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(54) Rotating mill

(57) The present invention regards a rotating mill (1) comprising a cylindrical shell (2) rotating around a longitudinal axis (X) and internally lined with a armour-plating consisting of a series of rings (3) of juxtaposed liners (4,5) which substantially cover the entire surface of the cylindrical shell (2), the mill (1) being characterised in that each liner (4,5) of a set ring (3) of liners (4,5) has a circumferential length (arc length) comprised in the range of 100 mm - 200 mm.

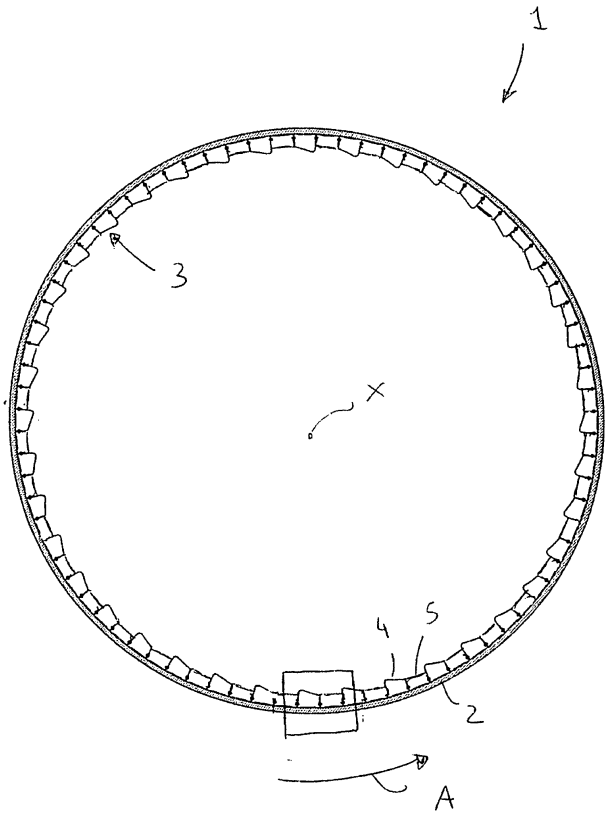

Fig. 1

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Description

Field of application

[0001] In its most general aspect, the present invention refers to a rotating mill with horizontal axis-for the grinding of materials.

[0002] In particular, the invention concerns a rotating mill of the type having a substantially cylindrical shell comprising at least one crushing chamber and possible (two or three) other chambers internally covered with a armour-plating and intended to contain the material to be ground as well as a load of grinding bodies.

Prior art

[0003] Rotating mills of the aforesaid type are widely used for the grinding of materials in the construction sector, for example for the production of cement, and in the mining industry.

[0004] Such mills comprise a cylindrical shell of metal material rotating around a longitudinal axis and internally lined in a first chamber or crushing chamber and in possibly other chambers with a armour-plating composed of a series of axially-mounted, juxtaposed liner rings which substantially cover the entire circumferential surface of the cylindrical shell.

[0005] Inside the mill and in a special manner in the crushing chamber, the single liners usually have a ramp or step profile (in some cases) or an undulated profile (in other cases) for promoting, during the mill rotation, the lifting of the grinding bodies and the material to be ground and their subsequent dropping in a substantially central zone of said mill, what involves the crushing and grinding of the material between the grinding bodies, the latter usually consisting of metal (for example steel) balls.

[0006] In particular, by adapting the shape of the ramp profile or of the undulations to the structural and operative characteristics of the mill (for example dimensions of the mill, speed of rotation, size of the grinding elements etc.) it is possible to attain a good grinding efficiency, limiting as much as possible the wear to which the liners are subjected deriving from their collision with the grinding bodies and the material to be ground.

[0007] On the lower part, on the other hand, the liners are made with a curved profile which substantially follows the circumferential profile of the cylindrical shell, so to be based on and installed on the latter in a series of axially-mounted, juxtaposed liner rings which substantially cover the entire circumferential surface of the cylindrical shell. The fixing of the liner rings to the cylindrical shell can be achieved in various ways, for example through fixing bolts passing through the liners and the cylindrical shell, or alternatively the liners can be maintained in pressure contact against the cylindrical shell, for example by means of the arching effect attained by fit-coupling liners of the same ring and inserting a special wedge-shaped bolted liner. Mixed fixing systems are also provided by means of bolts and fit coupling.

