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(54) ROLLER MILL WITH AN INTER-ROLLER PLATE

(57) The object of the invention is a roller mill with an inter-roller plate for the comminution of grainy minerals, biological materials, grains, heterogeneous and polymer materials, specifically the fine-grained, dry and wet ones, in a working or usable suspension, which includes a plate between the rollers for intensive comminution, characteristic in that the roller mill comminution assembly comprises two rotatable rollers, both of which include an external race, and between which a grating plate is set in a permanent manner, wherein the said comminution assembly is placed in a housing, connected to drive shafts of the mill, and fitted with a hopper and a partition wall to separate the milling product, with each rotatable roller that is intended to compress and grate including an external grating race. The width of clearance *a* between the rotatable grating rollers and the fixed grating plate is adjustable and depends on properties of the comminuted material as well as requirements for the obtained comminution product.

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Description

[0001] The object of the invention is a roller mill with an inter-roller plate intended for the comminution of grainy minerals, biological materials, grains, heterogeneous and polymer materials, specifically the fine-grained, dry and wet ones, in a working or usable suspension.

[0002] An array of design solutions for devices comminuting by dry and wet spatial cutting, in a suspension (called colloid devices), abrasion, trituration, scraping, grinding, milling, and carving have been known. Depending on the type of the comminuted (raw) material and dimensions of the product, these devices are usually called special, precision, colloid, or corundum mills, mixers, homogenisers, or even granulators. Comminution in these devices takes place as a consequence of scissor or inertial cutting with needle, knife, groove, or opening edges, or with an uneven surface being the working implement in discs, rollers, cones, drums affixed in a self-aligning separable or permanent manner. Multiple, single, and double rollers, rings, discs, needles, knives, rollers, or discs, and discs with knives rotate around a fixed axis. Blades of the cutting tool usually take the form of lines or sickles - curves, uneven surface, rectangular rams - and are active in terms of comminution in one or more planes. Subject to operation of blades (projections) of the tool, the input (raw) material or construction material is being cut off piece by piece and directly or indirectly passes through a sieve to a storage vessel for comminution products (troughs, trays, pouches, cyclones, containers, and others). Comminutors of the types mentioned above have been described in the following books: Sadkiewicz K., Sadkiewicz J., Urządzenia pomiarowo - badawcze dla przetwórstwa zbozowa - mącznego. Wydawnictwo Uczelniane UTP, Bydgoszcz 1989. Dmitrewski J.: *Teoria i konstrukcja maszyn rolniczych. T.3.* PWRiL Warsaw 1978; Drzymała Z.: *Badania i podstawy konstrukcji młynów specjalnych.* PWN Warsaw 1992; Koch R., Noworyta A.: Procesy mechaniczne w inżynierii chemicznej. WNT Warsaw 1995; Sikora R.: *Obróbka tworzyw wielkocząsteczkowych.*. Wyd. Żak - Warsaw 1996; Flizikowski J.: Rozdrabnianie tworzyw sztucznych. Wyd. Ucz. UTP in Bydgoszcz 1998; Flizikowski J.: Konstrukcja rozdrabniaczy żywrtosci. Wyd. Ucz. UTP in Bydgoszcz 2005, and others.

[0003] One of the drawbacks and inconveniences of the known design solutions for comminutors and triturators for biological materials as well as heterogeneous and compound after-wear materials is their small efficacy yet high consumption of energy and wear of machine components; high temperature generated in the area of splitting, a need for frequent replacement of cutting parts that often have a large size, and the process being unbalanced, which leads to lower durability of working parts and impacts the dimensional homogeneity of comminution products. It is a consequence of the fact that impulsive contact of working implements: needles, tines with the comminuted material leads to dispersion of matter and energy on the way to the splitting point, which is associated with uneven loads on the driving motor and edges cutting the material with the anticipated and actual degree of fragmentation.

