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(54) **MATERIAL BREAKING DEVICE**

(57) In a material milling device the mill chamber has a form of a cylinder, to the exterior of the lid thereof an aerodynamic turbine is connected. Inside of the mill chamber there is an aerodynamic classifier connected to the lid thereof. Thereby on the exterior side of the aerodynamic classifier there are vertical holes of definite shape made at a definite angle with respect to the airflow. Also inside of the mill chamber a coated ring is positioned. Thereby the device has at least one or more atomizers for pressurized air supply, which pass into openings of a nozzle of a definite shape provided on the ring. Thereby the atomizers are connected to the casing of the mill chamber at an angle with respect to a vertical axis and at an angle with respect to a cylindrical injector for supply of material and pressurized air. The proposed device provides for ultra-thin up to nanosizes milling of viscous and other materials.

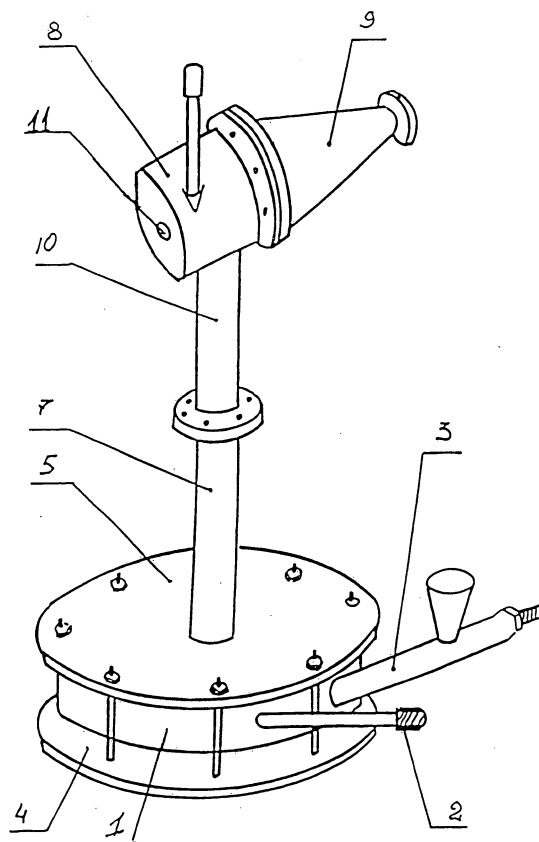


Fig.1

Description

Field of invention

[0001] A material milling device belongs to the designs of mills and is designed in particular for ultra-fine milling of viscous and other materials.

Description of the prior art

[0002] For ultra-fine milling of materials in various fields of industry jet mills are used as one of the basic types of equipment. There are several types of jet mill constructions, that differ by the form of mill chamber and number and mode of the jet nozzles location. But the principle of their functioning is the same: material to be ground is sped up by jets of an energy carrier and is ground by particle-on-particle impact or collision with a fixed barrier. For example, a counter flow jet mill having a mill chamber, a nozzle for feeding of an energy carrier and a booster pipe, where overheated steam, pressurized air, gas or jet engine exhausted gases are used as energy carriers is known (Akunov V.I. Jet mills. - M.: Mashgiz, 1962. - p. 111-113). In mills of this type the process of milling is not carried out sufficiently enough.

[0003] Usage of a high-pressure compressor as energy carrier does not allow reaching high acceleration speeds of particles of the material and respectively high efficacy of the milling processes.

[0004] A jet-type mill consisting of a flat type mill chamber limited by upper and lower lids and a multifaceted-shaped sidewall is also known (Certificate of authorship USSR No. 1423156, Cl. B 02C 19/06, 1987). Here gas flow in the grinding space is generated by peripheral supersonic nozzles that are equally spaced along the perimeter of the sidewall and are inclined with respect to its surface. Peripheral nozzles for gas energy carrier feeding allow the generation of a high speed jet stream near the sidewall of a mill chamber. But milling of the material here occurs in vortex flows in the zone of interaction /intersection/ of blasted streams and has local character. As is known, the gas speed in such zones of reciprocal motion is always lower than in a carrier flow, which leads to the significant reduction of the grinded material speed. Besides, in breaking points of the forming sidewall of the mill chamber there occur pressure drops that also lead to speed reduction, which will always be lower than sonic or supersonic ones. So, known designs do not allow the particles of ductile and super hard material to accelerate to the speeds that are sufficient for its effective milling.

[0005] The closest technical solution is a milling device presented as an aerodynamic jet mill designed, in particular, for soft milling of the materials (Patent USSR No. 1582977). The device consists of a chamber for grinding to which an injector and manifold are connected. In the known device grinded material enters the mill chamber in a form of gas suspension, which limits the speed of the flow fields. Milling here occurs in two phases, jet-type

in the injection devices and vortex-type in cylindrical mill chamber. After pre-cutting in the injection devices the material is conveyed to the mill chamber with loss of energy as the delivery of gas suspension through cylindrical channel also limits its speed, which cannot reach sonic or supersonic speed. This construction design is intended for soft milling.

[0006] The known solution accepted as the closest analogue can not ensure an acceleration to a high speed in the known device that leads to a reduction of the soft milling productiveness, including materials of super hard and viscous metals for which soft milling having this construction design is impossible, and more over high productiveness and purity of the materials are not obtained after the milling.

