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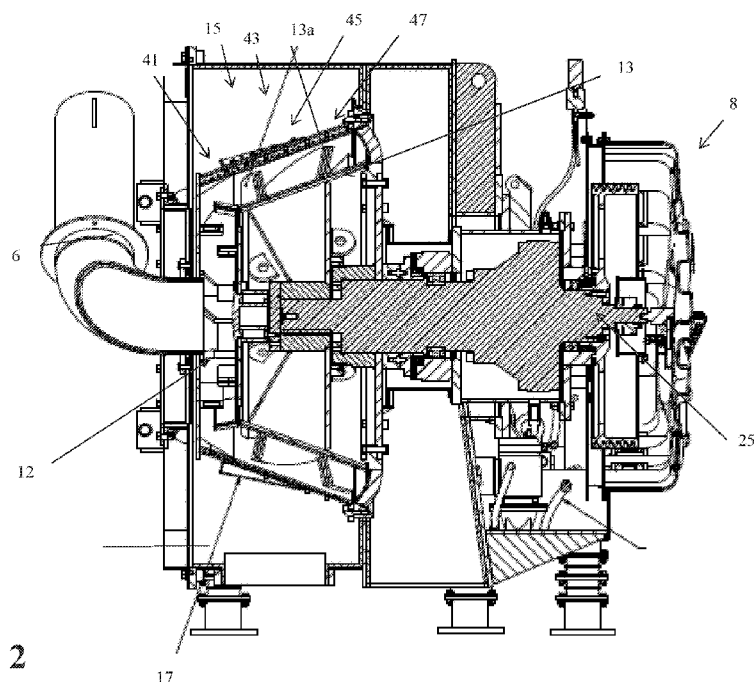


FIG. 2

(57) Abstract: A scroll screen centrifugal separator (1) includes a screen assembly (15) that includes a screen (15a) that is rotatable to facilitate separation of liquid from particulates within a slurry. The screen (15a) has a plurality of openings (15b). A plurality of blades (17) can be positioned adjacent to the openings (15b). The blades (17) can be shaped to direct air toward the openings (15b) of the screen (15a) when the screen assembly (15) is rotated to reduce a rate at which liquid is emittable through the openings (15b) of the screen when the screen (15a) is rotated. The retardation of the flow rate at which liquid is emittable through the openings (15b) of the screen (15a) can help improve the wear profile of the screen (15a) and the effective life of the screen (15a).

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CENTRIFUGAL SEPARATOR AND SCREEN HAVING BLADES FOR SAME FIELD OF THE INVENTION

The present invention relates to centrifugal devices. More particularly, the present invention relates to distributors that may be utilized in scroll screen centrifugal separators such as a horizontal scroll screen centrifuge or a vertical scroll screen centrifuge.

BACKGROUND OF THE INVENTION

Examples of centrifuge related apparatuses as well as other types of devices that can be used to separate liquids from solids may be appreciated from U.S. Patent Nos. 1,334,023, 1,664,769, 1,903,795, 2,370,353, 2,727,631, 2,752,043, 3,087,621, 3,302,895, 3,307,703, 3,315,810, 3,361,264, 3,411,631, 3,418,097, 3,428,246, 3,782,643, 3,837,913, 4,063,959, 4,922,625, 4,961,722, 5,256,289, 5,426,866, 5,410,795, 5,616,245, 8,257,587, 8,813,974, and 9,751,094, U.S. Patent Application Publication Nos. 2011/0006016, 2015/0041384, 2017/0282194, Chinese Patent Publication Nos. CN 102489416A, CN104815763A, CN207204395U, CN20270665U, CN206257893U, and CN201399387Y, Australian Patent Publication No. AU2010100939A, United Kingdom Patent Publication Nos. GB548561A, GB890667A, and GB2033242A, and International Patent Publication Nos. WO 2014/132236, WO 2015/162587, and WO 2018/202711. Some types of centrifugal devices may be used to pulverize rock or other material to a smaller size while other types of centrifugal devices may be utilized to separate different materials.

For example, scroll screen centrifuges may be utilized in some environments to separate liquid from solid particulate material. U.S. Patent Nos. 8,257,587 and 9,751,094 each discloses a scroll screen centrifuge that is configured to receive slurry and separate solid particulates from the liquid of the slurry.

SUMMARY OF THE INVENTION

I have determined that, during operations, the basket of a centrifuge (e.g. a scroll screen centrifuge) often experiences extensive wear in certain localized zones near the inlet of the basket at which a slurry is received. As a result, the basket may need to be replaced regularly. Replacing the basket can incur costs and undesirably stoppages in operation as the operator of the centrifuge shuts the centrifuge down for a period of time to remove an old basket and replace it with a new one. I have determined means by which such wear can be addressed to reduce the number of times a basket may need replaced and to reduce the number of undesired operational stoppages that can be caused by such maintenance.

Some embodiments of a centrifugal separator are provided that include a housing and a screen rotatably positioned in a cavity of the housing. The screen can have a plurality of blades adjacent a plurality of openings of the screen. The blades can be sized and configured so that, when the screen is rotated, the blades generate an air flow that is directed toward the openings of the screen and/or into the screen to reduce the rate at which liquid is emittable out of openings of the screen. This retardation of the emission of the liquid out of the openings can more uniformly spread the de-liquification of the particulates within the slurry so that the liquid is more uniformly separated from the particulates within a slurry as the particulates pass from the feed conduit to an outlet end of the scroll assembly.

In some embodiments, a feed conduit can be connected to the housing. The feed conduit can have a mouth through which the slurry is fed into a cavity of the housing. A scroll assembly can also be mounted for driven rotation within the cavity of the housing. The scroll assembly can be positioned within the screen assembly (e.g. within an enclosure defined by the body of the screen of the screen assembly).

Embodiments of the blades can have a particular shape or profile for defining a pre-selected air flow pattern when the screen is rotated. For example, the blades can be tapered so that a varied back pressure is provided by the rotating of the blades. This back pressure that is generated can be varied so that the back pressure is decreased as the slurry moves through the screen from the inlet toward the outlet. In some embodiments, the blades can have a tapered shape to help define this varied back pressure. The shape of the blades can also be structure so that a tapered second portion extends at an angle relative to a first linearly extending portion attached to the body of the screen. The second portion can be at an angle of between 120°-170°, 130°-160°, 140°-150° (e.g. 120°, 125°, 130°, 135°, 145°, 145°, 15°, 155°, 160°, 165°, 170°, or some other angle between 120° and 170°) relative to the first portion. In some embodiments, the second portion can be triangularly shaped to define the taper of the blade. The first portion can extend linearly and be smooth.

