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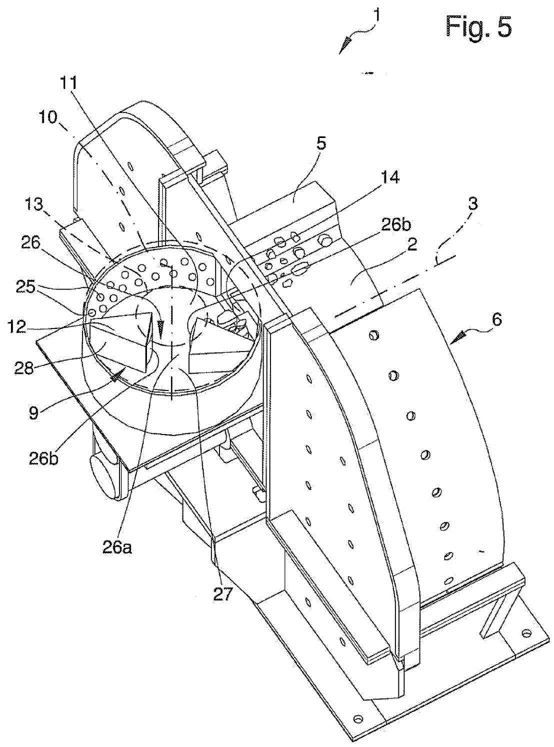
(54) **Impact mill for grinding loose material**

(57) The impact mill (1) for grinding loose material comprises at least a main rotor (2) moving in rotation around a first axis (3) inside a grinding chamber (4), at least a secondary rotor (9) moving in rotation around a second axis (10) inside an inlet chamber (11) communicating with the grinding chamber (4) and arranged on the side thereof, the secondary rotor (9) being suitable for introducing the material to be ground inside the grinding chamber (4) and wherein the inlet chamber (11) comprises at least an outlet mouth (14) of the material to be ground communicating with said grinding chamber (4).

Fig. 5



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Description

Technical Field

[0001] The present invention relates to an impact mill for grinding loose material.

Background Art

[0002] Impact mills for grinding loose materials generally comprise a main rotor moving in rotation around a relative axis and having one or more hammers suitable for crushing the incoming material.

[0003] The inner walls of the grinding chamber are suitably equipped with covering elements generally known to industry engineers by the name of "armours" which cooperate with the hammers to crush the material introduced into the grinding chamber.

[0004] A first type of hammer mill envisages the material entering the grinding chamber being crushed by squeezing between the hammers and the armours. The material is then crushed by effect of the cutting action of the hammers and of the armours, which on their part undergo speedy wear. In particular, the corners of the hammer faces are quickly chamfered, thus losing much of their effectiveness in the grinding process.

[0005] This type of mill was subsequently joined by the so-called impact mills.

[0006] Impact mills envisage a good part of the material entering the grinding chamber being crushed not by crushing between the hammers and the amours, but by effect of the impact of the material against the side surface of the hammers themselves.

[0007] For this to occur, the entry of the material into the grinding chamber must be synchronised with hammer movement.

[0008] The impact mills of known type can be classified as horizontal-axis mills or vertical-axis mills, depending on the spatial arrangement of the rotation axis of the main rotor.

[0009] The horizontal-axis mills generally have a secondary rotor arranged above the grinding chamber and suitable for conveying the material to be ground inside.

[0010] Two examples of horizontal-axis impact mills are described in WO2002022269 and in WO2008105019, wherein the secondary rotor suitable for conveying the material to be ground inside the grinding chamber is arranged above the main rotor and turns around a relevant axis arranged substantially parallel to the rotation axis of the main rotor itself, and therefore it too arranged horizontally. More in particular, WO2002022269 describes an impact mill wherein the secondary rotor, suitably fitted with blades to launch the material to be ground inside the grinding chamber, turns inside a substantially circular inlet chamber of the material to be ground and having a relative inlet mouth communicating with a pipe for introducing the material to be ground accessible from outside.

[0011] A drawback of this type of mill is tied to the fact that the secondary rotor blades tend to seize up in correspondence to the connection area between the inlet chamber and the introduction pipe of the material to be ground. The material arriving from the introduction pipe builds up in fact by gravity in this connection area and interposes, during blade rotation, between the blades themselves and the side wall of the grinding chamber.

[0012] In the event of the material to be ground being small in size, this is crushed between the upper part of the blades and the side wall of the inlet chamber, with consequent wear of the blades and of the chamber; if, on the other hand, this is large in size, it can even cause the breakage of the part which drives the movement of the secondary rotor inasmuch as it prevents the rotation of the latter around its own axis.

[0013] In the present treatise, by side wall is meant the wall surrounding the relative rotor, whether main or secondary, and which extends in a substantially parallel direction with respect to the axis of the rotor itself.

[0014] The relative movement of the blades with respect to the side wall of the inlet chamber produces a rubbing action of the blades themselves on the material thus interposed and consequently their rapid wear.

[0015] The direct consequence of the wear of the blades and of the inlet chamber is an inefficient distribution and an erroneous launching of the material to be ground inside the grinding chamber, inasmuch as a part of such material manages to bypass the blades and ends up directly in the grinding chamber, thus losing the synchronism with the hammers and another part directly strikes the main rotor causing considerable wear. The result is thus ineffective grinding.

[0016] Furthermore, the presence of material between the blade profile and the side walls of the relative chamber, besides causing considerable wear of the elements between which it is interposed, also obstructs the rotation of the secondary rotor, which can therefore suffer damage due to the resistance put up by the material to be ground.

[0017] The hammer mill described in WO2008105019 is-similar in structure to that described in WO2002022269. The biggest difference consists in the different shape of the inlet chamber inside which the secondary rotor is housed.

[0018] In this case in fact, the side wall of the inlet chamber does not have a round shape but has a series of flat surfaces, the slope of some of which can be adjusted to offset the gradual wear of the blades.

[0019] The hammer mill described in WO2008105019 also has a number of drawbacks.

[0020] In fact, in this type of mill as well, the material to be crushed that enters the inlet chamber tends to build up in correspondence to its inlet mouth communicating with the introduction pipe, thus interposing itself between the blades of the secondary rotor and the walls of the inlet chamber itself. This way, during the rotation of the secondary rotor, the cutting action exercised by the blades on the material thus interposed causes the rapid wear of the parts subject to rubbing. More in particular, the planarity of the side walls of the inlet chamber results in the compression of the material to be crushed between the side walls themselves and the upper part of the blades, which are therefore obstructed in their rotary movement and tend to break due to the resistance put up by the material compressed in this way.

[0021] Furthermore, in this case as well, the material that builds up between the blades and the side wall of the inlet chamber prevents the rotation of the secondary rotor, which is thus overloaded due to the resistance put up by the material itself.

[0022] The resistance put up by the material compressed between the side walls of the inlet chamber and the secondary rotor, similarly to a size of material at inlet just above 30 mm, fairly often causes the breakage of the drive means that move the secondary rotor itself, thereby making the mill unusable.

[0023] Yet another drawback of this type of known mill consists in the difficult performance of maintenance jobs on the secondary rotor, which result in heavy costs and long machine down times.

[0024] The vertical mills, on the other hand, generally only have the main rotor.

[0025] In this type of mill, the material to be ground is introduced into the grinding chamber through an opening above the main rotor.

[0026] The material to be ground then enters the inside of the grinding chamber by gravity and is conveyed towards its peripheral area by effect of the centrifugal force exercised by the rotor itself.

[0027] A first and consistent reduction in the grain size of the material to be ground then occurs following crushing between the crushing hammers and the side wall of the grinding chamber.

[0028] A further reduction also occurs when the material bounces back, after knocking against the armours and again encounters the hammers of the main rotor.

[0029] The vertical mills of known type also have a number of drawbacks.

[0030] In fact, the crushing of the material done with this type of mill is often inefficient.

[0031] In particular, the material to be ground is crushed between the area of extremity of the hammers and the armours which cover the internal wall of the grinding chamber. This crushing action, besides not crushing the incoming material efficiently also causes a rapid wear of the parts between which the material is interposed, and in particular of the crushing hammers.