Description of the invention

[0007] It is an object of the invention to improve a milling device by enhancement of its technical capabilities, in which the availability of an aerodynamic classifier provides for the directionality and controllability of the feed airflow to the coated ring with a cutting effect and at the same time vortex formula in the mill chamber is changed. Technical result of the proposed device is to obtain viscous and other materials ground to nanoparticles as well as to reach high productiveness and purity of the ground materials.

[0008] The object is reached by the proposed device having a cylindrical mill chamber wherein to an exterior surface of the lid thereof an aerodynamic turbine is connected, inside of the mill chamber an aerodynamic classifier is positioned and connected to the lid thereby on the exterior of the aerodynamic classifier vertical holes of definite shape are provided inclined at a definite angle with respect to the air flow. Also inside the mill chamber a coated ring is positioned, thereby the device has at least one pressurized air feeding atomizer which passes into the opening of the nozzle of a definite shape provided on the ring wherein the atomizers are connected to the mill camera casing inclined with respect to the vertical axis and inclined with respect to the cylindrical injector for pressurized air and feed stream.

[0009] Several pressurized air atomizers can be implemented.

[0010] Implementation of the aerodynamic classifier in a form of a cylinder with the thickening at its lower part in the central part of which there is a threaded opening allows the fastening of the aerodynamic classifier to the lower lid of the mill chamber.

[0011] Implementation of the slot-shaped vertical holes on the aerodynamic classifier inclined at an opposite sharp angle with respect to the airflow allows the control of the speed of the feed stream and to withdraw ground material from the feed stream.

[0012] Implementation of the round vertical holes on the aerodynamic at an opposite sharp angle with respect to the airflow allows control of the speed of the feed

stream and to withdraw grinded material from the feed stream.

[0013] The angle at which atomizers are connected to the mill chamber casing with respect to the vertical axis can be $0^\circ - 90^\circ$, likewise the angle at which atomizers are connected to the mill chamber casing with respect to the cylindrical injector can be $0^\circ - 90^\circ$ and provides for directionality of the high speed feed stream to the cutting part of the coated ring /in case of milling soft, viscous materials/. Change of the feed angle of the accelerating and cutting atomizers provides for the retraction of the high-speed feed stream from the coated ring and convey milling zone to the area between the exterior side of the classifier and the inner side of the coated ring that allows for grinding abrasives and special hard materials /milling as a result of impact/. Feed angle of accelerating and cutting atomizers is set up individually depending on the properties of the ground material.

[0014] Size of an angle is defined experimentally. It is optimal from the point of view of avoiding the presence of foreign body impurities and more over change of the angle leads to the change in the productiveness.

[0015] Holes of the ring nozzles can be slot-shaped, which allows a significant increase in the volume of milling in the cutting zone.

[0016] Holes of the ring nozzles can be round-shaped, which allows a significant increase in speed and directionality in the milling zones.

[0017] Coating of the ring is done by means of diamond dusting or other technologically acceptable material with cutting properties.

Brief description of drawings

[0018]

Fig. 1 shows a general view of the material milling device with one atomizer and aerodynamic passive turbine.

Fig. 2 - general view of the mill chamber

Fig. 3 - ring with a slot-shaped nozzle holes

Fig. 4 - ring with a round-shaped nozzle holes

Fig. 5 - aerodynamic classifier

Fig. 6 - general view of the equipment for material milling with several atomizers and aerodynamic passive turbine.

Fig. 7 - connection of atomizer to the casing.

Preferred embodiments of the invention

[0019] Device consists of the mill chamber 1 to which atomizers 2 and injector 3 are connected. Mill chamber 1 is a cylindrical reservoir with lids 4, 5. Atomizer 2 is connected to the chamber casing and passes into the opening 6 of definite shape nozzle on the ring 17. Device has at least one atomizer or more. Atomizers can be distributed in several levels along horizontal axis. Fig. 3 shows a ring with slot-shaped opening of the nozzle. Fig.

4 shows a ring with round opening of the jet nozzle. Injector 3 has a cylindrical form. To the exterior part of the lid 4 of the mill chamber 1 a manifold 7 is connected, to which an aerodynamic passive turbine is coupled. Aerodynamic passive turbine is made as a cylinder 8 that passes into the cone 9. On the sidewall of the cylinder there is a junction 10 with manifold 7, which is the inlet for the air-feed mass and is positioned tangentially to the horizontal axis. Inside of the cylinder 8 there is a spindle 11 that is connected by threaded connection to the exterior of the lid of the cylinder 8 at one end and has cone-shaped form at its other end and by this cone it is directed to the cone part of the turbine casing. The shaft is fixed, on the shaft there is a twelve-vane impeller 12 that is rigidly connected to the shaft. Atomizer 2 is connected to the casing of the mill chamber 1 at an angle of $0^\circ - 90^\circ$ with respect to the vertical axis and at an angle of $0^\circ - 90^\circ$ with respect to the injector which makes an angle of pressurized air feed. Device can have several atomizers.