In some embodiments, the screen can have a first end, a second end, and at least one intermediate portion between the first end and the second end. The screen can be positioned so that slurry is passable into the screen via the first end (e.g. a first inlet end). The screen can be arranged so that particulates within the slurry are to be emitted out of the screen adjacent the second outlet end of the screen after the particulates are passed through the screen from the first inlet end toward the second outlet end of the screen. The openings of the screen and the blades can be configured so that liquid of the slurry is passed out of the screen via the openings. At least one intermediate portion of the screen can include at least a first intermediate portion and a second intermediate portion in some embodiments. In other embodiments, there may be a third portion and also a fourth portion. The first, second, third and fourth portions can also be referred to as first, second, third, and fourth sections of the screen. Each of the blades can be tapered so

that a flow rate at which air is fed through the openings into the screen adjacent the first end when the screen is rotated is greater than a flow rate at which air is fed through the openings into the screen adjacent the first intermediate portion of the screen. The second intermediate portion can be located between the second outlet end of the screen and the first intermediate portion. Each of the blades can be tapered so that a flow rate at which air is directed toward the openings and/or into the screen adjacent the first end is greater than a flow rate at which air is fed toward the openings and/or into the screen adjacent the second intermediate portion of the screen and the flow rate at which the air is directed toward openings of the screen adjacent to the first intermediate portion is greater than the flow rate at which the air is directed toward the openings of the screen adjacent to the second intermediate portion.

Different embodiments of the blades can have different types of shapes or configurations. In some embodiments, each of the blades can include a first linearly extending portion attached to the screen and a tapered second portion extending along a first side of the first linearly extending portion at a pre-selected angle to the first linearly extending portion. The pre-selected angle can be an angle that is within the range of 120°-170°, 130°-160°, or 140°-150°. In some embodiments, the tapered second portion can have a triangular shape.

As another example, some embodiments of the blade can be configured so that the tapered second portion has a first end and a second end and the first end of the tapered second portion is closer to the first end of the screen than the second end of the tapered second portion. The second end of the tapered second portion can have a smaller width than the first end of the tapered second portion. The first end of the screen can be the end of the screen that is positioned to receive slurry from a feed conduit so that the solid particulates within the slurry are moved from the first end of the screen toward the second end of the screen as the screen is rotated to

expel the liquid of the slurry away from the solid particulates to separate the liquid from the solid particulates. The first linearly extending portion can have a uniform width and length. The blades can also be structured to include a plurality of spaced apart ribs. Each of the ribs can extend between the first linearly extending portion and the tapered second portion.

Embodiments of the centrifugal separator can be configured as a vertical scroll screen centrifugal separator or a horizontal scroll screen centrifugal separator. The scroll assembly can rotate at a speed that is different than a speed of rotation of the screen assembly to separate solid particulate material from liquid of the slurry. In some embodiments, the distributor is fastened to the scroll assembly.

A screen assembly for a centrifugal separator is also provided. The screen assembly can include a screen having a plurality of openings and a plurality of blades positioned adjacent to the openings. The blades can be sized and shaped to direct air toward the openings of the screen when the screen assembly is rotated to reduce a rate at which liquid is emittable through the openings of the screen when the screen is rotated.

Each of the blades can include a first linearly extending portion attached to a body of the screen and a tapered second portion extending along a first side of the first linearly extending portion at a pre-selected angle to the first linearly extending portion. The pre-selected angle can be within the range of 120°-170°, 130°-160°, or 140°-150°. In some embodiments, the tapered second portion has a triangular shape. For some embodiments, the tapered second portion can have a first end that is closer to the first end of the screen than the second end of the tapered second portion. The second end of the tapered second portion can have smaller width than the first end of the tapered second portion. The first end of the screen can be the end of the screen that is positioned to have slurry fed into the screen via a feed conduit. The first linearly

extending portion can have a uniform width and length. The blade can also include spaced apart ribs that extend between the first linearly extending portion and the tapered second portion. The ribs can be sized and shaped to provide additional rigidity or support to the structure of the blade.

Other details, objects, and advantages of the invention will become apparent as the following description of certain present preferred embodiments thereof and certain present preferred methods of practicing the same proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of a centrifugal separator and screen for use in centrifugal separators are shown in the accompanying drawings and certain exemplary methods of practicing the same are also illustrated therein. It should be understood that like reference numbers used in the drawings may identify like components.

Figure 1 is a perspective front view of a first exemplary embodiment of a centrifugal separator.

Figure 2 is a cross sectional view of the first exemplary embodiment of the centrifugal separator taken along line II-II shown in Figure 1.

Figure 3 is front view of the exemplary screen of the first exemplary embodiment of the centrifugal separator.

Figure 4 is a rear perspective view of the exemplary screen of the first exemplary embodiment of the centrifugal separator.

Figure 5 is a perspective view of an exemplary blade of the exemplary screen of the first exemplary embodiment of the centrifugal separator.

Figure 6 is a schematic view illustrating an exemplary method by which air flow in a blade air flow direction BAFD that is driven by blades 17 helps reduce the flow rate at which

liquid 63 (e.g. droplets of water, a flow of water, etc.) moves in a liquid flow direction LFD out of openings 15b of the screen 15a when liquid 63 is being separated from solid particulates 61 within the screen 15a.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Referring to Figures 1-6, a centrifugal separator 1 may include a housing 2 and a feed conduit 6 connected to a moveable wall 7 of the housing. The housing 2 may also include feet that are configured to directly contact a platform or floor to support the housing 2.

The moveable wall 7 can be moved from an open position to a closed position. When in the open position, the wall 7 may open the housing 2 to permit an operator or other person to gain access to the cavity defined within the housing 2 to perform maintenance work or other work within the housing 2. For example, a scroll assembly 13 and screen assembly 15 can be positioned in the cavity of the housing and the wall 7 may be moved to the open position so that maintenance work relating to the replacement or repair of elements of these components may be performed. When in the closed position, the wall 7 can be positioned to enclose the cavity of the housing 2 so that the material may be fed to the cavity defined by the housing 2 via a feed conduit 6 for separation of solid particulate material that is within a liquid (e.g. liquid water) of a slurry.

The feed conduit 6 may be a conduit (e.g. a pipe or duct, etc.) through which a slurry is passed to feed slurry to the centrifugal separator 1 so that solid particulate material within the slurry can be separated from the liquid of the slurry. A pump and/or other flow control mechanism can be connected to the feed conduit 6 to drive movement of the slurry toward the centrifugal separator 1. The particulate material may be a mineral or ore such as coal, gold,

silver, copper, iron, or other material. The liquid of the slurry can be water or may include water or another type of liquid.

