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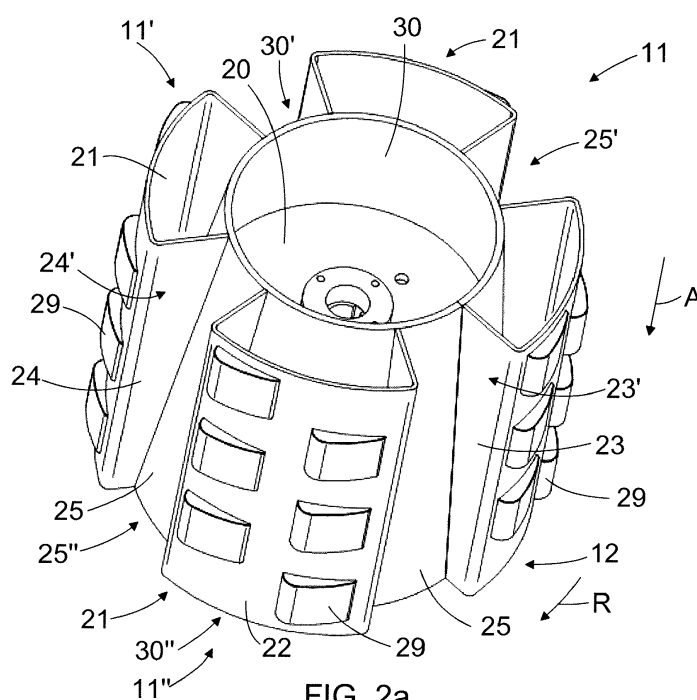
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(54) **Drum element and screen for screening pulp**

(57) A drum element (11) for a screen (1) for screening pulp. The drum element (11) comprises a first end (11') and a second end (11'') opposite to the first end (11'), at least one flow channel (25, 25a, 25b) arranged to extend from at least one end (11', 11'') of the drum

element (11) towards an opposite end (11', 11'') of the drum element (11) for a flow of pulp, and foil bits (29) arranged at an outer circumference of the drum element (11).



Description

FIELD OF THE INVENTION

[0001] The present invention relates to a screen for screening pulp. In particular, the invention relates to a drum element for a screen for screening pulp.

BACKGROUND OF THE INVENTION

[0002] Pulp used in paper and paperboard manufacture is screened in one of its processing phases before feeding the pulp to a paper or paperboard machine or a corresponding device. In pulp screening, various impurities, slivers and other such particles which deteriorate the quality of the paper or paperboard web being manufactured, are removed from the pulp. A device used for screening pulp is typically called a screen or a screening device. A commonly used screen type is a screen comprising a screen cylinder or a screen basket with a cylindrical screening surface equipped with apertures. A screen of this type typically further includes a rotor arranged inside the screen basket for rotating the pulp in the screen.

[0003] One kind of a screen is a screen comprising a frame, a screen basket arranged inside the frame and a rotor resembling the shape of a drum, i.e. a drum rotor, arranged inside the screen basket. The inner surface of the screen basket provides a screening surface of the screen. The drum rotor comprises a shaft and a cylindrical casing or a drum element attached to the shaft, the outer surface of the drum element providing an outer circumference of the drum rotor. The drum rotor is arranged inside the screen basket such that a distance is provided between the outer circumference of the rotor and the screening surface of the screen basket. A space located between the screening surface of the screen basket and the rotor provides a screening chamber. Pulp to be screened is fed into the screening chamber at a front part of the screen basket. A space located between the frame and the screen basket provides an accept chamber, receiving a portion of the pulp passing through the apertures in the screen basket, this portion of the pulp forming an accepted portion of the pulp, i.e. the accept. A space between an end part of the screen basket and the rotor provides a reject chamber, receiving a portion of the pulp not passing through the apertures in the screen basket, this portion of the pulp forming a rejected portion of the pulp, i.e. the reject.

BRIEF DESCRIPTION OF THE INVENTION

[0004] An object of the present invention is to provide a new type of a drum element for a screen.

[0005] A drum element for a screen for screening pulp is characterized in that the drum element comprises a first end and a second end opposite to the first end, at least one flow channel arranged to extend from at least

one end of the drum element towards an opposite end of the drum element for a flow of pulp and arranged to open towards an outer circumference of the drum element, and foil bits arranged at the outer circumference of the drum element. A cross-sectional area of the flow channel is arranged to decrease from a direction of the first end of the flow channel towards a direction of the second end of the flow channel in a flow direction of pulp in the flow channel.

[0006] A screen for screening pulp and comprising a screen basket provided with a screening surface is characterized in that the screen comprises at least one drum element as claimed in any one of claims 1 to 13.

[0007] According to an embodiment of the drum element, the drum element comprises a body and a casing, the casing comprising recesses extending from at least one end of the casing towards an opposite end of the casing, the recesses providing the flow channels of the drum element.

[0008] According to an embodiment of the drum element, the drum element comprises a body, a casing and a number of surface elements arranged at the casing, the surface elements extending from a first end of the casing towards a second end of the casing and in a radial direction of the drum element outwards from the casing, the surface elements being arranged at the casing in a circumferential direction of the drum element such that at least one recess is provided between neighbouring surface elements for providing the flow channel of the drum element.

[0009] According to an embodiment of the drum element, the drum element comprises a body and a casing and at least one surface element arranged at the casing and arranged to surround the casing, the casing and the at least one surface element together defining the flow channel of the drum element.

[0010] According to an embodiment of the drum element, the casing of the drum element comprises in a circumferential direction of the casing wave crests and between them wave troughs arranged to extend from the first end of the casing towards the second end of the casing, the drum element further comprising at least one surface element having the form of a ring or a spiral and arranged at the casing, whereby the wave troughs together with the at least one surface element define the flow channels of the drum element.

[0011] According to an embodiment of the drum element, the casing of the drum element has a cross-sectional shape of a triangle extending in an axial direction of the drum element, and the drum element further comprises at least one surface element having the form of a ring or a spiral and arranged at the casing, whereby side surfaces of the casing together with the surface elements define the flow channels of the drum element.

[0012] According to an embodiment of the drum element, the flow channel comprises at least one step arranged to provide a change in a cross-sectional size of the flow channel.

[0013] According to an embodiment of the drum element, the drum element comprises flow channels extending from the first end of the drum element towards the second end of the drum element, and flow channels extending from the second end of the drum element towards the first end of the drum element, the cross-sectional area of at least one flow channel being arranged to decrease from a first end of the flow channel towards a second end of the flow channel.

[0014] According to an embodiment of the drum element, in the longitudinal direction of the flow channel at least a portion of the flow channel is arranged to extend in a direction deviating from a direction of a projection of an axis of the drum element in the outer circumference of the drum element.

[0015] According to an embodiment of the drum element, a total cross-sectional area of the flow channels is 20 to 80%, preferably 30 to 70%, and more preferably 40 to 60%, of a cross-sectional area of an annular space between a screen basket of the screen and the outer circumference of the drum element at the end of the drum element where the pulp is fed to the screen.

[0016] According to an embodiment of the drum element, the drum element is arranged to provide at least part of a rotor of the screen.

[0017] According to an embodiment of the drum element, the foil bit has a front edge to be directed towards an intended rotation direction of the rotor of the screen, a tail edge to be directed oppositely to the intended rotation direction of the rotor of the screen, a first side edge and a second side edge connecting the front edge to the tail edge, and at least one of the side edges being straight.

[0018] According to an embodiment of the drum element, the foil bit is an embossed form provided to a piece of a sheet intended to provide at least part of the surface element of the drum element.

[0019] According to an embodiment of the screen, the screen comprises a rotor arranged inside the screen basket, and the rotor comprises at least one drum element as claimed in any one of claims 1 to 13.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the following, the invention will be described in greater detail by means of preferred embodiments and with reference to the accompanying drawings, in which

Figure 1 schematically shows a side view of a screen in cross-section;

Figures 2a, 2b, 2c and 2d schematically show a drum element for a screen;

Figures 3a and 3b schematically show a second drum element for a screen;

Figures 4a and 4b schematically show a third drum element for a screen;

Figures 5a and 5b schematically show a fourth drum element for a screen;

Figures 6a and 6b schematically show a fifth drum

element for a screen;

Figures 7a and 7b schematically show a sixth drum element for a screen;

Figures 8a and 8b schematically show a seventh drum element for a screen;

Figures 9a and 9b schematically show an eighth drum element for a screen;

Figures 10a and 10b schematically show a ninth drum element for a screen;

Figure 11 schematically shows a tenth drum element for a screen;

Figures 12a and 12b schematically show an eleventh drum element for a screen;

Figure 13 schematically shows a twelfth drum element for a screen;

Figure 14 schematically shows a thirteenth drum element for a screen;

Figure 15 schematically shows a fourteenth drum element for a screen;

Figure 16 schematically shows a fifteenth drum element for a screen;

Figure 17 schematically shows a sixteenth drum element for a screen;

Figure 18 schematically shows a variety of some possible flow channel geometries in a drum element;

Figures 19a and 19b schematically show a seventeenth drum element for a screen;

Figure 20 schematically shows an eighteenth drum element for a screen; and

Figures 21 to 23 schematically show some examples of possible foil bits to be used in a drum element.

[0021] The figures disclose only some embodiments in an exemplary way and not necessarily in scale.

DETAILED DESCRIPTION OF THE INVENTION

[0022] Figure 1 shows schematically a cross-sectional side view of a screen 1, which may be used to screen pulp to be used for paper and paperboard manufacture. Figure 1 shows schematically a general structure of a typical screen provided with a drum rotor. The screen 1 comprises a frame 2 having a cylindrical form and a first end plate 3 and a second end plate 4 attached at the ends of the frame 2. The frame 2 together with the end plates 3 and 4 define an interior 5 of the screen 1. The interior 5 of the screen 1 is provided with a screen basket 6 or a screen cylinder 6 whose cylinder surface, which is equipped with apertures 7, constitutes a screening surface 8 of the screen 1. In the interior of the screen basket 6 is provided a rotor 9 comprising a shaft 10 and a drum element 11 having a cylindrical shape and being supported on the shaft 10 by supports 46. The drum element 11 has a first end 11' and a second end 11". The shaft 10 and the drum element 11 together form the drum rotor 9, an outer surface 12 of the drum element 11 being provided by a cylinder surface of the drum element 11. The shaft 10 of the rotor 9 is connected to a rotating motor

13, which is arranged to rotate the rotor 9 when the screen 1 is in use.

