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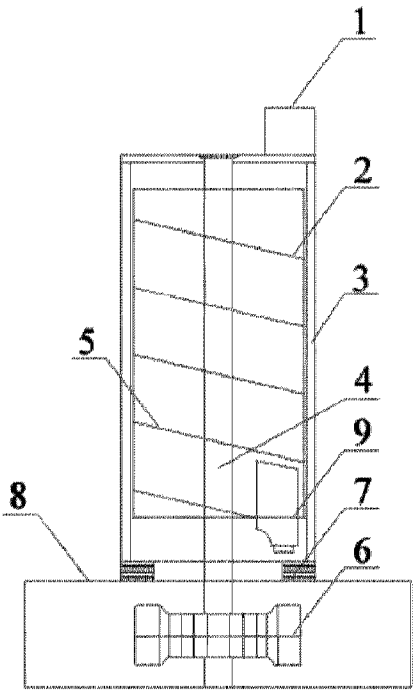
(54) **Titre : APPAREIL ET PROCEDE DE SEPARATION PAR GRAVITE POUR BOUE DE CHARBON GROSSIER**
(54) **Title: GRAVITY SEPARATION APPARATUS AND METHOD FOR COARSE COAL SLIME**



(57) **Abrégé/Abstract:**
Provided is a gravity separation apparatus for coarse coal slime. A spiral separation device is arranged above a spiral generating device. The spiral generating device comprises a base (8) and a vibration exciter (6) arranged in the base (8), and the spiral

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(57) **Abrégé(suite)/Abstract(continued):**
separation device comprises a columnar spiral external support (3). The top of the external support (3) of a separator is provided with an end cover, and one side of the end cover at the top of the external support (3) of the separator is provided with a feeding port (1). A joint of the bottom of the external support (3) of the separator and the base (8) is provided with a plurality of rubber spring tubes (7). A spiral middle shaft is axially provided at the center of a circle of the external support (3) of the separator, and a top end of the spiral middle shaft is movably connected to the end cover, and a bottom end thereof is connected to the vibration exciter (6). A spiral middle shaft support (4) is provided on the spiral middle shaft in the spiral external support (3). Spiral groove face grooves (5) are provided in the spiral middle shaft support (4) from top to bottom, and a bottom end of each of the spiral groove face grooves (5) is provided with a discharge port (9). A product interceptor is provided in the discharge port (9). Further provided is a method using the gravity separation apparatus for coal slime. The method comprises: feeding coal slime and water, as materials, into the spiral middle shaft support (4) in the spiral external support (3) through the feeding port (1), and separating the coal slime and water materials under the action of gravity; fast layering of material particle groups is realized under the action of the vibration exciter (6); finally, transversal zoning of light and heavy particles is realized on a spiral section of a spiral chute (2) according to a density difference, and a continuous coal slime zone is formed after material layering and zoning are stable; and finally, the product interceptor provided at a discharge end at the bottom of a spiral separator transversely segments the coal slime zone on the section of the spiral chute into three parts, i.e. clean coal, middlings and tailings, and the three parts are discharged through respective discharge ports (9), thereby improving the separation precision.

GRAVITY SEPARATION APPARATUS AND METHOD FOR COARSE COAL SLIME

Abstract

Provided is a gravity separation apparatus for coarse coal slime. A spiral separation device is arranged above a spiral generating device. The spiral generating device comprises a base (8) and a vibration exciter (6) arranged in the base (8), and the spiral separation device comprises a columnar spiral external support (3). The top of the external support (3) of a separator is provided with an end cover, and one side of the end cover at the top of the external support (3) of the separator is provided with a feeding port (1). A joint of the bottom of the external support (3) of the separator and the base (8) is provided with a plurality of rubber spring tubes (7). A spiral middle shaft is axially provided at the center of a circle of the external support (3) of the separator, and a top end of the spiral middle shaft is movably connected to the end cover, and a bottom end thereof is connected to the vibration exciter (6). A spiral middle shaft support (4) is provided on the spiral middle shaft in the spiral external support (3). Spiral groove face grooves (5) are provided in the spiral middle shaft support (4) from top to bottom, and a bottom end of each of the spiral groove face grooves (5) is provided with a discharge port (9). A product interceptor is provided in the discharge port (9). Further provided is a method using the gravity separation apparatus for coal slime. The method comprises: feeding coal slime and water, as materials, into the spiral middle shaft support (4) in the spiral external support (3) through the feeding port (1), and separating the coal slime and water materials under the action of gravity; fast layering of material particle groups is realized under the action of the vibration exciter (6); finally, transversal zoning of light and heavy particles is realized on a spiral section of a spiral chute (2) according to a density difference, and a continuous coal slime zone is formed after material layering and zoning are stable; and finally, the product interceptor provided at a discharge end at the bottom of a spiral separator transversely segments the coal slime zone on the section of the spiral chute into three parts, i.e. clean coal, middlings and tailings, and the three parts are discharged through respective discharge ports (9), thereby improving the separation precision.

