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RAKE-FREE THICKENER WITH THREE SECTIONS OF DISCHARGE OPENINGS

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The invention relates to the field of thickening treatment of coal slime, and more particularly, to a rake-free thickener with three sections of discharge openings. The three-section discharge rake-free thickener of the invention includes a center-section thickening tank and two side chamber-section thickening tanks. A “one-center and two-side” discharge mode is adopted. Coarse and fine particles are discharged and recycled from different openings. The coarse particles are discharged from a center underflow opening. The fine particles are discharged by being sucked upwards from side chamber underflow openings. A fine fraction extreme horizontal movement distance is 3 times a radius of the tank. The settling time is longer. A tank bottom of the thickening tank is in a large-dip-angle cone shape. Materials slide to the underflow openings by self-weight. No rake is needed during the discharge. The phenomenon of rake pressing is completely solved. The whole thickening operation achieves higher thickening efficiency. The thickener works more reliably and stably.

RAKE-FREE THICKENER WITH THREE SECTIONS OF DISCHARGE OPENINGS

BACKGROUND

Technical Field

5 The invention relates to the field of thickening treatment of coal slime, and more particularly, to a rake-free thickener with three sections of discharge openings.

Related Art

10 Most coal preparation plants in China use wet coal preparation. Coal slime treatment is an important part of a wet coal preparation process. From economic and environmental considerations, deep clarification of coal slime and closed loop of washing water are both required. Coal preparation plants usually use a flocculation method to treat the coal slime. The so-called flocculation method is to add a flocculant to a coal slime system, so that particles in the coal slime system agglomerate and then settle by gravity. In a traditional coal slime treatment process, a flocculant aqueous solution is generally added
15 to a pipeline or a chute in front of a feeding opening of a thickener. Whether the coal slime and the flocculant aqueous solution can be efficiently mixed is a prerequisite for the efficient thickening treatment of the coal slime.

20 The thickener is a key device in a modern coal slime treatment system. The thickener is a device that continuously thickens coal slime by flocculation and settlement of solid particles in the coal slime. The thickener is substantially composed of a tank for the sedimentation of coal slime and an underflow discharge system that collects sediments to an underflow opening and discharges the sediments. The thickener production process is continuous. Generally, coal slime is fed from the upper middle of the tank. Clarified overflow water flows into an overflow water tank from the periphery
25 of the tank. A sediment product (underflow) is pumped out from an underflow opening at a cone bottom of the tank. A traditional thickener is also known as a rake thickener, which has a rake that concentrates and transports sediments to the center. The rake thickener may be divided into two types: a central transmission type and a peripheral transmission type based on transmission characteristics. The rake thickener may be
30 divided into two types: an ordinary thickener and an efficient thickener based on structural characteristics. The efficient thickener feeds coal slime directly to a concentrate layer at a lower middle part of a thickener body, which shortens a distance

of slime settlement, contributes to settlement of slime particles, increases the resistance of slime entering overflow water, and improves the settlement effect, so it is called an efficient thickener, such as an EimcO-BSP efficient thickener and a domestic efficient thickener. Existing thickeners have been studied more on a transmission device and a body structure, but there are fewer innovations in the design of underflow discharge. In addition, in recent years, research focuses on how to ensure that reagents and coal slime are mixed fully and uniformly and that the turbulence in the thickener body is small, and how to ensure the working stability of the thickener and prevent a thickener rake frame from being pressed by high-concentration materials.

SUMMARY

Objects of the invention are to overcome the deficiencies in the prior art and design a novel three-section discharge rake-free thickener. The three-section discharge rake-free thickener is composed of a center-section thickening tank and two side chamber-section thickening tanks. A “one-center and two-side” discharge mode is adopted. That is, discharge of the center-section thickening tank is performed from a lower part of a center underflow opening, and discharge of the two side chamber-section thickening tanks is performed from side chamber underflow openings by upward suction. Large-floc coarse particles settle quickly, most in the center-section thickening tank, and small-floc fine particles settle for a long time, and may continue settling in the side chamber-section thickening tanks. By means of the “one-center and two-side” discharge mode, coarse and fine fraction materials may be recycled respectively. Underflow of the center-section thickening tank is mainly coarse particles, which may be recycled by using a settling filter centrifugal dehydrator and partially or totally doped into middling coal to obtain a higher economic value. Underflow of the side chamber-section thickening tanks is mainly fine particles, which may be dehydrated and recycled by a pressure filter to achieve complete solid-liquid separation. In addition, tank bottoms of the thickening tanks are all in a large-dip-angle cone shape. No rake is needed during the discharge. The phenomenon of rake pressing is completely solved. The thickener works stably.