[0023] The drum rotor 9 is arranged inside the screen basket 6 such that a distance is provided between the outer surface 12 of the drum rotor 9 and the screening surface 8 of the screen basket 6, whereby a space located between the screening surface 8 of the screen basket 6 and the drum element 11 of the rotor 9 constitutes a screening chamber 14, whereto the pulp to be screened is fed through an inlet channel 15 of the screen 1 at an upper part of the screen 1. If the inlet channel 15 is provided in the lower part of the screen 1, the pulp may be fed to the upper part of the screen 1, and further to the screening chamber 14, through the interior of the drum element 11, whereby there are openings in the supports 46 for allowing the pulp to flow from the lower part of the screen 1 to the upper part of the screen 1 through the interior of the drum element 11. The pulp entered into the screening chamber 14 is rotated in the screening chamber 14 by the rotor 9 when the screen 1 is in use, and the rotor 9 is rotated by the rotating motor 13. The space located between the frame 2 and the screen basket 6 provides an accept chamber 16, which receives a portion of the pulp passing through the apertures 7 in the screen basket 6. This portion of the pulp forming an accepted portion of the pulp, i.e. the accept, is removed from the screen 1 through an accept channel 17 for further processing. A space between the screen basket 6 and the drum element 11 of the rotor 9 at a lower part of the screen 1 provides a reject chamber 18, which receives a portion of the pulp not passing through the apertures 7 in the screen basket 6, this portion of the pulp forming a rejected portion of the pulp, i.e. the reject, which is removed from the screen 1 through a reject channel 19 for reject processing.

[0024] Figure 2a shows schematically a drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 2b shows schematically an end view of the drum element of Figure 2a, as seen from the first end 11' of the drum element 11. The drum element 11 comprises a body 20 and a casing 30 attached to the body 20. The casing 30 may also form a part of the body of the drum element 11. The body 20 is a support structure through which the drum element 11 may be supported on the shaft 10 of the rotor 9, Figure 2b showing an aperture 26 for the shaft 10. The casing 30 of Figure 2a has, in an axial direction A of the drum element 11, a conical form, a first end 30' of the casing 30 being of a smaller diameter, and a second end 30" of the casing 30 being of a larger diameter. In other words, the diameter of the casing 30 is arranged to increase in the axial direction A of the drum element 11 from the first end 30' towards the second end 30". The axial direction A of the drum element 11 is shown by arrow A in Figure 2a.

[0025] The drum element 11 of Figures 2a and 2b further shows a number of surface elements 21, to be more precise, four surface elements 21, which are arranged

at the casing 30 and arranged to extend from the first end 30' of the casing 30 to the second end 30" of the casing 30. The surface elements 21 provide in the drum element 11 protrusions extending in a radial direction RD of the drum element 11 outwards from the casing 30. The radial direction RD of the drum element 11 is shown by arrow RD in Figure 2b. The surface elements 21 comprise a covering plate 22 directed outwards from the casing 30. The surface elements 21 also comprise a first side plate 23 and a second side plate 24 attached, in a circumferential direction of the drum element 11, to opposite sides of the covering plate 22 and arranged to extend in the axial direction A of the drum element 11 between the covering plate 22 and the casing 30. The first side plate 23 of the surface element 21 is arranged to face towards rotation direction of the rotor 9 and the second side plate 24 of the surface element 21 is arranged to face towards a direction which is opposite to the rotation direction of the rotor 9, when the drum element 11 is arranged to form at least part of the rotor 9. The rotation direction of the rotor 9 is shown by arrow R in Figure 2b. The covering plates 22 of the surface elements 21 together form an outer surface 12 of the drum element 11. The ends 11', 11" of the drum element 11 may be closed by end plates 27, as shown below in Figures 2c and 2d.

[0026] In the direction of the circumference of the drum element 11, the surface elements 21 are arranged at a distance from one another so that recesses are provided between neighbouring surface elements 21, the recesses providing flow channels 25 between the neighbouring surface elements 21, which flow channels 25 extend, in the axial direction A of the drum element 11, from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11, or in other words, from the first end 30' of the casing 30 towards the second end 30" of the casing 30. A longitudinal direction of the flow channels 25 is thus from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11. An outer surface of the casing 30 provides a bottom surface of the flow channel 25 and the side plates 23, 24 of the neighbouring surface elements 21 provide a first side surface 23' and a second side surface 24' of the flow channel 25. The flow channel 25 has a first end 25' directed towards the first end 11' of the drum element 11 and open towards the first end 11' of the drum element 11, as well as a second end 25" directed towards the second end 11" of the drum element 11 and open towards the second end 11" of the drum element 11. Due to the conical form of the casing 30, a cross-sectional area of the flow channel 25 is arranged to decrease from a direction of the first end 25' of the flow channel 25 towards a direction of the second end 25" of the flow channel 25. The decreasing cross-sectional area of the flow channel 25 towards the second end 25" of the flow channel 25 means that the volume of the flow channel 25 decreases towards the second end 25" of the recess 25. In the embodiment of Figures 2a, 2b, 2c, and 2d, the decreasing cross-sectional area of the flow channel 25

is provided by the casing 30 having the conical shape so that the first end 30' of the casing 30 having a smaller diameter is directed towards the first end 11' of the drum element 11 while the second end 30" of the casing 30 having a larger diameter is directed towards the second end 11" of the drum element 11. The decreasing cross-sectional area of the flow channel 25 could also be provided by other means, for example, by reducing a width of the flow channel 25 in the extending direction of the flow channel 25.

[0027] When a screen is assembled, the first end 11' of the drum element 11 is to be directed towards the inlet channel 15 of the screen 1. When pulp is fed to the screen 1, the pulp may flow to the flow channel 25 through the first end 25' of the flow channel 25. The pulp fed to the flow channel 25 will further flow in the flow channel 25 towards the second end 25" of the flow channel 25. While the pulp flows towards the second end 25" of the flow channel 25, at least some part of the pulp fed to the flow channel 25 is forced from the flow channel 25, through an open top part of the flow channel 25, to the screening chamber 14 between the screen basket 6 and the rotor 9 because of the cross-sectional volume of the flow channel 25 decreasing towards the second end 25" of the flow channel 25 and centrifugal force. The cross-sectional area of the flow channel 25 is thus arranged to decrease from a direction of the first end 25' of the flow channel 25 towards a direction of the second end 25" of the flow channel 25 in a flow direction of pulp in the flow channel 25.

[0028] The flow channel 25 provides a passage for pulp to be fed to the screen 1 so that pulp may flow from a direction of the first end 11' of the drum element 11 towards the second end 11" of the drum element 11 substantially freely in the flow channel 25 so that pulp does not become clogged at a first portion of the screening chamber 14. On the other hand, the decreasing cross-sectional volume of the flow channel 25, together with the centrifugal force, forces pulp from the flow channel 25 to the screening chamber 14. In other words, the decreasing cross-sectional volume of the flow channel 25 in the flow direction of pulp in the flow channel 25, together with the centrifugal force, forces pulp from the flow channel 25 to the screening chamber 14. The flow channel 25 thus provides means for distributing pulp in the axial direction A of the screen 1 so that pulp may be distributed evenly over the area of the screening surface 8 so that blinding of the screening surface 8 at any part of the screen basket 6 may be avoided. Also, because the screening of pulp takes place over the whole length of the screen basket 6, a small flow of new pulp at the reject chamber 18 at the end of the drum element 11 is capable of preventing the clogging of pulp at the reject chamber 18. This means that a screening capacity of the screen 1 may be maintained high.

[0029] In addition to providing a way to distribute pulp evenly on the screening surface along the axial direction A of the screen 1, the recesses forming the flow channels

25 also provide discontinuities in the outer surface 12 of the drum element 11. These discontinuities cause turbulence or whirling on the pulp in the screening chamber 14, which prevents flocculation of pulp in the screening chamber 14.

[0030] The drum element 11 of Figures 2a and 2b further comprises foil bits 29 arranged at an outer circumference of the drum element 11, or in other words, at the outer surface 12 of the drum element 11 provided by outer surfaces of the covering plates 22 of the surface elements 21. When the rotor 9 of the screen 1 is rotating, the foil bits 29 are arranged to cause pressure pulsations on the pulp in the screening chamber 14, i.e. positive pressure pulses and negative pressure pulses. The positive pressure pulses cause the pulp to flow through the screening surface 8 from the side of the screening chamber 14 to the side of the accept chamber 16, the positive pressure pulses thus causing the screening of pulp. The negative pressure pulses cause a back flow of pulp through the screening surface 8 from the side of the accept chamber 16 to the side of the screening chamber 14, this back flow providing a flushing flow which detaches pulp particles attached to the screening surface 8, thus cleaning the screening surface 8 of the screen basket 6. Both positive pressure pulses and negative pressure pulses are thus important for efficient screening and high screening capacity. In the rotation direction R of the rotor, a leading part of the foil bits 29 directed towards the rotation direction R of the rotor 9 causes positive pressure pulses on the pulp and a trailing part of the foil bits 29 directed opposite to the rotation direction R of the rotor 9 provides negative pressure pulses or suction pressures on the pulp.

[0031] Figure 2c shows schematically one possible end view of the drum element 11 of Figures 2a and 2b, as seen from the first end 11' of the drum element 11, when the first end 11' of the drum element 11 comprises an end plate 27 which seals the internal structures of the casing 30 and the surface elements 21 at the first end 11' of the drum element 11. The second end 11" of the drum element 11 also comprises a similar end plate for sealing the internal structures of the casing 30 and the surface elements 21 at the second end 11" of the drum element 11, the end plate at the second end 11" of the drum element 11 being, however, provided with an aperture for the shaft 10 of the rotor 9, when the drum element 11 is to be arranged to be a part of the rotor 9 of the screen 1. In the radial direction RD of the drum element 11, the drum element 11 comprises branches 28 of the end plate 27 which are arranged to seal the internal structures of the surface elements 21 and which extend in the radial direction RD of the drum element 11 exactly to the covering plates 22 of the surface elements 21, whereby most of the pulp is fed to the screening chamber 14 between the rotor 9 and the screen basket 6 through the flow channels 25 but a small portion of the pulp is allowed to enter the screening chamber 14 through small gaps remaining between the end plate 27 of the drum

element 11 and the screen basket 6. When a small portion of the pulp is allowed to enter the screening chamber 14 through the small gaps between the end plate 27 of the drum element 11 and the screen basket 6, it is ensured that pulp is fed into the screening chamber 14 also at the very first portion of the screening chamber 14, whereby the whole area of the screening surface 8 of the screen basket 6 is utilized for screening the pulp.