[0032] In fact, the corners of the faces of the hammers are quickly chamfered by effect of the cutting action of the hammers themselves on the material to be ground, and thus lose a good part of their effectiveness in the crushing process. Another drawback of the vertical mills of known type consists in the fact that the material crushed this way has a flake or lamellar conformation that makes it unsuitable for various applications, and its size is not uniform.

[0033] This is due, in particular, to the fact that a part of the material that enters the grinding chamber does not knock against the hammers due to the lack of synchronisation between the fall of the material itself and the movement of the main rotor, and thereby reaches the exit mouth thus substantially bypassing the grinding phase.

Object of the Invention

[0034] The main aim of the present invention is to provide an impact mill for grinding loose material, whether such mill be horizontal or vertical, that allows obtaining considerably more effective grinding with respect to the impact mills of known type.

[0035] Within this aim, one object of the present invention is to provide a mill that allows achieving an efficient conveyance of the material to be ground inside the grinding chamber, in such a way as to optimise its impact with the relative crushing hammers. Object of the present invention is therefore to avoid, as much as possible, the material to be ground being crushed between the moving parts of the mill itself and the relative containment walls.

[0036] It follows therefore that one object of the present invention is to considerably reduce, with respect to the mills of known type, both the energy needed and the raw material needed for the production of such machines.

[0037] Another object of the present invention is to considerably reduce, with respect to the mills of known type, the wear of the parts that come into contact with the material to be ground, and in particular of the blades of the secondary rotor in horizontal-axis mills and of the crushing hammers in vertical-axis mills.

[0038] Yet another object of the present invention is to provide a hammer mill that allows avoiding excessive overloading of the motor means.

[0039] The present invention also aims, in particular as regards horizontal-axis mills, at considerably simplifying the maintenance operations of the secondary rotor with respect to impact mills of known type, in such a way as to cut the relative costs and machine down times.

[0040] Not the last object of the present invention is to improve, especially as regards vertical-axis mills, not only the final grain size of the material to be ground but also its uniformity.

[0041] Another object of the present invention is to provide an impact mill for grinding loose material which allows overcoming the mentioned drawbacks of the state of the art within the ambit of a simple, rational, easy, effective to use and low cost solution.

[0042] The above objects are achieved by the present impact mill for grinding loose material, comprising:

- at least a main rotor moving in rotation around a first axis inside a grinding chamber;
- at least a secondary rotor moving in rotation around a second axis inside an inlet chamber communicat-

ing with said grinding chamber, said secondary rotor being suitable for introducing the material to be ground inside said grinding chamber;

characterised by the fact that said inlet chamber is arranged on the side of said grinding chamber.

Brief Description of the Drawings

[0043] Other characteristics and advantages of the present invention will become more evident from the description of a preferred, but not sole, embodiment of an impact mill for grinding loose material, illustrated purely as an example but not limited to the annexed drawings in which:

figure 1 is a perspective rear view of the mill according to the invention in a first horizontal-axis embodiment;
figure 2 is a perspective rear view of the mill according to the invention in a second horizontal-axis embodiment;
figure 3 is a perspective front view of the mill of figure 2;
figure 4 is a plan view from above of the mill of figure 2;
figure 5 is a perspective view of the mill according to the invention in a third horizontal-axis embodiment;
figure 6 is a perspective view of a cross section of the mill according to the invention in a first vertical-axis embodiment;
figure 7 is a plan view from above of the mill according to the invention of figure 6;
figure 8 is a perspective view of a cross section of the mill according to the invention in a second vertical-axis embodiment.

Embodiments of the Intention

[0044] With particular reference to such figures, globally indicated by 1 is an impact mill for grinding loose material.

[0045] The mill 1 comprises a main rotor 2 moving in rotation around a first axis 3 inside a grinding chamber 4 and having at least two hammers 5 suitable for impacting the material to be ground.

[0046] More in particular, the grinding chamber 4 is defined by a containment body 6 which is hollow inside and which comprises at least a bottom wall 6a, arranged substantially at a right angle to the first axis 3, at least a closing wall, not shown for simplicity on the attached illustrations and facing the bottom wall 6a, and at least a side wall 6b substantially surrounding the main rotor 2 and which is interposed between the bottom wall 6a and the closing wall. The side wall 6b extends in a direction substantially parallel to the first axis 3.

[0047] Suitably, the walls delimiting the grinding chamber 4, i.e., the bottom wall 6a, the side wall 6b and the closing wall, are covered with removable protection plates 21, which can be of various shapes and which protect the containment body 6 from knocks with the material during the grinding phase.

[0048] The mill 1 also comprises a secondary rotor 9 moving in rotation around a second axis 10 and arranged inside an inlet chamber 11 of the material to be ground communicating with the grinding chamber 4.

[0049] The secondary rotor 9 has at least one or more blades 12, e.g., two blades 12 opposite one another as shown in the illustrations, and is suitable for conveying the material to be ground inside the grinding chamber 4.

[0050] The number of blades 12 of the secondary rotor 9 is suitable equal to the number of hammers 5 of the main rotor 2.

[0051] Advantageously, the second axis 10 is substantially vertical, as shown in the embodiments illustrated in the figures from 1 to 8. - According to a first embodiment, the first and the second axis 3 and 10 are arranged crossways the one to the other. More in particular, the angle formed between the first and the second axis 3 and 10 is between 45° and 135°. Preferably, as shown in the figures from 1 to 5, the first axis 3 is substantially at a right angle to the second axis 10 and is arranged substantially horizontal.

[0052] In a second embodiment, shown in the figures from 6 to 8, the first axis 3 is substantially parallel to the second axis 10 and, more specifically, they are both arranged vertically.

[0053] According to the invention, the inlet chamber 11 is arranged laterally, i.e. on the side of the grinding chamber 4.

[0054] The inlet chamber 11 is delimited by at least a bottom wall 11a, arranged substantially at a right angle to the second axis 10, and by at least a side wall 11b surrounding the secondary rotor 9 and extending substantially parallel to the second axis 10. The side wall 11b is therefore-arranged at a right angle to the bottom wall 11a.

[0055] More in particular, the inlet chamber 11 has a substantially cylindrical shape and the second axis 10 coincides with the longitudinal axis thereof.

[0056] Advantageously, the side wall 11b of the inlet chamber 11 has a plurality of reliefs 25 suitable for facilitating the sliding of the material to be ground. More in detail, the reliefs 25 defined on the side wall 11b have a substantially convex and curved outer surface. Preferably, the side wall 11b has a plurality of recesses and corresponding full elements partially fitted in these recesses so as to protrude into the inlet chamber 11 with respect to the side wall 11b, thus defining the reliefs 25.

[0057] The full bodies defining the reliefs 25 are preferably made of alubit and are free to rotate inside the corresponding recess to facilitate the sliding of the material to be ground and of the blades 12. Such full bodies can therefore be made up of cylindrical, spherical elements or the like.

[0058] The inlet chamber 11 comprise at least an inlet mouth 13 and at least an outlet mouth 14 of the material to be ground, the latter being in communication with the grinding chamber 4 and being defined in correspondence to the side wall 11b of the inlet chamber itself.

[0059] More in detail, the inlet mouth 13 is arranged so the material to be ground enters the inlet chamber 4 from above, along a direction substantially parallel to the second axis 10.

[0060] More in particular, the inlet mouth 13 is arranged above the secondary rotor 9 and is substantially facing the bottom wall 11a. The inlet mouth 13 is therefore arranged substantially perpendicular to the second axis 10 and substantially parallel to the surface brushed by the secondary rotor 9 in its movement around the second axis itself.

[0061] Suitably, the mill I according to the invention envisages two different arrangements of the inlet mouth 13.

[0062] In the embodiments of the mill 1 shown in the figures from 1 to 4 and 6, 7, the inlet mouth 13 is arranged in such a way as to unload the material to be ground in correspondence to an area of the inlet chamber 11 not comprising the outlet mouth 14. In this embodiment, the inlet chamber 41 comprises a partition 22 which substantially separates the inlet chamber itself into two areas, one accumulation area, communicating with the inlet mouth 13, and one launching area, communicating with the outlet mouth 14.