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Description

GRAVITY SEPARATION APPARATUS AND METHOD FOR COARSE COAL SLIME

I. Technical field

The present invention relates to a gravity separation apparatus for coarse coal slime and a method for gravity separation of coarse coal slime, in particular to an apparatus and a method for gravity separation of coarse coal slime applied in the technical field of coal separation.

II. Background Art

In the entire process of coal separation, owing to the fact that the particle size of coarse coal slime is around the lower limit of dense medium separation and the upper limit of flotation (2-0.3mm), it is difficult to separate coarse slime accurately by dense medium separation and flotation. Therefore, coarse coal slime is usually separated individually, and the separation process also plays a decisive linking role in the entire coal separation process and the separation effect has direct influence on the efficiency of dense medium separation and water treatment of coal slime. The extensive application of large diameter dense medium cyclones and fine coal processing apparatuses causes compromised separation effect of coarse coal slime near the granularity boundary between dense medium separation and water treatment of coal slime to a certain extent while improving the product quality and separation effect. The problem of coarse coal slime separation has become the main bottleneck affecting the improvement of clean coal yield in most domestic coal preparation plants.

Through the development in recent years, some new apparatuses have been applied in gravity separation apparatuses for coarse coal slime. Although the coal slime separation techniques have been improved continuously and new apparatuses have been applied continuously, some apparatuses still have some limitations in the treatment of coarse coal slime. According to Stokes' theory about the settlement of mineral particles in a density field of centrifugal force, the centrifugal force on the particles in a cyclone is proportional to the particle size. Therefore, in the settlement process of materials in particle diameter equal to or greater than +3mm, the centrifugal force on the mineral particles and the effective separation velocity can be increased owing to the large particle diameter. In the case of material separation by density, materials in about +0.3mm particle diameter can be separated by means of an ordinary cyclone. Coal slime in about -0.5mm particle diameter is absorbed preferentially by agents with strong selectivity, and can be well separated by flotation.

The existing coarse coal slime separation apparatuses have been widely applied, such as teetered bed separators (TBS), spiral separators, dense medium coal slime cyclones, etc. However, those apparatuses have more or less drawbacks in the coarse coal slime separation process, which restrict the improvement of separation accuracy. It is difficult to adjust the parameters of spiral separators to adapt to the change of the properties of the feed material, and spiral separators are usually suitable for separation at high separation density and have a poor concentration effect on platy shaped mineral particles; liquid-solid fluid-bed separators require a narrow particle-size range of the feed material, and are suitable for separation at low separation density; dense medium coal slime cyclones require a set of separate fine medium circulation and recovery system, and involve complex system design, difficulties in recovery of extra fine medium, and high production cost.

III. Summary of the Invention

To overcome the above drawbacks in the prior art, the present invention provides a gravity separation apparatus for coarse coal slime, which has a simple structure and high separation efficiency, and the present invention further provides a method thereof.

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To achieve the above technical object, the gravity separation apparatus for coal slime provided by the present invention includes a spiral generator, with a spiral separator disposed above the spiral generator; the spiral generator includes a base and a vibration exciter arranged in the base; the spiral separator includes a cylindrical spiral external bracket, with an end cover provided at the top of the separator external bracket, wherein a material feeding port is provided on a side of the end cover at the top of the separator external bracket, a plurality of rubber spring tubes are provided at the joint between the bottom of the separator external bracket and the base, a spiral central shaft is axially provided at the center of circle of the separator external bracket, the top end of the spiral central shaft is flexibly connected with the end cover, the bottom end of the spiral central shaft is connected with the vibration exciter, a spiral central shaft bracket is provided on the spiral central shaft in the cylindrical spiral external bracket, spiral surface grooves are provided on the spiral central shaft bracket from top to bottom, a material discharge port is provided at the bottom end of the spiral chute surface grooves, and a product interceptor is provided in the material discharge port.