[0032] Figure 2d shows schematically another possible end view of the drum element 11 of Figures 2a and 2b, as seen from the first end 11' of the drum element 11, when the first end 11' of the drum element 11 comprises an end plate 27 which seals the internal structures of the casing 30 and the surface elements 21 at the first end 11' of the drum element 11. The second end 11" of the drum element 11 also comprises a similar end plate for sealing the internal structures of the casing 30 and the surface elements 21 at the second end 11" of the drum element 11, the end plate at the second end 11" of the drum element 11 being, however, provided with an aperture for the shaft 10 of the rotor 9, when the drum element 11 is to be arranged to be a part of the rotor 9 of the screen 1. In the radial direction RD of the drum element 11, the branches 28 of the end plate 27 are arranged to extend over the covering plate 22 of the surface elements 21. This difference between the embodiments of Figures 2c and 2d can be seen in Figures 2c and 2d in the sense that in Figure 2c the foil bits 29 are totally visible but in Figure 2d only very small parts of the foil bits 29 are visible. When the branches 28 of the end plate 27 are arranged in the radial direction RD of the drum element 11 to extend over the covering plate 22 of the surface elements 21, almost all of the pulp is fed to the screening chamber 14 between the rotor 9 and the screen basket 6 through the flow channels 25, and only a minor portion of the pulp may enter the screening chamber 14 through small gaps remaining between the end plate 27 of the drum element 11 and the screen basket 6, the gaps forming clearances between the drum element 11 and the screen basket 6 necessary for allowing the rotor 9 to rotate in respect of the screen basket 6. When only a minor portion of the pulp may enter the screening chamber 14 through the gaps between the end plate 27 of the drum element 11 and the screen basket 6, it is ensured that no uncontrollable flow portions of pulp may enter the screening chamber 14.

[0033] In the embodiments of the drum element 11 shown in Figures 2a, 2b, 2c, and 2d, the flow channels 25 are arranged to extend from the first end 11' of the drum element 11 to the second end 11" of the drum element 11 in a direction which corresponds to a direction of projection of the axial direction A of the drum element 11 at the outer surface 12 of the drum element 11. Furthermore, in the embodiments shown in Figures 2a, 2b, 2c, and 2d, in the radial direction RD of the drum element 11, the width of the flow channels 25, i.e. a distance between the first side surfaces 23' and the second side surfaces 24' of the flow channels 25, is arranged to in-

crease from the bottom surface of the flow channel 25 towards the top part of the flow channel 25, i.e. towards the outer surface 12 of the drum element 11, symmetrically with respect to the first side surface 23' and the second side surface 24'. The symmetric increase of the width of the flow channel 25 in the radial direction RD of the drum element 11 towards the outer surface 12 of the drum element 11 is provided by an arrangement of the side plates 23, 24 of the surface elements 21, wherein an angle α_1 between the first side plate 23 of the surface element 21 and the casing 30 is the same as an angle α_2 between the second side plate 24 of the surface element 21 and the casing 30. This is achieved by arranging the side plates 23 and 24 to extend from the casing 30 towards the covering plate 22 in the radial direction RD of the drum element 11. When the cross-sectional shape and the extending direction of the flow channel 25 are as disclosed above, the flow channel 25 supplies pulp to the screening chamber 14 evenly, meaning that unscreened pulp to be fed to the screen 1 is distributed evenly over the whole area of the screening surface 8, whereby the whole area of the screening surface is utilized for screening effectively.

[0034] Figure 3a shows schematically a second drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 3b shows schematically an end view of the drum element 11 of Figure 3a, as seen from the first end 11' of the drum element 11. The basic structure of the drum element 11 of Figures 3a and 3b is the same as in the embodiment of Figures 2a and 2b, the differences between the embodiments of Figures 2a, 2b and 3a, 3b relating to the cross-sectional construction of the surface elements 21 and the flow channels 25.

[0035] In the embodiments of the drum element 11 shown in Figures 3a and 3b, the flow channels 25 are arranged to extend from the first end 11' of the drum element 11 to the second end 11" of the drum element 11 in a direction which corresponds to the direction of projection of the axial direction A of the drum element 11 at the outer surface 12 of the drum element 11. Furthermore, in the embodiments shown in Figures 3a and 3b, in the radial direction RD of the drum element 11, the width of the flow channels 25, i.e. a distance between the first side surfaces 23' and the second side surfaces 24' of the flow channels 25, is arranged to increase from the bottom surface of the flow channel 25 towards the top part of the flow channel 25, i.e. towards the outer circumference of the drum element 11, non-symmetrically with respect to the first side surface 23' and the second side surface 24'. The non-symmetric increase of the width of the flow channel 25 in the radial direction RD of the drum element 11 towards the outer circumference of the drum element 11 is provided by an arrangement of the side plates 23, 24 of the surface elements 21, wherein the angle α_1 between the first side plate 23 of the surface element 21 and the casing 30 is larger than the angle α_2 between the second side plate 24 of the surface element

21 and the casing 30, whereby the first side plate 23, which forms the first side surface 23' of the flow channel 25, is inclined clearly backwards in respect of the rotation direction R of the rotor 9. By means of the cross-sectional shape of the flow channel 25 as disclosed above, the first side surface 23' is arranged to push or force the pulp flowing in the flow channel 25 away from the flow channel 25, in the rotation direction R of the rotor 9, towards the screening chamber 14 between the screen basket 6 and the rotor 9, subjecting the pulp to turbulence which breaks fibre flocs.

[0036] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 3a and 3b may be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0037] Figure 4a shows schematically a third drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 4b shows schematically an end view of the drum element of Figure 4a, as seen from the first end 11' of the drum element 11. The basic structure of the drum element 11 of Figures 4a and 4b is the same as in the embodiment of Figures 2a, 2b, 3a, and 3b, the difference being that in the embodiment of Figures 4a and 4b, only three surface elements 21 and three flow channels 25 are provided. The cross-sectional construction of the surface elements 21 and the flow channels 25 is substantially the same as in the embodiment of Figures 3a and 3b.

[0038] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 4a and 4b may be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0039] Figure 5a shows schematically a fourth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 5b shows schematically an end view of the drum element of Figure 5a, as seen from the first end 11' of the drum element 11. The drum element 11 comprises a body 20 and a casing 30. The body 20 provides a support structure through which the drum element 11 may be supported on the shaft 10 of the rotor 9, Figure 5b showing an aperture 26 for the shaft 10. The casing 30 has a first end 30' and a second end 30". In the axial direction A of the drum element 11, the diameter of the casing 30 is arranged to increase from the first end 30' towards the second end 30" such that in the axial direction A of the drum element 11 the shape of the casing 30 resembles a conical form. In its circumferential direction, the casing 30 is arranged to have a wavelike form comprising wave crests and between them wave troughs or chutes or canals, the wave crests and wave troughs extending from the first end 30' of the casing 30 towards the second end 30" of the casing 30.

[0040] The drum element 11 of Figures 5a and 5b further shows a number of surface elements 31, to be more

precise, three surface elements 31, having the form of a ring and being arranged at the casing 30 in the axial direction A of the drum element 11 at a distance from each other such that gaps 32 are provided between the surface elements 31. The surface elements 31 provide the outer surface 12 of the drum element 11. The drum element 11 of Figures 5a and 5b further comprises foil bits 29 arranged at the outer circumference of the drum element 11, or in other words, at the outer surface 12 of the drum element 11, and more precisely, at the outer surface of the annular surface elements 31 of the drum element 11. The number of surface elements 31, as well as the number of foil bits 29 may be remarkably higher than that disclosed in Figures 5a and 5b.

[0041] In the embodiment of Figures 5a and 5b, the wave troughs of the casing 30 and the surface elements 31 together define flow channels 25 for pulp, the cross-sectional area of the flow channels 25 decreasing from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11 as a consequence of the diameter of the casing 30 increasing from the first end 30' of the casing 30 towards the second end 30" of the casing 30. In other words, the cross-sectional area of the flow channel 25 is thus arranged to decrease from the direction of the first end 25' of the flow channel 25 towards the direction of the second end 25" of the flow channel 25 in the flow direction of pulp in the flow channel 25. During the use of the screen provided with the drum element 11 as disclosed in Figures 5a and 5b, the pulp fed to the flow channels 25 moves from the flow channels 25 to the screening chamber 14 of the screen 1 in the areas remaining between the outermost surface elements 31 and the ends 11', 11" of the drum element 11 as well as through the gaps 32 between the neighbouring surface elements 31.

[0042] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 5a and 5b may also be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0043] Figure 6a shows schematically a fifth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 6b shows schematically an end view of the drum element of Figure 6a, as seen from the first end 11' of the drum element 11. The drum element 11 comprises a body 20 and a casing 30. The body 20 provides a support structure through which the drum element 11 may be supported on the shaft 10 of the rotor 9, Figure 6b showing an aperture 26 for the shaft 10. The casing 30 has a first end 30' and a second end 30" and a cross-sectional shape of a triangle in the direction transversal to the axial direction A of the drum element 11. In the axial direction A of the drum element 11, the diameter of the casing 30 is arranged to increase from the first end 30' towards the second end 30". In the embodiment of Figures 6a and 6b, the flow channels 25 of the drum element 11 are provided by the side surfaces

33 of the triangular casing 30.

[0044] The drum element 11 of Figures 6a and 6b further shows a number of surface elements 31, to be more precise, three surface elements 31, having the form of a ring and being arranged in the casing 30 in the axial direction A of the drum element 11 at a distance from each other such that gaps 32 are provided between the surface elements 31. The surface elements 31 provide the outer surface 12 of the drum element 11. The drum element 11 of Figures 6a and 6b further comprises foil bits 29 arranged at the outer circumference of the drum element 11, or in other words, on the outer surface 12 of the drum element 11, and more precisely, on the outer surface of the annular surface elements 31 of the drum element 11.

[0045] In the embodiment of Figures 6a and 6b, the side surfaces 33 of the casing 30 and the surface elements 31 together define flow channels 25 for the pulp, the cross-sectional area of the flow channels 25 decreasing from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11 as a consequence of the diameter of the casing 30 increasing from the first end 30' of the casing 30 towards the second end 30" of the casing 30. The cross-sectional area of the flow channel 25 is thus arranged to decrease from the direction of the first end 25' of the flow channel 25 towards the direction of the second end 25" of the flow channel 25 in the flow direction of pulp in the flow channel 25. During the use of the screen provided with the drum element 11 as disclosed in Figures 6a and 6b, the pulp fed to the flow channels 25 moves from the flow channels 25 to the screening chamber 14 of the screen 1 in the areas remaining between the outermost surface elements 31 and the ends 11', 11" of the drum element 11 as well as through the gaps 32 between the neighbouring surface elements 31.

