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(54) METHOD FOR SEPARATING A LOOSE MIXTURE IN A FLOWING MEDIUM AND DEVICE FOR CARRYING OUT SAID METHOD

(57) A method for separating a loose mixture in a flowing medium involves gravity feeding of particles, subjecting said particles to an aerodynamic, monotonically increasing action at an acute angle to the vertical by means of a cascade of planar jets and outputting the separated fractions. Prior to acting on the particles, each jet is expanded until it merges with the adjacent jets. Two differently sized circulation zones, upper and lower, are created in a interjet space of the adjacent jets, upstream of the merging point. Initial expansion is carried out continuously and unidirectionally - upwards only, to form a stable lower circulation zone. The upper circulation zone is formed periodically by the self-oscillation of the boundary where adjacent jets merge, both along and transverse to the direction of movement of the combined flow. The sizes of the upper circulation zone, at its maximum, do not exceed the sizes of the lower circulation zone. The claimed device comprises: a hopper having a vibrating chute; a multi-jet generator disposed therebelow; and rigid walls which are arranged at an angle to the vertical and which are abutted at an angle of more than 90° by additional walls. The generator is surrounded by lateral walls having fraction collectors and is connected to an air supply. The additional walls together with their adjacent pairs of walls form slot-like gaps. The width of the additional walls is at least seven times greater than the width of the adjacent gaps and is at least twice the width of the adjoining rigid walls.

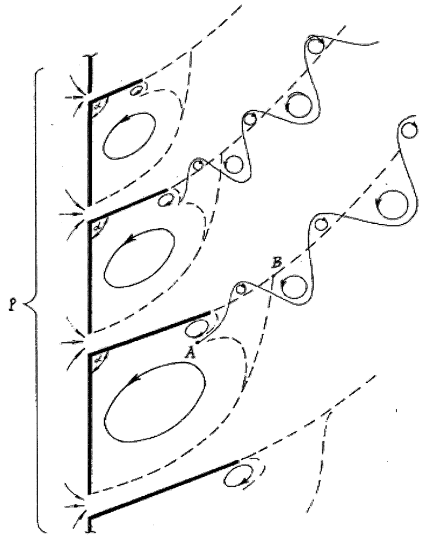

Fig. 2

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Description

Field of the invention

[0001] The invention relates to methods and devices for air separation of loose materials and may be advantageously utilized in agriculture for purification and sorting of seed of cereal, grass and other crops, at breeding stations, at farming enterprises, in flour and provender milling, as well as in production of building materials, in food, chemical, coal industry and in other sectors of national economy.

Prior art

[0002] The prior art discloses a method for separating a loose mixture in a flowing medium and a device for carrying out said method, which essence lies in the following. The method for separating a loose mixture in a flowing medium involves gravity feeding of particles, subjecting said particles to an aerodynamic, monotonically increasing action at an acute angle to the vertical by means of a cascade of planar jets, and outputting the separated fractions, wherein the action by means of the cascade of planar jets occurs in the mode of a free alternating forced scanning with the increase of the amplitude and the scanning angle. The device for carrying out said method comprises a hopper having a vibrating chute, a jet generator disposed therebelow with planar nozzles arranged one below another and at an acute angle to the vertical, their cross-section, pitch and position angle increase from top downward, wherein the generator is coupled to a pressurized air supply and surrounded by lateral walls, while fraction collectors are arranged below the nozzles [see pat. of Ukraine No. 45881 in the class B07B 4/02 published on 15.04.2002 in the Bul. 4].

[0003] A main disadvantage of the known separation method lies in a low quality of separation of the loose mixture into fractions, particularly, particles having a significant difference in weight and density. The essence of this disadvantage lies in the following: the alternating and free operation mode of the cascade of jets imminently leads to a periodic, instable over time and space occurrence of pressure and exhaustion zones accompanied by appearance of direct and reverse flows. In the zone of reverse flows there occurs a drawing of particles (especially the light ones) into a movement that is reverse to a direction of the main flow that leads to a partial mixing of the already separated material. The instability of this effect in time finally leads to a discoupling (breakage) of the cascade of air jets in any random point that leads to a failure of generation of an overall air flow, thereby significantly reducing the separation quality. A disadvantage of the known device lies in an imperfection of a structure of the generator of the cascade of air jets, in particular, its nozzles, which structural design cannot eliminate the occurrence of the reverse air flows in a separation chamber that leads to the reduction of the separation quality.