To achieve the above object, the invention adopts the following technical solutions:

A rake-free thickener with three sections of discharge openings at least includes a center-section thickening tank. A charge buffer chamber is designed at an upper central

position of the center-section thickening tank. A stirring shaft is arranged at an upper central position of the charge buffer chamber. The stirring shaft is driven by a motor to rotate at a low speed. Stirring impellers in multiple layers are designed at different vertical heights of the stirring shaft. The stirring impellers in multiple layers rotate together with the stirring shaft. A horn-shaped discharge cylinder is connected below the charge buffer chamber. The horn-shaped discharge cylinder is inserted straight down into a high-concentration floc layer at a lower middle part of the center-section thickening tank. Solid particles remain in floc, and settle to a tank bottom of the center-section thickening tank. The tank bottom of the center-section thickening tank is in a large-dip-angle cone shape. The solid particles settle to the tank bottom of the center-section thickening tank and then gradually slide to a center underflow opening by self-weight. The center underflow opening is connected to a slurry pump, and discharge is performed through suction of the slurry pump. Overflow water of the center-section thickening tank flows to side chamber-section thickening tanks through shared tank edges with the side chamber-section thickening tanks by itself. The side chamber-section thickening tanks are arranged adjacent to left and right sides of the center-section thickening tank. The side chamber-section thickening tanks on the left and right sides have the same structure. Tank bottoms of the side chamber-section thickening tanks are in a large-dip-angle cone shape. Materials gradually slide to side chamber underflow openings by self-weight. The materials at the side chamber underflow openings are discharged by being sucked upwards using a high-lift pump. An upward suction pipeline is also provided with a high-pressure flushing pipe for pipeline dredging. Overflow water of the side chamber-section thickening tanks is discharged from a clear water overflow weir.

The beneficial effects of the invention are as follows:

1) A flocculant distribution tank, a spiral slurry reagent mixing barrel, a pipeline mixer, and a three-section discharge rake-free thickener of the invention cooperate to form a coal slime thickening treatment system. The system is rationally arranged along a flow direction of coal slime. The design of the device also reflects the technological requirements of coal slime treatment. The flocculant distribution tank and the spiral slurry reagent mixing barrel achieve batch addition of reagents and preliminary uniform mixing of reagents and slurry, and further achieve uniform mixing through the pipe

mixer. The floc is uniformly presented in a whole coal slime system, and further enters the three-section discharge rake-free thickener. The three-section discharge rake-free thickener creatively adopts a “one-center and two-side” discharge mode based on a traditional efficient thickener. Compared with the existing thickeners, the three-section discharge rake-free thickener has the following advantages: (1) coarse and fine particles are discharged from different openings to form different product structures, large-floc coarse particles settle quickly, and most of them are discharged from the center underflow opening of the center-section thickening tank to form middling coal products, and small-floc fine particles continue settling in the side chamber-section thickening tanks and are discharged from the side chamber underflow openings to form tailings slime products. (2) Whether the fine particles settle in the thickener depends on a horizontal movement distance of the fine particles in the thickener, an extreme horizontal movement distance of the fine particles in the tank of the three-section discharge rake-free thickener is a sum of a radius r of the center-section thickening tank and a diameter $2r$ of the side chamber-section thickening tank, that is, $3r$, which is equivalent to a series connection process of three ordinary center charge thickeners, the same settling effect is achieved, and the floor area can be reduced by $1/3$. (3) Materials are discharged from the side chamber underflow openings of the side chamber-section thickening tanks by upward suction, which reduces the civil construction cost and facilitates routine maintenance. (4) no rake is needed for the discharge from the thickening tank, the phenomenon of rake pressing is completely solved, and the thickener works stably.

2) The process cooperation of the flocculant distribution tank and the spiral slurry reagent mixing barrel achieves the separate addition of reagents and the preliminary uniform mixing of reagents and slurry, the bottom of the flocculant distribution tank is perforated with a plurality of small round holes, each of which is connected with a vertical reagent adding tube, a flocculant aqueous solution is fed to spiral annular plates at different height positions of the spiral slurry reagent mixing barrel through the vertical reagent adding tube to achieve the separate addition of the reagents, the slurry spirally moves downwards along the spiral annular plates, and by means of the change in the flow direction and flow speed of the spirally moving slurry, the preliminary uniform mixing of the slurry and the reagents is achieved.