[0046] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 6a and 6b may also be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0047] Figure 7a shows schematically a sixth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 7b shows schematically an end view of the drum element of Figure 7a, as seen from the first end 11' of the drum element 11. The basic structure of the drum element 11 of Figures 7a, 7b is the same as in the drum element 11 of Figures 6a, 6b, the only difference being in the number of foil bits 29 attached to the outer circumference of the drum element 11, which is higher in the drum element 11 of Figures 7a, 7b than in the drum element 11 of Figures 6a, 6b. In the drum element of Figures 6a, 6b, foil bits 29 are arranged close to the peaks of the triangular casing 30 only whereas in the drum element of Figures 7a, 7b foil bits 29 are also arranged in the areas next to the side surfaces 33 of the triangular casing 30.

[0048] The first end 11' of the drum element 11 and

the second end 11" of the drum element 11 in the embodiment of Figures 7a and 7b may also be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0049] In the embodiments of Figures 5a, 6a, and 7a an edge of the foil bits 29 is arranged to extend over a side edge of the annular surface elements 31. The foil bits 29 may, however, be arranged in the surface elements 31 such that the foil bits 29 do not extend over the edges of the surface elements 31.

[0050] Figure 8a shows schematically a seventh drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 8b shows schematically an end view of the drum element of Figure 8a, as seen from the first end 11' of the drum element 11. The drum element 11 comprises a body 20 and a casing 30, the diameter of the casing 30 being arranged to increase from the first end 30' of the casing 30 towards the second end 30" of the casing 30. The outer surface of the casing 30 provides the outer surface 12 of the drum element 11. The body 20 provides a support structure of the drum element 11 through which the drum element 11 may be supported on the shaft 10 of the rotor 9 through an aperture 26 for the shaft 10. The casing 30 comprises, in the circumferential direction thereof, recesses extending from the first end 30' of the casing 30 towards the second end 30" of the casing 30, the recesses forming the flow channels 25 of the drum element 11. The cross-sectional area of the flow channels 25 is arranged to decrease from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11 as a consequence of the diameter of the casing 30 increasing from the first end 30' of the casing 30 towards the second end 30" of the casing 30. The cross-sectional area of the flow channel 25 is thus arranged to decrease from the direction of the first end 25' of the flow channel 25 towards the direction of the second end 25" of the flow channel 25 in the flow direction of pulp in the flow channel 25. The drum element 11 of Figures 8a and 8b further comprises foil bits 29, the foil bits 29 being arranged on the outer surface of the casing 30, in the areas of the casing 30 remaining between the flow channels 25, the foil bits 29 thus being arranged at the outer circumference of the drum element 11.

[0051] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 8a and 8b may also be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0052] In the embodiment of Figure 8a, the flow channels 25 are provided by the design or shaping of the casing 30, whereas in the embodiments of Figures 2a, 3a, and 4a the flow channels 25 are provided by surface elements 21 arranged on the outer surface of the casing 30. However, in the embodiments of Figures 2a, 3a, and 4a and in other similar embodiments, the surface elements 21 may be replaced by a corresponding design or

shaping of the casing 30 for providing the flow channels 25, whereby the protrusions of the drum element, the outer surfaces of which protrusions comprise foil bits 29, may be implemented by the design or shaping of the casing 30.

[0053] Figure 9a shows schematically an eighth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 9b shows schematically an end view of the drum element of Figure 9a, as seen from the first end 11' of the drum element 11. The drum element of Figures 9a and 9b comprises a casing 30 and a surface element 34 arranged in the casing 30. The casing 30 of Figures 9a and 9b corresponds to the casing 30 disclosed in Figures 5a and 5b. The surface element 34 is spiral-like element arranged to extend several times around the casing 30 in a spiral form so that gaps 32 are provided between neighbouring turns of the surface element 34. The surface element 34 provides the outer surface 12 of the drum element 11, and foil bits 29 are arranged on the outer surface of the surface element 34 so that the drum element 11 comprises foil bits 29 arranged at the outer circumference of the drum element 11.

[0054] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 9a and 9b may also be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0055] Figure 10a shows schematically a ninth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 10b shows schematically an end view of the drum element of Figure 10a, as seen from the first end 11' of the drum element 11. The drum element of Figures 10a and 10b comprises a casing 30 and a surface element 34 arranged at the casing 30. The casing 30 of Figures 10a and 10b corresponds to the casing 30 disclosed in Figures 6a and 6b. The surface element 34 is spiral-like element arranged to extend several times around the casing 30 in a spiral form so that gaps 32 are provided between neighbouring turns of the surface element 34. The surface element 34 provides the outer surface 12 of the drum element 11, and foil bits 29 are arranged on the outer surface of the surface element 34 so that the drum element 11 comprises foil bits 29 arranged at the outer circumference of the drum element 11.

[0056] The first end 11' of the drum element 11 and the second end 11" of the drum element 11 in the embodiment of Figures 10a and 10b may also be sealed with end plates 27 in a manner similar to that shown in the embodiments of Figures 2c and 2d.

[0057] Figure 11 shows schematically a tenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. The drum element 11 of Figure 11 resembles the drum element of Figures 2a, 2b, and

2c, one difference being, however, that only three surface elements 21 and, therefore, three flow channels 25 are provided in the embodiment of Figure 11 whereas in the embodiment of Figure 2a, 2b, and 2c four surface elements 21 and four flow channels 25 are provided.

[0058] When further considering the embodiments of Figures 11 and 2c, the end plate 27 in the embodiment of Figure 11 is arranged to seal only the inner sides of the surface elements 21 at the first end 30' of the casing 30, whereby a cavity 48 remains in the interior of the casing 30 of the drum element 11 at the first end 11' of the drum element 11. The cavity 48 increases the volume of a supply space of the screen 1, whereby the circular motion and the speed of pulp in the screening chamber 14 decreases, whereby the foil bits 29 have a stronger effect on the pulp in the screening chamber 14. On the other hand, the cavity 48 increases swirling of pulp, whereby the pulp entering the screening chamber 14 is of a more uniform quality.

[0059] In the embodiments shown above, the cross-sectional area of the flow channels 25 is arranged to decrease substantially continuously from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11, or in other words, the cross-sectional area of the flow channels 25 is arranged to decrease from the direction of the first ends 25' of the flow channels 25 towards the direction of the second ends 25" of the flow channels 25 in the flow direction of pulp in the flow channels 25.

[0060] In the embodiments disclosed above, and in the embodiments of Figures 13, 14, 15, 16, 17, 18, 19a, 19b and 20 disclosed later, the foil bits 29 are originally separate parts which are attached to the surface elements 21, 31, 34 individually for example by welding or by bolt fastening. When the foil bits 29 are attached to the surface elements 21, 31, 34 by welding, defects of form of the surface elements 21, 31, 34, and hence defects of form of the drum element 11, may appear due to a high temperatures used in welding. When the foil bits 29 are attached to the surface elements 21, 31, 34 by bolt fastening, the geometry of the foil bit 29 may become deteriorated. Both fastening ways are also laborious, time-consuming and expensive, because the foil bits 29 are fastened one by one during the manufacturing of the drum element 11 and unfastened one by one during the maintenance operations of the drum element 11. Also the casting of individual foil bits 29 is expensive.

[0061] An alternative solution for implementing foil bits 29 is disclosed in Figures 12a and 12b, wherein Figure 12a shows schematically an eleventh drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture, and Figure 12b shows schematically an end view of the drum element of Figure 12a, as seen from the first end 11' of the drum element 11. The basic structure of the drum element 11 of Figures 12a and 12b is substantially similar to that in Figures 9a and 9b. In Figures 12a and 12b, the foil bits 29 are embossed forms

35, which are for example stamped or die cutted to a sheet of material, like a steel band, to be used for forming the surface element 34, the embossed forms 35 having the shape or form corresponding to the desired shape or form of the foil bits 29. The surface element 34 will then be treated or processed, such as to have a desired diameter, so that it can be arranged at the casing 30 of the drum element 11. The surface element 34 will be arranged at the casing 30 of the drum element 11 in such a way that the embossed forms 35 are directed in the radial direction RD of the drum element 11 outwards from the casing 30 of the drum element 11. If there is a risk that pulp may stuck in a pocket remaining at a backing surface of the surface element 34 at the embossed forms 35, the pockets remaining at the backing surface of the surface element 34 may be covered.

[0062] In addition to the embodiment of Figures 12a, 12b comprising the surface element 34 having the form of a spiral, the embossed forms 35 providing the foil bits 29 may also be used in the embodiments having annular surface elements 31 or surface elements 21 comprising a plate-like covering plate 22. In all of these embodiments the embossed forms 35 may be first stamped or die cutted to a continuous steel band in a predetermined spacing, after which the steel band comprising the embossed forms 35 is cutted into parts of suitable size, which are processed for providing the spiral-like surface element 34, the annular surface element 33, a plate-like covering plate 22 for the surface element 21 or the whole surface element 21 comprising both the covering plate 22 and the side plates 23, 24.

[0063] The method for manufacturing the foil bits 29 as embossed forms 35 is fast and inexpensive. At the same time disadvantages relating to the manufacturing, fastening and unfastening of individual foil bits 29 may be avoided.

[0064] Figure 13 shows schematically a twelfth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. The basic structure of the drum element 11 of Figure 13 is substantially similar to that in Figure 2a, meaning for example that the flow channels 25 extend from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11 and that the cross-sectional area of the flow channels 25 is arranged to decrease from the direction of the first end 25' of the flow channel 25 towards the direction of the second end 25" of the flow channel 25 in the flow direction of pulp in the flow channel 25. In the drum element 11 of Figure 13, however, steps 36 are provided on the side surfaces 23', 24' in each flow channel 25 substantially in the middle part of the drum element 11 in the axial direction A of the drum element 11 so that the width of the flow channel 25 is arranged to decrease in the direction from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11, the step 36 thus providing a change in a cross-sectional size of the flow channel, which further decreases the cross-sectional ar-

ea of the flow channel 25 from the direction of the first end 25' of the flow channel 25 towards the direction of the second end 25" of the flow channel 25 in the flow direction of pulp in the flow channel 25. The steps 36 provide a discontinuity in the flow channel 25, which causes turbulence on the pulp in the screening chamber 14, which prevents flocculation of pulp in the screening chamber 14. The steps 36 and the decreased width of the flow channel 25 in the last part of the drum element 11 together also forces the pulp flowing in the flow channel 25 more vigorously to move from the flow channel 25 towards the screening chamber 14 between the rotor 9 and the screen basket 6 of the screen 1. The steps 36 in the flow channel 25 thus provide a kind of a stopper forcing the pulp towards the screening chamber 14, which provides an effective screening for pulp with low consistency of reject material.