The vibration direction of the vibration exciter is perpendicular to the central shaft bracket of a spiral chute.

The spiral grooves are removable, the depth in the spiral grooves is increased gradually from inside to outside in the radial direction, high-density particles move along the grooves from outside to inside under the action of bottom-layer swirling water flow; as the depth of the grooves decreases, low-density particles included in the bottom layer are washed out by the upper-layer water flow, so that the vertical speed difference of the water flow enhances the separation and lamination of the materials, and the lighter particles straying to the bottom of the spiral grooves and the heavier particles straying to the edges of the spiral grooves are laminated and zoned again.

A method for gravity separation of coal slime includes the following steps:

feeding coal slime and water as feed materials through the material feeding port to the spiral central shaft bracket in the spiral external bracket, so that the coal slime and water materials fall into the spiral chute under gravity action in a tangent direction and pass through the spiral chute surface grooves on the spiral chute sequentially for separation;

under the action of the vibration exciter, the spiral central shaft drives the spiral central shaft bracket to generate an exciting moment around the spiral central shaft in the vertical direction; on one hand, the radial centrifugal force of the materials is enhanced and the transverse movement speed of the upper-layer water flow in the spiral chute is accelerated, so that the low-density portion of the coarse coal slime floats in the upper-layer water flow and is quickly thrown to the outer edge of the chute, while the high-density portion of the coarse coal slime settles down into the lower-layer water flow, thus the material particle groups are laminated quickly; on the other hand, the exciting moment around the spiral central shaft increases the inward friction force of the surface of the spiral chute on the bottom-layer of materials, the swiveling speed of the coarse coal slime and the lower-layer water flow is decreased, and the speed difference between coarse coal slimes with different densities moving at the bottom of the spiral chute is enhanced; finally a high-density area, a medium-density area and a low-density area are sequentially formed on the spiral cross section of the spiral chute from inside to outside according to the density difference, thereby transverse zoning of lighter particles and heavier particles is realized;

spiral chute surface grooves are provided on the surface of the spiral chute along the upper spiral line, and the depth in the spiral chute surface grooves is increased gradually from inside to outside in the radial direction; when the materials pass through the spiral chute surface grooves under the action of the vibration exciter and gravity action, lighter particles straying to the bottom of the spiral surface grooves and the heavier particles straying to the edges of the grooves are laminated and zoned again under the action of the swirling movement of the lower-layer water flow, thereby the density-based separation effect is enhanced;

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after the material lamination and zoning becomes stable, coarse coal slime particles with different densities move along the spiral chute according to their respective radii of gyration, high-density particles and low-density particles are arranged evenly along the cross section of the spiral chute from inside to outside, forming a continuous coal slime strip; finally the coal slime strip on the cross section of the spiral chute is separated into three sections, including a clean coal section, a medium coal section and a tail coal section, by the product interceptor provided at the bottom discharge end of the spiral separator, and the sections are discharged through corresponding material discharge ports respectively.

Benefits:

A. The vibration exciter of the spiral central shaft bracket generates an exciting moment around the spiral central shaft in the vertical direction and the exciting moment around the spiral central shaft enhances the radial centrifugal force of the materials; on one hand, the radial centrifugal force of the materials is enhanced and the transverse movement speed of the upper-layer water flow in the spiral chute is accelerated, so that the low-density portion of the coarse coal slime floats in the upper-layer water flow and is quickly thrown to the outer edge of the chute, while the high-density portion of the coarse coal slime settles down into the lower-layer water flow, thus the material particle groups are laminated quickly; on the other hand, the exciting moment around the vertical shaft increases the inward friction force of the surface of the chute on the bottom layer of materials, decreases the swirling speed and centrifugal force of the coarse coal slime and the lower-layer water flow, and enhances the speed difference between coarse coal slimes with different densities moving at the bottom of the chute, thereby, the lamination efficiency and accuracy of the materials in the chute are improved, and transverse zoning of lighter particles and heavier particles is realized;

B. Grooves are provided on the surface of the spiral chute along the upper spiral line, and the depth in the grooves is increased gradually from inside to outside in the radial direction, thus, the vertical speed difference of the water flow enhances the separation and lamination of the materials; grooves are provided on the surface of the spiral chute along the upper spiral line, and the depth in the grooves is increased gradually from inside to outside in the radial direction so that lighter particles straying to the bottom of the grooves and heavier particles straying to the edges of the grooves are laminated and zoned again under the action of the swirling movement of the lower-layer water flow, thereby the effect of density-based separation is enhanced and the separation accuracy is improved;

