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(54) **TAPERED TUBE HOLLOW SHAFT, DRAINAGE DEVICE, AND YANKEE DRYER**

(57) The present invention is suitable for the field of paper drying, and proposes a tapered tube hollow shaft, a drainage device, and a Yankee dryer. The tapered tube hollow shaft comprises tapered tubes (1) and riser pipes (2). Each tapered tube is provided with a large head end and a small head end. There are at least two tapered tubes. Multiple tapered tubes are communicated through the large head ends and the small head ends. There are at least two groups of the riser pipes. Each group of the riser pipes is respectively communicated with the large head end of the tapered tube. The tapered tube hollow shaft proposed by an embodiment of the present invention increases the discharge rates of blow-through steam and condensate water, and improves the drainage efficiency and the heat transfer efficiency by increasing the number of the tapered tubes and the riser pipes. The tapered tube hollow shaft can be applied to the Yankee dryer in a wide paper machine.

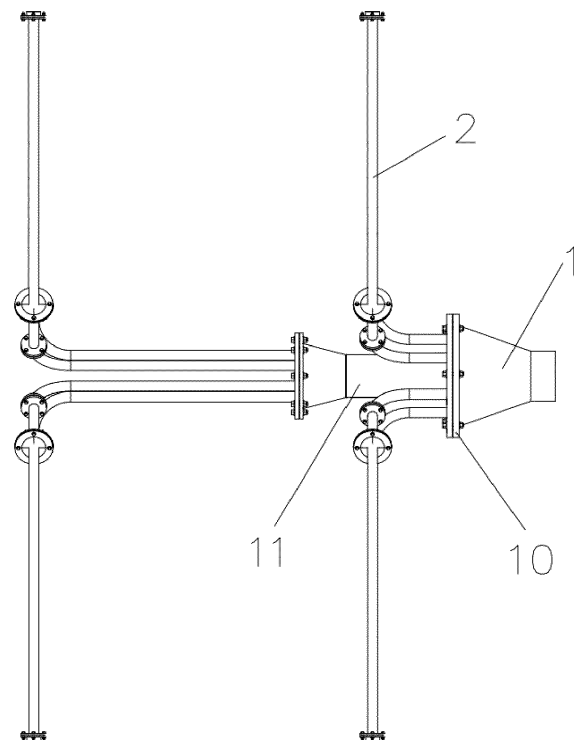


FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention belongs to the field of paper drying, and in particular, relates to a tapered tube hollow shaft, a drainage device, and a Yankee dryer.

BACKGROUND

[0002] The paper is still mainly dried by a dryer in the paper making process. The main principle of the dryer is to transfer the heat of steam into a wet paper to evaporate the water of the wet paper, so as to dry the paper. In the dryer, a condensate water drainage device is a machine utilizing the steam and the pressure difference of a drainage section to drain the condensate water. There are three forms of draining the condensate water: a bailing bucket type, a fixed syphon type, and a rotating syphon type. The bailing bucket type drainage device is only utilized in the ancient low-speed paper machine, and is not utilized in the existing high-speed paper machine. The fixed syphon type drainage device is generally mostly utilized in the wide paper machine; wherein the inner wall of the dryer does not have grooves and is equipped with turbulence bars to break through the water ring and enhance the heat transfer and the drainage; the distance between the tube opening head and the dryer wall is in the range of 2-3 mm. In the rotating syphon type drainage device, a thin syphon tube bundle is connected with a square water collecting pipe; the riser pipes are connected with a hollow drainage pipe; a drainage end is fixedly mounted in an end cap on a drive side in the dryer; generally, 2-8 syphons (which are also called the riser pipes) form a group of syphons and are uniformly distributed on the same plane by 360 degrees; the group of syphons rotates along with the dryer. The rotating syphon type drainage device is difficult to drain the water under a high drainage pressure caused by centrifugal force at high speed. However, if allowing that the steam (namely the blow-through steam which is discharged by the drainage device in the dryer and is uncondensed) with the condensate water is drained from the syphons, the effectively density of drainage will be largely reduced, such that the drainage pressure difference is largely reduced.

[0003] A Yankee dryer is a kind of the dryer. Its integral structure is a cylinder, and a hollow supporting shaft is arranged in the center of the cylinder. The hollow supporting shaft is utilized as the gravity support of the cylinder (the end faces of the hollow shaft support the cylinder through the dryer two sides of round steel plate), and also utilized as the driving shaft of the cylinder rotating process. The discharge flow rates of the blow-through steam and the condensate water depend on the size of the sectional area of the riser pipe group. However, in the prior art, no matter how the diameter and the width of the Yankee dryer vary, only one riser pipe group is set. So, the riser pipe group cannot meet the requirements

of draining the condensate water and the steam, causing unsmooth drainage and low heat transfer efficiency.