[0020] Inside, in the centre of the mill chamber 1, aerodynamic classifier 13 is positioned, which is connected by threaded connection 14 to the lid of the mill chamber 1. Aerodynamic classifier 13 is a cylinder exterior side of which equals to the height of the mill chamber 1, also on the exterior there are vertical holes 15 of definite shape - for example, slot-shaped or round-shaped holes - inclined at specific angle with respect to the airflow. Specific angle can be opposite with respect to the airflow. Lower part of the aerodynamic classifier 13, namely cylinder, has a significant thickening in the centre of which there is a threaded opening 16. Inside of the mill chamber 1 there is a ring 17 with coating 18, besides this coating performs cutting function for milling the material. The coating 18 of the ring 17 is done by means of diamond dusting or other technologically acceptable material having cutting properties. The size of the particles is chosen according to the requirements for the grinded material. Fig. 6 shows availability of several atomizers /atomizer is shown under number 2, as well as in other figures/ that are connected to chamber casing and pass into the opening 6 of the definite shape nozzle made on the ring 17. Connection of the nozzle to the casing is shown at fig.7

Device functions in the following way:

[0021] Pressurized air is delivered to the chamber 1 for milling by pressurized air, through injector 3 is accelerated in the mill chamber 1 by means of pressurized air stream blasted into the mill chamber through atomizer 2. In the mill chamber 1 feed stream of the material is accelerated due to volume contraction, in which the material is ground in the mill chamber 1 by aerodynamic classifier 13. Centrifugal forces, that emerge, direct the particles flux of the material to the ring 17 with coating 18, which is performing the cutting function. Ground particles due to loss of centrifugal forces are taken by the reverse stream of aerodynamic classifier 13 and are conveyed through manifold to the cyclone where the material is

separated from air. As a result of change of feed angles degree of pressurized air through the atomizers 2 of the mill chamber 1, grinding of some materials can be carried out due to particle-on-particle impact directed by the openings of atomizers. Aerodynamic turbine takes down back pressure in the mill chamber and increases pressure in the cone part of the turbine which increases centrifugal force of the ground material and as a result particles of the material takes the form of pellets.

Industrial use of the invention

[0022] Material milling device can be used in different fields of industry including mining, civil engineering, chemical industry, metallurgy, agriculture, food industry and provides ultra-thin up to nanosizes milling of viscous and other materials. High productiveness up to several tons per hour is obtained and purity of the materials after milling excludes presence of impurities.

Claims

1. Material milling device with a mill chamber, an injector and a manifold connected to the chamber, **characterized by** a cylindrical form of the mill chamber, wherein an aerodynamic turbine is connected to the exterior of the lid thereof, inside of the mill chamber an aerodynamic classifier is positioned and connected to the lid, wherein at the exterior of the aerodynamic classifier there are vertical holes of a definite shape provided at a definite angle with respect to an air flow; inside of the mill chamber there is further a ring with a coating whereby the device has at least one or more atomizers for supply of pressurized air, which pass into the opening of a nozzle of a definite shape provided on the ring wherein the atomizers are connected to the mill chamber casing at an angle with respect to a vertical axis and at an angle with respect to a cylindrical injector for supply of material and pressurized air. 25 30 35 40
2. Device according to claim 1, **characterized by** the possibility of providing several atomizers for supply of pressurized air. 45
3. Device according to claim 1, **characterized by** an aerodynamic classifier that has a cylindrical form with the lower part having a thickening, in the centre of which there is a threaded opening. 50
4. Device according to claims 1 and 3, **characterized by** vertical holes on the aerodynamic classifier that are slot-shaped and provided at an opposite sharp angle with respect to the airflow. 55
5. Device according to claims 1 and 3, **characterized by** vertical holes on the aerodynamic classifier that

are round-shaped and provided at an opposite sharp angle with respect to the airflow.

6. Device according to claims 1 and 2, **characterized in that** the angle at which the atomizers are connected to the casing of the mill chamber with respect to the vertical axis can be from 0° to 90°. 5
7. Device according to claims 1 and 2, **characterized in that** the angle at which the atomizers are connected to the casing of the mill chamber with respect to the cylindrical injector can be from 0° to 90°. 10
8. Device according to claim 1, **characterized by** slot-shaped jet nozzle holes. 15
9. Device according to claim 1, **characterized by** round-shaped jet nozzle holes.
10. Device according to claim 1, **characterized in that** the ring coating is made of diamond dusting or any other technologically acceptable materials having cutting properties. 20 25 30 35 40 45 50 55