3) The pipeline mixer achieves the further uniform mixing of the slurry and the reagents, and a plurality of sets of staggered grid bars arranged inside the pipeline mixer increases the turbulence of a fluid and achieves the uniform mixing of the slurry and flocculating reagents.

5 4) The three-section discharge rake-free thickener achieves efficient thickening and settlement of ore particles and discharge of coarse and fine materials from different openings. The three-section discharge rake-free thickener is composed of a center-section thickening tank and two side chamber-section thickening tanks. A charge buffer chamber is designed at an upper central position of the center-section thickening tank.

10 A stirring shaft having stirring impellers in multiple layers is arranged at an upper central position of the charge buffer chamber. The stirring shaft rotates at a low speed to make floc uniformly presented in the whole coal slime system. A horn-shaped discharge cylinder is connected below the charge buffer chamber. The horn-shaped discharge cylinder is inserted straight down into a high-concentration floc layer at a lower middle

15 part of the center-section thickening tank. Solid particles remain in floc, and settle to a tank bottom of the center-section thickening tank. The tank bottom of the center-section thickening tank is in a large-dip-angle cone shape. The solid particles settle to the tank bottom of the center-section thickening tank and then gradually slide to a center underflow opening by self-weight. The center underflow opening is connected to a slurry

20 pump, and discharge is performed through suction of the slurry pump. Unsettled fine particles become overflow water of the center-section thickening tank, and flow to the side chamber-section thickening tanks through shared tank edges with the side chamber-section thickening tanks by themselves. An extreme horizontal movement distance in the side chamber-section thickening tank is a diameter $2r$ of the side chamber-section

25 thickening tank, and 2 times the settling time of a center charge thickener. Tank bottoms of the side chamber-section thickening tanks are in a large-dip-angle cone shape. Materials gradually slide to side chamber underflow openings by self-weight. The materials at the side chamber underflow openings are discharged by being sucked upwards using a high-lift pump. An upward suction pipeline is also provided with a

30 high-pressure flushing pipe for pipeline dredging. Overflow water of the side chamber-section thickening tanks is discharged from a clear water overflow weir. No rake is needed for the underflow discharge of the whole three-section discharge rake-free

thickener, the phenomenon of rake pressing is completely solved, and the thickener works stably.

BRIEF DESCRIPTION OF THE DRAWINGS

5 FIG. 1 is a flowchart of a system according to the invention.

FIG. 2 is a partial enlarged view of a flocculant distribution tank in a structure of FIG. 1.

FIG. 3 is a schematic structural diagram of a spiral slurry reagent mixing barrel in the structure of FIG. 1.

10 FIG. 4 is a schematic structural diagram of a charge buffer chamber in the structure of FIG. 1.

A corresponding relationship between structures shown in the figures and component names of the invention is as follows:

1-Flocculant distribution tank, 1A-Vertical reagent adding tube, 1B-Small round
15 hole, 2-Spiral slurry reagent mixing barrel

2A-Spiral annular plate, 2B-Feeding opening, 2C-Discharge opening, 3-Slurry buffer barrel

3C-Pipeline, 4-Pipeline mixer, 5-Three-section discharge rake-free thickener, 5A-Center-section thickening tank

20 5A1-Charge buffer chamber, 5A2-Stirring shaft, 5A3-Motor, 5A4-Stirring impeller
5A5-Horn-shaped discharge cylinder, 5A6-Tank bottom of center-section thickening tank, 5A7-Center underflow opening

5A8-Slurry pump, 5A9-Shared tank edge, 5B-Side chamber-section thickening tank, 5B1-High-lift pump

25 5B2-High-pressure flushing pipe, 5B3-Tank bottom of side chamber-section thickening tank, 5B4-Side chamber underflow opening

5B5-Clear water overflow weir

DETAILED DESCRIPTION

30 In order to facilitate understanding, specific embodiments of the invention are further described below with reference to FIGS. 1-4. The specific components of the invention are divided into several modules, including: a flocculant distribution tank (1),

a spiral slurry reagent mixing barrel (2), a slurry buffer barrel (3), a pipeline mixer (4), and a three-section discharge rake-free thickener (5), which are described one by one below:

1. Flocculant Distribution Tank

5 The flocculant distribution tank has a rectangular parallelepiped structure. The bottom of the rectangular parallelepiped flocculant distribution tank is perforated with a plurality of small round holes (1B). Each small round hole (1B) is connected with a vertical reagent adding tube (1A). A flocculant aqueous solution is fed to spiral annular plates (2A) at different height positions of the spiral slurry reagent mixing barrel (2)
10 through the vertical reagent adding tube (1A).