[0008] It is also known that in accordance with the manufacturing standards of this technical sector and to facilitate the mounting operations, the liners are made in particular in the grinding chamber with a constant circumferential length (arc length) around a theoretical value of 314 mm, with manufacturing tolerances of +- 5-6 mm.

[0009] Thus, for example, for a rotating mill having a diameter of 4m for the cylindrical shell and liners with circumferential length equal to 314 mm, a number of liners equal to 40 is provided in the prior art for each liner ring.

[0010] Nevertheless, this solution does not lack drawbacks, even if it meets the usually adopted manufacturing standards. It should be noted in fact that during the prolonged operation of the traditional rotating mills there are sometimes deformations on the circular profile of the cylindrical shell, which can be caused by different factors including, for example, several liners missing during the mill functioning, delays in the substitution of worn liners and liner manufacturing defects.

[0011] Such deformations considerably compromise the stability of the cylindrical shell liners, since the liners are poorly adapted to the new profile induced by the deformations due to the fact that they are made of a rigid wear-resistant material and have a relatively high circumferential length equal to the aforesaid theoretical value of 314 mm (arc length).

[0012] In particular, in the presence of such deformations, there is a considerable reduction of the support surface of the liners on the cylindrical shell, which causes, during mill operation, their breaking at portions thereof which are no longer supported on the cylindrical shell and the subsequent detachment.

[0013] For example, in the case of deformations of the cylindrical shell towards the interior of the rotating mill, several liners can be supported on the cylindrical shell only at their reduced central zone, hence they are exposed to detachment or breaking at peripheral zones which are no longer supported at the cylindrical shell, during the operation of the rotating mill.

[0014] On the other hand, in the case of deformations towards the outside of the rotating mill, several liners can be supported on the cylindrical shell only at their more reduced end portions, hence they are more exposed to breaking at a larger central zone which is not supported at the cylindrical shell, during the operation of the rotating mill.

[0015] Due to the aforesaid drawbacks, said rotating mills are also subjected to greater maintenance costs deriving from the substitution of the damaged or detached liners.

[0016] A further drawback of the rotating mills of the prior art moreover lies in a certain structural difficulty of the liners deriving from the need to provide zones with different radial height, above all in the crushing chamber, so as to have the aforesaid step (or steps) or undulations necessary for the lifting of the material and grinding bod-

ies for the efficient grinding of said material.

[0017] The technical problem underlying the present invention is that of making available a rotating mill which has structural and functional characteristics such to overcome or limit at least in part the drawbacks mentioned above with reference to the prior art.

Summary of the invention

[0018] Such problem is solved according to the invention by a rotating mill comprising a cylindrical shell rotating around a longitudinal axis and internally lined with a armour-plating consisting of a series of juxtaposed liner rings, characterised in that each liner of a set liner ring has a circumferential length (arc length) comprised in the range of 100 mm - 200 mm.

[0019] Preferably, each liner of a set liner ring has a circumferential length comprised in the range of 147 mm - 167 mm.

[0020] According to a particularly preferred embodiment of the invention, each liner of a set liner ring has a circumferential length of about 157 mm.

[0021] Preferably, said series of juxtaposed liner rings are arranged at least in one crushing chamber of said mill.

[0022] In the present invention, the liners are mounted axially, with the possibility to be aligned (along the longitudinal axis of the cylindrical shell) or staggered o non-axially mounted or with a mixed axial - non-axial arrangement.

[0023] Thanks to the present invention, it has been found that by limiting the longitudinal length of the liners in the above-indicated range of values, the destabilising effects induced by the deformations of the cylindrical shell are greatly reduced, as are, consequently, the risks of detachment and breaking of the liners during the operation of the rotating mill, without comprising the excellent wear-resistance of the liners and grinding efficiency which are comparable with those of the mill liners according to the prior art.

[0024] In accordance with a preferred aspect of the present invention, each liner ring comprises a plurality of liners, preferably in the crushing chamber, which follow each other in the circumferential direction according to a predefined order, each liner having a step on the rear face, seen from the rotation direction of the mill, of greater radial height than that of the front face.