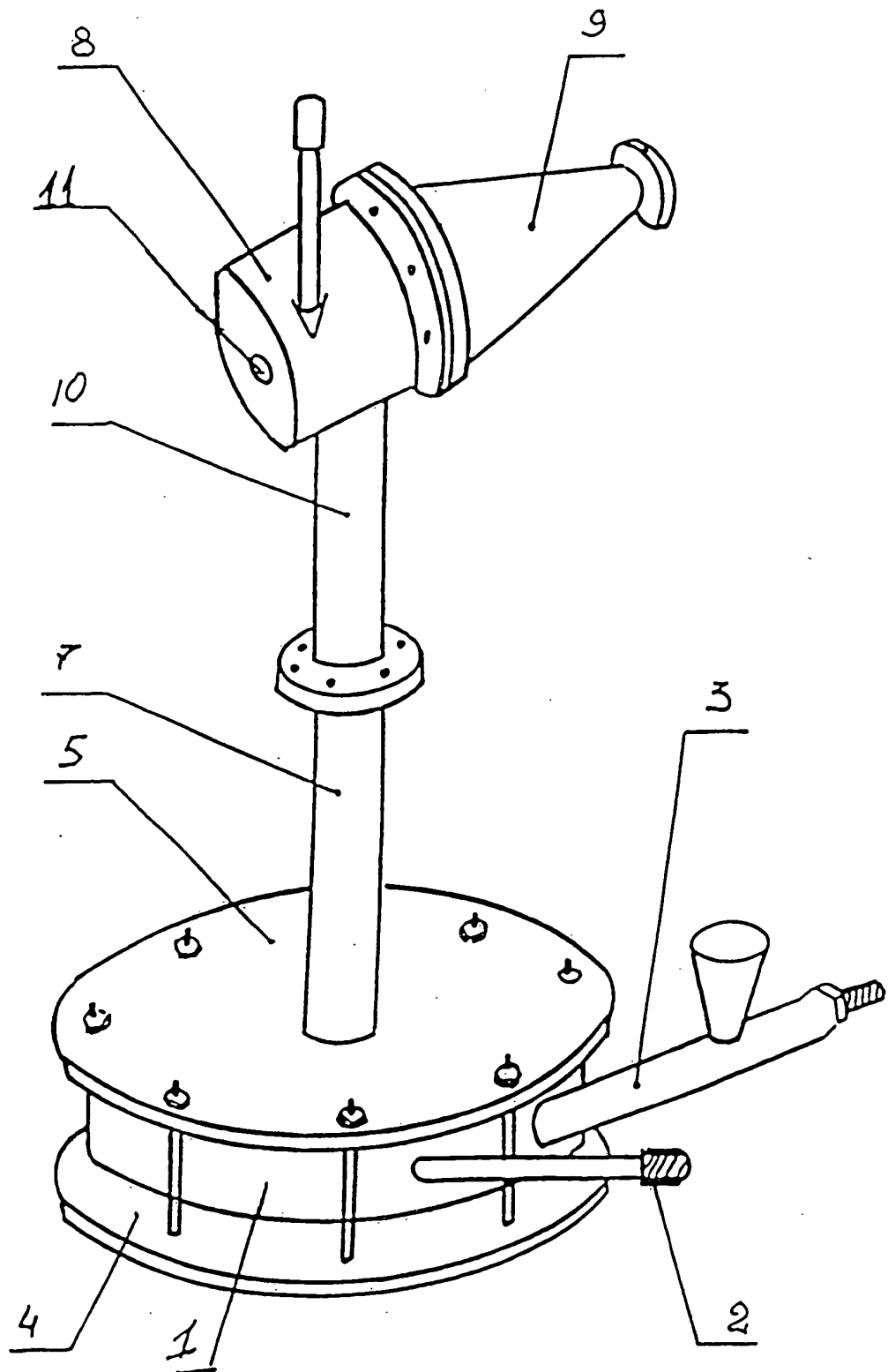


Fig.1

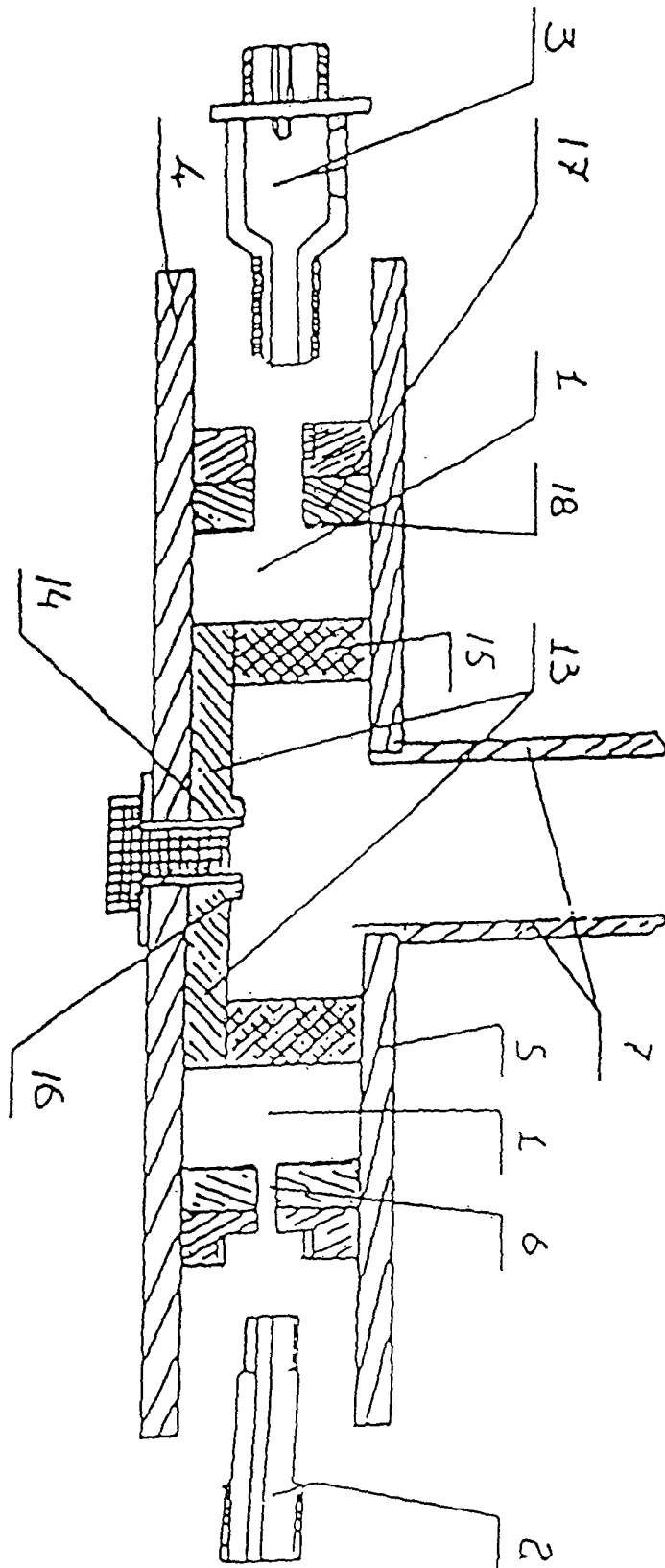