2. Spiral Slurry Reagent Mixing Barrel

 The spiral slurry reagent mixing barrel (2) is a spiral structure from top to bottom. Slurry is fed from an upper feeding opening (2B) and spirally moves downwards along the spiral annular plates (2A). The vertical reagent adding tube (1A) adds reagents to the
15 spiral annular plates (2A) at different height positions. The slurry and the reagents are uniformly mixed and then discharged from a lower feeding opening (2C) into the slurry buffer barrel (3). The slurry in the slurry buffer barrel (3) is transported by a pipeline (3C). The pipeline mixer (4) is arranged on the transportation pipeline (3C) to further achieve mixing of slurry and flocculating reagents.

3. Pipeline Mixer

20 The pipeline mixer (4) is a cylinder. A plurality of sets of grid bars is arranged inside the pipeline mixer in a staggered manner. A fluid flows through the grid bars to increase the turbulence and achieve mixing of the slurry and the flocculating reagents. The mixed slurry enters a charge buffer chamber (5A1) of the three-section discharge rake-free
25 thickener (5).

4. Three-Section Discharge Rake-Free Thickener

 The three-section discharge rake-free thickener (5) is composed of a center-section thickening tank (5A) and two side chamber-section thickening tanks (5B). A charge buffer chamber (5A1) is designed at an upper central position of the center-section
30 thickening tank (5A). A stirring shaft (5A2) is arranged at an upper central position of the charge buffer chamber (5A1). The stirring shaft (5A2) is driven by a motor (5A3) to rotate at a low speed. Stirring impellers (5A4) in multiple layers are designed at different

vertical heights of the stirring shaft (5A2). The stirring impellers (5A4) in multiple layers rotate together with the stirring shaft (5A2). A horn-shaped discharge cylinder (5A5) is connected below the charge buffer chamber (5A1). The horn-shaped discharge cylinder (5A5) is inserted straight down into a high-concentration floc layer at a lower middle part of the center-section thickening tank. Solid particles remain in floc, and settle to a tank bottom (5A6) of the center-section thickening tank. The tank bottom (5A6) of the center-section thickening tank is in a large-dip-angle cone shape. The solid particles settle to the tank bottom (5A6) of the center-section thickening tank and then gradually slide to a center underflow opening (5A7) by self-weight. The center underflow opening (5A7) is connected to a slurry pump (5A8), and discharge is performed through suction of the slurry pump (5A8). Overflow water of the center-section thickening tank flows to the side chamber-section thickening tanks (5B) through shared tank edges (5A9) with the side chamber-section thickening tanks by itself. The side chamber-section thickening tanks (5B) are arranged adjacent to left and right sides of the center-section thickening tank. The side chamber-section thickening tanks on the left and right sides have the same structure. Tank bottoms of the side chamber-section thickening tanks are in a large-dip-angle cone shape. Materials gradually slide to side chamber underflow openings (5B4) by self-weight. The materials at the side chamber underflow openings are discharged by being sucked upwards using a high-lift pump (5B1). An upward suction pipeline is also provided with a high-pressure flushing pipe (5B2) for pipeline dredging. Overflow water of the side chamber-section thickening tanks is discharged from a clear water overflow weir (5B5).

In summary, the structure and working mechanism of the invention fully consider the technological characteristics of flocculation and settlement of coal slime. The three-section discharge rake-free thickener adopts a “one-center and two-side” discharge mode. Coarse and fine particles are discharged and recycled from different openings. A fine fraction extreme horizontal movement distance is 3 times the radius of the tank, and the settling time is longer. Materials are discharged from side chamber underflow openings by upward suction, which reduces the civil construction cost and facilitates routine maintenance. The tank bottoms of the thickening tanks are all large-dip-angle cones, no rake is needed during the discharge, and the phenomenon of rake pressing is completely solved. The whole thickening operation is more reagent-saving than

traditional thickening and settling equipment, the thickening efficiency is higher, the thickener works more reliably and stably, and the production cost is also reduced significantly.