C. The spiral chute surface grooves are removable, the radial heights of the spiral chute surface grooves may be of different types, and grooves with different types of heights can be selected according to the properties of different coal samples. For coarse coal slime materials that have smaller density differences and are difficult to separate, spiral chute surface grooves with greater radial height change may be selected to enhance the density-based lamination effect of the coal slime and improve the separation efficiency; for coarse coal slime materials that have greater density differences and are easy to separate, spiral chute surface grooves with smaller radial height change may be selected to improve slime treatment throughput and ensure recovery rate.

IV. Description of Drawings

Fig. 1 is a schematic structural view of the gravity separation apparatus in the present invention;

Fig. 2 is a top view of the structure of the spiral chute surface groove in the present invention;

Fig. 3 is a sectional view of the structure of the spiral chute surface groove in the present invention.

In the drawings: 1 - material feeding port; 2 - spiral chute; 3 - spiral external bracket; 4 - spiral central shaft bracket; 5 - spiral chute surface groove; 6 - vibration exciter; 7 - rubber spring tube; 8 - base; 9 - material discharge port.

V. Detailed Description

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Hereunder the embodiments of the present invention will be further described in detail with reference to the drawings.

As shown in Fig. 1, the gravity separation apparatus for coal slime includes: a spiral generator, with a spiral separator disposed above the spiral generator, wherein the spiral generator includes a base 8 and a vibration exciter 6 arranged in the base 8; the spiral separator includes a cylindrical spiral external bracket 3, with an end cover provided at the top of the separator external bracket 3, wherein a material feeding port 1 is provided on a side of the end cover at the top of the separator external bracket 3, a plurality of rubber spring tubes 7 are provided at the joint between the bottom of the separator external bracket 3 and the base 8, a spiral central shaft is axially provided at the center of circle of the separator bracket 3, the top end of the spiral central shaft is flexibly connected with the end cover, the bottom end of the spiral central shaft is connected with the vibration exciter 6, the vibration direction of which is perpendicular to the central shaft bracket in the spiral chute, a spiral central shaft bracket 4 is provided on the spiral central shaft in the spiral external bracket 3, spiral chute surface grooves 5 are provided on the spiral central shaft bracket 4 from top to bottom, a material discharge port 9 is provided at the bottom end of the spiral chute surface grooves 5, and a product interceptor is provided in the material discharge port 9.

As shown in Figs. 2 and 3, the spiral grooves 5 are removable, the depth in the spiral grooves 5 is increased gradually from inside to outside in the radial direction, high-density particles move along the grooves from outside to inside under the action of bottom-layer swirling water flow, as the depth of the grooves 5 decreases, low-density particles included in the bottom layer are washed out by the upper-layer water flow, so that the vertical speed difference of the water flow enhances the separation and lamination of the materials, and the lighter particles straying to the bottom of the spiral grooves 5 and the heavier particles straying to the edges of the spiral grooves 5 are laminated and zoned again.

A method for gravity separation of coal slime includes the following steps:

feeding coal slime and water as feed materials through the material feeding port 1 to the spiral central shaft bracket 4 in the spiral external bracket 3, so that the coal slime and water materials fall into the spiral chute 2 under gravity action in a tangent direction and pass through the spiral chute surface grooves 5 on the spiral chute 2 sequentially for separation;

under the action of the vibration exciter 6, the spiral central shaft drives the spiral central shaft bracket 4 to generate an exciting moment around the spiral central shaft in the vertical direction; on one hand, the radial centrifugal force of the materials is enhanced and the transverse movement speed of the upper-layer water flow in the spiral chute is accelerated, so that the low-density portion of the coarse coal slime floats in the upper-layer water flow and is quickly thrown to the outer edge of the chute 2, while the high-density portion of the coarse coal slime settles down into the lower-layer water flow, thus the material particle groups are laminated quickly; on the other hand, the exciting moment around the spiral central shaft increases the inward friction force of the surface of the spiral chute 2 on the bottom-layer of materials, decreases the swiveling speed of the coarse coal slime and the lower-layer water flow, and enhances the speed difference between coarse coal slimes with different densities moving at the bottom of the spiral chute 2; finally a high-density area, a medium-density area and a low-density area are sequentially formed on the spiral cross section of the spiral chute 2 from inside to outside according to the density difference, thereby transverse zoning of lighter particles and heavier particles is realized;