The centrifugal separator 1 may include a motor or other type of drive unit 8. Alternatively, the centrifugal separator 1 can be configured to be coupled to a motor or a drive unit. The motor or drive unit may be a remote device that is connectable and releaseably from the centrifugal separator 1. One type of drive unit that may be utilized is the drive assembly disclosed in U.S. Pat. No. 8,257,587. In other embodiments, a different type of drive unit 8 may be utilized in the centrifugal separator 1.

The drive unit 8 may include an electric motor that is configured to rotate a drive belt to drive rotation of a shaft 25 that extends into an inner cavity defined by the housing 2. The scroll assembly 13 and the screen assembly 15 can each be coupled to the shaft 25 within the housing 2 such that rotation of the shaft 25 rotates a screen 15a of the screen assembly 15 and a scroll of the scroll assembly 13. The scroll assembly 13 and screen assembly 15 may each be connected to the shaft 25 via fasteners, welding, or other types of connection mechanisms.

The scroll assembly 13 and the screen assembly 15 can each be coupled to the shaft 25 such that the scroll assembly 13 rotates at a speed that is different than the speed at which the screen assembly rotates. The difference in rotation between the screen assembly 15 and scroll assembly 13 can help facilitate the separation of liquid from the solid particulates within the slurry fed into the housing 2 via the feed conduit 6.

In some embodiments, the scroll assembly 13 may be coupled to the shaft 25 so that the scroll of the scroll assembly 13 rotates at a speed that is greater than the speed at which the screen of the screen assembly 15 rotates. In other embodiments, the scroll assembly 13 may be coupled to the shaft 25 such that the scroll of the scroll assembly 13 rotates at a speed that is less

than the speed at which the screen of the screen assembly 15 rotates. The scroll assembly 13 and screen assembly 15 may be attached to the shaft 25 such that the rotational speed difference between the scroll assembly 13 and the screen assembly 15 is a fixed ratio or is adjustable so that the rotational speed differential between the screen assembly 15 and the scroll assembly 13 is variable.

Flutes 13a can be attached to the body of the scroll of the scroll assembly 13 such that the flutes 13a rotate when the scroll rotates via rotation of the shaft 25 driven by the drive unit 8 coupled to the shaft 25 via a drive belt or other coupling mechanism. Each scroll flute 13a may be attached to the body of the scroll via welding, bolts, or other types of fastening mechanisms. The scroll flutes may be curved or helical shaped members that are configured to help facilitate movement of the slurry within the cavity of the housing and within the space between the screen assembly 15 and the scroll assembly 13.

The screen assembly 15 may include a screen 15a that is structured as basket or other configuration that has a plurality of openings 15b that are sized to permit liquid to pass through the openings 15b, but retain solid particulate material within the screen 15a so that the solid material is retained between the screen 15a and body of the scroll assembly 13 so that the liquid of the slurry can be expelled away from the solid particulate material and the scroll body to a position located outside of the screen 15a. The liquid may be moved via rotation of the scroll and screen 15a so that the liquid is output from the cavity of the housing 2 via at least one liquid discharge outlet defined within the housing 2. The solid particulate material may be discharged from at least one particulate discharge outlet defined within the housing 2.

Pipes or other conduits may be connected to each liquid discharge outlet to receive the output liquid and feed that liquid to another device or mechanism. Pipes or other conduits may

be connected to each particulate discharge outlet to receive the separated solid particulate material and transport that material to another device. Alternatively, a hopper or other retaining device may be positioned in alignment with each particulate discharge outlet to receive the separated solid particulate material. The particulate material may subsequently be periodically dumped out of the hopper or otherwise removed from the hopper for further transport or processing.

In some embodiments, a distributor 12 can be utilized. For example, a distributor 12 can be connected to the scroll assembly 13 or the shaft 25 and be positioned in the cavity of the housing 2 such that the distributor 12 is located between a mouth of the feed conduit through which slurry is fed into the cavity of the housing and the flutes 13a of the scroll assembly 13 such that slurry fed into the cavity via the feed conduit 6 contacts the distributor 12 and is diverted by the distributor toward the screen 15a of the screen assembly 15. The distributor 12 can be positioned to direct the slurry fed into the cavity of the housing via the inlet mouth 3a of the feed conduit 6 so that the slurry is distributed along a preselected range of angles from the front face of the distributor 12 to within the scroll and screen 15a adjacent first ends, or inlet ends of the screen 15a and scroll.

As may best be seen from Figures 3-5, the screen 15a of the centrifugal separator 1 can include a body that has a plurality of openings 15b defined therein. The screen 15a includes an inlet end 15d that is opposite an outlet end 15e. The inlet end 15d can be considered a first end and the outlet end 15e can be considered a second end that is opposite the first end. The inlet end 15d can have a central feed opening 15c defined therein that is sized to receive slurry from the feed conduit 6. The inlet end 15d of the screen 15a can be closer to the mouth of the feed conduit 6 than the outlet end 15e.

Slurry is passable into the screen 15a via the inlet end 15d and feed conduit 6. During operation, the screen 15a can rotate to help expel liquid 63 away from the solid particulates 61 within the slurry fed into the enclosure 15f defined by the screen 15a. The openings 15b can be sized to permit the liquid to be emitted out of the screen 15a via openings 15b while also retaining the solid particulates within the enclosure 15f. The enclosure 15f can be sized so that the scroll is positionable within the enclosure 15f as well. During operation, the solid particulates within the slurry can be moved from the first inlet end 15d toward the second outlet end 15d. As the slurry is passed from the first inlet end 15d to the second outlet end 15e, the liquid of the slurry is expelled via rotation of the screen 15a and the rotation of the scroll of the scroll assembly 13 within the enclosure 15f. Once at the outlet end 15e, the particulates may be passed out of the screen 15a via one or more particulate discharge openings defined adjacent the second outlet end 15e of the screen 15a. The particulates that are driven to the second outlet end 15e can be substantially free of liquid (e.g. dry, damp but no longer within a slurry, etc.) due to the expelling of the liquid out of the screen 15a via openings 15b.

Blades 17 can be attached to the body of the screen 15a adjacent the openings 15b. The blades 17 can extend from their first end 17a to their second end 17b along the screen 15a so that the blades extend along the body of the screen 15a from adjacent the first inlet end 15d toward the second outlet end 15e.

The blades 17 can be shaped so that the blades 17 can generate an air flow for directing air toward the openings 15b and into the enclosure 15f defined by the body of the screen 15a when the screen 15a rotates. The directing of air in a blade air flow direction BAFD toward and/or into the openings 15b for retarding some of the flow of liquid in the liquid flow direction LFD out of openings 15b so that the rate at which liquid is expelled out of openings 15b is

slowed for different portions of the screen 15a. Figure 6 schematically illustrates an exemplary process by which the air driven by blades 17 in the blade air flow direction BAFD helps retard the flow of liquid 63 out of openings 15b of the screen 15a.