[0004] Temporary nature of the comminuting load, which leads to local decohesion of input material, causes significant increase in the lost energy on account of its impulsive course and, as a consequence, extensive discrepancies in form and geometric dimensions as well as product flow obstruction, loss of efficacy, excessive power requirements and unit consumption of energy, and, above all, intensive wear and the need to replace large components, working assemblies in the form of discs and rollers (drums).

[0005] The aim of the invention is to remove the known drawbacks and inconveniences by designing a mill with an inter-roller plate for the trituration of biological and mineral (lime), heterogeneous and compound materials with a new design of the inter-roller plate assembly for a mill equipped with static components that, together with rollers, are to triturate grainy (raw) materials passing through it.

[0006] The mill with an inter-roller plate for comminution of grainy biological and mineral raw materials as well as heterogeneous and compound materials, which includes a plate between the rollers for intensive comminution by grating as provided for by the invention, is characteristic in that the roller mill comminution assembly comprises two rotatable rollers, both of which include an external race, between which a grating plate is set in a permanent manner, and the said comminution assembly is placed in a housing, connected to drive shafts of the mill, and fitted with a hopper and a partition wall to separate the milling intermediate product, with each rotatable roller that is intended to compress and grate including an external grating race, whilst the width of clearance *a* between the rotatable grating rollers and the fixed grating plate is adjustable and depends on properties of the comminuted material as well as requirements for the obtained comminution product. In an advantageous embodiment, in case of fine comminution, the width of clearance *a* amounts to less than 0.10 mm.

[0007] Owing to relevant features of the rollers and the plate, which are suitably assembled with drive shafts within the housing, working parts are constantly being in contact with the comminuted input material, rotatable rollers - particularly in their external race, with the plate, its external race, and the milled material, set by a separable connection on the shaft relative to each other so that they evenly and effectively grate the input material passing through between them. At the same time the clearances created between the rollers and the plate act as spaces that enable the comminution product to pass through and the possible support of an additional airstream allows the

product to be put out of the comminutor in an aspirational fashion (after the desired value of diameter and specific surface area of the product is attained). On the other hand, the distance between the rotatable grating rollers and non-rotatable grating plate is a multidimensional working gap that affects the degree of fragmentation and other usable process characteristics, with utilisation of the said rotatable grating rollers and the non-rotatable plate enabling intensive grating of the input material as well as fast and easy replacement of implements after they get worn out.

[0008] Purposefully invoked phenomena outside the roller area, and in particular the contact with the grating plate, cause an increase in efficacy and lower unit energy consumption, concomitantly eliminating excessive wearing of large working parts, rotor casings, or stators.

[0009] One of the technical advantages of the invention is the elimination of single comminuting components such as various needles, pins, or rods, by introducing integrated plate and roller components whose cutting, grating, processing, and wear properties are better that those of the parts listed above. In addition, the shape, relative movement, and form of the rollers in external (peripheral) races and the fixed plate ensure good conditions for moving the input material in the area of product preparation, comminution, and ejection, directing and orienting particles in space to constantly ensure contact of the grating races with grainy minerals and raw materials contained in air, liquid, or suspension (e.g. in biological water) subject to comminution, and thereby ensuring even, mild course of their deformations and displacements during comminution to obtain the set product particle size, for instance - less than 10 μm (colloid milling) or, with another clearance setting - less than 0.10 mm (fine milling). These phenomena have a positive impact on efficacy, they lower power requirements and unit energy consumption, and make the use of large structural components of comminutors redundant by their adaptation to the external races being worn as working parts that are easy to replace, thus comprehensively improving economic characteristics and environmental impact of processing.

[0010] The mill of the invention has been shown in the figures in a schematic manner, Fig. 1 shows the mill with an inter-roller plate in vertical view/section across the working area, in a plane parallel to the axes of the working rollers, Fig. 2 shows a cross-section of the mill in the vertical plane A-A, perpendicular to axes of the working rollers, Fig. 3 shows a side view of the mill in the vertical cross-section B-B.