[0063] In the embodiments of the mill 1 shown in the figures 5 and 8, the inlet mouth 13 is on the other hand arranged substantially along the second axis 10. More in particular, the mill 1 comprises a covering element of the inlet chamber 11, not visible in detail in the illustrations and arranged on the opposite side of the bottom wall 11a with respect to the secondary rotor 9. This covering element has a central opening, in which a funnel is inserted for conveying the material to be ground inside the inlet chamber 11, which substantially defines the inlet mouth 13.

[0064] In both the described arrangements of the inlet mouth 13, the means of conveyance of the material to be ground in the grinding chamber 4 can be of various types, such as a sloping ramp, a hopper or the like.

[0065] In the embodiments in the figures 5 and 8, the secondary rotor 9 advantageously comprises at least a receiving area 26 for the material to be ground which enters through the inlet mouth 13. The receiving area 26 is therefore defined in correspondence to the second axis 10, i.e., in the central area of the secondary rotor 9, and is substantially aligned with the inlet mouth 13.

[0066] The receiving area 26 is shaped so as to the convey the material to be ground to the side wall 11b of the inlet chamber 11 dupe to the effect of the centrifugal force of the secondary rotor 9.

[0067] More in particular, the receiving area 26 is substantially hollow and has at least a side opening 27 to allow the material to be ground to move from the central area of the secondary rotor 9 to the side wall 11b of the inlet chamber 11.

[0068] More in detail, the receiving area 26 comprises a supporting surface 26a, substantially parallel to the bottom wall 11a and facing the inlet mouth 13, and one or more containment surfaces 26b extending upwards from the supporting surface 26a and delimiting at the side the receiving area 26. Suitably, the containment surfaces 26b are separated from one another by the openings 27.

[0069] Preferably, the secondary rotor 9 comprises a plate 18 having an extension such as to substantially fully cover the bottom wall 11a and which defines the supporting surface 26a and a peripheral surface 30 substantially surrounding the supporting surface 26a; on the peripheral surface 30 the material to be ground is collected and pushed due to the effect of the centrifugal force towards the side wall 11b.

[0070] The receiving area 26 is substantially placed between the blades 12, which protrude from the receiving area itself towards the outside, i.e. towards the side wall 11b.

[0071] Preferably, in the embodiments in figures 5 and 8, each blade 12 comprises two impact surfaces 28 incident the one to the other, suitable for intercepting the material to be ground accumulated on the peripheral surface 30 during the movement of the secondary rotor 9 around the second axis 10. Furthermore, in these same embodiments, each blade 12 also has a rear surface turned towards the receiving area 26, shaped in such a way as to avoid the accumulation of the material to be ground between the blades 12 and the receiving area 26. This rear surface, which corresponds to the containment surface 26b mentioned above, is substantially convex.

[0072] In the embodiment in figure 8, the secondary rotor 9 also comprises at least a stiffening element 29 connecting the blades 12 together. More in particular, the stiffening element 29 is composed of an annular element associated with the upper area of the blades 12 turned towards the inlet mouth 13.

[0073] As mentioned above, the outlet mouth 14 of the inlet chamber 11 is defined on the side wall 11b thereof and communicates with the grinding chamber 4.

[0074] In horizontal-axis mills 1 the outlet mouth 14 faces in correspondence to the bottom wall 6a, as shown in the figures from 1 to 5, or to the side wall 6b of the grinding chamber 4.

[0075] In vertical-axis mills 1, shown in the figures from 5 to 8, the outlet mouth 14 of the material to be ground faces in correspondence to the side wall 6b of the grinding chamber 4.

[0076] In the embodiments shown in the figures 1 and 5 and from 6 to 8, the side wall 11b of the inlet chamber 11 joins the bottom wall 6a and the side wall 6b respectively of the grinding chamber 6 in correspondence to the extremities thereof which delimit the outlet mouth 14. Preferably, in these embodiments, the junction area of the side wall 11b with the bottom wall 6a is substantially with sharp corner, i.e, devoid of curvilinear connections.

[0077] The present invention then envisages two different construction solutions aimed at permitting the variation of the launching angle of the material to be ground inside the grinding chamber 4.

[0078] Suitably, in both these embodiments described below, the extremity areas of the side wall 11b delimiting the outlet mouth 14 protrude inside the grinding chamber 4 and pass through a corresponding crack defined on its wall 6a,6b on which faces the outlet mouth itself.

[0079] Advantageously, the extremities of the side wall 11b delimiting the outlet mouth 14 protrude inside the grinding chamber 4 in such a way as not to interfere with the hammers 5 and, more particularly, remain inside the profile defined by the protection plates 21.

[0080] Alternatively, the extremities of the side wall 11b delimiting the outlet mouth 14 remain substantially flush with the wall 6a,6b onto which they face.

[0081] The first solution envisages that the side wall 11b of the inlet chamber 11 is moving in rotation around a third axis with respect to the wall 6a,6b of the grinding chamber 4 onto which it faces. Preferably, the third rotation axis coincides with the second rotation axis 10 of the secondary rotor 9. This embodiment, though not shown in detail in the illustrations, is constructively similar to the embodiments of figure 1, 5, 6, 7 and 8 with the difference that the side wall 11b is free from the wall 6a,6b onto which it faces and can rotate around the second axis 10.

[0082] The second solution, shown in the figures from 2 to 4, envisages that the side wall 11b has a fixed part 23a and at least a mobile part 23b, the latter defining a corresponding free extremity of the side wall 11b itself.

[0083] Preferably, the side wall 11b comprises two mobile parts 23b delimiting in point of fact the outlet mouth 14.

[0084] More in particular, the mobile parts 23b are associated revolving with the fixed part 23a around a relative fourth rotation axis 24 substantially parallel to the second axis 10.

[0085] The rotation of the mobile parts 23b around the relative fourth rotation axes 24 can be adjusted by an operator by means of relative adjustment means, not shown in detail in the illustrations, to vary the exit angle of the material to be ground from the inlet chamber 11.

[0086] In a further embodiment, not shown in the illustrations, the mill 1 comprises two main rotors 2 arranged inside the grinding chamber 4, associated integral in rotation with one another and whose hammers 5 are shifted out of place by an angle between 45° and 135°.

[0087] This particular embodiment also envisages the presence of two secondary rotors 9, arranged inside relative inlet chambers I and moving in rotation around a relative second axis 10, suitable for launching the material to be ground against a relative main rotor 2.

[0088] Advantageously, the secondary rotors 9 are also shifted out of phase by an angle between 45° and 135°, and more precisely corresponding to the out-of-phase angle of the main rotors 2, so that the entry of the material to be ground launched by each of them inside the grinding chamber 4 is substantially synchronised with the passage of the hammers 5 of the relative main rotor 2. The out-of-phase shift of the secondary rotors 9 corresponds to the angular out-of-phase shift of the relative blades 12.

[0089] In the case of the horizontal-axis mills 1, the outlet mouths 14 can be facing one onto the bottom wall 6a and the other onto the covering wall opposite the bottom wall itself or both onto the side wall 6b of the grinding chamber 4 while in the case of the vertical-axis mills 1 they both face onto the side wall 6b. Suitably, the mill 1 comprises connection means 15 in rotation of the main rotor 2 with the secondary rotor 9, only visible in the figures 1 and 2, suitable for maintaining the synchronism and therefore the correct phasing between them. The connection means 15 can be either of the mechanical or electric type.

[0090] In the embodiment shown in the figures 1 and 2, the connection means 15 in rotation comprise at least a first shaft 16 associated integral in rotation with the main rotor 2, at least a second shaft, not visible in detail in the illustrations, associated integral in rotation with the secondary rotor 9 and transfer means of the rotation from the first shaft 16 to the second shaft. The first and the second shaft extend along the directions defined by the rotation axes 3 and 10 of the respective rotors 2 and 9 and the transfer means are therefore suitable for connecting in rotation two axes in competition with one another.

[0091] More in particular, in this embodiment, the transfer means of the rotation from the first shaft 16 to the second shaft are of the mechanical type and comprise a bevel gear pair, not visible in detail in the illustrations, interposed between the first shaft 16 and the second shaft. This bevel gear pair is interposed between the second shaft and an intermediate shaft 19 arranged substantially perpendicular to the second shaft itself. The intermediate shaft 19 is therefore arranged substantially parallel to the first shaft 16 and is connected in rotation to the latter by means of a belt 20.