For example, the screen can be considered to have a plurality of portions, or sections. The portions, or sections, can include a first section 41, a second section 43, a third section 45, and a fourth section 47 (these sections can also be referred to as portions and can be considered intermediate portions that are located between first end 15d and second end 15e of the screen 15a). The first section 41 can be located adjacent the first inlet end 15d, the fourth section 47 can be located adjacent the second outlet end 15e, the third section 45 can be between the second section 43 and fourth section 47, and the second section 43 can be between the first section 41 and the third section 45. The blades 17 can be sized and shaped so that they each have a larger first end 17a than a second end 17b that is opposite their first end 17a. The first end 17a of the blades 17 can be positioned to be closer to the first inlet end 15d of the screen than the second end 17b of the blades 17. This size difference can provide a variable back pressure that is generated when the screen 15a is rotated so that the flow rate of air driven toward and/or into the openings 15b of the screen 15a differs depending on the location of the openings relative to the first inlet end 15d of the screen 15.

For example, the blades 17 can be shaped and sized so that the rate at which air is fed toward and/or into openings 15b in a first section 41 of the screen 15a is at a first flow rate, the rate at which air is fed toward and/or into openings 15b in the second section 43 of the screen is at a second flow rate, the rate at which air is fed toward and/or into openings 15b in the third section 45 of the screen is at a third flow rate, and the rate at which air is fed toward and/or into openings 15b in the fourth section 47 of the screen is at a fourth flow rate. The first flow rate can

be the highest flow rate, the fourth flow rate can be the lowest flow rate, or slowest flow rate. The second flow rate can be higher than the third flow rate and also be lower than the first flow rate. The third flow rate can be lower than the second flow rate and lower than the first flow rate, but also higher than the fourth flow rate.

The blades 17 may not always be designed to direct air toward and/or into openings 15a of four different sections of the screen 15a. For example, in some embodiments, the blades 17 can be positioned so that air is only directed toward and/or into openings 15b at the first section 41, only directed toward and/or into openings 15b of the first and second sections 41 and 43, or only passed into openings of the first, second, and third sections 41, 43, and 45. In yet other embodiments, there may be additional sections (e.g. a fifth section, or fifth portion, a sixth section, or sixth portion, etc.) and the blades 17 can be sized and shaped to provide a back pressure that affects a flow rate of liquid out of these additional sections.

An exemplary configuration for the blades 17 may best be seen in Figure 5. Each of the blades 17 can be tapered so that the first end 17a of the blade has a larger width W than the second end 17b. The change in width W can be defined by first and second portions 18 and 19 of the blade. The tapered second portion 19 that extends adjacent to the first linearly extending portion 18 can have a variable width W that decreases as the tapered section extends along its length L from adjacent its first end 19a to its distal second end 19b. This tapered shape can define a triangular portion in some embodiments of the second portion 19.

The length of each blade 17 can be any of a number of suitable lengths. In some embodiments, the length of the blades 17 can be in the range of 30 mm in length to extending along an entire length of the screen 15a. In other embodiments, the lengths of the blades 17 may

vary for different blades to provide a desired air flow pattern that is to be formed via the blades 17 being rotated via screen rotation.

The first linearly extending portion 18 and tapered second portion 19 of each blade can be defined as sections of a unitary cast structure or unitary molded structure. Alternatively, the first linearly extending portion 18 and tapered second portion 19 can each be a particular shaped member (e.g. plate, element, bar, etc.) that is welded to each other on or adjacent the first side 18d of the first linearly extending portion 18 and a first inner edge 19i of the tapered second portion 19. A second outer edge 19o of the tapered second portion 19 can define the outermost edge of the blade for directing air toward openings 15b when the screen is rotated.

The length L of the first linearly extending portion 18 can be about the same length as the second portion 19 as the first linearly extending portion extends from its first end 18a (located at or adjacent the first end 17a of the blade 17) to its opposite second end 18b (located at or adjacent the second end 17b of the blade 17). The width W of the first linearly extending portion can be the same throughout the length L of the first linearly extending portion 18. In some embodiments, the body of the first linearly extending portion 18 can include holes 18c that are sized to facilitate attachment to the body of the screen 15a via bolts, screws, or other type of fasteners. Alternatively, the holes 18c may not be present and the attachment of the first linearly extending portion 18 to the screen 15a may occur via welding or other type of fastening mechanism.

Ribs 20 can be spaced apart from each other and extend between the first linearly extending portion and the tapered second portion 19 to provide additional rigidity or support to the blade structure. The ribs 20 can extend from a first end that is attached to a side of the first linearly extending portion 18 to a rear side of the tapered second portion 19. The front side of

the tapered second portion 19 that is opposite this rear side to which the ribs 20 are attached can define the face of the blade that contacts the air for driving the flow of the air into the openings 15b.

The tapered second portion 19 can extend along its length L at a pre-selected angle θ relative to the first linearly extending portion 18. The width W of the tapered second portion 19 may extend away from a first side of the first linearly extending portion 18 linearly along this angle θ . The extension of the tapered second portion along its width W can define the face of the blade that directs air toward and/or into openings 15b of the screen body. The angle θ at which the width W of the tapered second portion 19 extends from the first side of the first linearly extending portion 18 can be an angle of between 120° - 170° (e.g. an angle in the range of 120° - 170° , an angle in the range of 160° - 130° , an angle in the range of 140° - 150° , or an angle of 120° , 130° , 140° , 150° , 160° , 170° , or some other angle between 120° and 170°). The width W of the tapered second portion 19 can be vary continuously as the tapered second portion extends along its length L from its first end 19a (positioned at or adjacent the first end 17a of the blade 17) to its second end 19b (located at or adjacent the second end 17b of the blade 17). The width W can be greater at a first section 19c that is adjacent the first end 19a of the tapered second portion (located at or adjacent the first end 17a of the blade 17). The width W can be lowest at the second end 19b of the tapered second portion 19. The width of a second section 19d that is between the first section 19c and a third section 19e can be greater than the width of the third section 19e and also smaller than the width of the first section 19c. The width W of the third section 19e can be greater than the width at the terminal second end 19b of the tapered second portion and smaller than the width W of the second section 19d.