[0065] In the embodiment of Figure 13, the steps 36 are arranged to provide a change in the cross-sectional shape of the flow channels 25. Similar kind of steps could also be used in the other embodiments shown for providing a change in the cross-sectional shape of the flow channels 25.

[0066] Figure 14 shows schematically a thirteenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. The basic structure of the drum element 11 of Figure 14 is substantially similar to that in Figure 2a. In the drum element 11 of Figure 14, however, separate flow channels 25 are provided at the top part of the drum element 11 and the bottom part of the drum element 11. In other words, the drum element 11 of Figure 14 comprises both flow channels 25a extending from the first end 11' of the drum element 11 towards the second end 11" of the drum element 11 and flow channels 25b extending from the second end 11" of the drum element 11 towards the first end 11' of the drum element 11. Both in flow channels 25a and in flow channels 25b, the cross-sectional area of the flow channel 25 is arranged to decrease from the first end 25' of the flow channel 25a, 25b towards the second end 25" of the flow channel 25. The flow channels 25a, 25b are also arranged to end, in the axial direction A of the drum element 11, substantially at a middle part of the drum element 11 such that in the axial direction A of the drum element 11 a portion of the drum element 11 is provided at the middle part of the drum element 11 not comprising any portion of any flow channel 25a, 25b. In other words, the second ends 25" of both the flow channels 25a and 25b are arranged to be placed, in the axial direction A of the drum element 11, at a middle part of the drum element 11 such that in the axial direction A of the drum element 11 a portion of the drum element 11 is provided at the middle part of the drum element 11 not comprising any portion of any flow channel 25a, 25b.

[0067] The drum element 11 of Figure 14 may be used for example in a screen 1 comprising an inlet channel 15 at both ends of the screen 1 so that pulp to be screened

may be supplied towards the drum element 11 at both ends of the drum element 11, whereby the pulp enters the flow channels 25a, 25b at the first ends 25' of the respective flow channels 25. Thus, in the drum element 11 of Figure 14, the cross-sectional areas of the flow channels 25a, 2b are arranged to decrease from the direction of the first ends 25' of the flow channels 25a, 25b towards the direction of the second ends 25" of the flow channels 25a, 25b in the flow direction of pulp in the flow channels 25a, 25b. The reject chamber 18 as well as the reject channel 19 may thereby be placed in the axial direction A of the drum element 11 at the middle part of the drum element 11 not comprising any portion of any flow channel 25a, 25b.

[0068] Figure 15 shows schematically a fourteenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. The basic structure of the drum element 11 of Figure 15 is substantially the same as for example that of the drum element 11 of Figure 2a but, in the longitudinal direction of the flow channel 25, a portion 37 of the flow channel 25 is provided which is arranged to extend in a direction deviating from a direction of a projection of the axis of the drum element 11. In the embodiment of Figure 15, the portion 37 of the flow channel 25, starting from the first end 25' of the flow channel 25 and extending some distance towards the second end 25" of the flow channel 25, is arranged to be inclined towards the rotation direction R of the rotor 9. With this solution the supply of pulp into the flow channel 25 may be intensified. Other kinds of flow channel implementations, wherein a portion of the flow channel is arranged to extend in a direction deviating from a direction of a projection of the axis of the drum element 11 in the outer surface 12 of the drum element 12, are also possible.

[0069] In the embodiment of Figure 15, the end of the surface element 21 at the first end 11' of the drum element 11 is closed with an end plate 47 having a first portion 47' and second portion 47", which are arranged to descend substantially linearly towards the second end 11" of the drum element 11 such that the inclination angle of the second portion 47" is larger than that of the first portion 47'. The second portion 47" of the end plate 47 meets the second side plate 24 of the surface element 21 at a point located above the uppermost foil bit 29 next to the second side plate 24 of the surface element 21.

[0070] Further, in the embodiment of Figure 15 the first side plate 23 of the surface element 21 comprises at the first end 11' of the drum element 11 a portion 23c which is arranged to be linearly inclined towards the rotation direction R of the rotor 9. The portion 23c meets the first portion 47' of the end plate 47 of the surface element 21 at the first end 25' of the flow channel 25. The portion 23c of the first side plate 23 and the first portion 47' of the end plate 47 together provide a cam which effectively guides pulp to the flow channel 25. It is, however, possible that the first side plate 23 is substantially straight such that no specific cam is provided at the first end 25' of the

flow channel 25 on the side of the first side plate 23.

[0071] In the embodiment similar to that of Figure 15, the end plate 47 could also consist of one linearly inclined portion only.

[0072] Figure 16 shows schematically a fifteenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. The basic structure of the drum element 11 of Figure 16 is substantially the same as that of the drum element 11 of Figure 15 but the first portion 47' and the second portion 47" of the end plate 47, as well as the portion 23c of the first side plate 23, are curved, instead of being straight as in the embodiment of Figure 15.

[0073] In the embodiment similar to that of Figure 16, the end plate 47 could also consist of one curved portion only.

[0074] Figure 17 shows schematically a sixteenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. The basic structure of the drum element 11 of Figure 17 is substantially the same as that of the drum element 11 of Figures 15 and 16. The end plate 47 in Figure 17 comprises a substantially horizontal first portion 47' and a slightly curved second portion 47" inclined towards the second end 11" of the drum element 11. The side plates 23, 24 of the surface elements 21 are arranged to be curved such that the shape of the flow channel 25 in the extending direction of the flow channel 25 resembles a spiral.

[0075] In the embodiments of Figures 15, 16, and 17, the surface elements 21 may also be replaced by corresponding design or shaping of the casing 30, as stated above.

[0076] Figure 18 shows schematically an end view of a drum element 11, as seen from the first end 11' of the drum element 11. In Figure 18, the side plates 23, 24 of the surface elements 21 shown in continuous line form the drum element embodiment with a flow channel geometry as shown in Figure 2a. Further, Figure 18 shows, in broken line, some possible alternative side plate constructions. Reference number 23a refers to a first side plate which is inclined backwards in respect of the rotation direction R of the rotor 9 while reference number 24a refers to a second side plate which is inclined towards the rotation direction R of the rotor 9, when the first side plate 23a and the second side plate 24a are viewed in respect of points at which the first side plate 23a and the second side plate 24a meet the bottom surface of the flow channel 25. The first side plate 23a and the second side plate 24a together provide a flow channel construction whose width is arranged to increase symmetrically towards the outer circumference of the drum element 11.

[0077] Further, when considering Figure 18, reference number 23b refers to a first side plate which is inclined towards the rotation direction R of the rotor 9 while reference number 24b refers to a second side plate which is inclined backwards in respect of the rotation direction

R of the rotor 9, when the first side plate 23b and the second side plate 24b are again viewed in respect of points at which the first side plate 23b and the second side plate 24b meet the bottom surface of the flow channel 25. The first side plate 23b and the second side plate 24b together provide a flow channel construction whose width is arranged to decrease symmetrically towards the outer circumference of the drum element 11, which prevents any uncontrollable pulp flows from entering the screening chamber 14 from the flow channel 25.

[0078] When further considering Figure 18, any combination of the first side plate 23, 23a, 23b and the second side plate 24, 24a, 24b shown may be chosen to provide the side surfaces 23', 24' for the flow channels 25. One drum element 11 may comprise flow channels 25 wherein the geometries of all the flow channels 25 are the same. Alternatively, the geometries of different flow channels 25 in a single drum element 11 may be different. It should also be noted that the angle α_1 and/or α_2 of the respective side plate in respect of the bottom surfaces of the flow channels 25 may vary from those presented in the embodiment of Figure 18 or any other embodiment presented.

[0079] An example of a drum element 11 comprising flow channels 25 with different cross-sectional geometries is shown in Figures 19a and 19b, wherein Figure 19a shows schematically a seventeenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. Figure 19b shows schematically an end view of the drum element of Figure 19a, as seen from the first end 11' of the drum element 11. The drum element of Figures 19a and 19b comprises a total of four flow channels 25 with two different cross-sectional geometries. Two of the flow channels 25 have a curved bottom surface so that the cross-sectional geometry of the flow channels resembles a bisected cone. The other two flow channels 25 have a straight bottom surface. The cross-sectional area of each flow channel 25 is arranged to decrease in two different ways in the flow direction of pulp in the flow channels 25. A depth of the flow channels 25 decreasing from the first ends 25' of the flow channels 25 towards the second ends 25" of the flow channels 25 due to a diameter of the casing 30 increasing from the first end 30' of the casing 30 towards the second end 30" of the casing 30 is one way how to decrease the cross-sectional area of the flow channels 25. Another way to decrease the cross-sectional area of the flow channels 25 is the width of the flow channels 25 decreasing from the first ends 25' towards the second ends 25".

[0080] In some embodiments shown above, the end plate 27 seals both ends 30', 30" of the casing 30 as well as an inner side of possible surface elements 21 or corresponding protrusions, whereas in some other embodiments the end plate 27 only seals possible surface elements 21 or corresponding protrusions, leaving the cavity 48 at the end of the casing 30 open. However, in all embodiments, other kinds of end plates 27 may be used.

[0081] In all of the embodiments above, the cross-sectional area of the flow channel 25 is arranged to decrease, in the longitudinal direction of the flow channel 25 from the direction of the first end 25' of the flow channel 25 towards the direction of the second end 25" of the flow channel 25 in the flow direction of pulp in the flow channels 25.

[0082] Figure 20 shows schematically an eighteenth drum element 11 which may be applied to a drum rotor 9 of a screen 1 for screening pulp to be used for paper and paperboard manufacture. In the drum element 11 of Figure 20, the depth of the flow channel 25 is arranged to decrease towards the second end 25" of the flow channel 25 and the width of the flow channel 25 is arranged to increase towards the second end 25" of the flow channel 25. Depending on the actual dimensions of the structures defining the flow channel 25, the cross-sectional area of the flow channel 25 may, however, decrease from the direction of the first end 25' towards the second end 25" of the flow channel 25.