[0004] Also, there are known a method for separating a loose mixture in a flowing medium and device for carrying out said method, which technological and structural essence lies in the following. The method for separating a loose mixture in a flowing medium involves gravity feeding of particles of the mixture, subjecting them to an aerodynamic, monotonically increasing action at an acute angle to the vertical by means of a cascade of planar jets, and outputting the separated fractions, wherein prior to subjecting the particles of the mixture to the aerodynamic action, a flow of each air jet is switched to a mode of a developed turbulence by means of expanding these jets along the vertical until they merge with each other with an eagre form of the flow or close thereto and creation, in the beginning of each interjet space of all adjacent jets, of not less than two differently sized circulation zones. The device for carrying out the suggested method for separating a loose mixture in a flowing medium comprises a hopper having a vibrating chute for gravity feeding the mixture to the separation zone, a jet generator disposed therebelow with nozzles are arranged one below another and at an acute angle to the vertical, the nozzles having rigid walls abutting to them from the top along the entire width, as well as a pitch and an arrangement width of the nozzles increase from top downward, and the generator is coupled to an air supply for supplying a pressurized air thereto and surrounded by lateral walls, which simultaneously form a separation chamber having fraction collectors arranged therebelow. Furthermore, the width dimension of the rigid wall is not less than three height dimensions of the cross-section of the abutting nozzle, and a ratio of arrangement pitch of the nozzles to the height of the cross-section of the upper nozzle relative thereto is not less than four [see the International application No. WO2010056220 in the classes B07B 11/00, B07B4 /02, B07B 4/00, published on 20.05.2010].

[0005] A main disadvantage of the known method for separating a loose mixture in a flowing medium lies in its low performance that is predefined by an insignificant intensity of the separation process. Firstly, it is caused by technological limitations in terms of provision of the turbulence mode, namely: by means of a mere two-side extension of the jets followed by their merge into a single eagre flow. In this case it is not possible to maintain a relatively powerful turbulence, since only two circulation zones occur and operate (according to the claimed subject matter, not less than two, however, as practice shows, not more as well, for the confirmation see Fig. 1 in said international application, wherein the author illustrates the circulation zones). An absence of a technological possibility to increase a number of the circulation zones without a risk of failure of the generation and breakage of the eagre form of the flow of jets, as well as to create additional aerodynamic effects in order to enhance the turbulence phenomena, e.g., by creating microvortexes, leads to impossibility to increase the intensity and the separation process quality, in particular, to increase a thickness of the mixture layer during gravity

feeding thereof. That is, this scheme of creation of the cascade of jets and turbulence zones is at the end of its resources, since it is not possible to achieve a more developed turbulence in the separation chamber, thus, the quality of the process for separating the loose mixture into separate fractions cannot be further increased.

[0006] A main disadvantage of the known device for separating the loose mixture in the flowing medium is a presence of flat and horizontal nozzles in the structure thereof. It is known that a nozzle, as a technological device, is intended to accelerate liquids or gases up to a given speed and to set a certain direction of the flow. As a result of utilizing the flat and horizontal nozzles in the structure of the known device, the resulted cascade of air jets is too powerful and rapid (high-speed), so that the zone of the developed turbulence is displaced to the middle of the separation chamber and has a small length, thus, the separation of the mixture into fractions fails to occur fully therein. Therefore, a portion of the loose mixture is firstly accelerated by straight jets up to a high speed and then it partly drops through the zone of the developed turbulence, while remaining non-separated, - they are simply drifted by the powerful air flows and they are chaotically settled in different collectors. This leads to a non-controlled formation of mixed fractions. Therefore, a presence of said nozzles with rigid walls does not facilitate the increased in the separation quality in any way, yet otherwise deteriorates it, as well as complicates the structure of the separator unreasonably.

