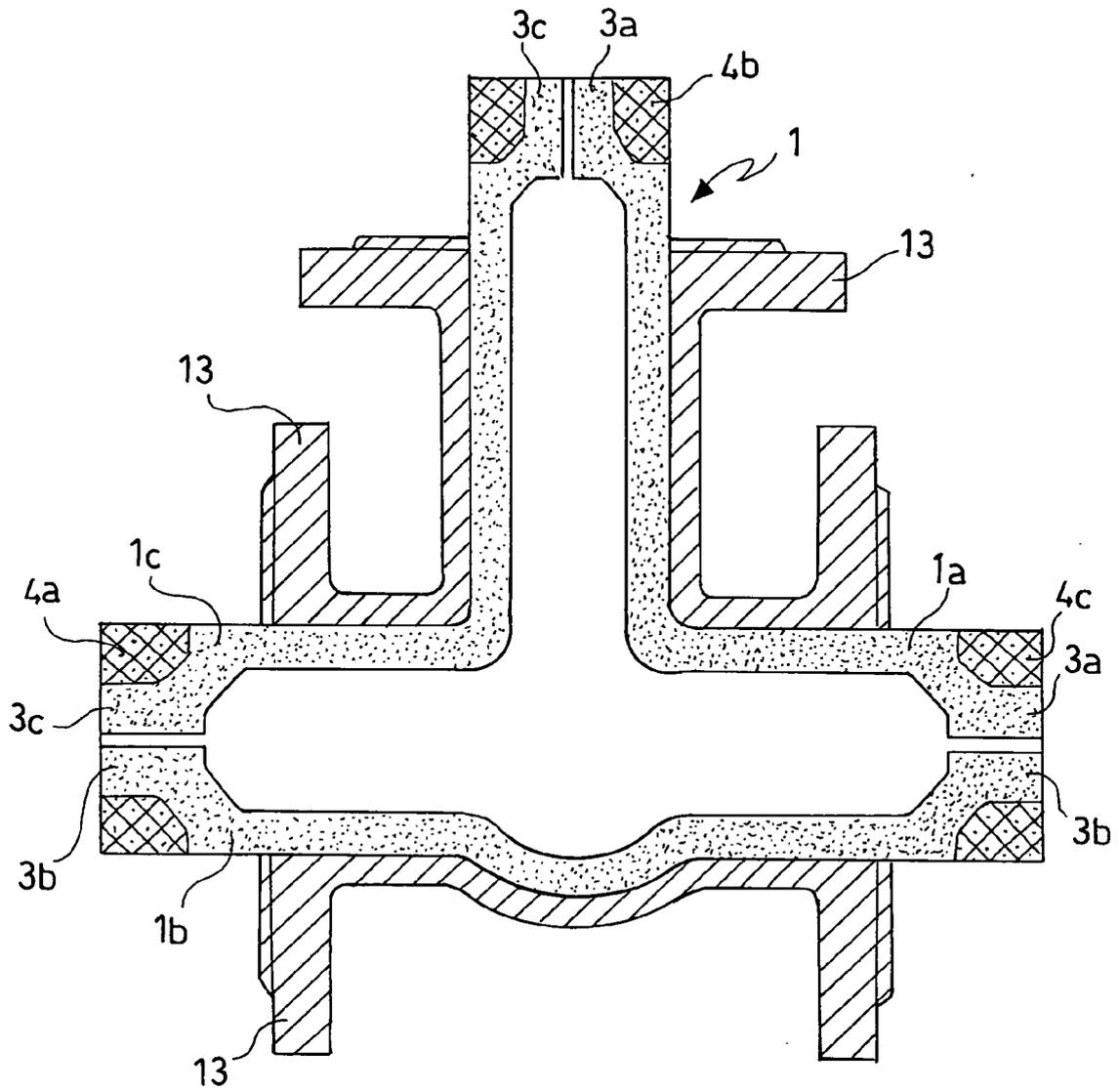


FIG. 7





DOCUMENTS CONSIDERED TO BE RELEVANT				
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)	
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		-/--		
The present search report has been drawn up for all claims				
Place of search <b>Munich</b>		Date of completion of the search <b>16 November 2005</b>	Examiner <b>Lombois, T</b>	
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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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
Place of search Munich		Date of completion of the search 16 November 2005	Examiner Lombois, T
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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EPO FORM 1503 03/02 (P04C01)

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

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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  
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