[0083] In the embodiments shown above, the drum element 11 is to be used as a part of the drum rotor 9 of the screen 1. However, the drum elements 11 disclosed may also be used in screens wherein the screen basket 6 is arranged to rotate, whereby the drum element 11 may be fixed non-rotationally in the space inside the screen basket 6, the direction of the rotation of the screen basket 6 being the same as the rotation direction R of the rotor 9 disclosed above. The effects of the non-rotational drum element are similar to those disclosed above.

[0084] A total cross-sectional area of the flow channels 25 of a cross-sectional area of an annular space between the screen basket 6 and the outer circumference of the drum element 11 may vary. The outer circumference of the drum element 11 corresponds to an imaginary circular line running along a level of the outer surface 12 of the drum element 11, to which outer surface 12 the foil bits 29 are to be attached. The total cross-sectional area of the flow channels 25 of 0% of the cross-sectional area of an annular space is determined to correspond to a case in which the flow channels 25 are not open towards the feed of pulp and the pulp flows to the flow channels 25 and the screening chamber 14 through the annular space between the drum element 11 and the screen basket 6. Correspondingly, the total cross-sectional area of the flow channels 25 of 100% is determined to correspond to a case in which the annular space between the drum element 11 and the screen basket 6 is closed and all pulp to the screening chamber 14 flows through the flow channels 25.

[0085] Referring to the definition above, the total cross-sectional area of the flow channels 25, at the end of the drum element where pulp is fed to the screen 1, may vary between 0 and 100 % of the cross-sectional area of the annular space between the screen basket 6 and the outer circumference of the drum element. Typically, the total cross-sectional area of the flow channels 25 is arranged to vary between 20 and 80%, preferably between 30 and

70 % and more preferably between 40 and 60%, of the cross-sectional area of an annular space between the screen basket 6 and the outer circumference of the drum element 11 at the end of the drum element where pulp is fed to the screen, whereby the flow of pulp to the screening chamber 14 may take place partly through the flow channels 25 and partly through the annular space between the screen basket 6 and the outer circumference of the drum element 11.

[0086] Figures 21 to 23 schematically show some examples of possible foil bits 29 to be used in a drum element 11. Figure 21 shows a schematic side view of the foil bit 29 and Figures 22 and 23 show two schematic alternative top views of the foil bit 29. The foil bit 29 has a front edge 38 to be directed towards the intended rotation direction R of the rotor 9, a tail edge 39 directed opposite to the intended rotation direction R of the rotor 9, and a first side 40 and a second side 41 connecting the front edge 38 and tail edge 39. The foil bit 29 further has a curved upper surface 42 to be directed away from the drum element 11, and a curved bottom surface 43 to be directed towards the drum element 11. The part of the upper surface 42 being arranged to curve towards the front edge 38 of the foil bit 29 provides a leading part 44 of the foil bit 29, the leading part 44 being arranged to apply a positive pressure pulse to the pulp being screened. The part of the upper surface 42 being arranged to curve towards the tail edge 39 of the foil bit 29 provides a tailing part 45 of the foil bit 29, the tailing part 45 being arranged to apply a negative pressure pulse to the pulp being screened. In the embodiment of Figure 22 the first 40 and second 41 side edges of the foil bit 29 are straight, but in the embodiment of Figure 23 the second side edge 41 is partly curved towards the tail edge 39 of the foil bit 29. Alternatively, both of the side edges 40, 41 could be curved towards the tail edge 39 of the foil bit 29, either over a part of their length or over their whole length.

[0087] It will be obvious to a person skilled in the art that, as technology advances, the inventive concept can be implemented in many different ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims. The number of surface elements may thus differ from that presented in the Figures. Also the number of foil bits, both in the axial direction of the drum element and the circumferential direction of the drum element, may differ from that presented in the Figures. Also the distance between the adjacent surface elements or foil bits, both in the axial direction of the drum element and the circumferential direction of the drum element, may differ from that presented in the Figures, meaning that the adjacent surface elements or foil bits, both in the axial direction of the drum element and the circumferential direction of the drum element, may be located more sparsely or more densely than that presented in the Figures.

Claims

1. A drum element (11) for a screen (1) for screening pulp, the drum element (11) comprising a first end (11') and a second end (11'') opposite to the first end (11'), at least one flow channel (25, 25a, 25b) arranged to extend from at least one end (11', 11'') of the drum element (11) towards an opposite end (11', 11'') of the drum element (11) for a flow of pulp and arranged to open towards an outer circumference of the drum element (11), and foil bits (29) arranged at the outer circumference of the drum element (11), **characterized in that** a cross-sectional area of the flow channel (25, 25a, 25b) is arranged to decrease from a direction of the first end (25') of the flow channel (25) towards a direction of the second end (25'') of the flow channel (25) in a flow direction of pulp in the flow channel (25, 25a, 25b).
2. A drum element as claimed in claim 1, **characterized in that** the drum element (11) comprises a body (20) and a casing (30), the casing (30) comprising recesses extending from at least one end (30', 30'') of the casing (30) towards an opposite end (30', 30'') of the casing (30), the recesses providing the flow channels (25, 25a, 25b) of the drum element (11).
3. A drum element as claimed in claim 1, **characterized in that** the drum element (11) comprises a body (20), a casing (30) and a number of surface elements (21) arranged at the casing (30), the surface elements (21) extending from a first end (30') of the casing (30) towards a second end (30'') of the casing (30) and in a radial direction of the drum element (11) outwards from the casing (30), the surface elements (21) being arranged at the casing (30) in a circumferential direction of the drum element (11) such that at least one recess is provided between neighbouring surface elements (21) for providing the flow channel (25, 25a, 25b) of the drum element (11).
4. A drum element as claimed in claim 1, **characterized in that** the drum element (11) comprises a body (20) and a casing (30) and at least one surface element (31, 34) arranged at the casing (30) and arranged to surround the casing (30), the casing (30) and the at least one surface element (31, 34) together defining the flow channel (25) of the drum element (11).
5. A drum element as claimed in claim 4, **characterized in that** the casing (30) of the drum element (11) comprises in a circumferential direction of the casing (30) wave crests and between them wave troughs arranged to extend from the first end (30') of the casing (30) towards the second end (30'') of the casing (30), the drum element (11) further comprising at least one surface element (31, 34) having the form of a

ring or a spiral and arranged at the casing (30), whereby the wave troughs together with the at least one surface element (31, 34) define the flow channels (25) of the drum element (11).

6. A drum element as claimed in claim 4, **characterized in that** the casing (30) of the drum element (11) has a cross-sectional shape of a triangle extending in an axial direction (A) of the drum element (11), the drum element (11) further comprising at least one surface element (31, 34) having the form of a ring or a spiral and arranged at the casing (30), whereby side surfaces (33) of the casing (30) together with the surface elements (31) define the flow channels (25) of the drum element (11).

7. A drum element as claimed in any one of the preceding claims, **characterized in that** the flow channel (25) comprises at least one step (35, 36) arranged to provide a change in a cross-sectional size of the flow channel (25).

8. A drum element as claimed in any one of the preceding claims, **characterized in that** the drum element (11) comprises flow channels (25a) extending from the first end (11') of the drum element (11) towards the second end (11'') of the drum element (11), and flow channels (25b) extending from the second end (11'') of the drum element (11) towards the first end (11') of the drum element (11), the cross-sectional area of at least one flow channel (25a, 25b) being arranged to decrease from a first end (25') of the flow channel (25a, 25b) towards a second end (25'') of the flow channel (25a, 25b).

9. A drum element as claimed in any one of the preceding claims, **characterized in that** in the longitudinal direction of the flow channel (25) at least a portion (37) of the flow channel (25) is arranged to extend in a direction deviating from a direction of a projection of an axis of the drum element (11) in the outer circumference of the drum element (11).

10. A drum element as claimed in any one of the preceding claims, **characterized in that** a total cross-sectional area of the flow channels (25) is 20 to 80%, preferably 30 to 70% and more preferably 40 to 60%, of a cross-sectional area of an annular space between a screen basket (6) of the screen (1) and the outer circumference of the drum element (11) at the end (11', 11'') of the drum element (11) where the pulp is fed to the screen (1).

11. A drum element as claimed in any one of the preceding claims, **characterized in that** the drum element (11) is arranged to provide at least part of a rotor (9) of the screen (1).

12. A drum element as claimed in any one of the preceding claims, **characterized in that** the foil bit (29) has a front edge (38) to be directed towards an intended rotation direction (R) of the rotor (9) of the screen (1), a tail edge (39) to be directed oppositely to the intended rotation direction (R) of the rotor (9) of the screen (1), a first side edge (40) and a second side edge (41) connecting the front edge (38) to the tail edge (39), and that at least one of the side edges (40, 41) is straight.

13. A drum element as claimed in any one of the preceding claims, **characterized in that** the foil bit (29) is an embossed form (35) provided to a piece of a sheet intended to provide at least part of the surface element (21, 31, 34) of the drum element (11).

14. A screen (1) for screening pulp, the screen (1) comprising a screen basket (6) provided with a screening surface (8), **characterized in that** the screen (1) comprises at least one drum element (11) as claimed in any one of claims 1 to 13.

15. A screen as claimed in claim 14, **characterized in that** the screen (1) comprises a rotor (9) arranged inside the screen basket (6), and that the rotor (9) comprises at least one drum element (11) as claimed in any one of claims 1 to 13.