[0011] The mill of the invention has been presented in greater detail in an embodiment. The mill with an inter-roller plate includes a comminution assembly, which is composed of rotatable, contra-rotating working rollers 2, both of which are fitted with an external race, between which a fixed plate 3 is symmetrically/asymmetrically set to act as a partition inter-roller wall, with the said assembly being placed in housing 9, whose rollers are connected to drive shafts 4 and which is equipped with a hopper 1 and a milling product container 7, whilst the width of clearance a between the rotatable rollers and the grating plate is adjustable and depends on properties of the comminuted material as well as requirements for the obtained target comminution product, with the said width of clearance **a** being smaller than 0.10 mm for fine comminution in the presented embodiment.

[0012] The hopper 1 feeds the product split by partition walls to comminution/milling spaces of the rotatable roller/rollers 2 via the non-rotatable grating plate 3, which performs grating in cooperation with the rotatable rollers 2. The plate is permanently, separably fixed in the housing by bolt fasteners 8 serving the purpose of retaining the non-rotatable plate 3. The product of milling leaves the working area and the separating clearance, giving mass of the product in time - milling efficacy by weight.

[0013] Two electric motors 5 were used to drive the mill with an inter-roller plate, one for each working roller. The motors drive rotational motion of the rollers 2 through combined belt and gear transmission units 6 together with a control system, with the drive shaft and the rollers being set through a bearing system in the housing 9.

[0014] Operation of the mill with an inter-roller plate involves the hopper 1 feeding grain to the mill through partition walls that feed and stabilise the comminution spaces as well as initially separating the input grain bulk in the milling spaces. The rotatable working rollers 2 are fixed on working shafts 4 having axes of rotation that are parallel to each other, with their bearings in the housing 9. The working rollers 2 rotate with rotational speed n_z and their peripheral surface is grooved to a set roughness as provided for by the principle of operation of open-closed roller mills. Placed inside is a non-rotatable plate 3 grating on its own side surfaces and on those of the rollers 2. The drive shafts 4 are used to transmit torque from the motors 5 through combined belt and gear transmission units 6 onto the rollers 2. The product is put out through the central assembly separating the bulk of the milling product. The mill is founded on a base 7 and driven by motors with a control system via belt and gear transmission units powering the rotational motion of the rollers 2. The motion is facilitated by a bearing system in the housing 9.

[0015] Working clearances **a** between the rotatable rollers 2 and the non-rotatable grating plate 3 intensify the milling process by relative motion arising from a driving force of friction between the race of the rotatable rollers 2 and the plate 3.

[0016] The presented mill with an inter-roller plate as per the essential elements of the invention is not exhaustive of all possibilities of its embodiment. This detailed description of an advantageous embodiment and its mode of operation must not be construed as limiting the overall inventive idea described in the core section of this description.

Claims

1. A mill with an inter-roller plate for the comminution of grainy biological, mineral, heterogeneous, and compound materials, containing a roller-based comminution assembly wherein the said comminution assembly is placed in a housing 9 and connected to drive shafts 4 of the mill to constitute, together with the inter-roller plate, a comminution assembly that comprises two rotatable grating rollers 2, both of which include an external race fitted, and between which a grating plate 3 is set at a specific distance that constitutes clearance (a), with the said comminution assembly being fitted with hopper 1 and partition walls in working spaces for separation of the milling product, ensuring continuous operation.

2. The mill of claim 1 wherein width of the clearance (a) between the rotatable rollers 2 and the grating plate 3 is adjustable depending on properties of the comminuted material and requirements for the obtained comminution product.