[0092] Different embodiments cannot however be ruled out in which the connection means in rotation 15 of the rotors 2 and 9 envisage the use of electric motors suitably phased the one with the other or of technical equivalents known to experts in the sector.

[0093] In the embodiment of the mill 1 in which the first and the second axis 3 and 10 are arranged substantially parallel to each other, as shown in the figures from 6 to 8, the main rotor 2 and the secondary rotor 9 revolve in the same direction the one to the other so the hammers 5 "see" the material to be ground coming during their rotation around the first axis 3. In point of fact, the inlet trajectory of the material to be ground in the grinding chamber 4 is directed in a direction substantially contrary to the direction of rotation of the main rotor 2.

[0094] The present invention operates as follows.

[0095] The material to be ground arriving from outside, e.g., from a collection hopper not shown in the illustrations, is introduced inside the inlet chamber 11 from the inlet mouth 13 placed above the secondary rotor 9.

[0096] In the embodiments of the mill according to the invention shown in the figures from 1 to 4 and 6, 7, the material to be ground falls by gravity inside the inlet chamber 11 and is collected in an area away from the outlet mouth 14. During the rotation of the secondary rotor 9 around the second axis 10 its blades 12 encounter the material to be ground thus unloaded and drag it towards the outlet mouth 14. The entry of the material to be ground along a direction substantially perpendicular to the surface brushed by the secondary rotor 9 and the fact that the material itself accumulates in correspondence to a closed area of the inlet chamber 11, i.e., away from the outlet mouth 14, prevents the material itself from interposing between the side wall 11b and the blades 12, thus preventing the secondary rotor 9 from balking and the blades themselves from wearing.

[0097] In the preferred embodiment shown in the figures 5 and 8, on the other hand, the material to be ground enters through the inlet mouth 13 located above the secondary rotor 9, centrally to this, and falls on the receiving area 26. The material to be ground thus accumulates on the supporting surface 26a and is pushed towards the outside of the secondary rotor 9, i.e., towards the side wall 11b of the inlet chamber 11, due to the effect of the rotation of the secondary rotor itself and therefore of the centrifugal force deriving from it. The material to be ground then passes through the openings 27 and deposits on the peripheral surface 30. The material that accumulates in correspondence to the containment surfaces 27b is also pushed towards the outside, thanks also to the convex shape of the containment surfaces themselves which prevent this from accumulating. During the rotation of the secondary rotor 9, the blades 12 encounter the material to be ground thus deposited on the peripheral surface 30 and drag it towards the outlet mouth 14 before launching it against the hammers 5.

[0098] More in particular, the impact surfaces 28 of the blades 12 do not encounter the material to be ground during its fall from the inlet mouth 13, but only strike, due to the effect of the rotation speed of the secondary rotor 9, the material to be ground which is arranged resting on the peripheral surface 30. This allows considerably reducing the turbulence inside the inlet chamber 4.

[0099] The presence of the rounded reliefs 25 on the side wall 11b, as shown in the figures 5 and 8, ensures the easier sliding of the material to be ground on the side wall 11b and thus reduces the risk of balking of the blades 12.

[0100] The material to be ground, dragged by the rotation of the blades 12 towards the outlet mouth 14, is then introduced inside the grinding chamber 4 through its bottom wall 6a, as shown in the figures from 1 to 5, or its side wall 6b, as shown in the figures from 6 to 8.

[0101] In the case of the side wall 11b being revolving around the second axis 10 with respect to the grinding chamber 4 or in the case of this being equipped with mobile parts 23b as described above, the launching trajectory of the material to be ground inside the grinding chamber 4 can be changed according to its specific weight and grain size, so as to obtain the most efficient impact possible with the hammers 5, by rotating the side wall 11b itself or its mobile parts 23b. Once the material to be ground has entered the inside of the grinding chamber 4 it is struck by the hammers 5 of the main rotor 2, the rotation of which around the first axis 3 is suitably synchronised with the rotation of the secondary rotor 9 by means of the connection means 15 in rotation.

[0102] The impact of the grinding chamber 4 with the hammers 5 first and then with the protection plates 21 causes the crushing of the material introduced inside the grinding chamber 4.

[0103] In the embodiment of the mill 1 envisaging the use of two main rotors 2 in accordance with what has been previously described, the two secondary rotors 9 launch the material to be ground inside the grinding chamber 4 in an out-of-phase way the one to the other, so as to synchronise the entry of the material itself with the passage of the hammers 5 of the relative main rotor 2.

[0104] The different phasing of the entry of the material to be ground, launched by each secondary rotor 9, inside the grinding chamber 4 allows optimising the efficiency of the mill, cutting energy wastes and at the same time considerably reducing vibrations and dust.

[0105] It has in fact been ascertained how the described invention achieves the proposed objects and in particular the fact is underlined that the particular arrangement of the inlet chamber and the consequent positioning of the axis of the secondary rotor, substantially parallel to the inlet direction of the material to be ground, permits preventing the accumulation of the material itself between the blades of the secondary rotor and the walls of the inlet chamber, thereby considerably reducing the wear of the blades themselves and the risk of balking of the secondary rotor.

[0106] The mill according to the invention also allows, in the embodiment that envisages the inlet mouth of the material to be ground arranged along the second axis and the presence of the receiving area on the secondary rotor, further upgrading the launching phase of the material inside the grinding chamber and at the same time reducing the wear of the blades. In fact, according to this embodiment, there is no interference between the movement of the blades of the secondary rotor and the fall of the material to be ground inside the inlet chamber, and consequently the blades only encounter the material to be ground when this is stopped and resting on the peripheral surface of the plate connecting integral the blade themselves the one to the other. This particular configuration of the mill according to the invention permits considerably reducing the turbulence inside the inlet chamber itself and the wear of the blades.

[0107] The mill according to the invention therefore permits optimising the insertion phase of the material to be ground inside the grinding chamber. In fact, the absence of material interposing between the blades and the side wall of the inlet chamber and the consequent reduction in wear of the blade themselves allows the secondary rotor to remain in phase with the main rotor and also prevents part of the inserted material from bypassing the secondary rotor and directly entering the grinding chamber.

[0108] The result therefore is more successful grinding and, consequently, smaller and more uniform piece size compared to impact mills of known type, as well as being able to use the same machine, by changing its speed, both as a tertiary mill and as a secondary mill.

[0109] What is more, the particular arrangement of the inlet chamber, alongside the grinding chamber, ensures easier maintenance operations compared to hammer mills of known type and consequently reduces to the utmost the machine down times required for carrying out such operations.

Claims

1. Impact mill (1) for grinding loose material, comprising:

- at least a main rotor (2) moving in rotation around a first axis (3) inside a grinding chamber (4);
- at least a secondary rotor (9) moving in rotation around a second axis (10) inside an inlet chamber (11) communicating with said grinding chamber (4) and arranged on the side thereof, said secondary rotor (9) being suitable for introducing the material to be ground inside said grinding chamber (4);

characterised by the fact that said inlet chamber (11) comprises at least an outlet mouth (14) of the material to be ground communicating with said grinding chamber (4).

2. Mill (1) according to claim 1, **characterised by** the fact that said outlet mouth (14) is defined on the side wall (11b) of said inlet chamber (11) which substantially surrounds said secondary rotor (9).

3. Mill (1) according to claim 1 or 2, **characterised by** the fact that said outlet mouth (14) faces on a bottom wall (6a) of said grinding chamber (4) arranged substantially at a right angle to said first axis (3).

4. Mill (1) according to claim 1 or 2, **characterised by** the fact that said outlet mouth (14) faces on the side wall (6b) of said grinding chamber (4) which substantially surrounds said main rotor (2).
Suitably, in both these embodiments described below,

5. Mill (1) according to one or more of the preceding claims, **characterised by** the fact that the extremity areas of said side wall (11b) delimiting said outlet mouth (14) protrude inside said grinding chamber (4) and pass through a corresponding crack defined on its wall (6a,6b) on which faces the outlet mouth itself.

6. Mill (1) according to claim 5, **characterised by** the fact that said first axis (3) is substantially parallel to said second axis (10).