CONCLUSIES

1. Een rakelvrij verdikkingsmiddel met een drietraps uitlaat, omvattende een verdikkingstanklichaam centrale gedeelte (5A), waarbij een bovenste centrale positie van een verdikkingstanklichaam centrale gedeelte (5A) is voorzien van een voedingsbufferkamer (5A1), en een roeras (5A2) is aangebracht bij een boven centrale positie van de voedingsbufferkamer (5A1) en de roeras (5A2) wordt aangedreven door een motor (5A3) om met lage snelheid te draaien en meerlagige roerders (5A4) op verschillende verticale hoogten langs de roeras (5A2) ontworpen zijn, de meerlagige roerders (5A4) samen met de roeras (5A2) draait en het onderste deel van de voedingsbufferkamer (5A1) verbonden is met een hoornvormige afvoercilinder (5A5), de hoornvormige afvoercilinder (5A5) naar beneden gaat in de hooggeconcentreerde vloklaag in een onder centraal deel van een werkgebied van het verdikkingstanklichaam centrale gedeelte (5A), vaste deeltjes in de voedingsslurrie zich op een tankbodem (5A6) van het verdikkingstanklichaam centrale gedeelte neerzetten en de bodem (5A6) van het verdikkingstanklichaam centrale gedeelte een grote hellingskegel heeft en de vaste deeltjes bezinken op de tankbodem (5A6) van het verdikkingstanklichaam centrale gedeelte, dan geleidelijk naar beneden schuiven naar de centrale bodemuitlaat (5A7) door hun eigen gewicht, de centrale bodemuitlaat (5A7) verbonden is met een slurriepomp (5A8) en uitvoer wordt voorzien door het afzuiging van de slurriepomp (5A8), overstroom water vanzelf van het verdikkingstanklichaam centrale gedeelte (5A) naar zijkamerdeel verdikkingstanks (5B) door de gedeelte groefzijde (5A9) met de zijkamerdeel verdikkingstanks (5B) stroomt, de zijkamerdeel verdikkingstanks (5B) opgesteld zijn naast linker- en rechterzijden van het verdikkingstanklichaam centrale gedeelte en de zijkamerdeel verdikkingstanks aan de linker- en rechterzijde dezelfde structuur hebben, tankbodems van de zijkamerdeel verdikkingstanks (5B3) een grote grote valhoek kegelvorm hebben en het materiaal geleidelijk naar zijkamerbodemuitlaten (5B4) glijdt door het eigen gewicht en het materiaal bij de zijkamerbodemuitlaten (5B4) door afzuiging omhoog door een hogedrukpomp (5B1) wordt afgevoerd, en een opwaartse zuigleiding verder voorzien is van een hogedrukspoelslang (5B2) voor baggeren middels leidingen, en overstortwater van het zijkamergedeelte verdikkingstanks wordt afgevoerd uit een overstortwatervoorziening voor helder water (5B5).