SUMMARY

[0004] An objective of an embodiment of the present invention is to propose a tapered tube hollow shaft to solve the problems in the background art.

[0005] The embodiment of the present invention is achieved as follows: a tapered tube hollow shaft comprises:

tapered tubes, wherein each tapered tube is provided with a large head end and a small head end; there are at least two tapered tubes; multiple tapered tubes are communicated through the large head ends and the small head ends; riser pipes, wherein there are at least two groups of the riser pipes; each group of the riser pipe is respectively communicated with the large head end of the tapered tube.

[0006] Preferably, the tapered tube hollow shaft further comprises:

a connector, wherein the connector is arranged at the large head end of the tapered tube; the riser pipes are communicated with the large head end of the tapered tube through the connector; a straight tube section, wherein the straight tube section is arranged between the connector and the small head end of the tapered tube; the small head end of one tapered tube is communicated with the large head end of another tapered tube through the connector and the straight tube section.

[0007] Another objective of the embodiment of the present invention is to propose a drainage device. The drainage device comprises a hollow supporting shaft with through holes, and the above tapered tube hollow shaft. The tapered tubes are arranged in the hollow supporting shaft.

[0008] Preferably, the drainage device further comprises:

at least one water collecting pipe, wherein one end of each riser pipe away the tapered tube is communicated with the water collecting pipe, and the water collecting pipe is arranged outside the hollow supporting shaft; at least one thin syphon tube bundle, wherein each thin syphon tube bundle is communicated with each water collecting pipe.

[0009] Preferably, the drainage device further comprises:

a water collecting pipe support, wherein one end of the water collecting pipe support is connected with the hollow

supporting shaft while the other end is connected with the water collecting pipe.

[0010] Another objective of the embodiment of the present invention is to propose a Yankee dryer. The Yankee dryer comprises a cylinder and the above drainage device. The drainage device is arranged in the cylinder. The hollow supporting shaft is fixedly connected with the cylinder.

[0011] Preferably, the Yankee dryer further comprises:

a steam inlet tube, which is arranged on the cylinder and is communicated with the hollow supporting shaft;

a steam outlet tube, which is arranged on the cylinder and is communicated with the hollow supporting shaft.

[0012] Preferably, the Yankee dryer further comprises: turbulence bars, which are arranged on the inner wall of the cylinder.

[0013] Preferably, grooves are formed in the inner wall of the cylinder. One end of the thin syphon tube bundle is arranged in each groove.

[0014] The tapered tube hollow shaft proposed by the embodiment of the present invention increases the discharge rates of blow-through steam and condensate water, and improves the drainage efficiency and the heat transfer efficiency by increasing the number of the tapered tubes and the riser pipes. The tapered tube hollow shaft can be applied to the Yankee dryer in a wide paper machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 is a schematic structural diagram of a tapered tube hollow shaft proposed by an embodiment of the present invention.

FIG. 2 is a schematic structural diagram of a drainage device proposed by an embodiment of the present invention.

FIG. 3 is a side view of a Yankee dryer proposed by an embodiment of the present invention.

FIG. 4 is a schematic structural diagram of a Yankee dryer including two stages of a tapered tube hollow shaft, proposed by an embodiment of the present invention.

FIG. 5 is a schematic structural diagram of a Yankee dryer including four stages of a tapered tube hollow shaft, proposed by an embodiment of the present invention.

FIG. 6 is a perspective view of a Yankee dryer proposed by an embodiment of the present invention.

FIG. 7 is a schematic structural diagram of thin syphon tube bundles proposed by an embodiment of the present invention.

[0016] In the drawings: 1-tapered tube, 2-riser pipe, 3-hollow supporting shaft, 4-water collecting pipe, 5-thin syphon tube bundle, 6-cylinder, 7-steam inlet tube, 8-steam outlet tube, 9-water collecting pipe support, 10-connector, and 11-straight tube section.

DESCRIPTION OF THE EMBODIMENTS

[0017] To make the objectives, technical solutions, and advantages of the present invention clearer, the following further describes the present invention in detail with reference to the accompanying drawings and embodiments. It should be understood that the described specific embodiments are merely used to explain the present invention rather than to limit the present invention.

[0018] The specific implementation of the present invention will be described in detail below with reference to the specific embodiments.

[0019] FIG. 1 is a schematic structural diagram of a tapered tube hollow shaft proposed by an embodiment of the present invention. The multistage tapered tube hollow shaft comprises:

tapered tubes 1, wherein each tapered tube 1 is provided with a large head end and a small head end; there are at least two tapered tubes 1; multiple tapered tubes 1 are communicated through the large head ends and the small head ends;

riser pipes 2, wherein there are at least two groups of the riser pipes 2; each group of the riser pipes 2 is respectively communicated with the large head end of the tapered tube 1.