7. Mill (1) according to one or more of the preceding claims, **characterised by** the fact that said second axis (10) is substantially vertical.

8. Mill (1) according to one or more of the preceding claims, **characterised by** the fact that said first axis (3) is arranged substantially transversal to said second axis (10).

9. Mill (1) according to claim 8, **characterised by** the fact that the angle formed between said first axis and said second axis (3, 10) is comprised between 45° and 135°.

10. Mill (1) according to claim 9, **characterised by** the fact that said first axis (3) is substantially at a right angle to said second axis (10).

11. Mill (1) according to one or more of the preceding claims, **characterised by** the fact that the side wall (11b) of said inlet chamber (11) is moving in rotation around a third axis to vary the direction of the inlet trajectory of the material to be ground in said grinding chamber (4).

12. Mill (1) according to claim 11, **characterised by** the fact that said third axis substantially coincides with said second axis (10).

13. Mill (1) according to one or more of the claims from 1 to 10, **characterised by** the fact that the side wall (11b) of said inlet chamber (11) comprises at least a fixed part (23a) and at least a mobile part (23b) associated in rotation with said fixed part (23a) around a fourth axis (24), said mobile part (23b) being movable to vary the direction of the inlet trajectory of the material to be ground in said grinding chamber (4).

14. Mill (1) according to claim 13, **characterised by** the fact that said fourth axis (24) is arranged substantially parallel to said second axis (10).

15. Mill (1) according to claim 13 or 14, **characterised by** the fact that the side wall (11b) of said inlet chamber (11) comprises two of said mobile parts (23b) arranged in correspondence to its extremal areas delimiting said outlet mouth (14).