The variable width W of the tapered second portion can define the varied back pressure provided by the blades when the screen 15a rotates. This varied back pressure can decrease along the screen body from a higher back pressure adjacent the inlet end 15d and a lower back pressure adjacent the second outlet end 15e of the screen 15. The varied back pressure can affect the flow rate at which liquid is expellable out of the openings 15b so that the rate at which the liquid is expelled out of the openings 15b is more uniform along the entirety of the path of travel of the particulates of the slurry within the enclosure 15f. This more uniform expelling of liquid can help ensure wear is experienced more uniformly along the screen 15a so that a screen 15a does not need replaced or repaired due to excessive wear experienced near the inlet end of the screen 15a.

For example, I have determined that conventional screens in scroll screen centrifuges can experience excessive wear at their inlet sections as compared to the outlet end sections due to the speed of rotation of the screen 15a and scroll, which can cause more of the liquid to pass out of openings closest to the inlet such that this portion of the screen body experiences the most wear. I have determined that the use of tapered blades 17 can address this problem by providing a means of retarding the flow rate of liquid out of the openings 15b at a variable rate along the screen body via the variable back pressure created by the tapered blades 17 driving a varied flow rate of air toward the openings 15b. By providing a varied back pressure that decreases as the slurry is passed from the first inlet end 15d to the second outlet end 15e of the screen 15a, the rate at which liquid is passed out of openings 15b can be more uniform so that a much larger portion of the screen, if not the entirety of the screen 15a, experiences wear more evenly. By spreading out the deliquification of the slurry (e.g. dewatering) over a significantly larger surface area of the screen 15, the wear experienced by the screen 15a can be evened out to improve the

overall life of the screen 15a. This can require less replacements or repairs of the screen 15a as compared to a conventional screen design (e.g. reduce the time a centrifuge separator may be off-line due to maintenance or repair to reduce operational costs and improve profitability, reduce the number of screens needed for annual use of the centrifuge to reduce operational costs and costs associated with repair and maintenance, etc.).

The second portion 19 is shown as being triangular shape in the drawings. But, other embodiments can be configured so that the second portion has a different type of shape. For instance, in some embodiments, the second portion 19 can be shaped to have a curved outer edge 19o instead of a linearly extending outer edge 19o. In other embodiments, the outer edge 19o can have an irregular shape, be configured to define a rectangular shape (e.g. the second portion 19 has little or no taper), or can be configured to define a polygonal shape or irregular shape that has variable widths along the length of the second portion 19. For example, in some embodiments, the second portion 19 can have an outer edge 19o that includes a series of spaced apart linearly extending segments that are separated by curved or linearly angled segments to define an irregular shape (e.g. a “W” type shape, an “S” type shape, a “N” type shape, a “M” type shape, a “A” type shape, A “V” type shape, a “U” type shape, etc.).

The first linearly extending portion 18 has been shown as a relatively straight and smooth member (e.g. a bar, an elongated plate, etc.). In other embodiments, the first linearly extending portion 18 can be considered a first portion 18 of the blade 17 that extends along its length as an elongated member and have a different type of shape or configuration (e.g. a rod, a tube, etc.).

The width of the second portion 19 of the blade 17 can also be adjusted to meet a particular set of design criteria. It is contemplated that the widths of the second portions 19 of the blades 17 can be in the range of 20 mm to 150 mm for many embodiments. But, lesser

widths (e.g. less than 20 mm) and greater widths (e.g. greater than 150 mm) could also be utilized for the second portion 19. As discussed herein, the width of the second portion 19 can be variable and vary at different segments along the length of the second portion 19 in some embodiments (e.g. by tapering linearly to a lesser width, by tapering in an irregular pattern, by tapering in a curved pattern, etc.). The full width of the second portion 19 in such embodiments can be considered a maximum width. Other less width segments may be considered to be widths of different segments or portions of the second portion 19 (e.g. first section 19c can have this maximum width and second section 19d can have a lesser width, and third section 19e can have a same width as the second section 19d, a lesser width, or a greater width, etc.).

It should be appreciated that different changes can be made to embodiments of the centrifuge and screen 15a to meet different sets of design criteria. For example, the size and shape of the screen 15a, flutes 13a, shaft 25, housing 2, or openings 15b can be any particular size or shape that can meet a particular set of design criteria. As another example, the size and shape of the blades 17, their length, the extent to which they taper, or their structure can be any of a number of different configurations to meet a particular set of criteria. For example, some blades in some embodiments may have a much longer length than other blades 17 in other embodiments. As another example, whether ribs 20 are needed, the number of ribs 20 used, and the extent to which the blades taper can be adjusted to meet a particular set of design criteria. As yet another example the attachment of the tapered second portion 19 to the first linearly extending portion 18 of each blade can be any of a number of different mechanism (e.g. cast as an integral unit, portions are welded together, and/or other fastening mechanism is used, etc.) As yet another example, the number of blades 17, their spacing about the outer periphery of the screen 15a, and their size and shape can be adjusted to meet any particular set of design criteria

(e.g. capacity of the centrifuge, rotational rates of the screen 15a when the centrifuge is operated, the size of particulates within the slurry to be processed, etc.).

As yet another example, it is contemplated that a particular feature described, either individually or as part of an embodiment, can be combined with other individually described features, or parts of other embodiments. The elements and acts of the various embodiments described herein can therefore be combined to provide further embodiments. Thus, while certain exemplary embodiments of a centrifugal separator and a screen for a centrifugal separator and methods of making and using the same have been shown and described above, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. A centrifugal separator comprising:

a housing, the housing having a cavity; and

a screen assembly mounted within the cavity of the housing for driven rotation within the housing, a screen of the screen assembly having a plurality of blades positioned adjacent to openings defined in the screen, the blades being sized and shaped to direct air toward the openings of the screen assembly when the screen assembly is rotated to reduce a rate at which liquid is emitted through the openings of the screen when the screen is rotated.

2. The centrifugal separator of claim 1 wherein the centrifugal separator is a vertical scroll screen centrifugal separator or a horizontal scroll screen centrifugal separator and wherein the scroll assembly rotates at a speed that is different than a speed of rotation of the screen assembly to separate solid particulate material from liquid of the slurry.

3. The centrifugal separator of claim 1, comprising:

a scroll assembly mounted for driven rotation within the cavity of the housing, the scroll assembly being positioned within the screen of the screen assembly.

4. The centrifugal separator of claim 1, wherein a scroll of the scroll assembly is configured to rotate at a first speed and the screen of the screen assembly is configured to rotate at a second speed that differs from the first speed.

5. The centrifugal separator of claim 1, comprising:

a feed conduit connected to the housing, the feed conduit having a mouth through which slurry is fed into the cavity of the housing, a first end of the screen being closer to the mouth than a second end of the screen.