[0007] Further significant disadvantage of the known device lies in that the whole set of nozzles with the rigid walls of the generator is arranged in a single vertical plane. Considering the fact that the rigid walls are arranged at an acute angle to the vertical, their pitch and angle are increased from top downwards, between the vertical wall of the generator and each of the above-mentioned rectangular rigid walls there are formed "pockets", which receive particles of the loose mixture, heavy impurities etc. Eventually it leads to filling said "pockets" with these substances. In view of notable volumes of such accumulations (the width of the rigid walls increases from top downwards), there is a need in a periodical stop of the operation of the separator and its cleaning in order to avoid its overload and deterioration of conditions for forming the cascade of air jets. This procedure is non-technological and rather long-term, since the device must be partially disassembled and assembled after the cleaning, as well as it is economically unjustified, since a compulsory "shut down" for a preventive servicing will negatively affect the overall performance of the device. Furthermore, the structure of the nozzles with the rigid walls is generally non-perfect, since it is rather problematic to manufacture and fix them in the air generator exactly in a parallel arrangement.

[0008] In terms of an essence and an effect being achieved, the closest ones are a method for separating a loose mixture in a flowing medium and a device for carrying out said method, which are taken as a prototype and which process and structural essence lies in the following. The method for separating a loose mixture in a flowing medium comprising gravity feeding of particles of the mixture, subjecting them to an aerodynamic, monotonically increasing action at an acute angle to the vertical by means of a cascade of planar jets, and outputting the separated fractions, wherein prior to subjecting the particles of the mixture to the aerodynamic action, a flow of each jet is switched to a mode of a developed turbulence by means of expanding them along the vertical until they merge with each other with an eagre form of the flow or close thereto and creation, in the beginning of each interjet space of all adjacent jets, of two differently sized circulation zones, upper and lower. This method is characterized in that prior to the creation of the circulation zones, the direction of the flow of the jets is rapidly changed from the vertical one to almost horizontal one followed by their compression along the vertical. The device for carrying out the described method for separating a loose mixture in a flowing medium comprises a hopper having a vibrating chute, an air generator disposed therebelow with rigid walls arranged one below another and at an acute angle to the vertical, their pitch and position width increase from top downward, and coupled to an air supply to supply a pressurized air to the generator and surrounded by lateral walls, as well as fraction collectors, wherein an end of each rigid wall is provided with an additional wall arranged at an angle thereto along its entire length, the width of the additional wall is less than a distance between an adjacent rigid wall located above, which are arranged in a shifted manner along the horizontal, thereby forming a gap relative to a lower rigid wall, and a chamber for turning the air flow at an entry into the gap, wherein the chambers for turning and the gaps increase from top downwards [see pat. of the Russian Federation No. 2462319 C2 in the class B07B 4/02 published on 27.09.2012].

[0009] A main disadvantage of the known method for separating lies in that it does not provide a qualitative separation of particles of a complex shape and a non-uniform surface roughness into fractions. The presence of this disadvantage is caused by structural imperfection of the device that carries out said method. The jet generator of the prototype is configured so that the air jets run out into slots between the rigid wall and, according to the Coanda effect, tilt (adhere) to the additional wall. At the same time, an exhaustion zone appears beyond the rigid wall on the side of the separation chamber, wherein two turbulence zones are explicitly formed, which are comparable in sizes, and beyond them, almost symmetrically thereto, there is formed a third sub-tie turbulence zone having nearly the same sizes. That is, the three turbulence zones build an almost symmetrical figure that consists of the turbulence zones. As a result of such situation, beyond the last turbulence zone there is formed a plurality of air vortexes having a small and (attention!) identical (emphasis added) size, which then causes a straight-lined flow of the jets upon their merge,

the vectors of the jets is directed upwardly in an inclined manner. Since all the vortexes have identical size and rotate with identical speed, an overall turbulent flow becomes non-sensitive to the shape and non-uniformity of the roughness of the particles being separated. Since the material being separated, e.g., a grain mass, consists of particles, which differ not only in sizes (the known method produces separation of the particles into fractions according to the sizes), but also in a shape and roughness, these physical parameters of the particles, the known method is not able to take into account these circumstances, thus, it poorly interacts with said particles, thereby resulting in that they enter the fraction collectors, which are not the ones, which are intended for them according to their sizes. Generally, this decreases the separation quality caused by a specificity of the turbulence flow (a symmetry and presence of the vortexes having an identical kinetic energy therein), which is formed due to structural characteristics of the jet generator

Problem to be solved

[0010] The invention is aimed at increasing the quality of separation of the particles having a complex shape and a non-uniform surface roughness due to creation of an upward turbulent flow having non-uniform properties across a section by changing the structure of the jet generator.