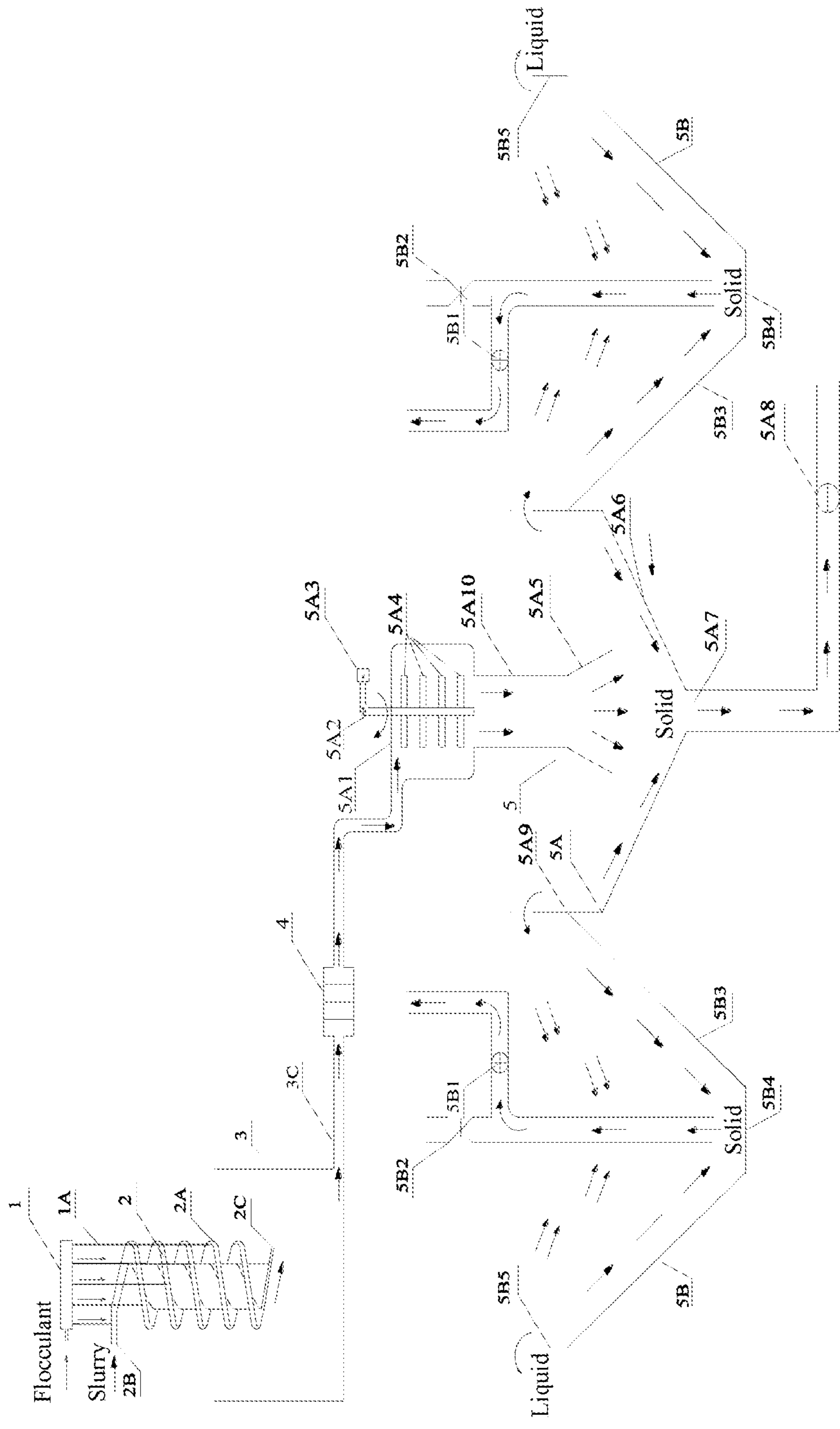


FIG. 1