[0025] In such a manner, all of the liners of each ring are capable of lifting the material and the load of grinding bodies, which is advantageous for an increased grinding efficiency.

[0026] In accordance with another particularly preferred aspect of the present invention, each liner ring comprises first liners and at least one second liner which follow one another in the circumferential direction according to a predefined order, each first liner having a step on the rear face, seen from the rotation direction of the mill, of greater radial height than that of the front face and said at least one second liner having instead a radial height on the rear face, seen from the rotation direction of the mill, substantially equal to that of the front face.

[0027] Preferably, each liner ring comprises a plurality of first liners and a plurality of second liners which follow each other in the circumferential direction according to an alternating or non-alternating sequence.

[0028] In such a manner, the productive cycle of the liners is advantageously simplified since a smaller number of liners is provided with steps without compromising the lifting of the material and grinding bodies necessary to obtain an efficient grinding of said material.

[0029] Moreover, since several liners have more uniform radial height (and thus thickness), the risks of cracks or breaks in the material of the liners are reduced during the heat treatments of the same to favour their hardening.

[0030] According to a preferred aspect of the present invention, the aforesaid second liners have a constant radial height between the respective front and rear faces.

[0031] Further characteristics and advantages of the rotating mill according to the present invention will be clearer from the following description of a specific embodiment, made with reference to the drawings herein attached and provided as illustrative and non-limiting.

Brief description of the drawings

[0032]

Fig. 1 shows a cross section view of a rotating mill according to the present invention at a first chamber or crushing/grinding chamber;

Fig. 2 shows an enlarged section view of a detail of the rotating mill of figure 1.

Detailed description

[0033] With reference to the aforesaid figures, a rotating mill according to the invention is indicated in its entirety with 1.

[0034] The rotating mill 1 comprises a cylindrical shell 2 rotating around a longitudinal axis X and closed at opposite ends by respective bottoms (not shown since they are conventional), and having at least one crushing/grinding chamber equipped with an opening for the inlet of the material to be ground and of the loading of grinding bodies in the rotating mill 1 and for the outlet of the ground material together with the grinding bodies.

[0035] The cylindrical shell is internally lined with a armour-plating composed of a series 3 of juxtaposed liner rings which substantially cover the entire internal surface of the cylindrical shell 2. For the sake of simplicity in figure 1 only one ring 3 of liners is shown.

[0036] The liners are composed of a metal material with high wear-resistance, of *per se* conventional type.

[0037] In accordance with the present embodiment, each liner ring 3 has a circumferential length of about 157 mm (theoretical value), or a circumferential length

equal to about half that of the liners according to the prior art.

[0038] This means that, in accordance with the teachings of the invention, the number of liners of a rotating mill with 4m diameter is equal to 80 for each liner ring.

[0039] In the present example, and in accordance with another aspect of the present invention, each ring 3 comprises a plurality of first liners 4 and a plurality of second liners 5 which follow each other in the circumferential direction according to an alternating sequence.

[0040] More in particular, the liners 4 are of the type with upper step profile, since they have a step 6 on the rear face 4a, seen from the rotation direction A of the mill 1, of greater radial height than the height of the front face 4b.

[0041] On the other hand, the liners 5 lack of step and have a substantially constant radial height between the respective rear 5a and front 5b faces, as seen from the rotation direction A of the mill.

[0042] On the lower part, in contact with the cylindrical shell 2, the first liners 4 and the second liners 5 have a profile substantially matching that of the cylindrical shell 2 on which they are supported at lower end portions 8. A cavity 9 is moreover made at the lower surface of the liners 4 and 5, between the support portions 8 on the cylindrical shell 2.

[0043] The first liners 4 and the second liners 5 in series with each other to form the rings 3 can be axially aligned, i.e. along the longitudinal axis X of the cylindrical shell 2, or non-aligned (staggered), or in part aligned and in part non-aligned.

[0044] The rotating mill 1 is moreover provided with means of maintaining the first liners 4 and the second liners 5 of each ring 3 under pressure against the cylindrical shell, substantially by means of the arching effect.