Fig. 1

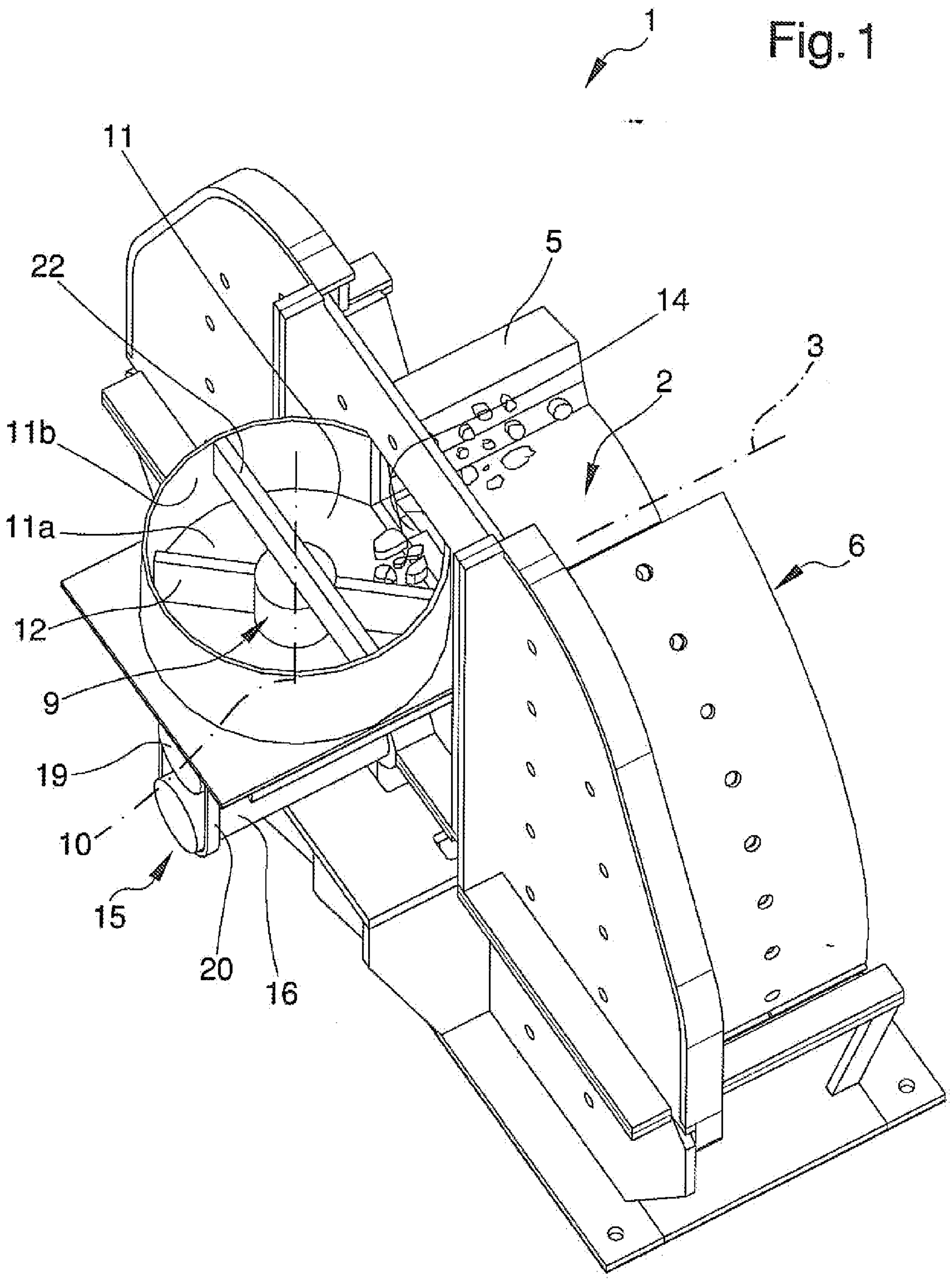


Fig. 2

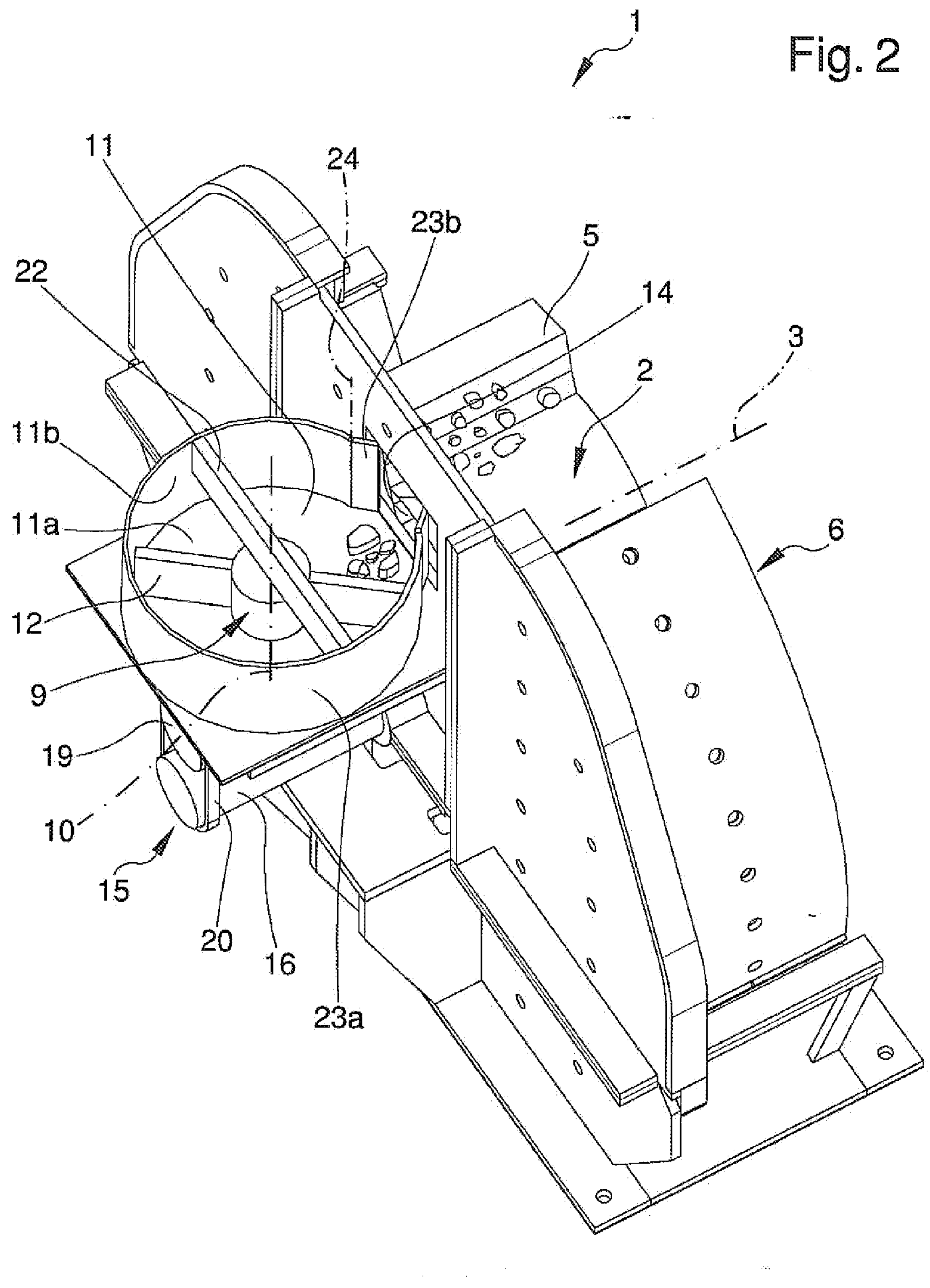


Fig. 3