Fig.2

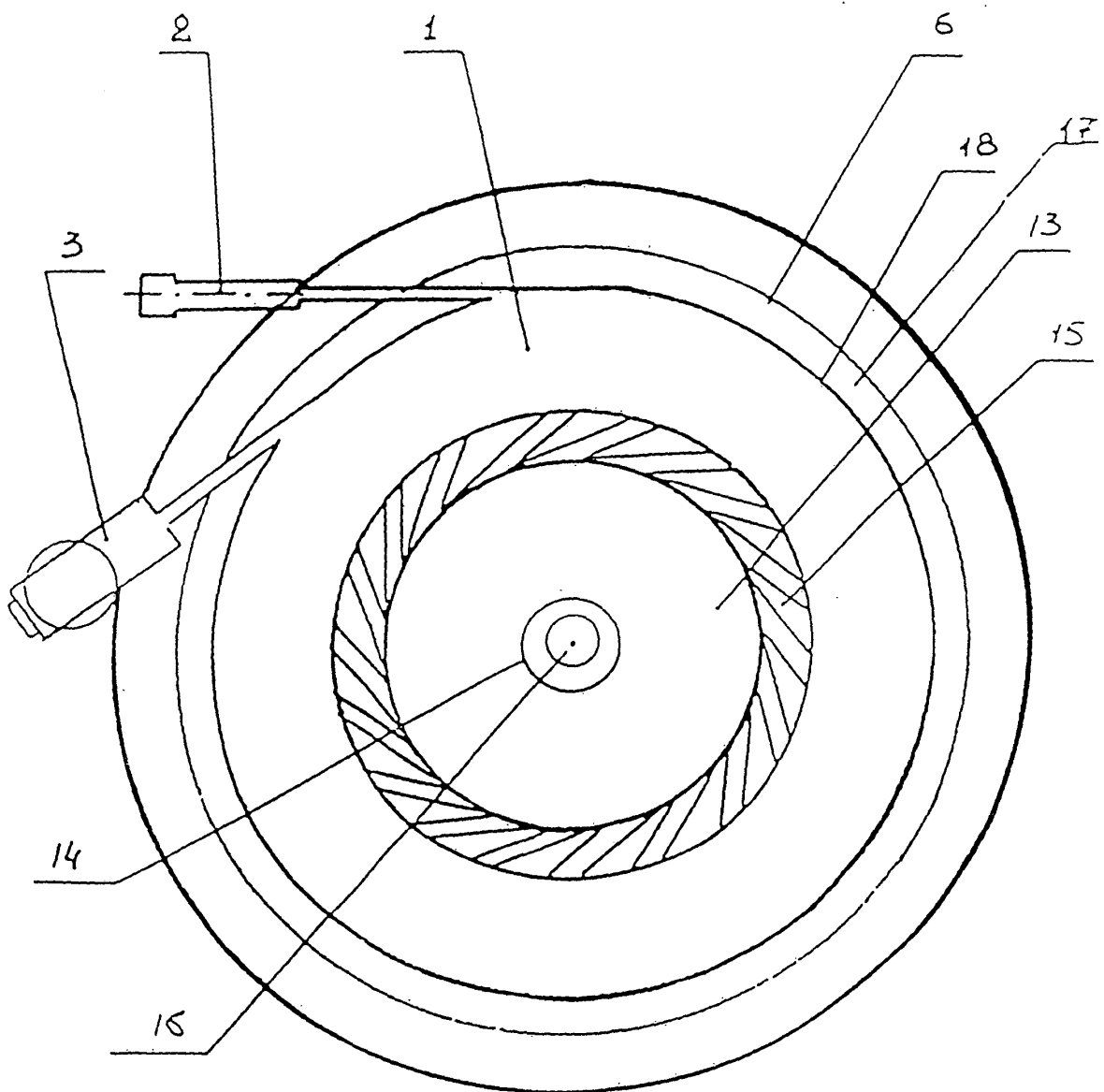