[0045] To this end, according to a preferred embodiment of the invention shown in the figures (in particular in figure 2), each first liner 4 or second liner 5 of a ring 3 has, on its rear face 4a or 5a and on its front face 4b and 5b, a respective recess 10 and said means are a plurality of elements of template thickness 13 interposed between consecutive first liners 4 and second liners 5 of each ring 3, the elements 13 being provided with opposing projections 12 which are coupled into respective facing recesses 10 of said consecutive first liners 4 and said second liners 5.

[0046] To close the ring crown 3, bolted rows of liners and/or specific bolted liners may also be provided.

[0047] In addition to the characteristics and advantages mentioned above, a further advantage of the rotating mill according to the invention lies in the greater ease of installation of the liners and of substitution of the latter in case of need.

[0048] Of course, a man skilled in the art can make numerous modifications and variants to the rotating mill described above, all moreover contained in the protective scope of the invention as defined by the following claims.

Claims

1. Rotating mill (1) comprising a cylindrical shell (2) rotating around a longitudinal axis (X) and internally lined with a armour-plating consisting of a series of rings (3) of juxtaposed liners (4, 5) which substantially cover the entire surface of the cylindrical shell (2), **characterised in that** each liner (4,5) of a set ring (3) of liners (4,5) has a circumferential length (arc length) comprised in the range of 100 mm - 200 mm.

2. Rotating mill (1) according to claim 1, **characterised in that** each liner (4,5) of a set ring (3) of liners (4,5) has a circumferential length comprised in the range of 147 mm - 167 mm.

3. Rotating mill (1) according to claim 1 or 2, **characterised in that** each liner (4,5) of a set ring (3) of liners (4,5) has a circumferential length of about 157 mm.

4. Rotating mill (1) according to any one of the preceding claims, **characterised in that** said series of rings of juxtaposed liners are arranged at least in one crushing chamber of said mill.

5. Rotating mill (1) according to any one of the preceding claims, **characterised in that** each ring (3) of liners comprises a plurality of liners (4) which follow each other in the circumferential direction according to a predefined order, each liner (4) having a step (6) on the rear face (4a), seen from the rotation direction (A) of the mill (1), of greater radial height than that of the front face (4b).

6. Rotating mill (1) according to any one of the preceding claims 1-4, **characterised in that** each ring (3) of liners (4,5) comprises first liners (4) and at least one second liner (5) which follow each other in the circumferential direction according to a predefined order, each first liner (4) having a step (6) on the rear face (4a), seen from the rotation direction (A) of the mill (1), of greater radial height than that of the frontal face (4b) and said at least one second liner (5) having instead a radial height on the rear face (5a), seen from the rotation direction (A) of the mill (1), substantially equal to that of the front face (5b).

7. Rotating mill (1) according to claim 6, **characterised in that** each ring (3) of liners (4,5) comprises a plurality of first liners (4) and a plurality of second liners (5) which follow each other in the circumferential direction (A) according to an alternating or non-alternating sequence.

8. Rotating mill (1) according to claim 7, **characterised in that** said liners (5) have a constant radial height

between the respective front and rear faces (5a, 5b).

9. Rotating mill (1) according to any one of the preceding claims, further comprising means for maintaining under pressure said liners (4,5) of each ring (3) against said cylindrical shell (2) substantially by means of the arching effect or not.

10. Rotating mill (1) according to claim 9, **characterised in that** each liner (4,5) of a ring (3) has a respective recess (10) on its rear face (4a, 5a) and its front face (4b, 5b) and **in that** said means consists of a plurality of elements of template thickness (13) inserted between said consecutive liners (4,5) of each ring (3), the elements (13) being provided with opposing projections (12) which are coupled into respective facing recesses (10) of said consecutive liners (4,5).

11. Rotating mill (1) according to any one of the preceding claims, **characterised in that** said liners (4,5) are axially aligned along the longitudinal axis (X) of the cylindrical shell (2) or non-aligned (staggered) or in part aligned and in part non-aligned.