Summary of the invention

[0011] The stated problem is solved by the fact that in a method for separating a loose mixture in a flowing medium comprising gravity feeding of particles, subjecting them to an aerodynamic, monotonically increasing action at an acute angle to the vertical by means of a cascade of planar jets, and outputting the separated fractions, wherein prior to subjecting the particles, each jet is expanded until it merges with the adjacent ones and creation of two differently sized circulation zones, upper and lower, in an interjet space of the adjacent jets, upstream of the merging point, according to the proposal, the initial expansion is carried out continuously and unidirectionally - upwards only to form a lower stable circulation zone, and the upper circulation zone is formed periodically by the self-oscillation of the boundary where the adjacent jets merge, both along and transverse to the direction of movement of the overall flow, wherein the sizes of the upper circulation zone, at its maximum, do not exceed the sizes of the lower circulation zone.

[0012] The stated problem is also solved by the fact that in a device for carrying out said separation method comprising a hopper having a vibrating chute, a multijet generator disposed therebelow, the generator including rigid walls which are arranged at an acute angle to the vertical and which are abutted by additional walls at an angle, which form slot-like gaps together with adjacent pairs of walls, wherein the generator is coupled to a pressure supply and surrounded by lateral walls having fraction collectors, according to the proposal, the slot-like gaps are arranged above the rigid walls, and the additional walls abut to the rigid walls at an angle of more than 90°, wherein the width of the additional walls is at least seven times greater than the width of the abutting gaps and is twice the width of the adjoining rigid walls.

[0013] The proposed technical solution implies separation in a turbulent flow that is non-symmetrical in a structure that is characterized by a presence of vortexes of different calibers therein, which, during interaction between each other, exchange energy in a more intensive manner that vortexes of identical sizes (as peculiar to the prototype) due to a difference in linear rotation speeds that leads to intensification of the turbulence of the overall air flow. Due to the difference in the linear rotation speeds caused by different sizes of the adjoining vortexes, there is observed a smooth turnup of the overall air flow along the length of the separation chamber that even strongly enables to retain the particles in an active zone and thus to perform more accurate separation of the particles having a complex shape and a non-uniform surface roughness into fractions as a result of the fact that the "small" vortexes better interact with the small particles, and "large" vortexes better interact with the large particles. Therefore, different calibers of the vortexes enable to act on all types of the particles with an identical intensity, and thus to increase the quality of the separation of the loose mixture. Achievement of said purpose became possible mainly due to the structural change of the multijet generator. While the Coanda effect is used in the prototype for "adherence" of the upper plane of the jet to the rigid wall, in the claimed one it is inversely used for "adherence" by the lower plane. Precisely because of this, in a wide range of sizes the vortexes of different calibers are formed along an "effective" section of the jet that eventually leads to increase of the turbulization of the overall air flow, and as it is known, in case of a high turbulence extent, an air "shadow" that is usually formed beyond the grain almost disappears.

[0014] The increase of the turbulence of the air flow firstly enables to reduce the length of the separation chamber, thus, a metal consumption of the device (a separator), secondly, to reduce an energy consumption of the separation process, thus, to use power facilities (a fan) of lower power, to increase a versatility (to increase a non-sensitivity to a composition and type of the loose mixture), thirdly, to increase the separation quality regardless of the shape and roughness of the particles comprised in the loose mixture.

[0015] Therefore, a set of all essential features of the proposed technical solutions relating to the method for separating a loose mixture in a flowing medium and device for carrying out said method obtained as a result of introduction of certain structural changes into the multijet generator enables to achieve the technical effect stated in the statement of the problem.

List of figures of the illustrative materials

[0016] Further essence of the invention is explained by the illustrative material that depicts the following:

Figure 1 - a diagram of the proposed device for carrying out the claimed method;
Figure 2 - a cross-section of the multijet generator intended to explain a process of forming the circulation zones.

Arrows in the Figures 1 and 2 illustrate movement directions of the air flows. The dashed line in the Figure 2 shows a change in the flow direction of the air jet, the solid lines show the turbulence zones and the vortexes.