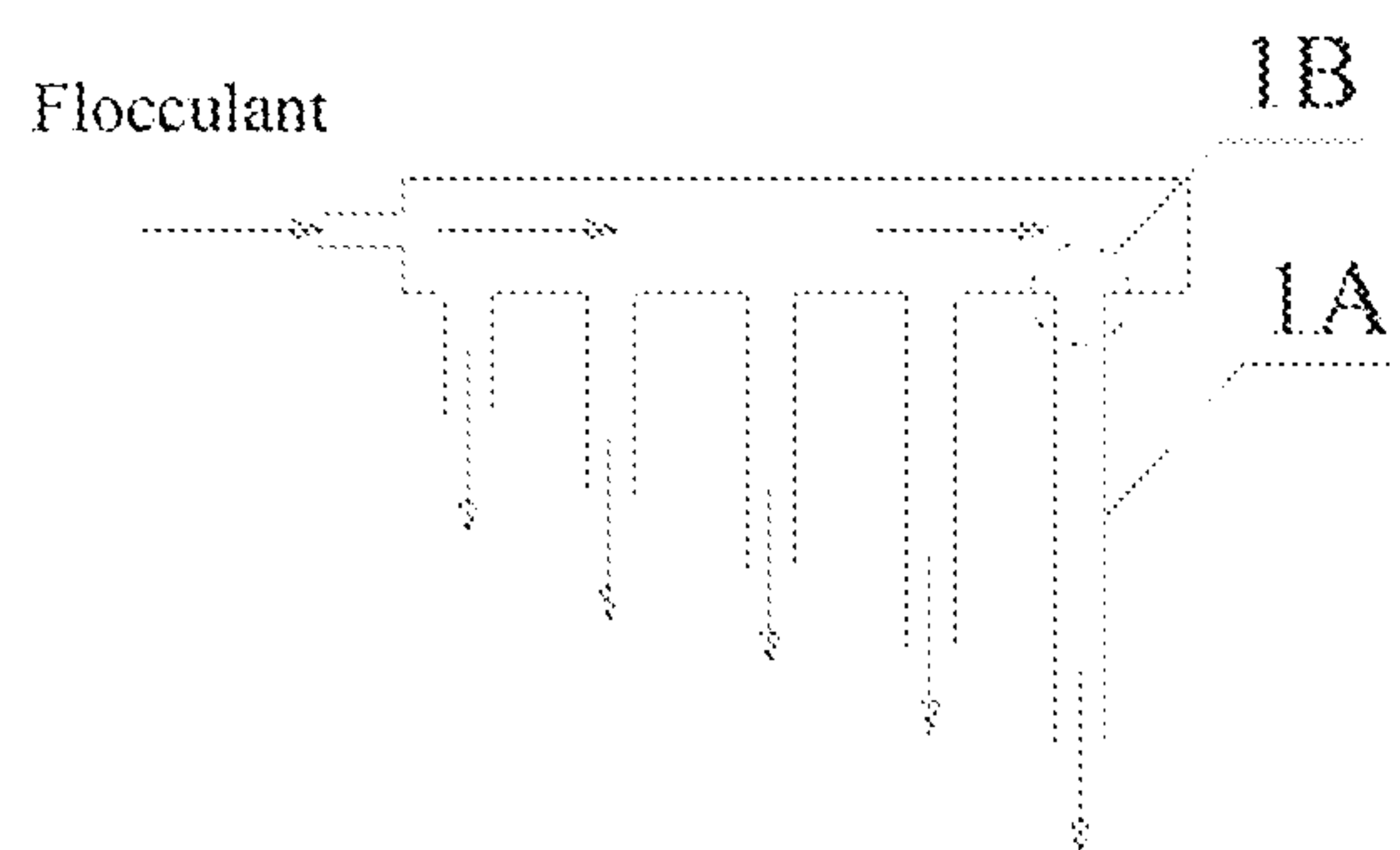


FIG. 2

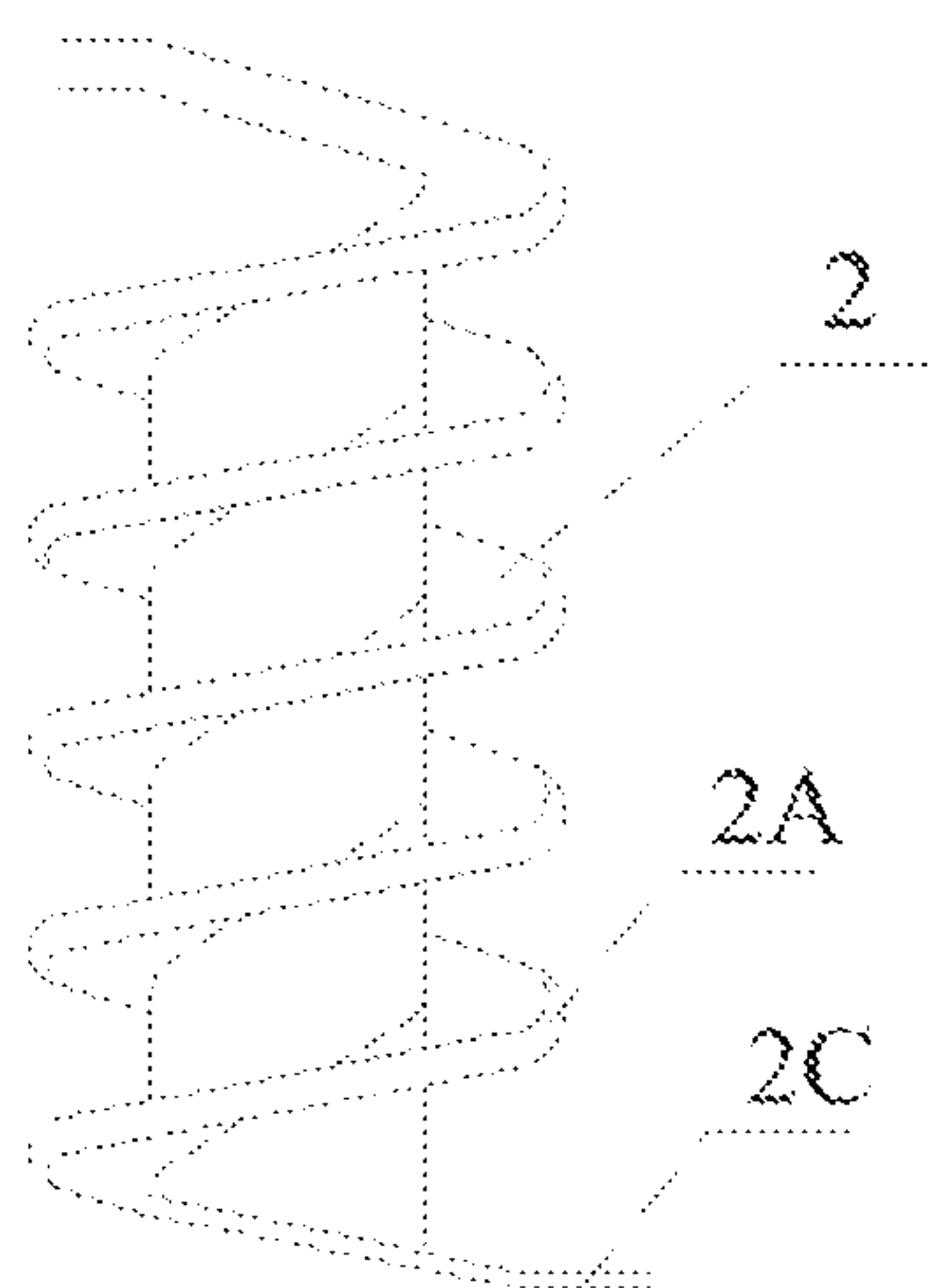