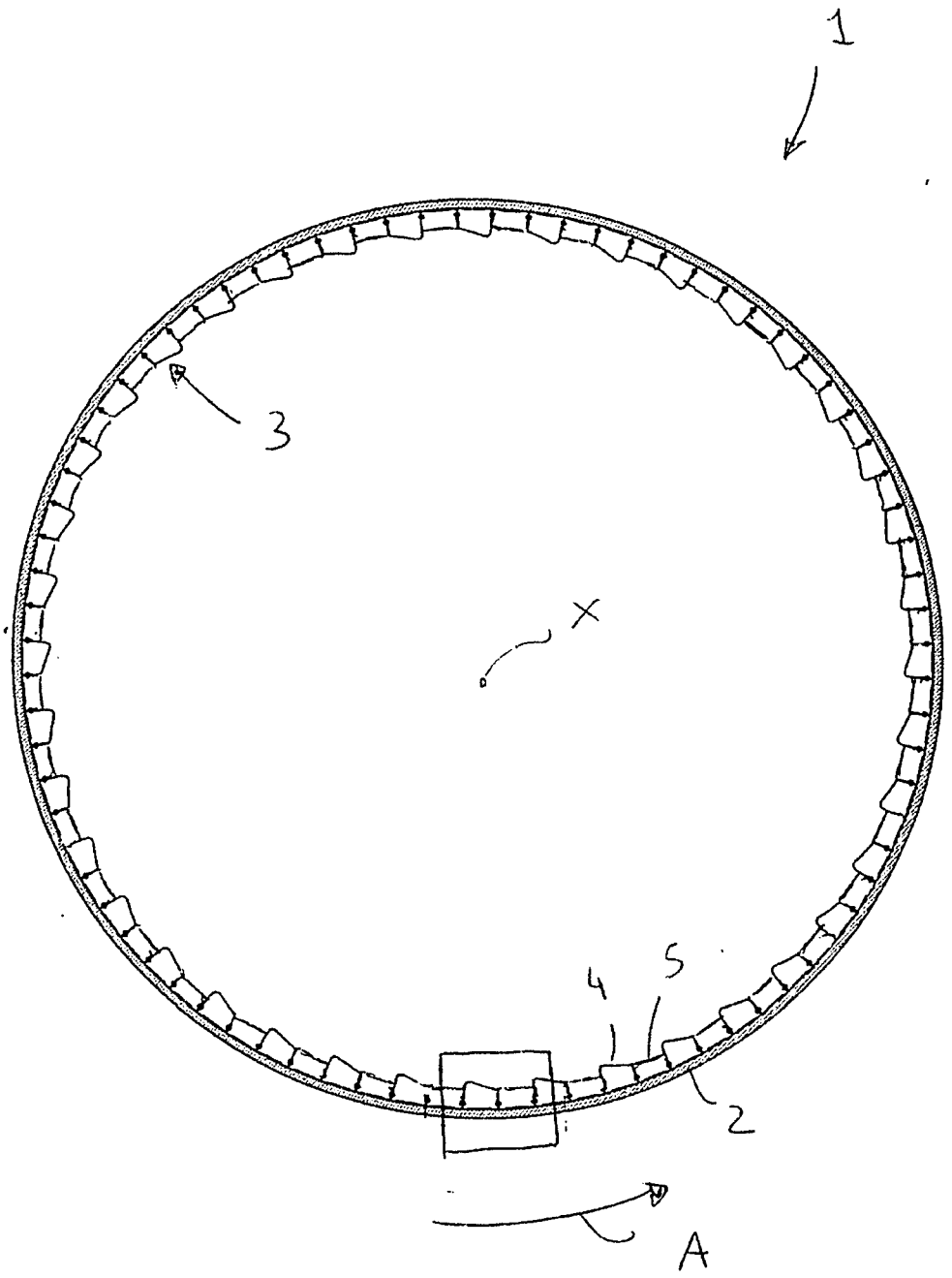

Fig. 1

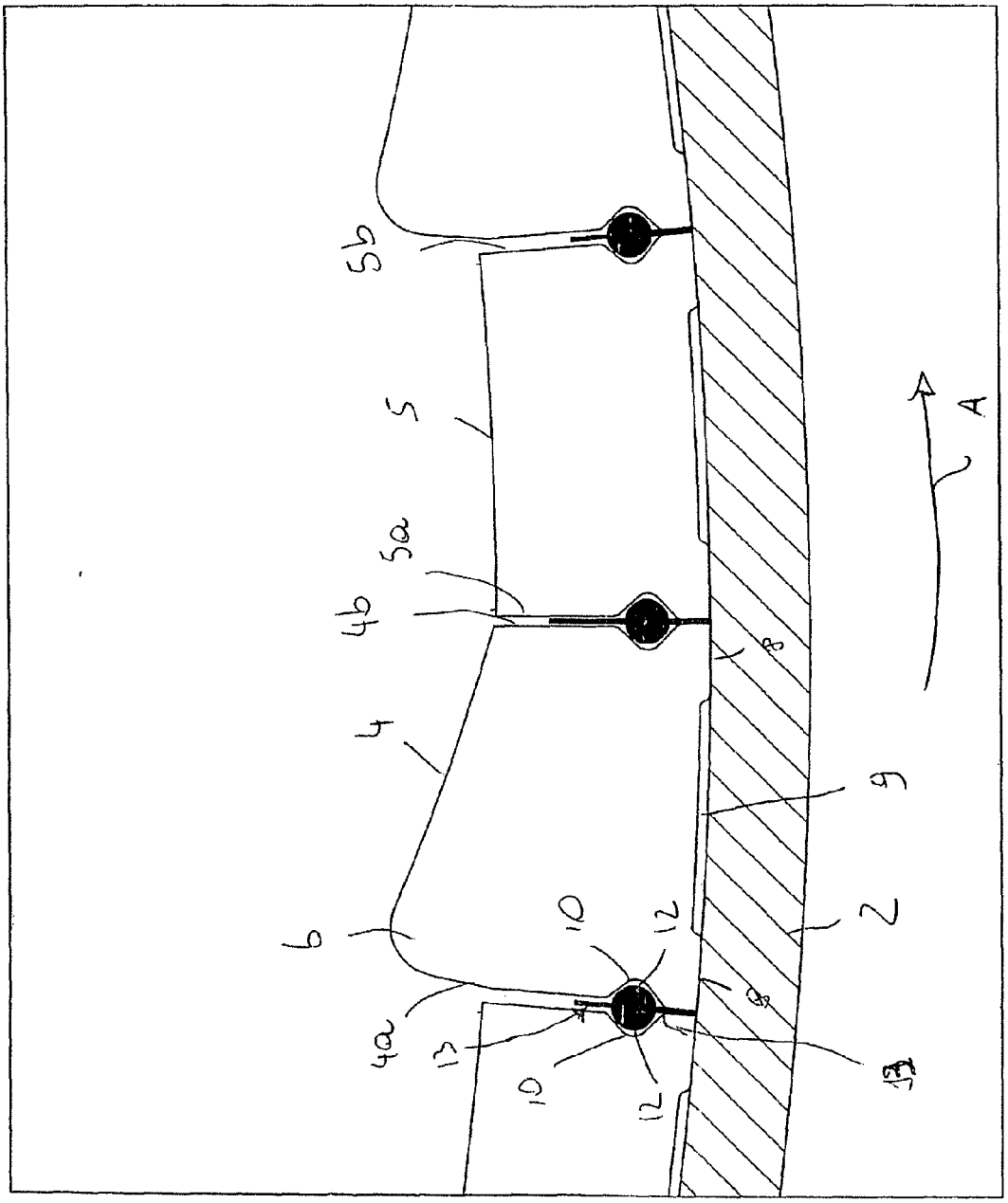

Fig 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 42 5047

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	FR 1 524 865 A (MAGOTTEAUX FOND) 10 May 1968 (1968-05-10) * page 1, left-hand column, line 1 - line 5 * * page 2, left-hand column, line 8 - line 58 * * page 3, left-hand column, line 3 - page 4, right-hand column, line 11 * * figures 1-26 *	1-4,9,11 5-8,10	INV. B02C17/22
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X	WO 98/16317 A (PFEIFFER CHRISTIAN MASCHF [AT]; BEIGL JOSEF [AT]; HACKL HELMUT [AT]; O) 23 April 1998 (1998-04-23) * page 1, line 4 - line 15 * * page 3, line 9 - line 27 * * page 11, line 9 - line 34 * * page 13, line 12 - page 20, line 15 * * figures 1-11 *	1-4,9,11	TECHNICAL FIELDS SEARCHED (IPC) B02C
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 June 2007	REDELSPERGER, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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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13-06-2007

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