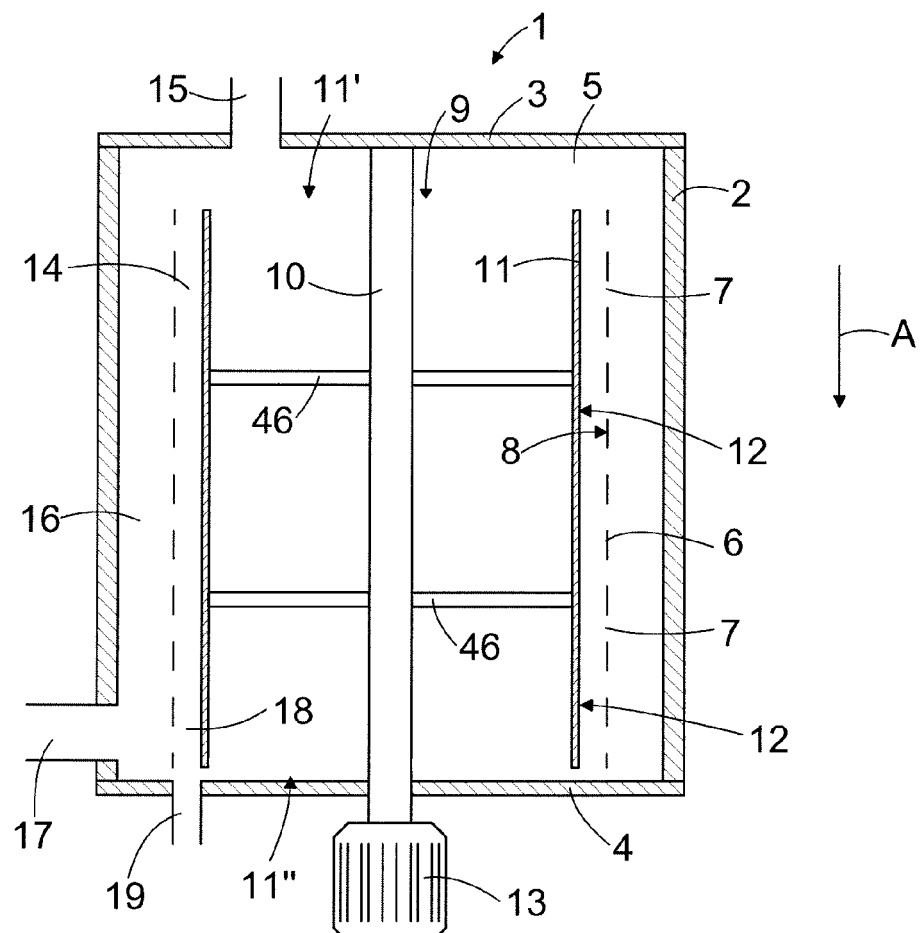


FIG. 1

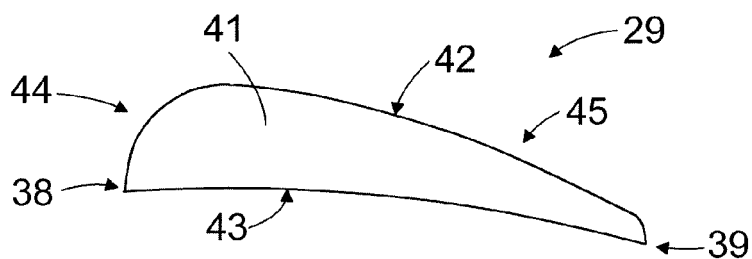


FIG. 21

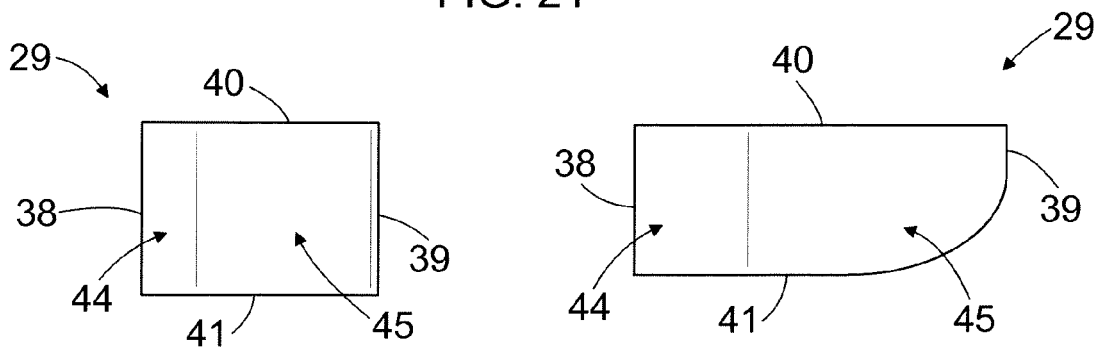
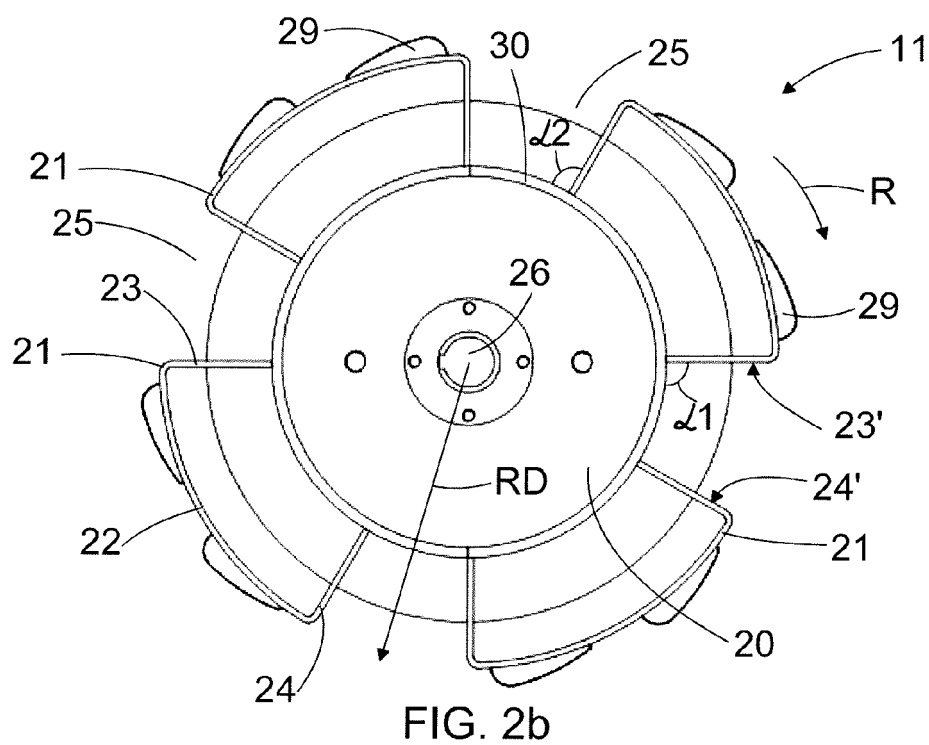
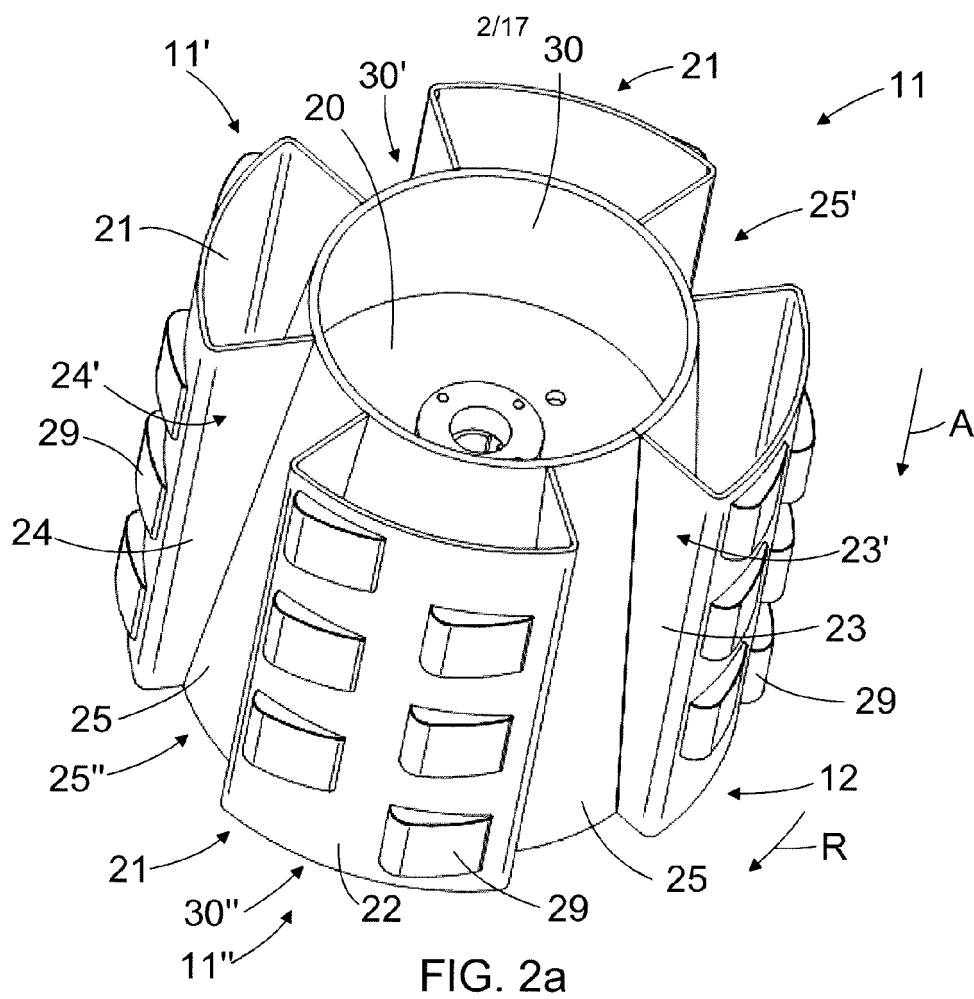