Fig.3

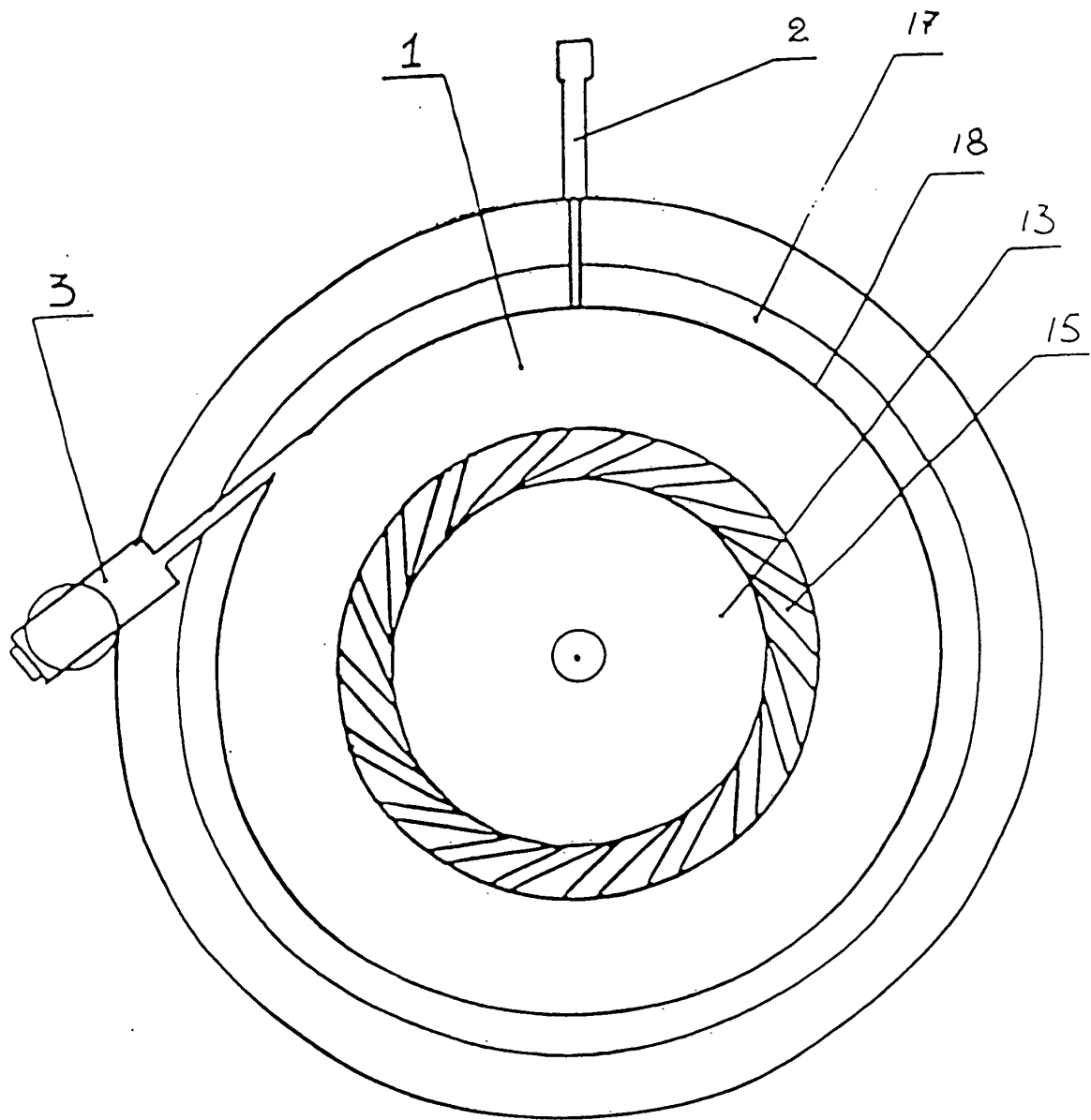


Fig.4