Description of the preferred embodiment of the invention

[0017] The device for carrying out the proposed method for separating a loose mixture in a flowing medium consists of a hopper 1 having a vibrating chute 2 for gravity feeding particles of the loose mixture to a separation zone. A multijet generator 3 is disposed under the vibrating chute 2, the generator being an enclosed volume having a set of output slot-like gaps 4 mainly having a rectangular section. A height of the section of the output slot-like gaps 4 and an interval therebetween increase from top downwards. The slot-like gaps 4 are arranged above rigid walls 5, while additional walls 6 abut to the rigid walls at an angle $\alpha > 90°$. The width of the additional walls 6 is at least seven times greater than the width of the abutting slot-like gaps 4 and is at least twice the width of the adjoining rigid walls 5. Fraction collectors 7 adjoin the multijet generator 3 from the side of the slot-like openings 4. The multijet generator 3 is coupled to a pressurized air supply P for supplying the air thereto, and its side edges are surrounded by lateral walls 8.

[0018] The proposed method for separating the loose mixture in the flowing medium is carried out as follows.

[0019] The loose mixture to be separated is gravity fed from the hopper 1 to the separation zone by means of the vibrating chute 2. The particles of said mixture, which are in a free fall, are subjected to the action of a cascade of air jets at an acute angle to the vertical in a mode of a developed deep turbulence. The upper portion of the air flow that comes out from the slot-like gap 4 immediately becomes to incline upwardly, since it does not encounter any mechanical obstacle, and the lower portion of the same air flow continues to move in parallel to the rigid wall 5 and is able to slightly incline downwardly only in the end thereof. As a result of the different inclination of the upper and lower portions of the air flow, the merge of the adjacent lower portion of the upper jet and the upper portion of the lower one (the adjacent jet that comes out of the adjacent slot-like gap 4) takes place in a point ***B*** in a non-symmetrical manner relative to the additional wall 6. Under the action of instable additional circulation zones under the additional wall 6, the point ***B*** periodically moves to the point ***A***. As a result of presence of the self-oscillation process, there is formed a doubled tail consisting of a plurality of the upper small vortexes 8 and lower larger vortexes 9. It is observed that in the doubled tail there is a more intensive interlayer friction of the air flow that increases the overall extent of turbulization of the air flow. When two vortexes of different sizes (small and large) meet with each other, they, at the same time having different kinetic energy, convey a part of the energy to each other due to a deceleration that eventually leads to a curvature of the jet upwardly, thereby resulting in a buoyant aerodynamic force that increases a residence time of the particles of the mixture in the active highly turbulated zone and it positively affects the quality of separation of the loose mixture. After the particles of the loose mixture passed the cascade of the air jets and the developed turbulence zone, the separated fractions are removed.

[0020] The significant difference of the proposed method for separating the loose mixture in the flowing medium and, thus, the device for carrying out said method, from other known solutions in this field of the knowledge lies in the formation of a change of conditions for cleavage of the air flow in the turbulization zone to form the air vortexes having different sizes, and thus having different kinetic energy, and to increase the power and to increase the extent of the turbulent operation mode of the cascade of the air jets in such particular way. Said difference provides a high quality of the separation process and, at the same time, a significant simplification of the device structure. None of the known methods for separating a loose mixture in a flowing medium could simultaneously have all the above-mentioned properties, since they absolutely do not imply a change in conditions for cleavage of the air jets, increase the turbulization zone, in particular, by forming microvortexes, which are different in sizes.

[0021] Therefore, the principle of separation of the loose mixture in the flowing medium and the structure of the multijet generator that provides carrying out said method, which are proposed in the present invention, lead to achievement of the qualitatively new technical effect as compared to the known analogues and the prototype.

[0022] The proposed method and device do not comprise any elements or processes, which could not be reproduced at the present stage of development of science and technology, in particular, when manufacturing air separators, therefore, they are considered to be the ones that meet the criteria of "industrial applicability".

[0023] The known sources of patent documentation, scientific and technical information and another information do not disclose any method for separating a loose mixture in a flowing medium and a device for carrying out said method which could have the proposed set of essential features, thus, the proposed technical solutions are considered to be the ones that meet the criteria of "novelty".