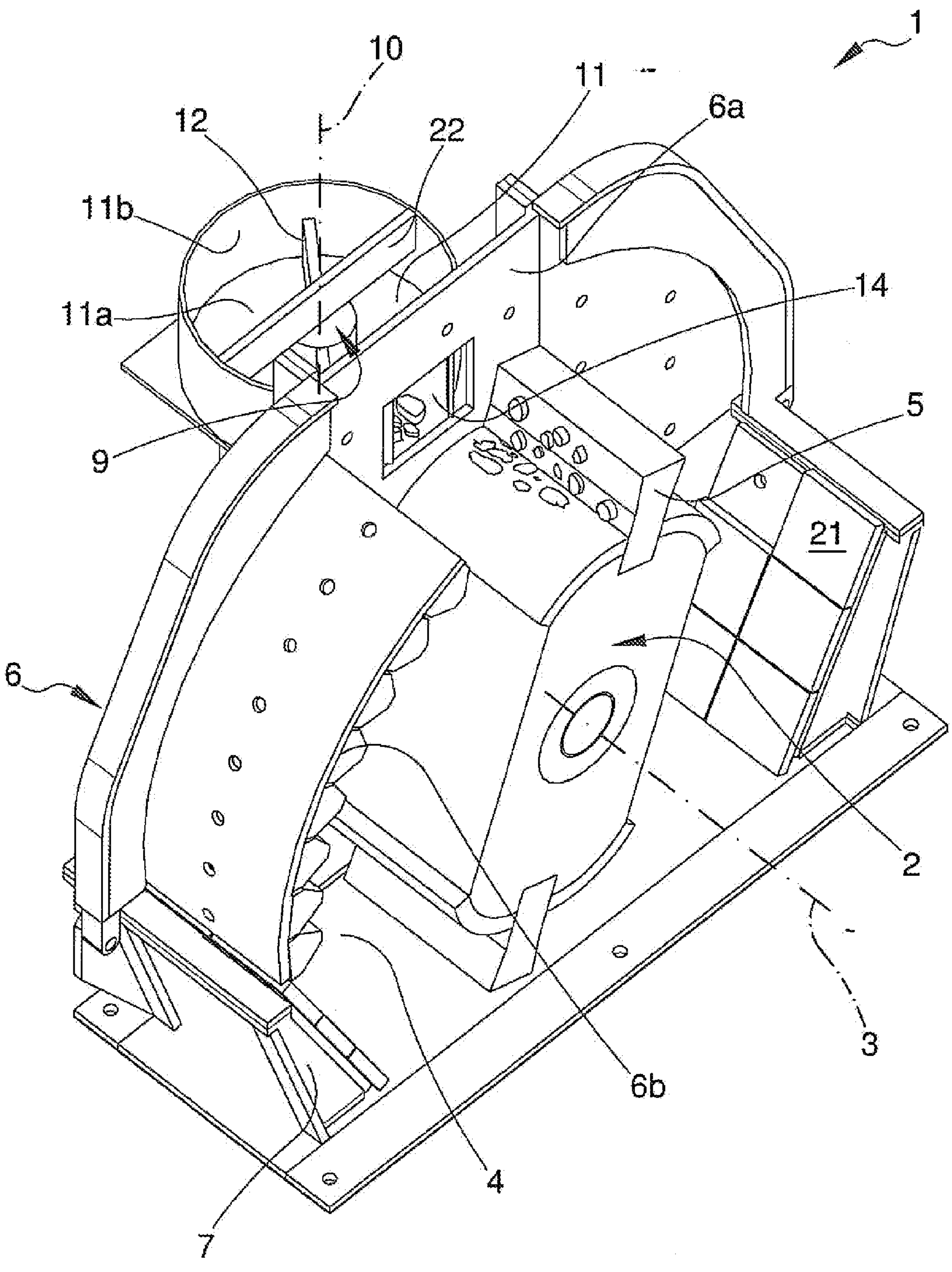


Fig. 4

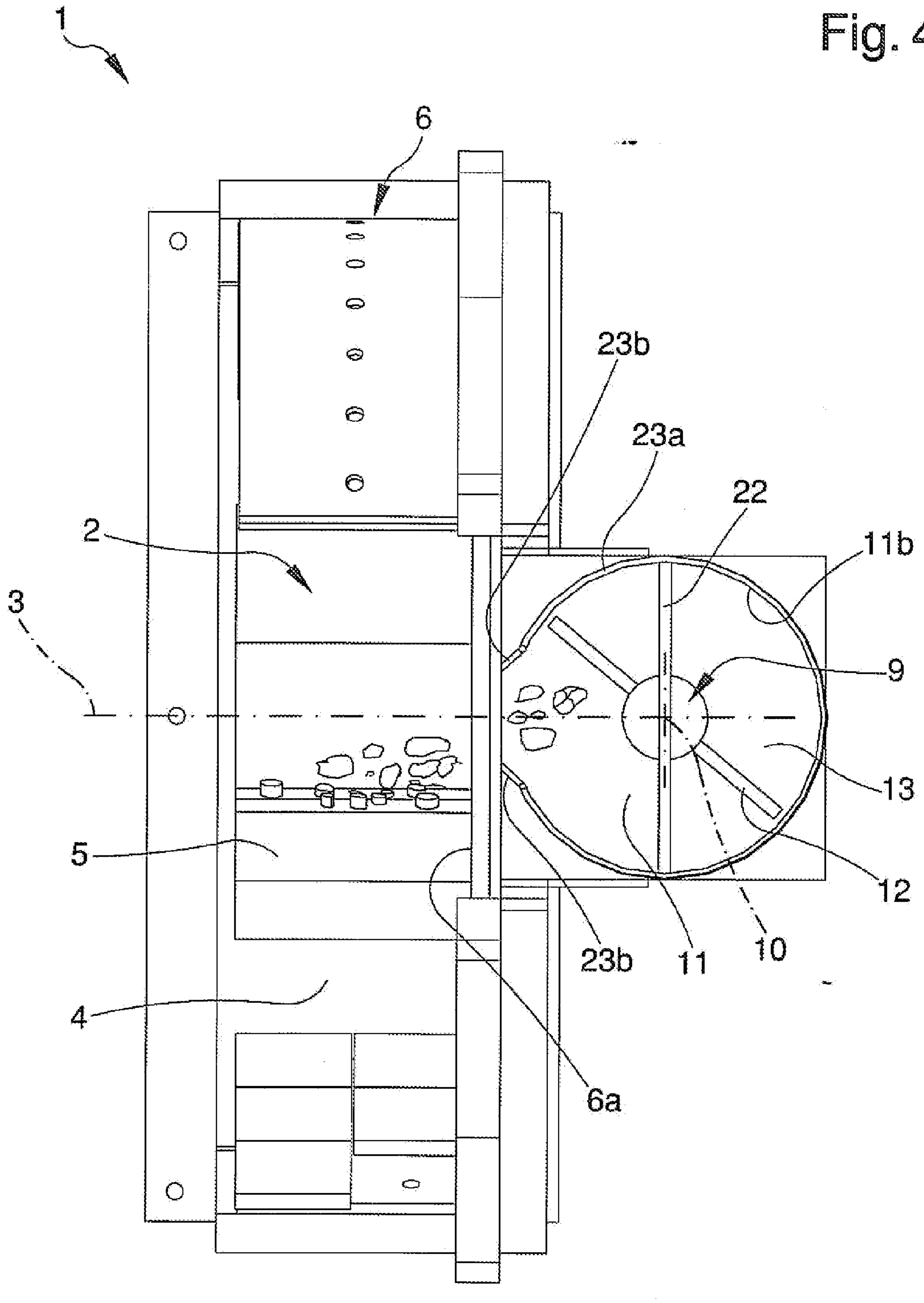
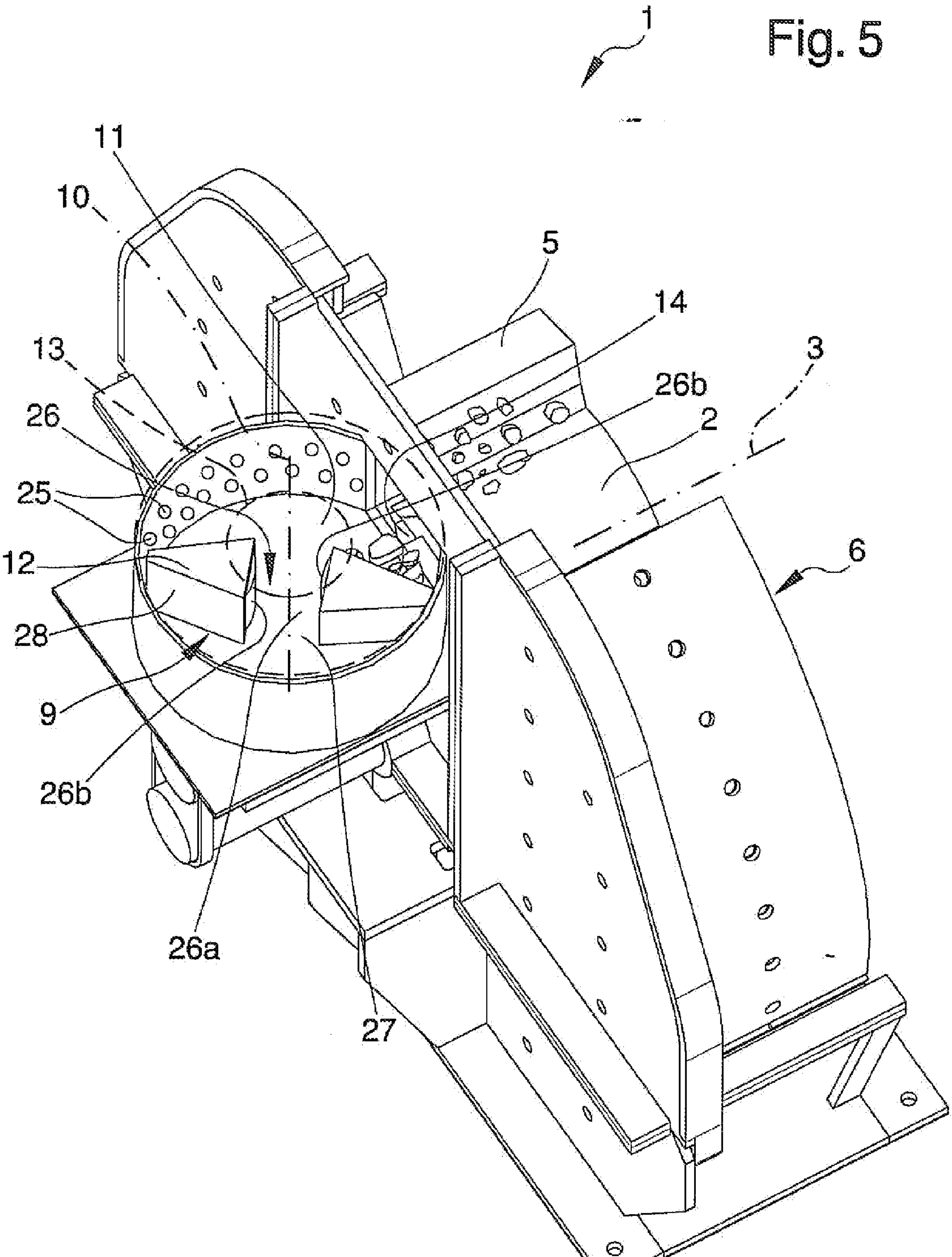