6. The centrifugal separator of claim 1, wherein the screen has a first end, a second end, and at least one intermediate portion between the first end and the second end, slurry being passable into the screen via the first end, particulates within the slurry to be emitted out of the screen adjacent the second end, the openings and blades of the screen configured so that liquid of the slurry is passed out of the screen via the openings.

7. The centrifugal separator of claim 6, wherein the at least one intermediate portion comprises a first intermediate portion and each of the blades is tapered so that a flow rate at which air is directed toward the openings of the screen adjacent the first end when the screen is rotated is greater than a flow rate at which air is directed toward the openings of the screen adjacent the first intermediate portion of the screen.

8. The centrifugal separator of claim 6, wherein the at least one intermediate portion also comprises a second intermediate portion between the second end of the screen and the first intermediate portion, and

each of the blades being tapered so that a flow rate at which air is fed through the openings toward the screen adjacent the first end is greater than a flow rate at which air is directed to the openings of the screen adjacent the second intermediate portion of the screen and

the flow rate at which the air is fed toward openings into the screen adjacent to the first intermediate portion is greater than the flow rate at which the air is directed toward the openings adjacent to the second intermediate portion.

9. The centrifugal separator of claim 1, wherein each of the blades comprises:

a first linearly extending portion attached to the screen; and

a tapered second portion extending along a first side of the first linearly extending portion at a pre-selected angle to the first linearly extending portion.

10. The centrifugal separator of claim 9, wherein the pre-selected angle is within the range of 120°-170°, 130°-160°, or 140°-150°.

11. The centrifugal separator of claim 9, wherein the tapered second portion has a triangular shape.

12. The centrifugal separator of claim 9, wherein the screen has a first end and a second end opposite the first end, slurry being passed into the screen via the first end, and

wherein the tapered second portion has a first end and a second end, the first end of the tapered second portion being closer to the first end of the screen than the second end of the tapered second portion, the second end of the tapered second portion having a smaller width than the first end of the tapered second portion.

13. The centrifugal separator of claim 9, wherein the first linearly extending portion has a uniform width and length; and the blades also comprise:

ribs extending between the first linearly extending portion and the tapered second portion.

14. A screen assembly for a centrifugal separator, comprising:

a screen having a plurality of openings; and

a plurality of blades positioned adjacent to the openings, the blades being sized and shaped to direct air toward the openings of the screen when the screen is rotated to reduce a rate at which liquid is emittable through the openings of the screen when the screen is rotated.

15. The screen assembly of claim 14, wherein each of the blades comprises:

a first linearly extending portion attached to the screen; and

a tapered second portion extending along a first side of the first linearly extending portion at a pre-selected angle to the first linearly extending portion.

16. The screen assembly of claim 15, wherein the pre-selected angle is within the range of 120°-170°, 130°-160°, or 140°-150°.

17. The screen assembly of claim 15, wherein the tapered second portion has a triangular shape.

18. The screen assembly of claim 15, wherein the screen has a first end and a second end opposite the first end, slurry being passable into the screen via the first end, and

wherein the tapered second portion has a first end and a second end, the first end of the tapered second portion being closer to the first end of the screen than the second end of the tapered second portion, the second end of the tapered second portion having a smaller width than the first end of the tapered second portion.

19. The screen assembly of claim 18, wherein the first linearly extending portion has a uniform width and length.

20. The screen assembly of claim 18, wherein the blades also comprise:

ribs extending between the first linearly extending portion and the tapered second portion.