Technical advantages of the invention

[0024] A comparative analysis of the proposed invention with the known technical solution taken as the prototype has shown that the asymmetry of the merge of the jets causes their general curvature upwards during formation of their cascade and leads to creation of new technical advantages, in particular, the following ones:

- creation of the vortexes of different sizes, which enhance the extent of the turbulization of the air jet due to a presence of the self-oscillation process in the zone of merge of the adjacent jets;
- for the same reason, formation of the upward curvature of the jets of the overall cascade that enables to increase the residence time of the particles in the zone of high turbulence of the air flow;
- reduction of sizes of the separation chamber due to increase of the extent of turbulization of the air flow and its upward curvature;
- reduction of the energy consumption of the process for separating the loose mixture for the same reason;
- increase of the quality of the separation of the loose mixture regardless of the shape and roughness of the particles comprised therein due to non-sensitivity to the shape and non-uniformity of the roughness of the particles.

[0025] Since these properties are not obvious and do not clearly follow for persons having skills in this field of knowledge from the existing prior art, it can be concluded that the proposed technical solutions meet the criteria of "inventive step".

[0026] The economic benefit of introduction of the invention into the manufacturing industry as compared to use of the prototype is obtained due to increase of yield of the qualitative product, reduction of the device cost and reduction of the energy costs for the separation process.

[0027] After the proposed method for separating a loose mixture in a flowing medium and device for carrying out said method are described, it should be obvious for persons skilled in this field of knowledge that the above-described matter is only illustrative, but not limiting, being represented by the present example. Numerous possible embodiments of the proposed method and device may vary dependent on characteristics of an initial loose material, field of use and desired manufacture volumes, and it is clear that they fall within a scope of one of traditional and natural approaches in this field of knowledge and considered as being the ones that fall within the scope of the proposed technical solutions.

[0028] The key essence of the proposed technical solutions lies in that in the separation process during the formation of the circulation zones there is the self-oscillation process occurring in the zone of the jets merge thereby forming the vortexes having different sizes that is caused by the change of the structure of the multijet generator of the device for separation that, in combinations, enables to curve the cascade of the air jets upwards significantly and to increase the extent of the turbulization of the jet cascade, thus, to increase the intensity of action onto the particles of the mixture having different shape and roughness, and thereby to increase the separation quality with simultaneous compression of the energy resources being used, and these particular circumstances enabled the proposed method and device to gain the above-mentioned and other benefits. Surely, use of only separate elements of the proposed technological and structural advancements will limit a range of benefits listed above and cannot be considered as novel technical solutions in this field of knowledge, since other technical solutions similar to the described method and device already do not require any creative approach from designers and engineers, and cannot be considered as results of their creative work or new intellectual property objects to be protected by protection documents.

Claims

1. A method for separating a loose mixture in a flowing medium comprising gravity feeding of particles, subjecting them to an aerodynamic, monotonically increasing action at an acute angle to the vertical by means of a cascade of planar jets, and outputting the separated fractions, wherein prior to subjecting the particles, each jet is expanded until it merges with the adjacent ones and creation of two differently sized circulation zones, upper and lower, in an inter-jet space of the adjacent jets, upstream of the merging point, **characterized in that** the initial expansion is carried out continuously and unidirectionally - upwards only, to form a lower stable circulation zone, and the upper circulation zone is formed periodically by the self-oscillation of the boundary where the adjacent jets merge, both along and transverse to the direction of movement of the overall flow, wherein the sizes of the upper circulation zone at is maximum do not exceed the sizes of the lower circulation zone.

2. A device for carrying out the method for separating according to claim 1, the device comprising a hopper having a vibrating chute, a multi-jet generator disposed therebelow, the generator including rigid walls which are arranged at an acute angle to the vertical and which are abutted by additional walls at an angle, which form slot-like gaps together with adjacent pairs of walls, wherein the multijet generator is coupled to a pressure supply and surrounded by lateral walls having fraction collectors, **characterized in that** the slot-like gaps are arranged above the rigid walls, and the additional walls abut to the rigid walls at an angle of more than 90°, wherein the width of the additional walls is at least seven times greater than the width of the abutting gaps and is twice the width of the

adjoining rigid walls.