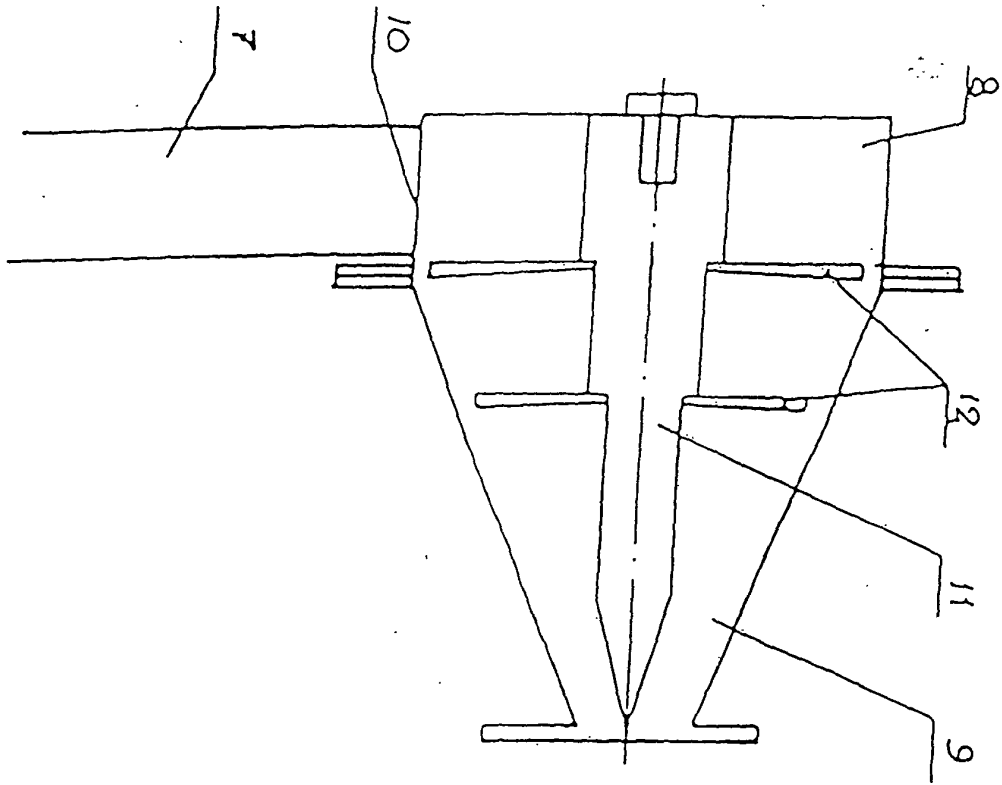
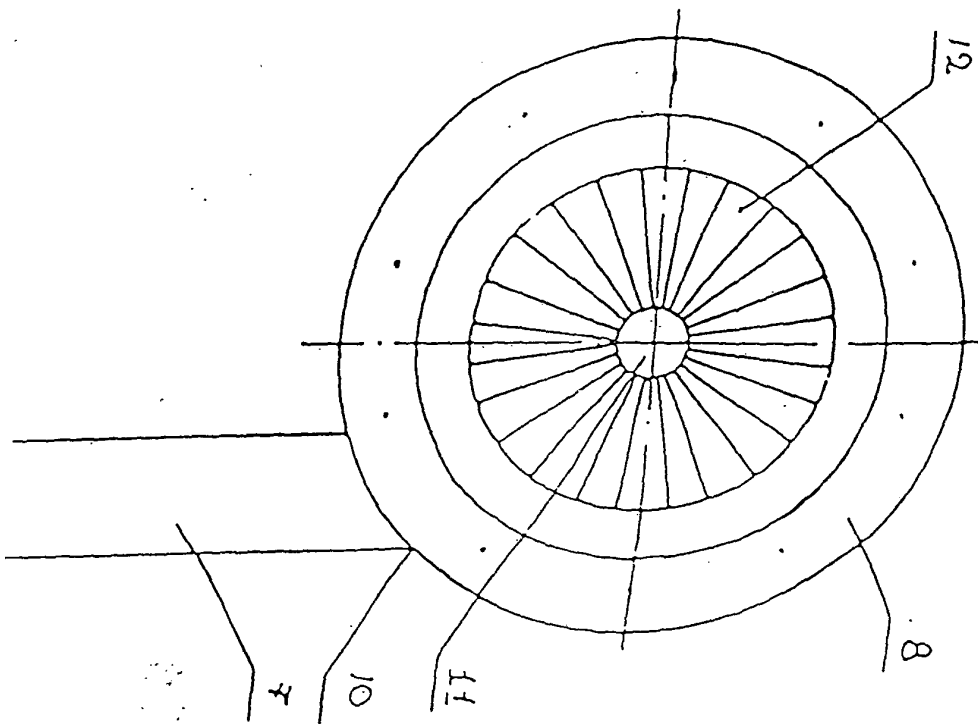