spiral chute surface grooves 5 are provided on the surface of the spiral chute 2 along the upper spiral line, and the depth in the spiral chute surface grooves 5 is increased gradually from inside to outside in the radial direction; when the materials pass through the spiral chute surface grooves 5 under the action of the vibration exciter 6 and gravity action, lighter particles straying to the bottom of the spiral chute surface grooves 5 and the heavier particles straying to the edges of the grooves are laminated and zoned again under the action of the swirling movement of the lower-layer water

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flow, thereby the density-based separation effect is enhanced;

after the material lamination and zoning becomes stable, coarse coal slime particles with different densities move along the spiral chute 2 according to their respective radii of gyration, high-density particles and low-density particles are arranged evenly along the cross section of the spiral chute 2 from inside to outside, forming a continuous coal slime strip; finally the coal slime strip on the cross section of the spiral chute is separated into three sections, including a clean coal section, a medium coal section, and a tail coal section, by the product interceptor provided at the bottom discharge end of the spiral separator, and the sections are discharged through corresponding material discharge ports 9 respectively.

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Claims

1. An gravity separation apparatus for coal slime, comprising: a spiral generator, with a spiral separator disposed above the spiral generator, wherein the spiral generator comprises a base (8) and a vibration exciter (6) arranged in the base (8); the spiral separator comprises a cylindrical spiral external bracket (3), with an end cover provided at the top of the spiral external bracket (3), wherein a material feeding port (1) is provided on a side of the end cover at the top of the spiral external bracket (3), a plurality of rubber spring tubes (7) are provided at the joint between the bottom of the spiral external bracket (3) and the base (8), a spiral central shaft is axially provided at the center of circle of the spiral external bracket (3), the top end of the spiral central shaft is flexibly connected with the end cover, the bottom end of the spiral central shaft is connected with the vibration exciter (6), a spiral central shaft bracket (4) is provided on the spiral central shaft in the spiral external bracket (3), spiral chute surface grooves (5) are provided on the spiral central shaft bracket (4) from top to bottom, a material discharge port (9) is provided at the bottom end of the spiral chute surface grooves (5), and a product interceptor is provided in the material discharge port (9).

2. The gravity separation apparatus for coal slime according to claim 1, wherein the vibration direction of the vibration exciter (6) is perpendicular to the central shaft bracket of a spiral chute.

3. The gravity separation apparatus for coal slime according to claim 1, wherein spiral chute surface grooves (5) are provided on a spiral chute (2), the spiral chute surface grooves (5) are removable, the depth in the spiral chute surface grooves (5) is increased gradually from inside to outside in the radial direction, high-density particles move along the grooves from outside to inside under the action of bottom-layer swirling water flow; as the depth of the spiral chute surface grooves (5) decreases, low-density particles included in the bottom layer are washed out by the upper-layer water flow, so that the vertical speed difference of the water flow enhances the separation and lamination of the materials, and the lighter particles straying to the bottom of the spiral chute surface grooves (5) and the heavier particles straying to the edges of the spiral chute surface grooves (5) are laminated and zoned again.

4. A separation method utilizing the gravity separation apparatus for coal slime according to claim 1, comprising the following steps:

   feeding coal slime and water as feed materials through the material feeding port (1) to the spiral central shaft bracket (4) in the spiral external bracket (3), so that the coal slime and water materials fall into the spiral chute (2) under gravity action in a tangent direction and pass through the spiral chute surface grooves (5) on the spiral chute (2) sequentially for separation;

   driving the spiral central shaft bracket (4) by the spiral central shaft, under the action of the vibration exciter (6), to generate an exciting moment around the spiral central shaft in the vertical direction; on one hand, the radial centrifugal force of the materials is enhanced and the transverse movement speed of the upper-layer water flow in the spiral chute is accelerated, so that the low-density portion of the coarse coal slime floats in the upper-layer water flow and is quickly thrown to the outer edge of the chute (2), while the high-density portion of the coarse coal slime settles down into the lower-layer water flow, thus the material particle groups are laminated quickly; on the other hand, the exciting moment around the spiral central shaft increases the inward friction force of the surface of the spiral chute (2) on the bottom-layer of materials, decreases the swiveling speed of the coarse coal slime and the lower-layer water flow, and enhances the speed difference between coarse coal slimes with different densities moving at the bottom of the spiral chute (2); finally a high-density area, a medium-density area and a low-density area are sequentially formed on the spiral cross section of the spiral chute (2) from inside to outside