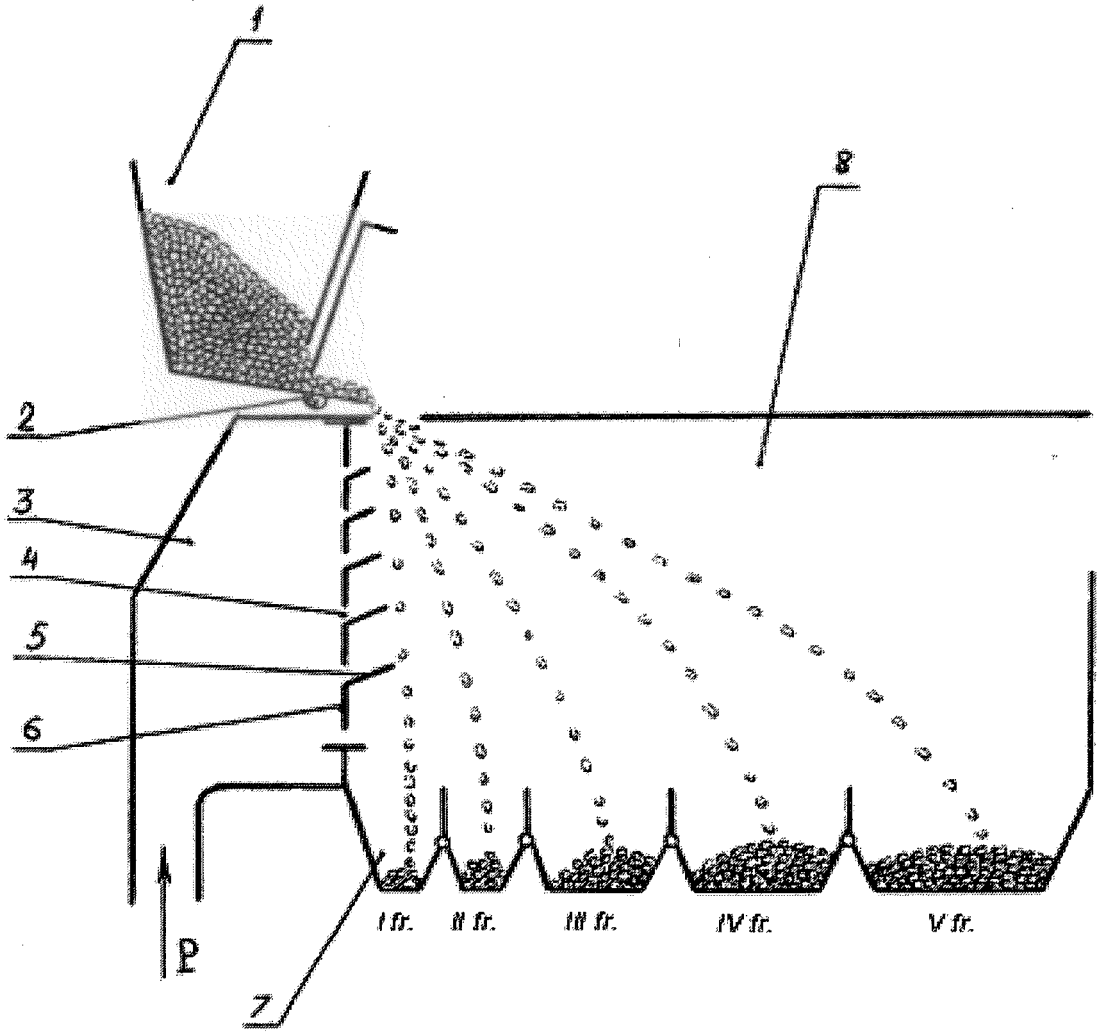

Fig. 1

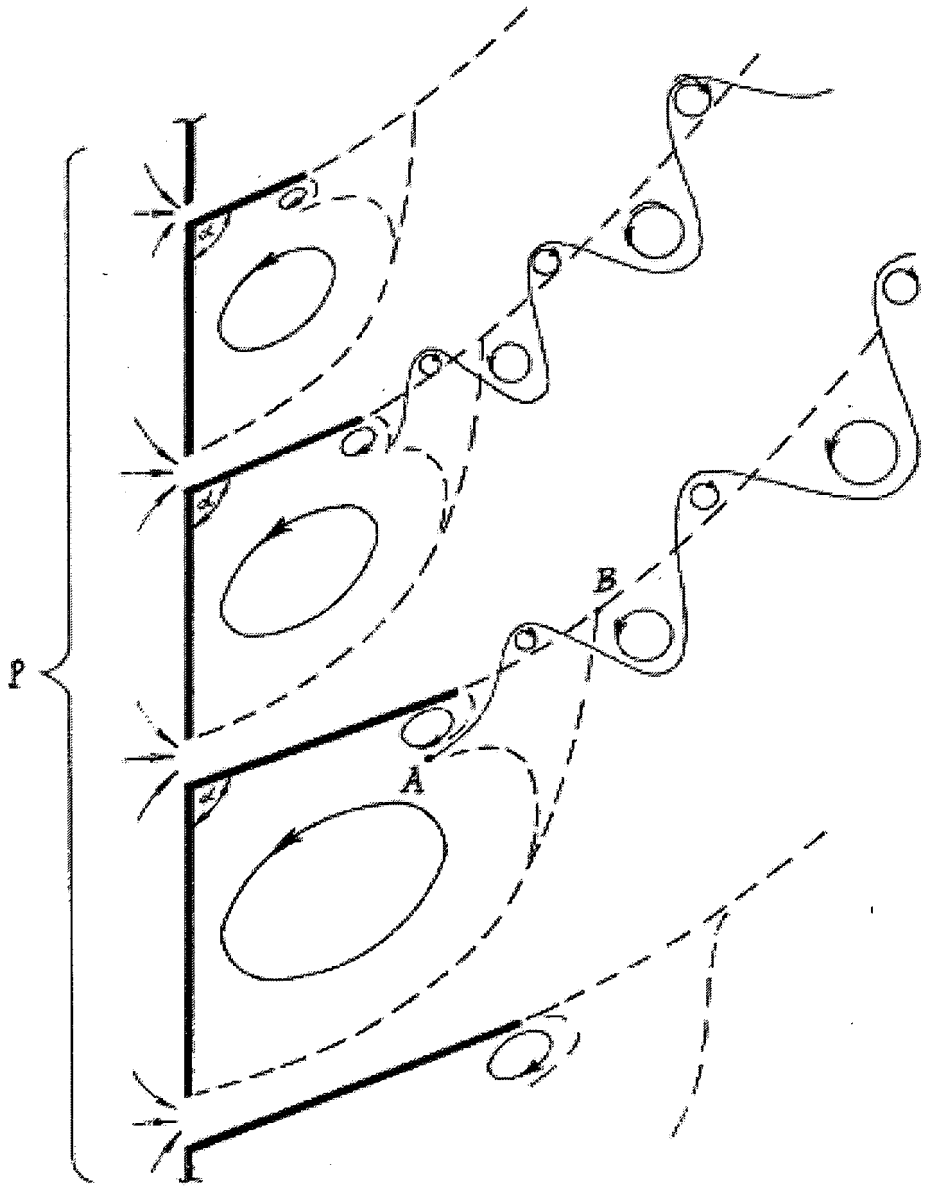

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/UA 2018/000078

A. CLASSIFICATION OF SUBJECT MATTER
B07B 4/02 (2006.01); A01F 12/44 (2006.01)

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)
B07B 4/00, 4/02, 4/04, 11/00, A01F 12/00, 12/44

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)
PatSearch, esp@cenet, USPTO, Google

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2403096 C1 (OBSCHESTVO S OGRANICHENNOI OTVETSTVENNOSTJU "NAUCHNO-PROIZVODSTVENNAYA FIRMA "AEROMEKH") 10.11.2010	1-2
D, A	RU 2462319 C2 (SUKHIN VLADIMIR STEPANOVICH) 27.09.2012	1-2
A	US 2015/0189828 A1 (VADERSTAD-VERKEN AV) 09.07.2015	1-2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 October 2018 (29.10.2018)	08 November 2018 (08.11.2018)
Name and mailing address of the ISA/ RU	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

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Patent documents cited in the description

- UA 45881 **[0002]**
- WO 2010056220 A **[0004]**
- RU 2462319 **[0008]**