[0020] In the actual application, the number of the tapered tubes 1 and the riser pipes 2 can be set according to the actual drainage capacity. The riser pipe 2 is an L-shaped syphon. When there are multiple tapered tubes 1, multiple groups of the riser pipes 2 are correspondingly arranged. The multiple tapered tubes 1 are communicated through the large head ends and the small head ends. Each group of the riser pipes 2 is formed by 2-8 riser pipes 2 uniformly distributed on the end face of the large head end of the tapered tube 1 by 360 degrees. The embodiment of the present invention increases the discharge rates of blow-through steam and condensate water, and improves the drainage efficiency and the heat transfer efficiency by increasing the number of the tapered tubes 1 and the riser pipes 2.

[0021] As shown in FIG. 1, as a preferred embodiment of the present invention, the multistage tapered tube hollow shaft further comprises:

a connector 10, wherein the connector 10 is arranged at the large head end of the tapered tube 1; the riser pipes 2 are communicated with the large head end of the tapered tube 1 through the connector 10;

a straight tube section 11, wherein the straight tube

section 11 is arranged between the connector 10 and the small head end of the tapered tube 1; the small head end of one tapered tube 1 is communicated with the large head end of another tapered tube 1 through the connector 10 and the straight tube section 11.

[0022] Specifically, the connector 10 may be a flange. The connector 10 is fixed to the end face of the large head end of the tapered tube 1 through screws. Each group of the riser pipes 2 is uniformly distributed on the connector 10 by 360 degrees. One end of each riser pipe 2 is communicated with the tapered tube 1 through the connector 10. When there are multiple tapered tubes 1, the small head end of one tapered tube 1 is communicated with the large head end of another tapered tube 1 through the connector 10 and the straight tube section 11. The small head end is fixedly arranged in an area surrounded by the multiple riser pipes 2. Additionally, the riser pipe 2 enters the tapered tube 1 through the connector 10 so as to be capable of reducing the steam erosion of the blow-through steam to the tube wall of the tapered tube 1. A pipe connecting flange of the riser pipe 2 is designed at one end in 90 degrees with the tapered tube 1 and helps manufacture and pipe connection.

[0023] As shown in FIG. 2, the embodiment of the present invention further proposes a drainage device. The drainage device comprises a hollow supporting shaft 3 with through holes, and the above tapered tube hollow shaft. The tapered tubes 1 are arranged in the hollow supporting shaft 3.

[0024] In actual application, the riser pipe 2 penetrates through the side wall of the hollow supporting shaft 3 and is fixed to the hollow supporting shaft 3. The tapered tube hollow shaft in FIG. 2 is a four-stage tapered tube hollow shaft.

[0025] As shown in FIG. 2 and FIG. 7, as a preferred embodiment of the present invention, the drainage device further comprises:

at least one water collecting pipe 4, wherein one end of each riser pipe 2 away the tapered tube 1 is communicated with the water collecting pipe 4, and the water collecting pipe 4 is arranged outside the hollow supporting shaft 3;

at least one thin syphon tube bundle 5, wherein each thin syphon tube bundle 5 is communicated with each water collecting pipe 4.

[0026] Specifically, the cross section of the water collecting pipe 4 is square. Each water collecting pipe 4 is communicated with one or more riser pipes 2 distributed in one direction. Each thin syphon tube bundle 5 comprises two rows of thin syphon tubes arranged in a certain angle. The existing rotating syphon type drainage device is difficult to drain the water under a high drainage pressure caused by centrifugal force at high speed. However, if allowing that the steam (namely the blow-through

steam) with the condensate water is drained from the thin syphon tubes, the effectively density of drainage will be largely reduced, such that the drainage pressure difference is largely reduced. The optimal flow rate of the mixed liquid of the blow-through steam and the condensate water in the thin syphon tube is in the range of 23-46 m/s. If the flow rate is too high, the mixed liquid may generate steam erosion to the thin syphon tube and the hollow supporting shaft 3. Furthermore, the more the steam mixed into the condensate water is, the smaller the density of the mixed liquid is; so, the smaller the pressure difference (the difference between the steam feeding pressure and the condensate water discharging pressure) is, and the easier the mixed liquid is to be drained out of the thin syphon tube.

[0027] As shown in FIG. 2, as a preferred embodiment of the present invention, the drainage device further comprises:

a water collecting pipe support 9. Wherein one end of the water collecting pipe support 9 is connected with the hollow supporting shaft 3 while the other end is connected with the water collecting pipe 4.

[0028] Specifically, the water collecting pipe support 9 may be an integral structure or comprises multiple supporting rods. The water collecting pipe 4 is fixedly connected with the hollow supporting shaft 3 through the water collecting pipe support 9.

[0029] As shown in FIG. 3 to FIG. 6, the embodiment of the present invention further proposes a Yankee dryer. The Yankee dryer comprises a cylinder 6 and the above drainage device. The drainage device is arranged in the cylinder 6. The hollow supporting shaft 3 is fixedly connected with the cylinder 6.