Fig.5



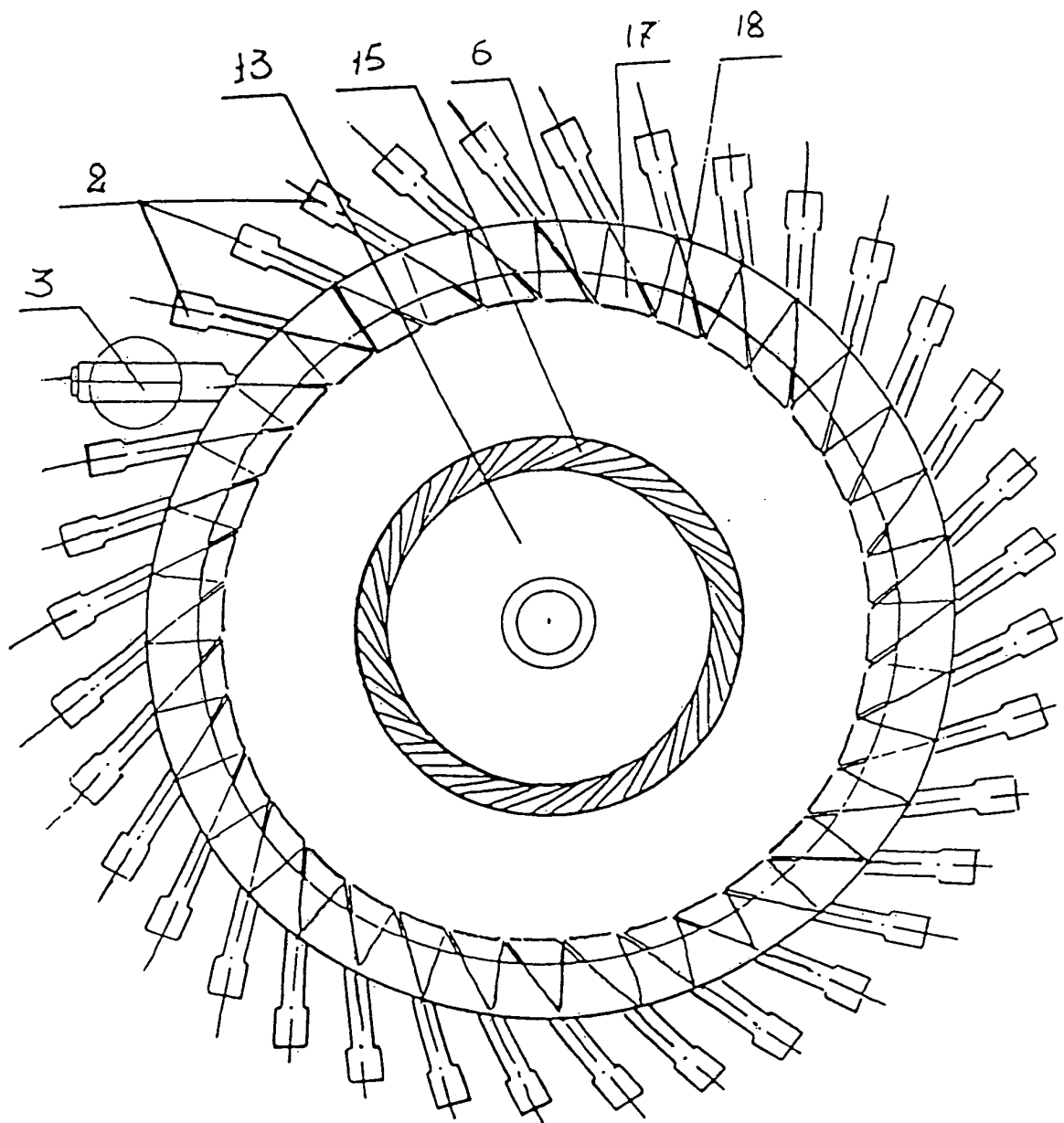


Fig.6

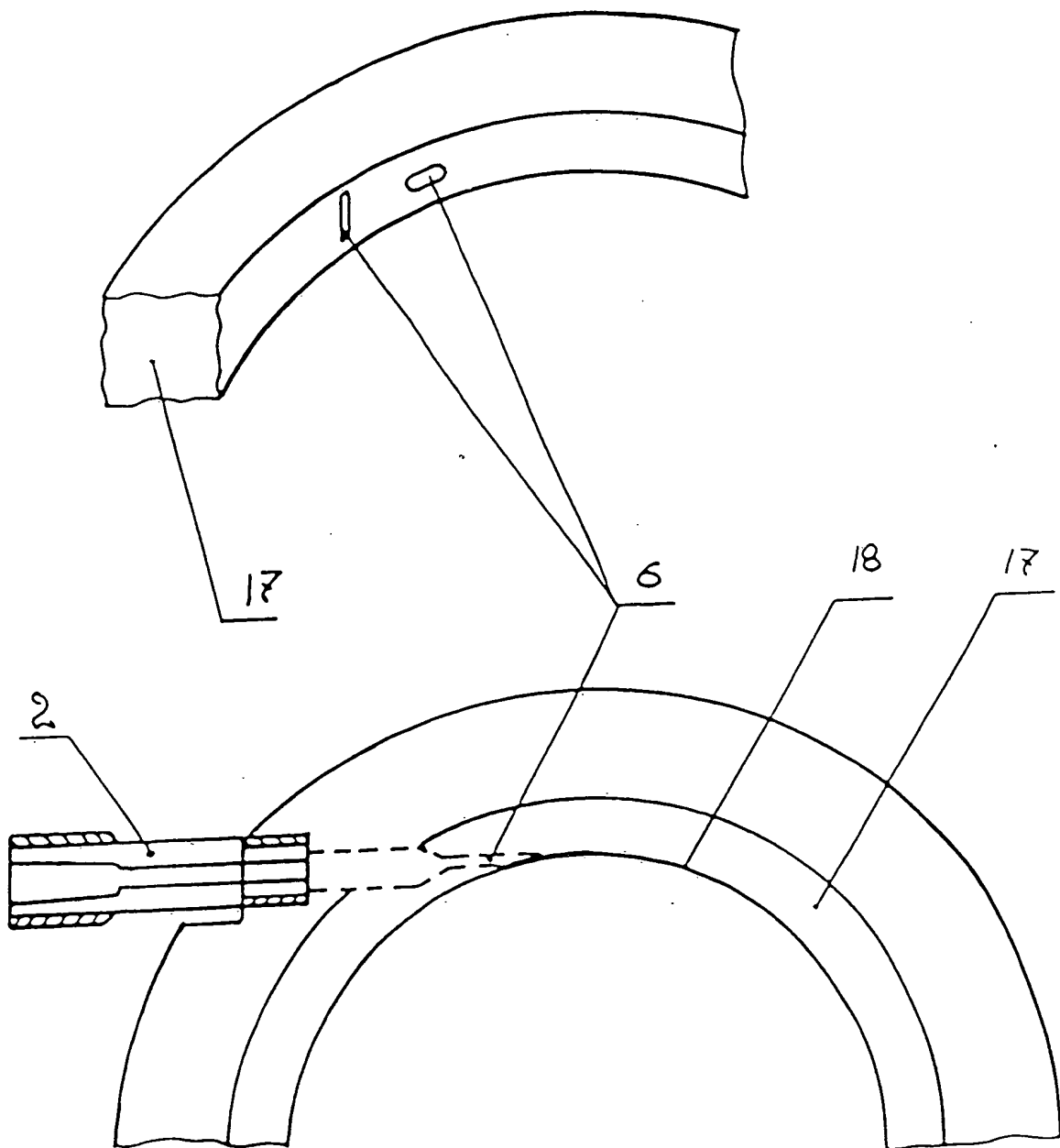


Fig.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/UA 2004/000032

A. CLASSIFICATION OF SUBJECT MATTER		
B02C 19/06		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
B02C 13/00-13/31, 18/00-18/44, 19/06, 19/12, B28C 1/14-1/18, E01C 19/05		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU 1582977 A3 (MADIYAR ALJUMINIUMIPARI TREST), 30.07.90	1-10
A	SU 886985 A (GOSUDARSTVENNY VSESOJUZNY NAUCHNO- ISSLEDOVATELSKY INSTITUT TSEMENTNOI PROMYSHLENNOSTI), 07.12.81	1-10
A	RU 2100082 C1 (SHOSTAK VIKTOR VLADIMIROVICH et al.), 27.12.97	1-10
A	US 4611764 A (CHINOIN GYOGYSZER ES VEGYESZETI TERMEKEK GYARA RT.) 16. 09. 1986	1-10
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search		Date of mailing of the international search report
17 September 2004 (17.09.2004)		07 October 2004 (07.10.2004)
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