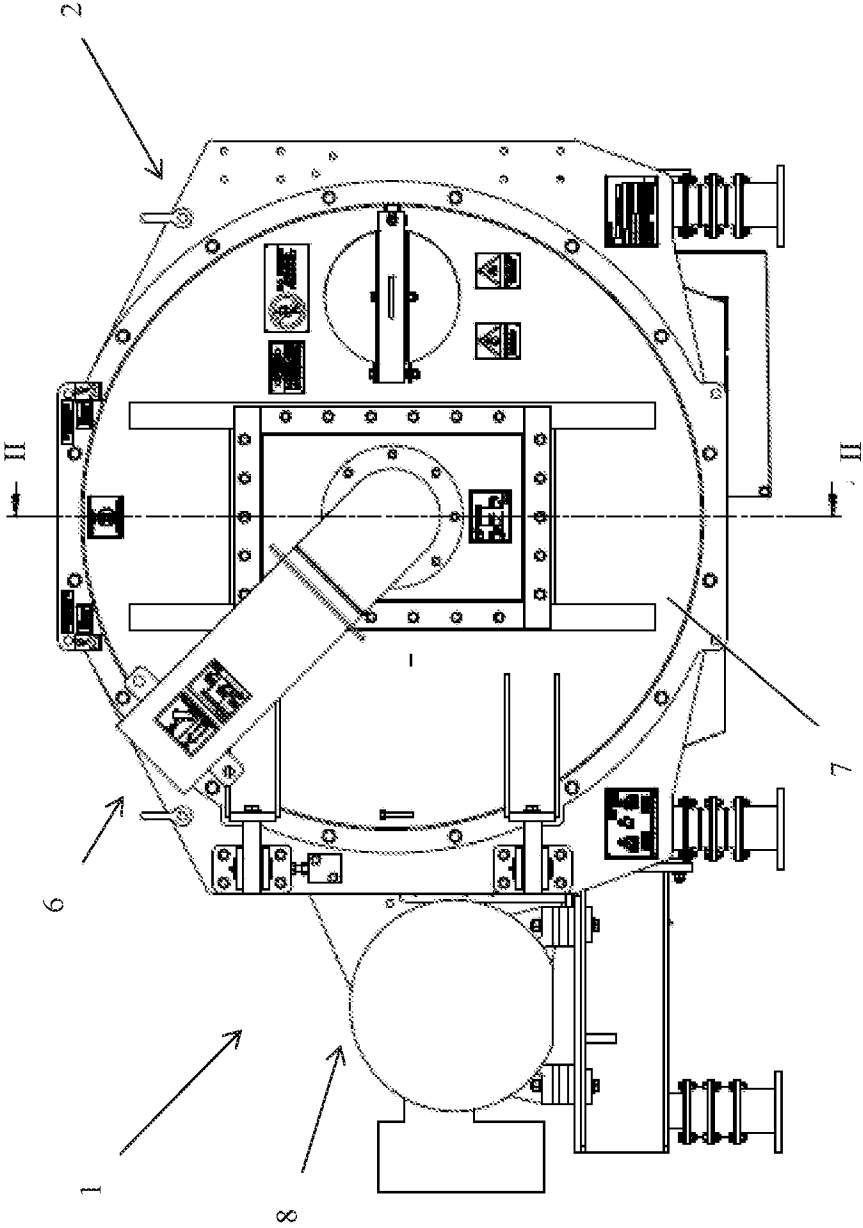


FIG. 1

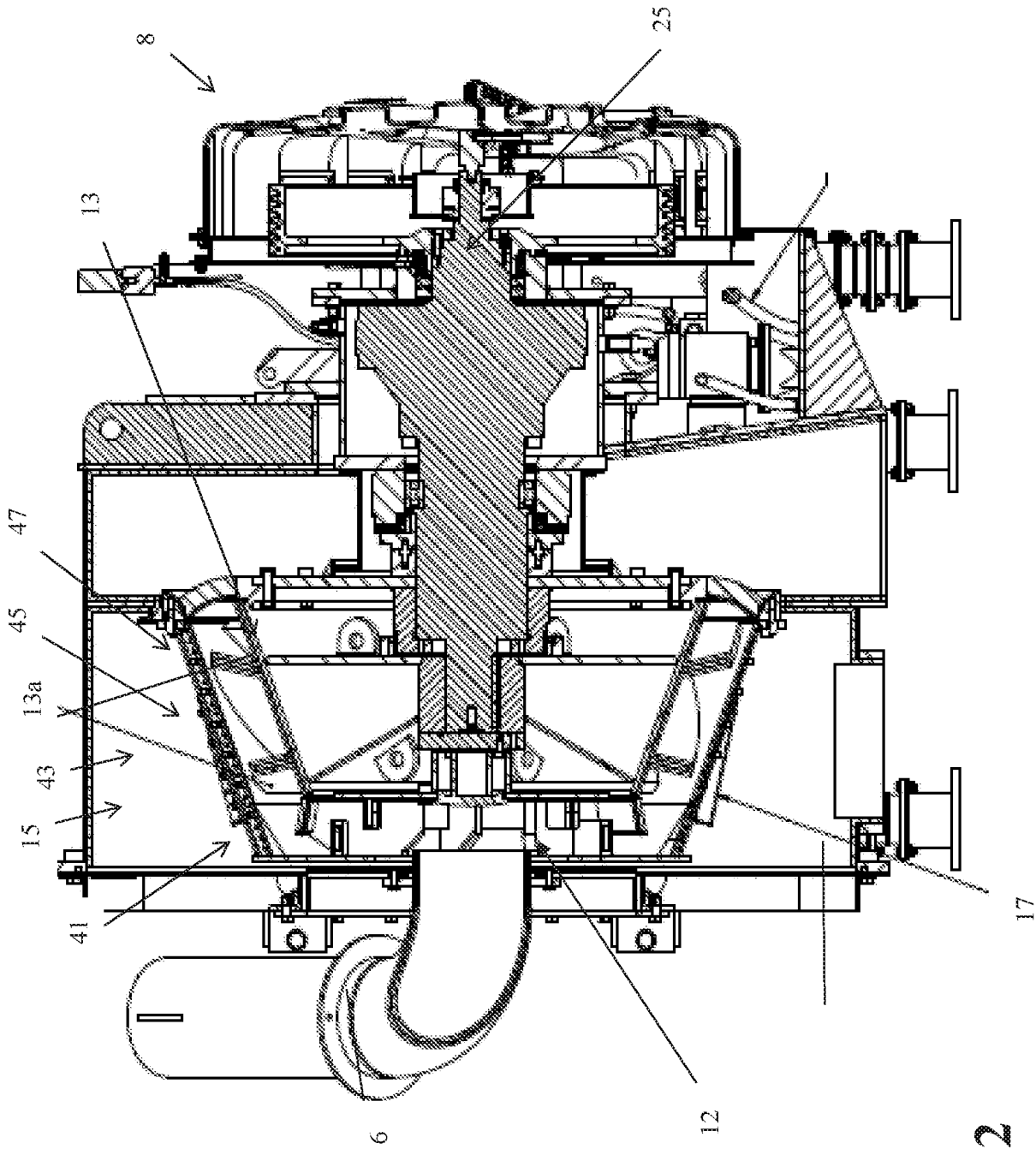


FIG. 2

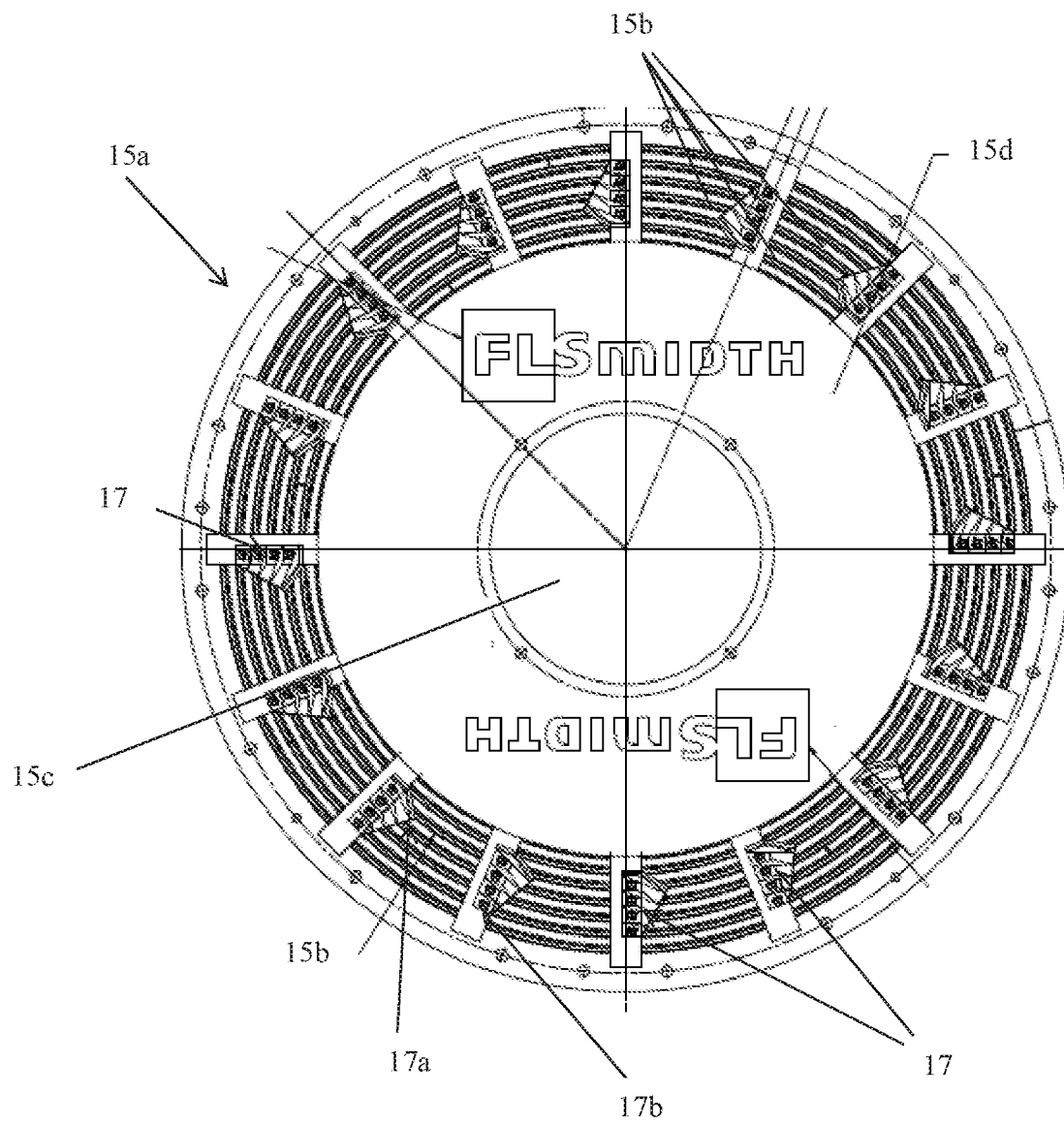


FIG. 3

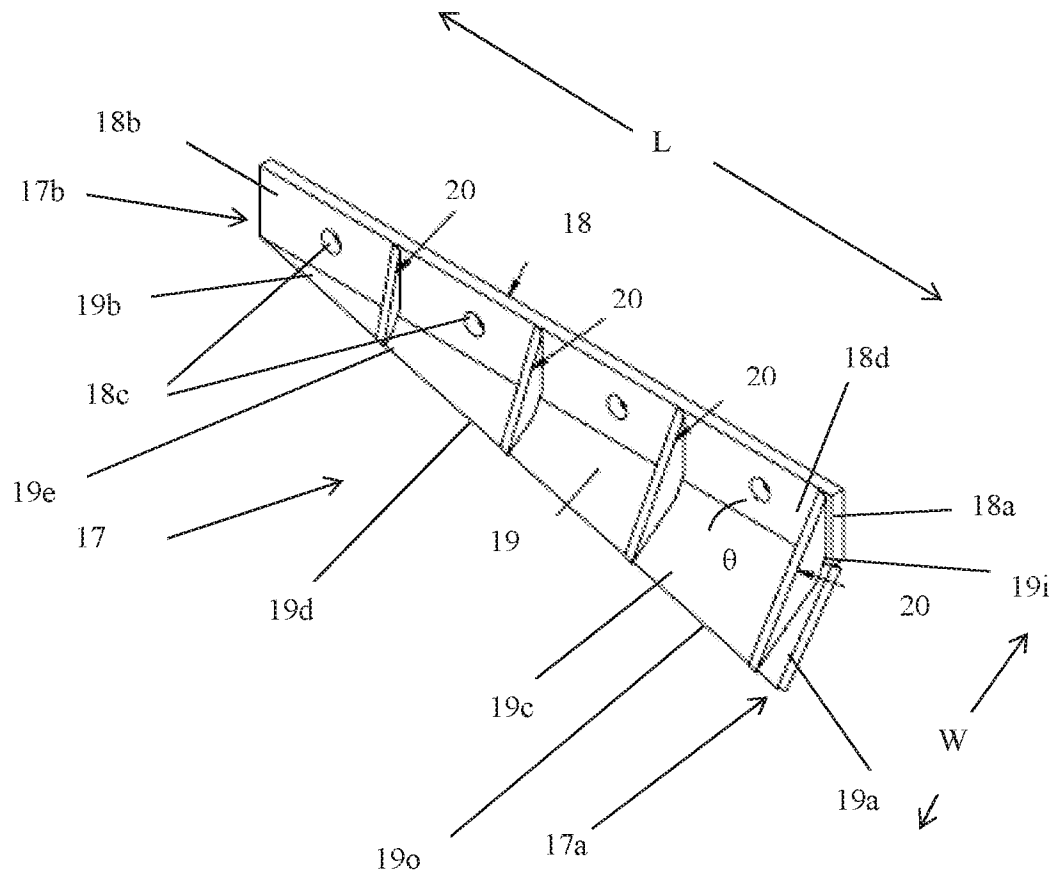


FIG. 5

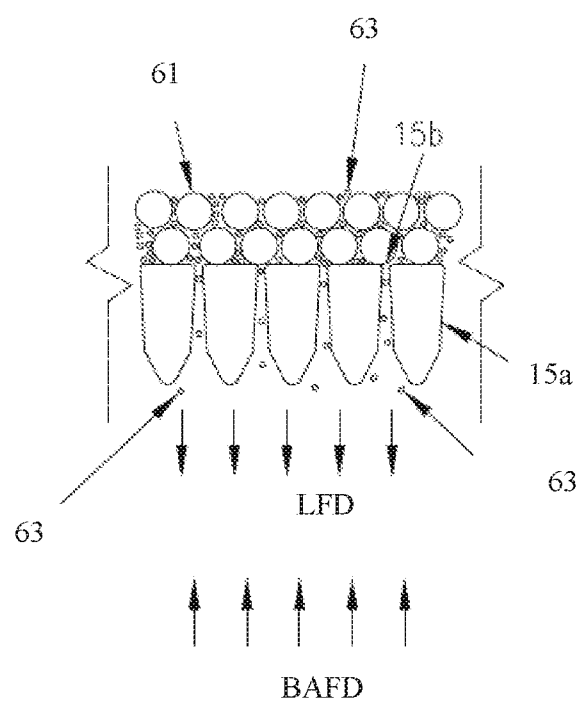


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/052711

A. CLASSIFICATION OF SUBJECT MATTER INV. B07B1/24 B04B3/04 B01D33/11 ADD.		
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 B04B B01D B04C		
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) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 1 070 212 A (SIEBTECHNIK GMBH) 20 July 1954 (1954-07-20)	1-6,14
Y	page 1, right-hand column, line 10 - line 42 page 2, right-hand column, line 1 - line 50 claims figures	7-13, 15-20
Y	----- EP 0 246 629 A1 (ISLIKER ALWIN) 25 November 1987 (1987-11-25)	7,8
A	abstract column 1, line 1 - line 27 column 5, line 51 - line 31, paragraph 6 column 7, line 27 - line 30 claims figures ----- -/-	1,2,5,6, 14
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "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 11 June 2020	Date of mailing of the international search report 22/06/2020	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer van der Zee, Willem	

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2020/052711

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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