[0030] In actual application, the cylinder 6 may be fabricated by cast iron and steel. The cast iron cylinder has a thicker wall and lower loading capability than the steel cylinder (the working pressure can be 7 bars); so, the cast iron cylinder is gradually obsolete. The steel cylinder emerges in recent 15 years and is gradually popular.

The steel cylinder has nearly a half thick wall than the cast iron cylinder, and the high loading capability (the working pressure can be 9 bars). The heat transfer efficiency of the steel cylinder is 15-30% higher than that of the cast iron cylinder. The two sides of the Yankee dryer respectively are an operation side and a drive side. The working pressure of high-pressure steam entering the Yankee dryer generally is in the range of 7-8 bars. The high-pressure steam enters the hollow support shaft 3 from the operation side, passes through the through holes of the hollow supporting shaft 3, and then enters the interior of the Yankee dryer. At this time, the high-pressure steam meets the low-temperature inner wall of the Yankee dryer to release its latent heat, and wet paper absorbs the surface heat of the Yankee dryer and then evaporates its water. The degree of dryness of the finished product can reach 95-96%. The high-pressure steam forms the condensate water after releasing the latent heat. The thin syphon tube bundle 5 absorbs the

condensate water, the uncondensed high-pressure steam and incondensable gas into the water collecting pipes. Such mixture flows through the riser pipes 2, then enters the tapered tube 1, and finally is drained from the drive side. Furthermore, the length of the small head end of the tapered tube 1 close to the drive side can be gradually increased to discharge the blow-through steam and the condensate water of the water collecting pipes 4 at a far end from the drive side as soon as possible.

[0031] As shown in FIG. 3 to FIG. 6, as a preferred embodiment of the present invention, the Yankee dryer further comprises:

- a steam inlet tube 7, which is arranged on the cylinder 6 and is communicated with the hollow supporting shaft 3;
- a steam outlet tube 8, which is arranged on the cylinder 6 and is communicated with the hollow supporting shaft 3.

[0032] Specifically, the steam inlet tube 7 is close to the large head end of the tapered tube 1, and the operation side of the Yankee dryer and the steam inlet tube 7 are arranged on the same side. The steam outlet tube 8 is close to the small head end of the tapered tube 1, and the drive side of the Yankee dryer and the steam outlet tube 8 are arranged on the same side.

[0033] As a preferred embodiment of the present invention, the Yankee dryer further comprises: turbulence bars, which are arranged on the inner wall of the cylinder 6.

[0034] Specifically, the turbulence bars can make the condensate water ring to oscillate so as to obtain a strong turbulent flow, which is widely applied to a wide paper machine. The turbulence bars are mounted on the inner wall of the cylinder 6, synchronously move along with the cylinder 6 to break through the water ring. The turbulence bars facilitate the condensate water layer in the cylinder 6 to generate local turbulence and the turbulent flow, so as to improve the heat transfer uniformity and the drying efficiency of the cylinder 6.

[0035] As a preferred embodiment of the present invention, grooves are formed in the inner wall of the cylinder 6. One end of the thin syphon tube bundle 5 is arranged in each groove.

[0036] Specifically, in a high-speed toilet paper machine, a steam-condensate water system uses a heat pump, and the Yankee dryer generally utilizes a groove type (without the turbulence bars). The drainage device adopts the rotating syphon tubes and the thin syphon tube bundle 5. The distance between the thin syphon tube bundle 5 and the bottom of the groove is about in the range of 1.25-2 mm. The thin syphon tube bundle 5 is inserted into the groove of the Yankee dryer to absorb the condensate water, the uncondensed steam and the incondensable gas out.

[0037] The above merely describes preferred embodiments of the present invention, but are not used to limit

the present invention. Any modifications, equivalent replacements, improvements and the like within the spirit and principle of the present invention shall be all contained in the protection scope of the present invention.

Claims

1. A tapered tube hollow shaft, comprising:

tapered tubes, wherein each tapered tube is provided with a large head end and a small head end; there are at least two tapered tubes; multiple tapered tubes are communicated through the large head ends and the small head ends; riser pipes, wherein there are at least two groups of the riser pipes; each group of the riser pipe is respectively communicated with the large head end of the tapered tube.

2. The tapered tube hollow shaft according to claim 1, further comprising:

a connector, wherein the connector is arranged at the large head end of the tapered tube; the riser pipes are communicated with the large head end of the tapered tube through the connector;

a straight tube section, wherein the straight tube section is arranged between the connector and the small head end of the tapered tube; the small head end of one tapered tube is communicated with the large head end of another tapered tube through the connector and the straight tube section.

3. A drainage device, comprising a hollow supporting shaft with through holes, and the tapered tube hollow shaft according to any one of claims 1 and 2, wherein the tapered tubes are arranged in the hollow supporting shaft.