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according to the density difference, thereby transverse zoning of lighter particles and heavier particles is realized;

providing spiral chute surface grooves (5) on the surface of the spiral chute (2) along the upper spiral line, and the depth in the spiral chute surface grooves (5) is increased gradually from inside to outside in the radial direction; when the materials pass through the spiral chute surface grooves (5) under the action of the vibration exciter (6) and gravity action, lighter particles straying to the bottom of the spiral chute surface grooves (5) and the heavier particles straying to the edges of the grooves are laminated and zoned again under the action of the swirling movement of the lower-layer water flow, thereby the density-based separation effect is enhanced;

providing, after the material lamination and zoning becomes stable, for coarse coal slime particles with different densities move along the spiral chute (2) according to their respective radii of gyration, high-density particles and low-density particles are arranged evenly along the cross section of the spiral chute (2) from inside to outside, forming a continuous coal slime strip; finally the coal slime strip on the cross section of the spiral chute is separated into three sections, including a clean coal section, a medium coal section, and a tail coal section, by the product interceptor provided at the bottom discharge end of the spiral separator, which are discharged through corresponding material discharge ports (9) respectively.

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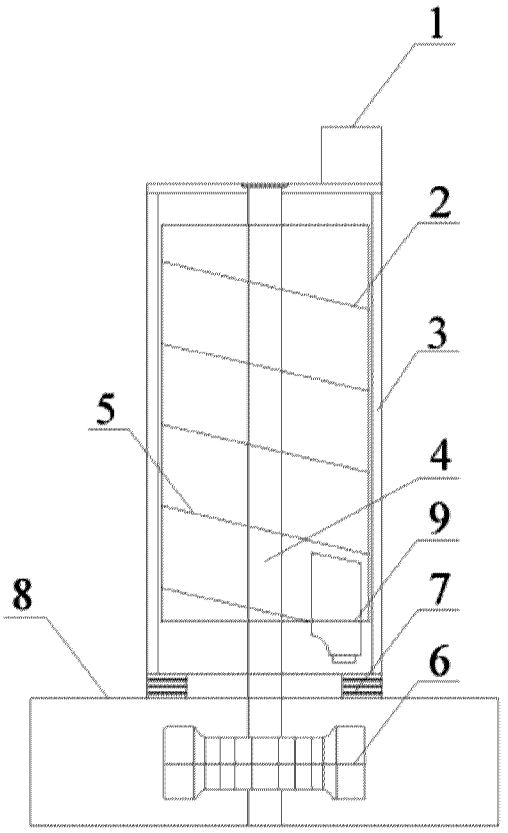