3. The mill of claim 1 or 2 wherein the width of the clearance (a) < 0.10 mm.

Fig.1

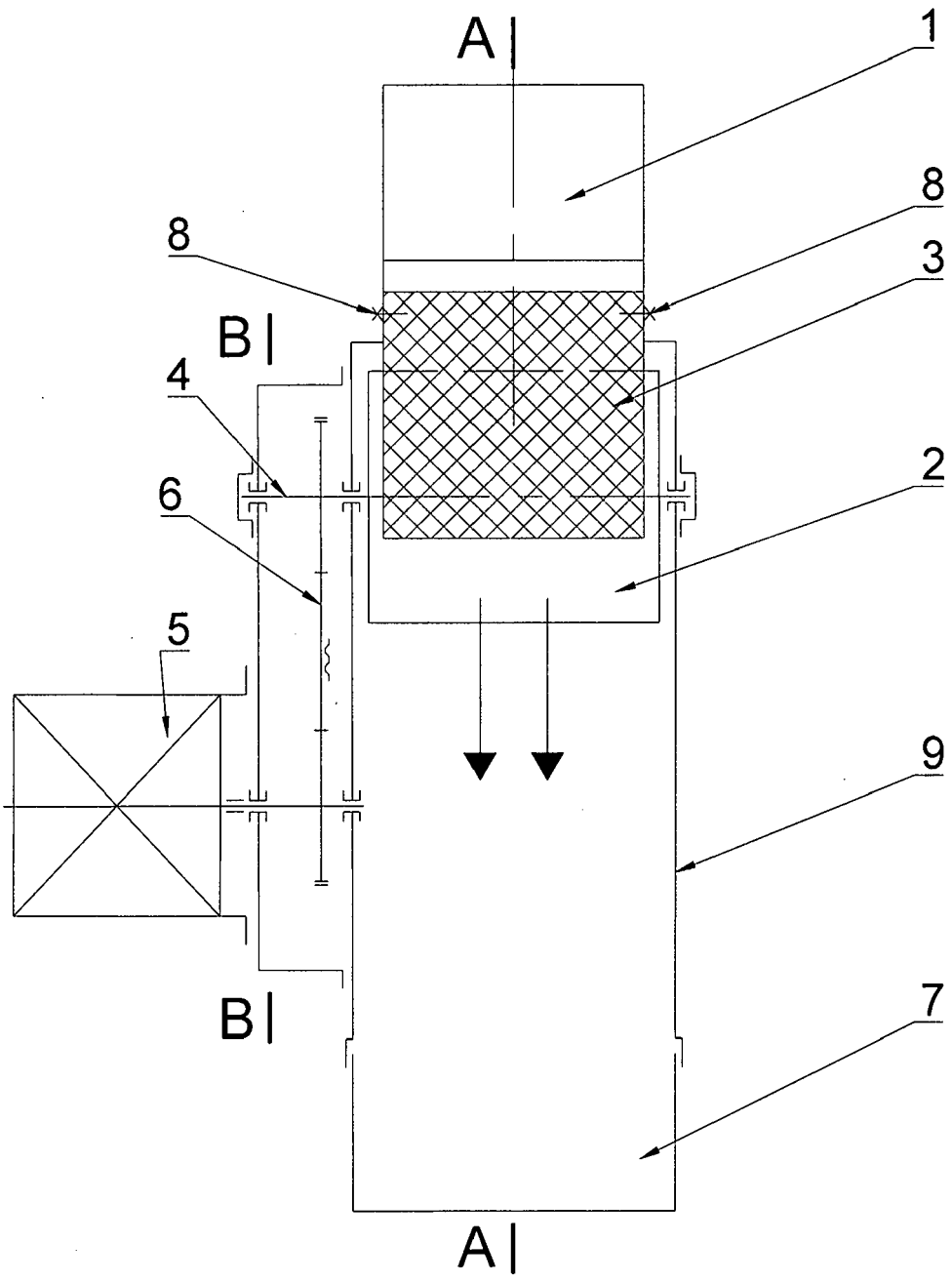


Fig.2

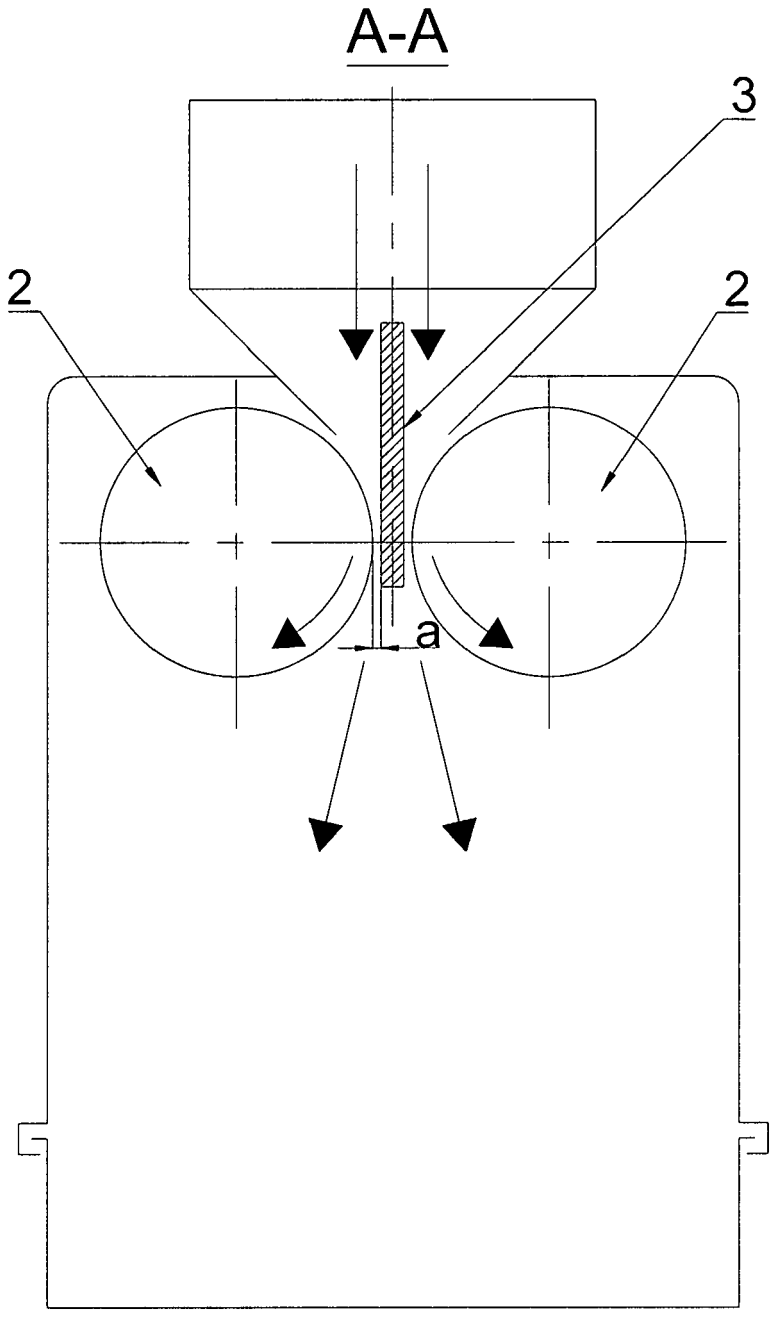
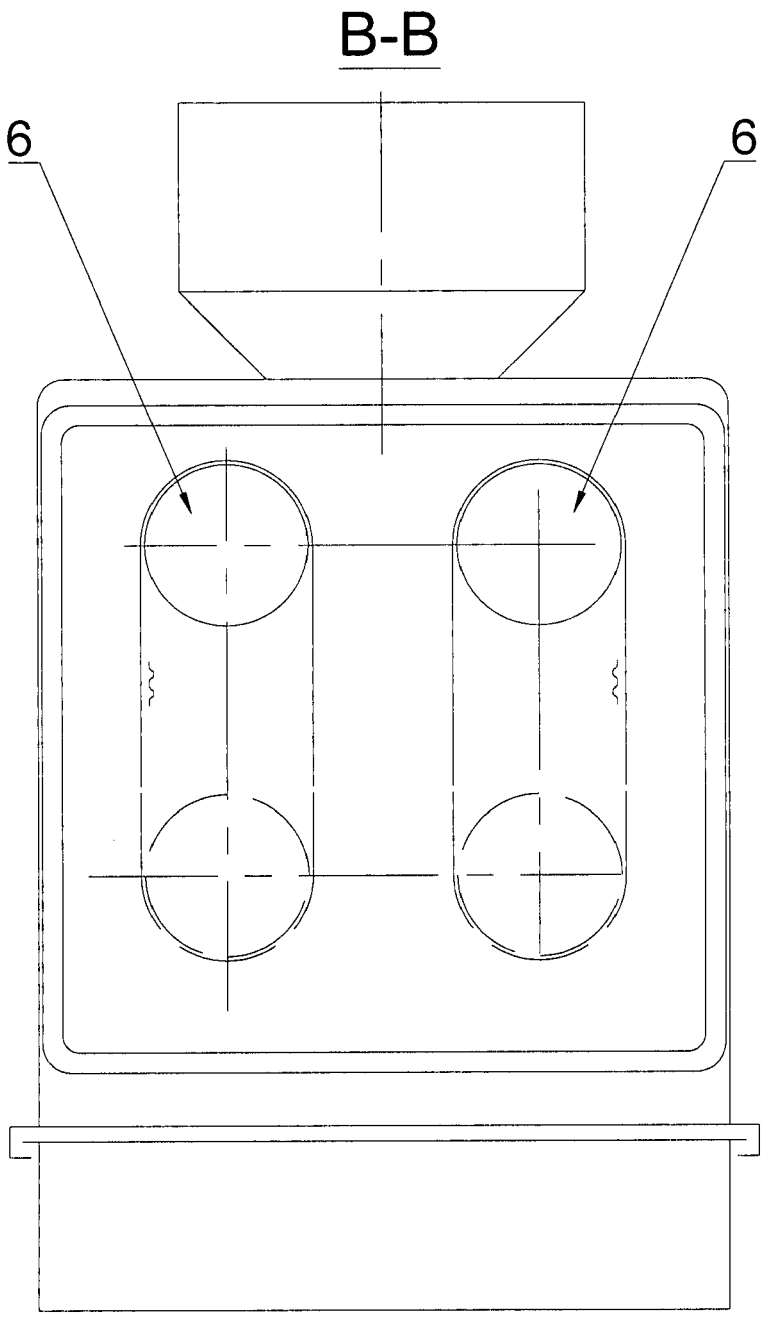


Fig.3



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EUROPEAN SEARCH REPORT

Application Number
EP 18 46 0051

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	DE 645 854 C (HUMBOLDT DEUTZMOTOREN AG) 4 June 1937 (1937-06-04)	1	INV. B02C4/02 B02C4/12 B02C4/26
A	* page 1, column 2, lines 46-54; figures 1,2 * * page 2, column 1, line 10 - column 2, line 67 *	2,3	
A	US 4 205 951 A (SOLLICH HELMUTH [DE]) 3 June 1980 (1980-06-03) * page 1, column 1, line 57 - column 2, line 22; figures 1-4 * * page 2, column 2, line 51 - column 3, line 51 *	1	
A	US 3 491 403 A (SCHEE BERNARD L A VAN DER) 27 January 1970 (1970-01-27) * page 2, column 1, line 63 - column 2, line 56; figures 1-4 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

B02C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 January 2019	Iuliano, Emanuela

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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T : theory or principle underlying the invention
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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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22-01-2019

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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