4. The drainage device according to claim 3, further comprising:

at least one water collecting pipe, wherein one end of each riser pipe away the tapered tube is communicated with the water collecting pipe, and the water collecting pipe is arranged outside the hollow supporting shaft;

at least one thin syphon tube bundle, wherein each thin syphon tube bundle is communicated with each water collecting pipe.

5. The drainage device according to claim 4, further comprising:

a water collecting pipe support, wherein one end of the water collecting pipe support is connected with

the hollow supporting shaft while the other end is connected with the water collecting pipe.

6. A Yankee dryer, comprising a cylinder and the drainage device according to any one of claims 3 to 5, wherein the drainage device is arranged in the cylinder; the hollow supporting shaft is fixedly connected with the cylinder. 5
7. The Yankee dryer according to claim 6, further comprising: 10
- a steam inlet tube, which is arranged on the cylinder and is communicated with the hollow supporting shaft; 15
- a steam outlet tube, which is arranged on the cylinder and is communicated with the hollow supporting shaft.
8. The Yankee dryer according to claim 6, further comprising: 20
- turbulence bars, which are arranged on the inner wall of the cylinder.
9. The Yankee dryer according to claim 6, wherein 25
- grooves are formed in the inner wall of the cylinder; one end of the thin syphon tube bundle is arranged in each groove.

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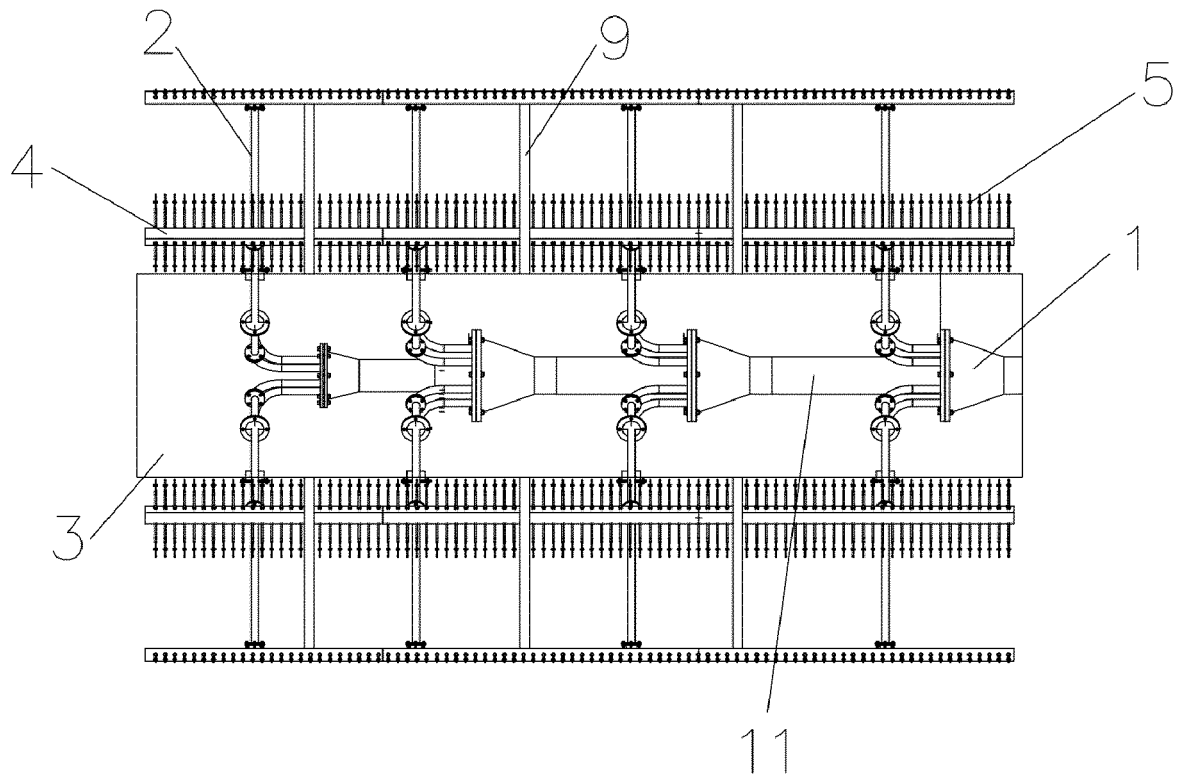