FIG. 3

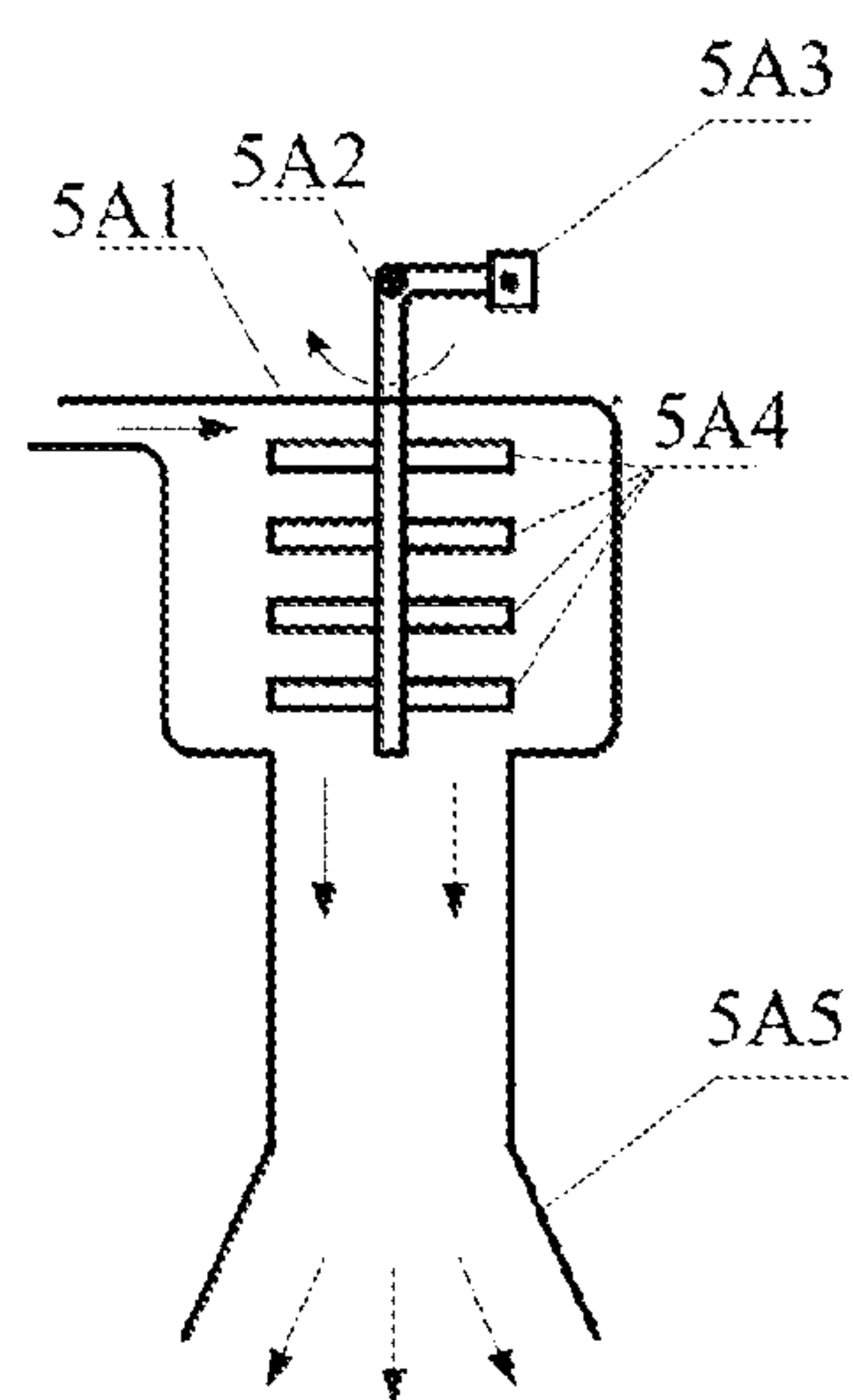


FIG. 4