Fig. 5



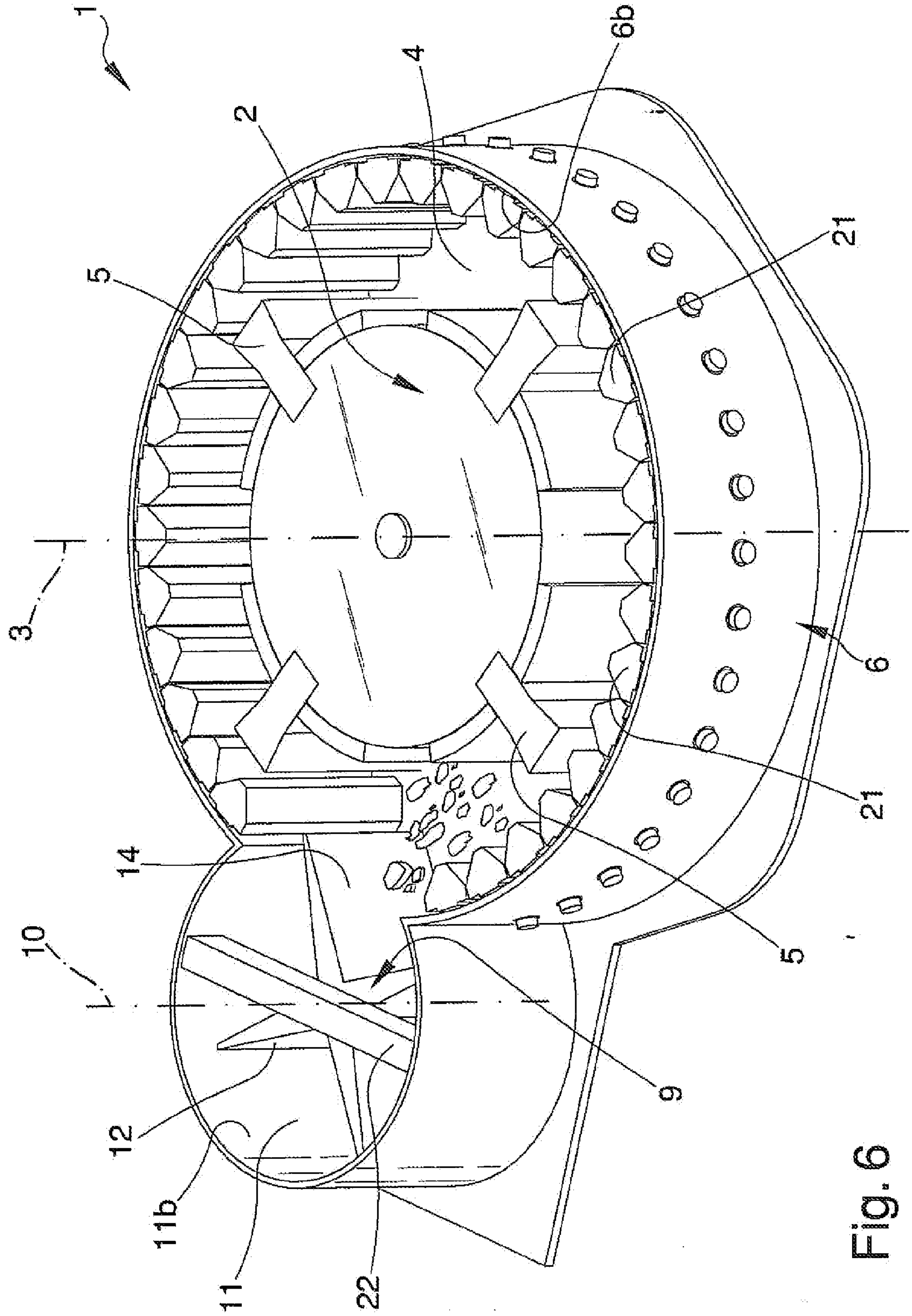
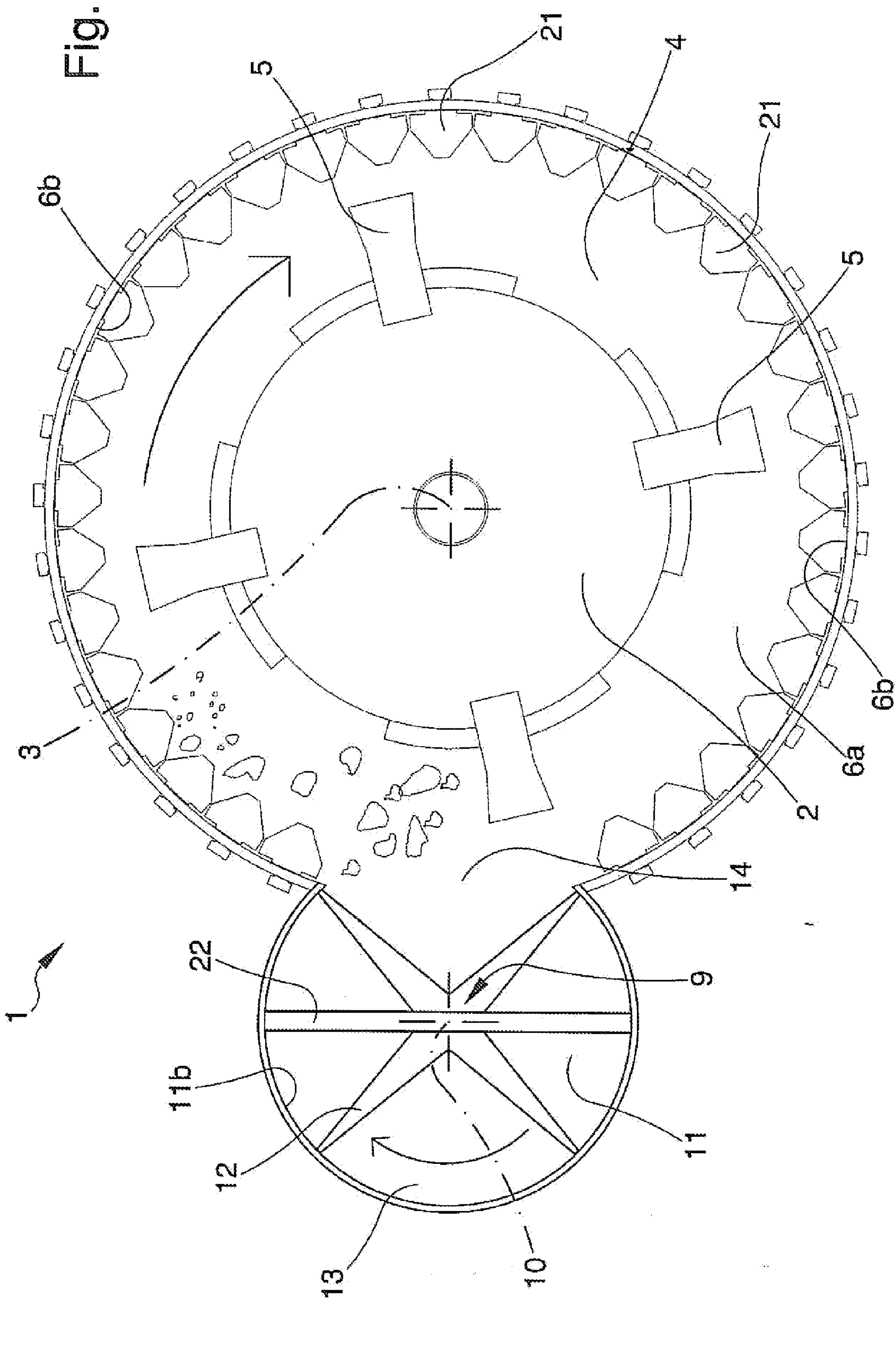


Fig. 6

Fig. 7



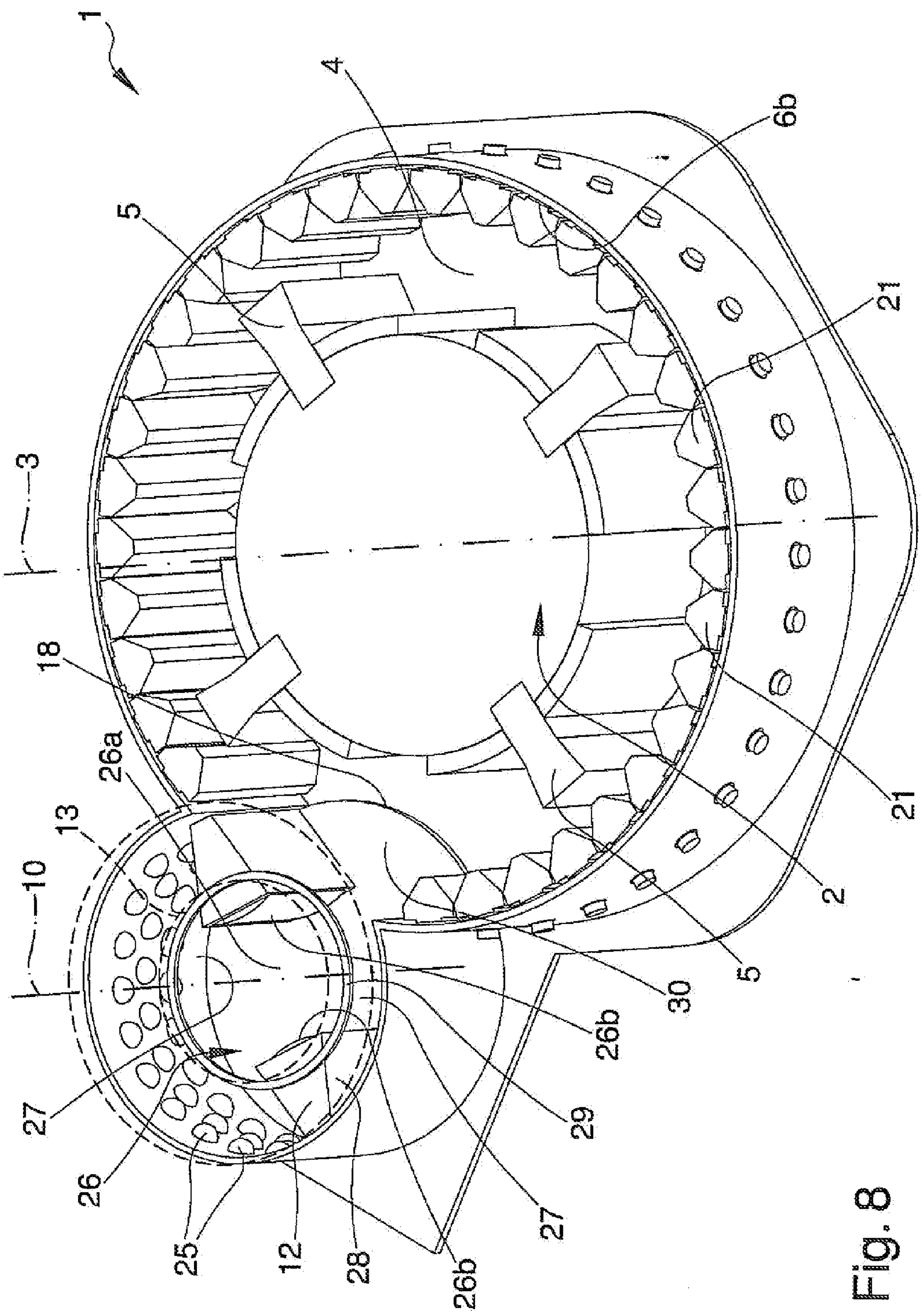


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2002022269 A **[0010] [0017]**
- WO 2008105019 A **[0010] [0017] [0019]**