FIG. 2

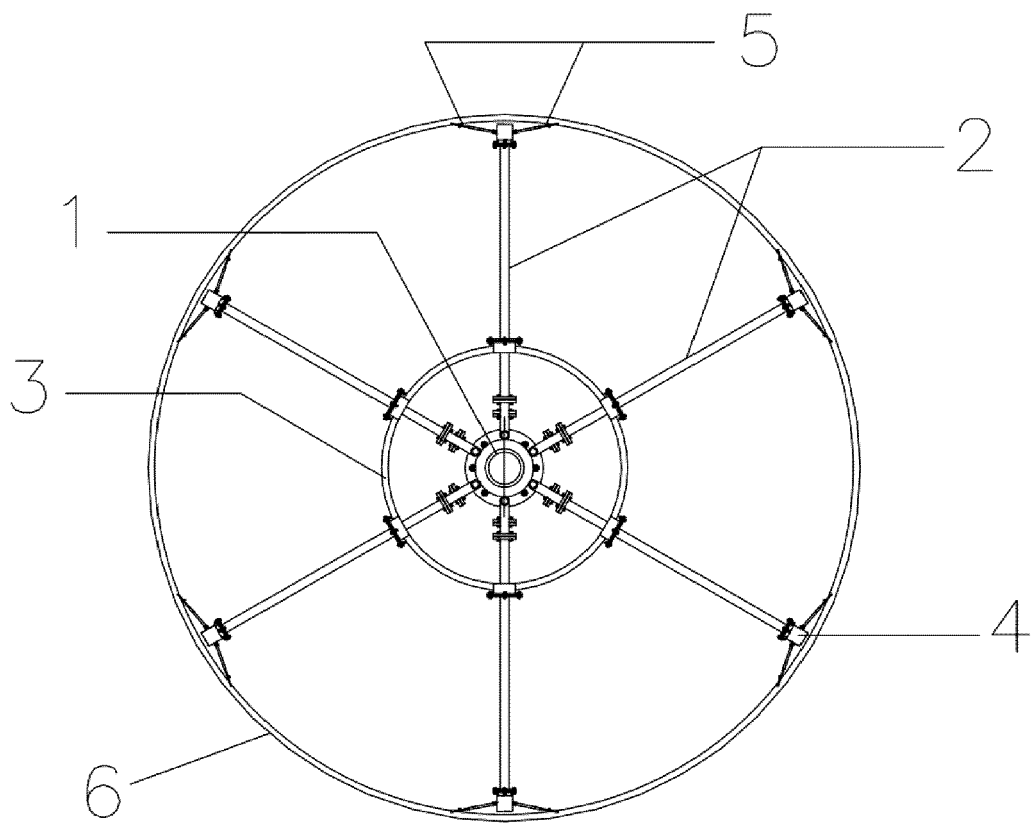


FIG. 3

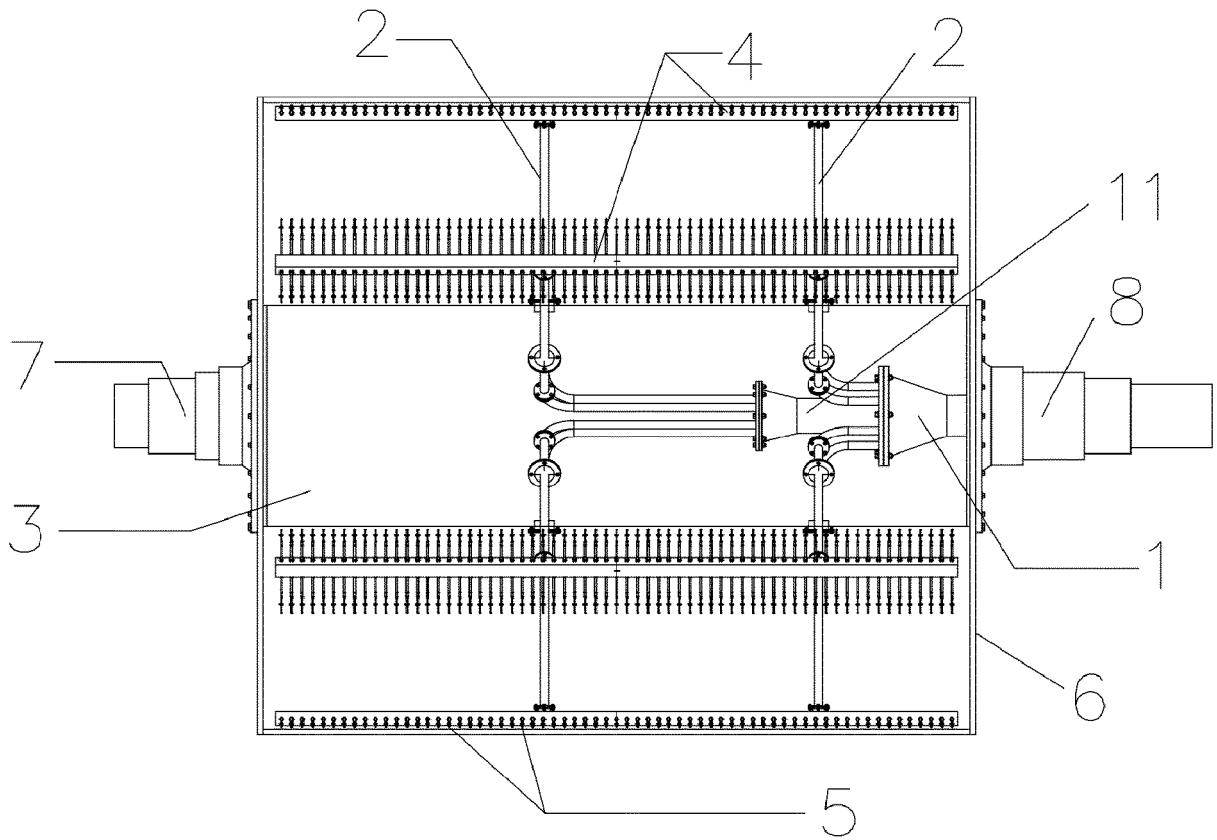


FIG. 4

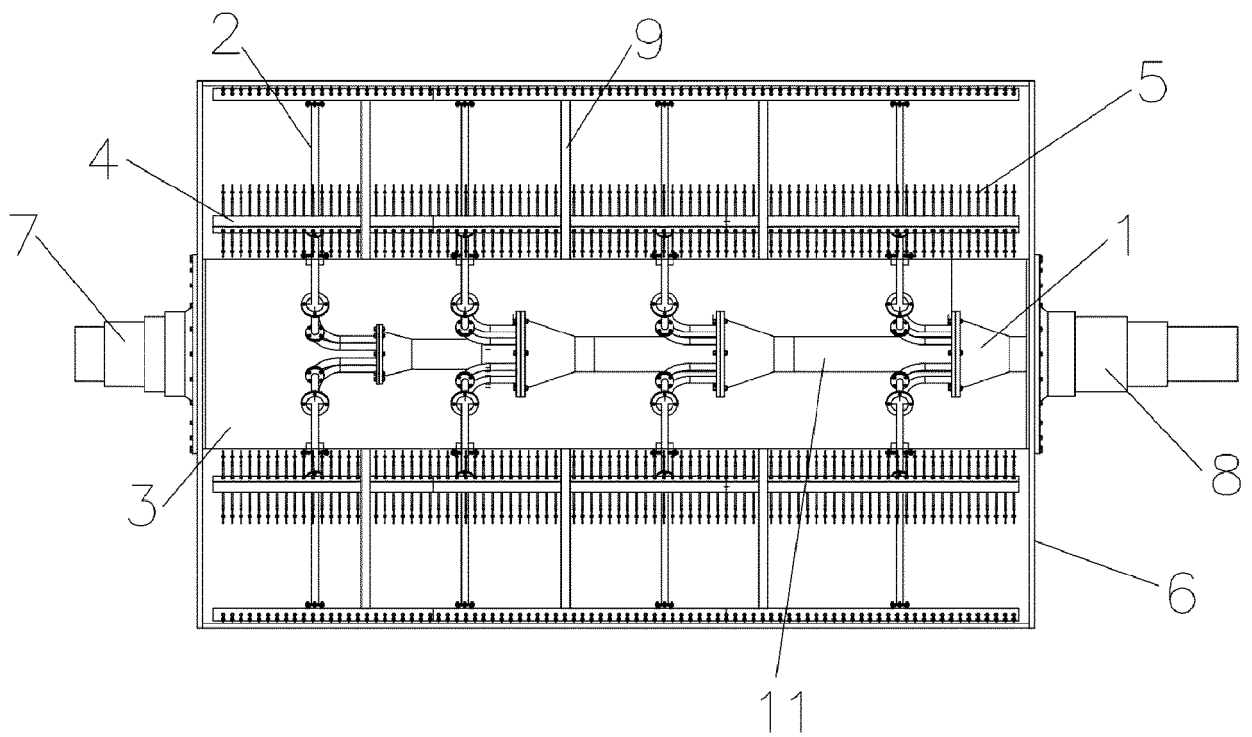


FIG. 5

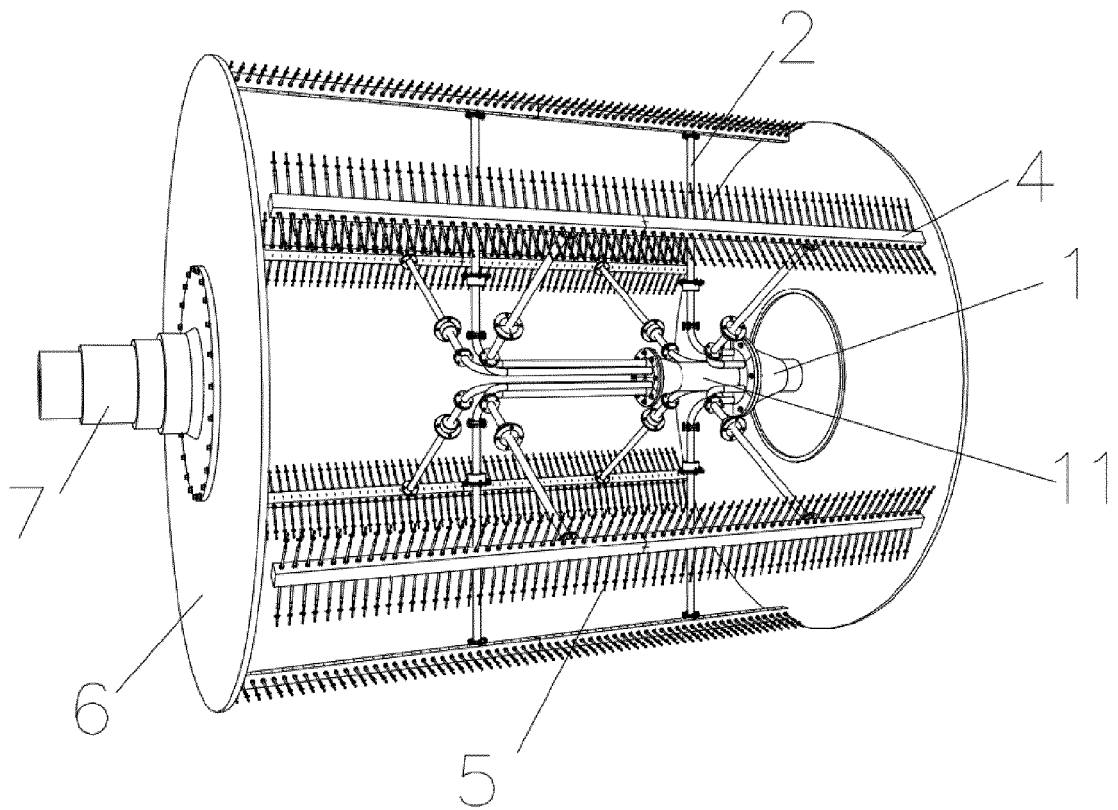