Fig. 1

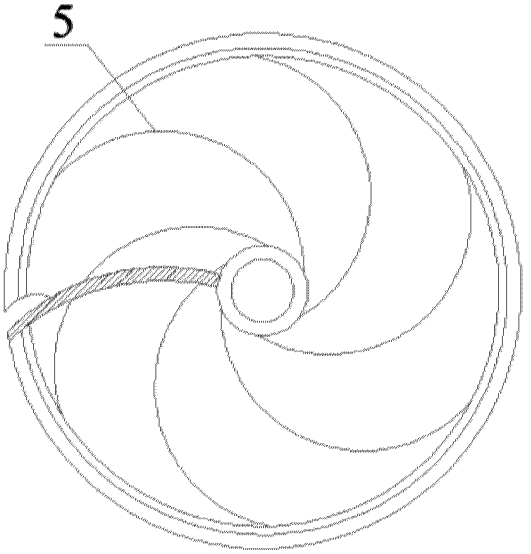

Fig. 2

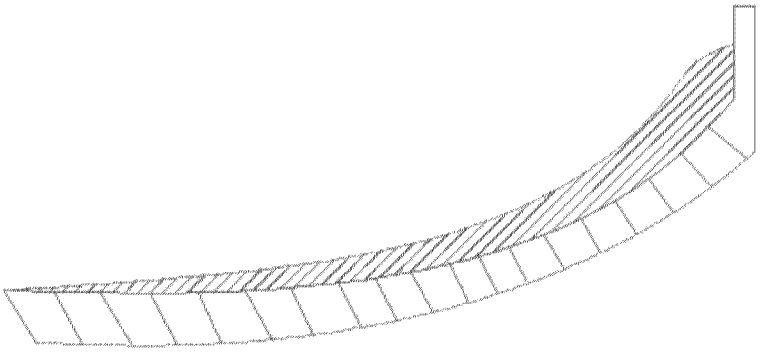

Fig. 3

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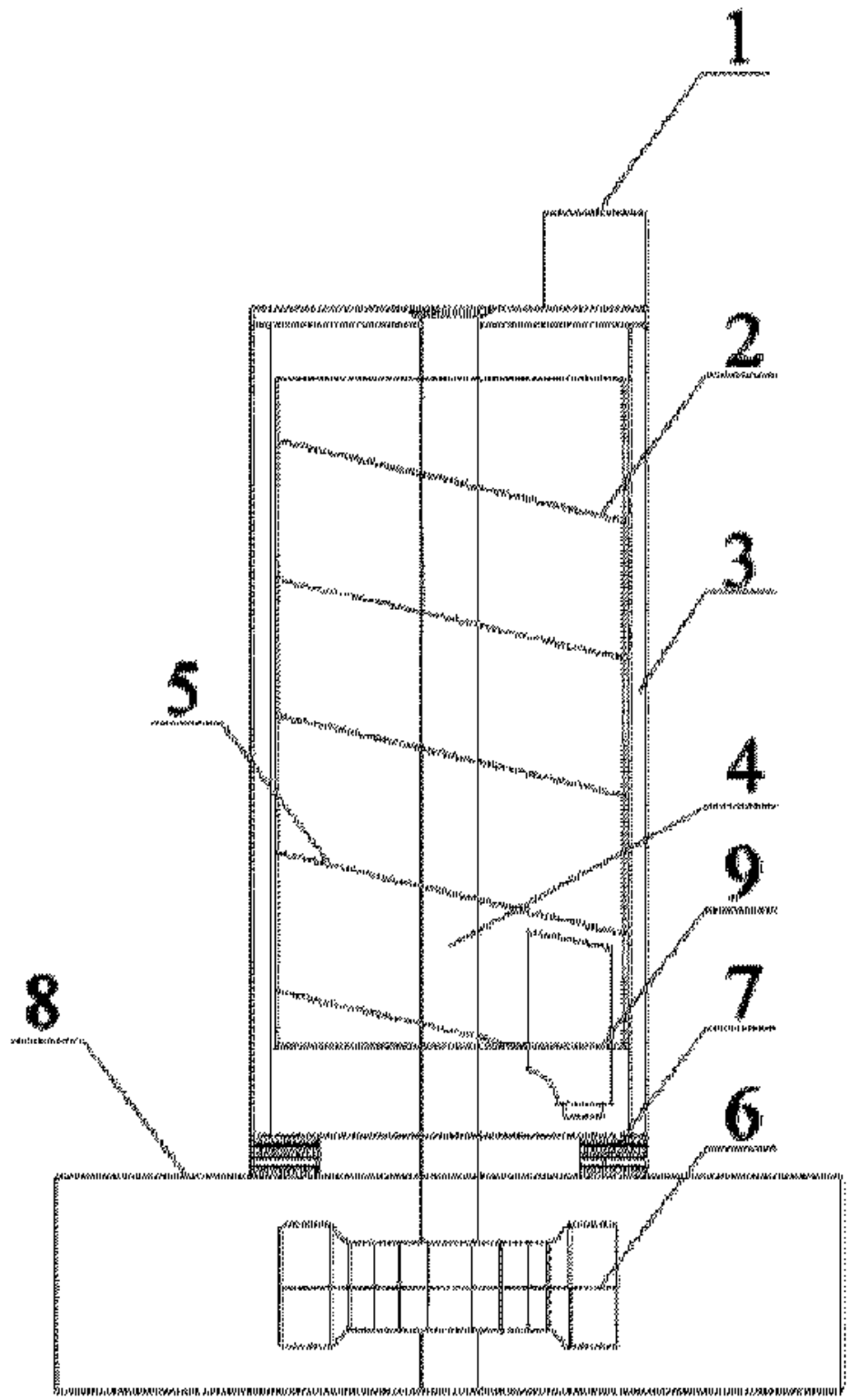
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