FIG. 6

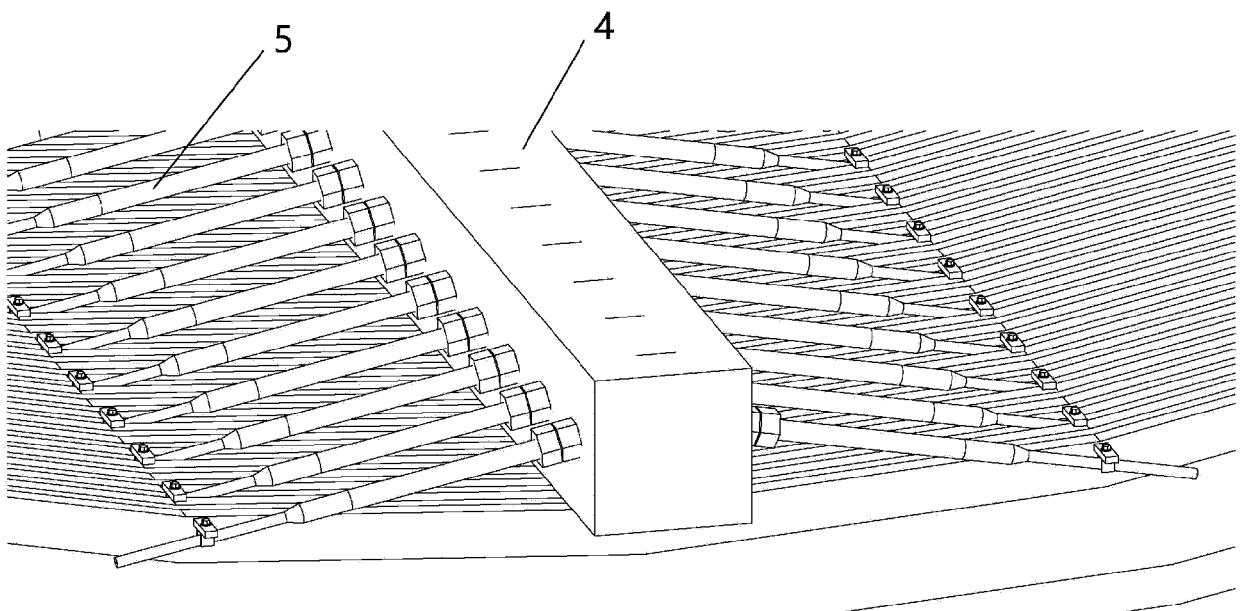


FIG. 7



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Application Number
EP 20 19 2970

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Place of search Munich		Date of completion of the search 30 November 2020	Examiner Maisonnier, Claire
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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