FIG. 22

FIG. 23



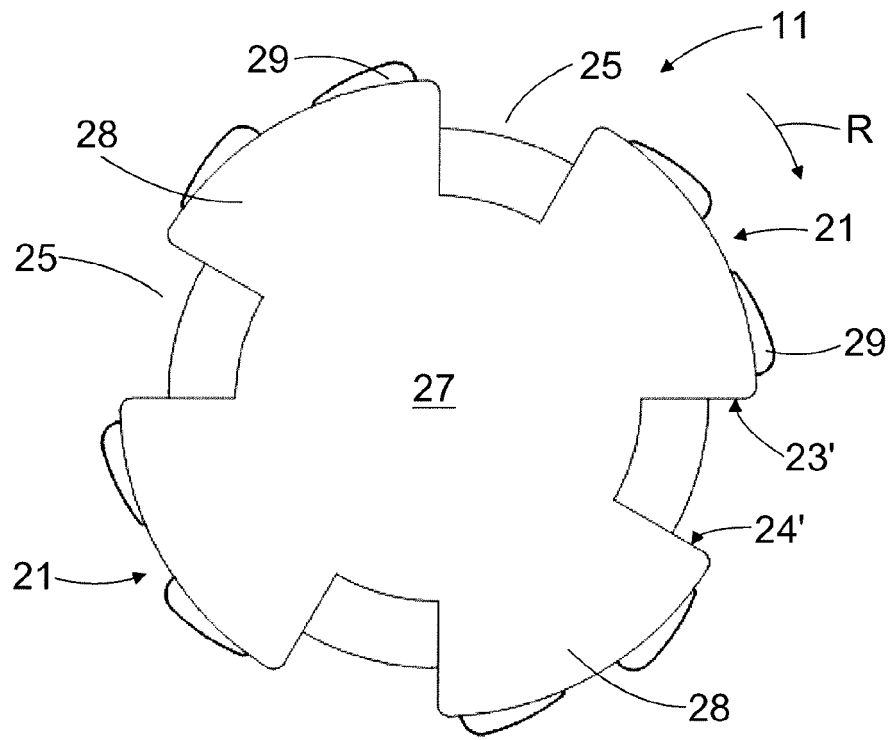


FIG. 2c

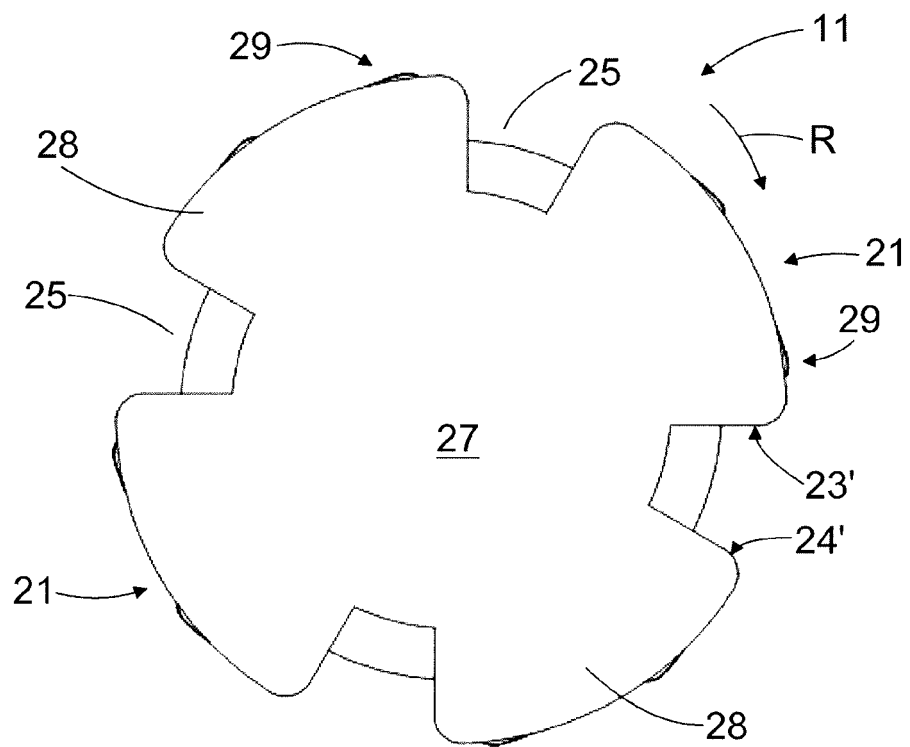
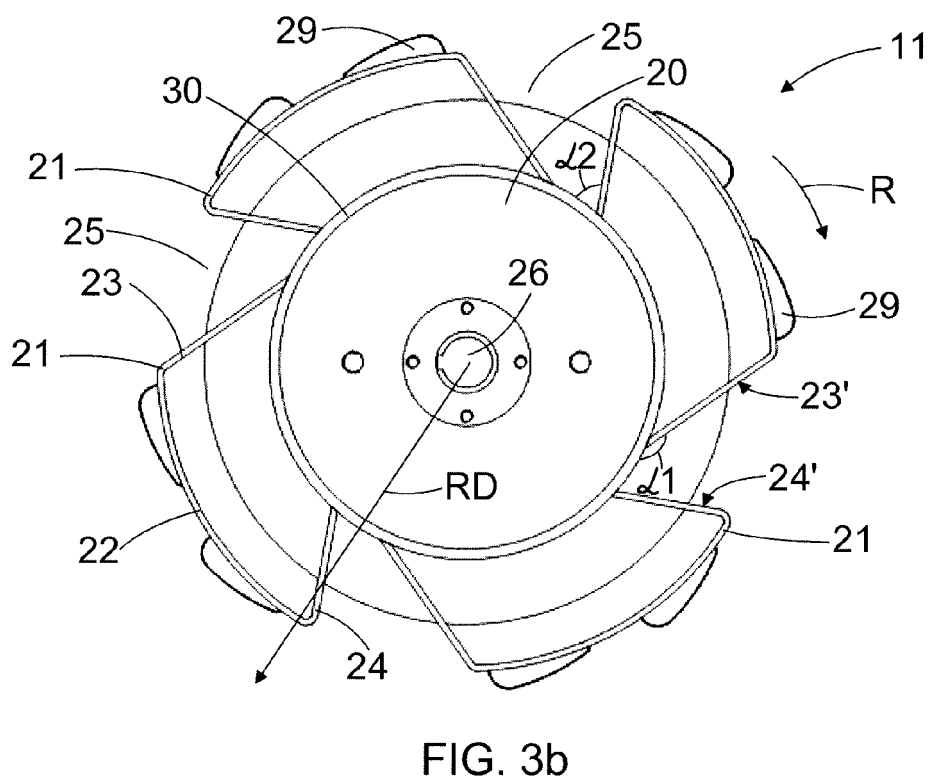
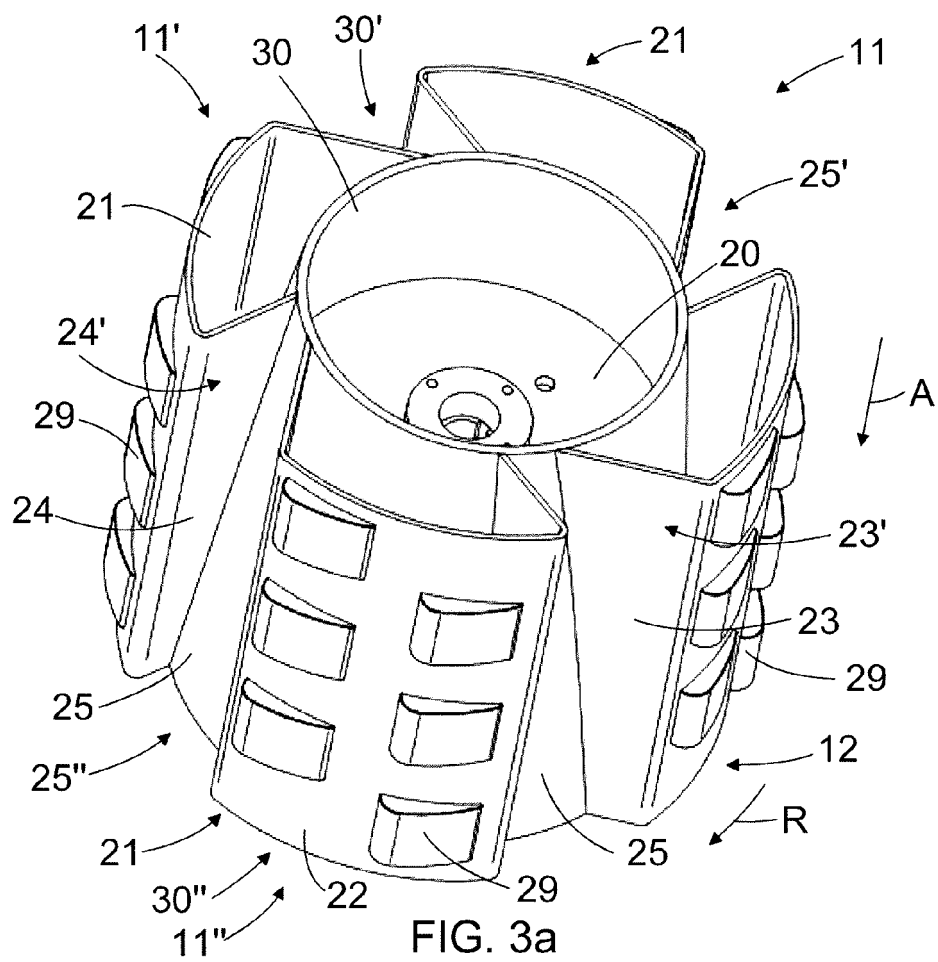
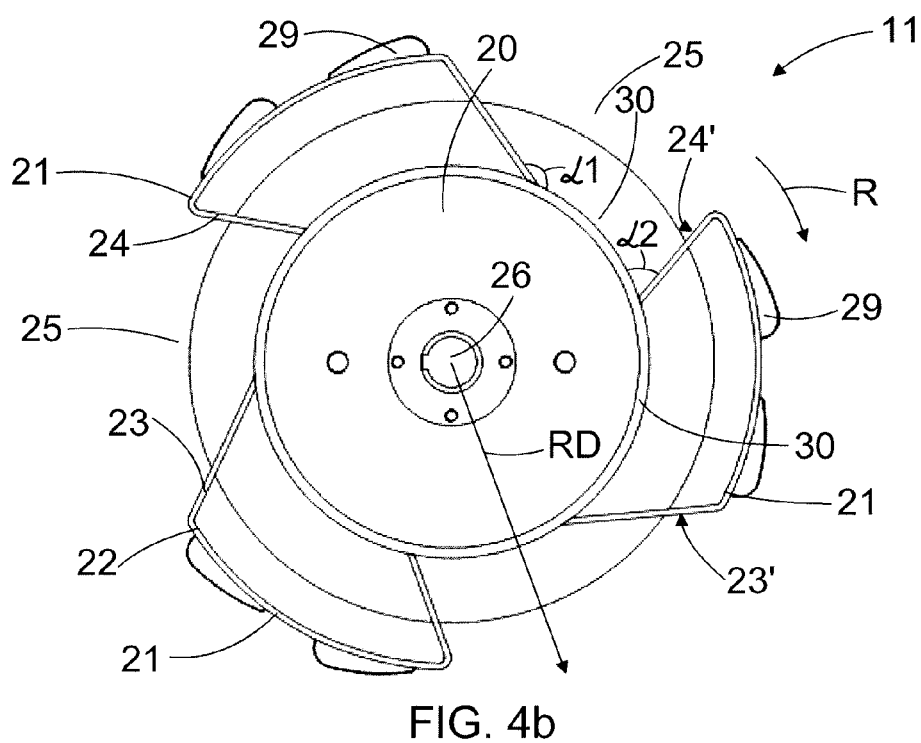
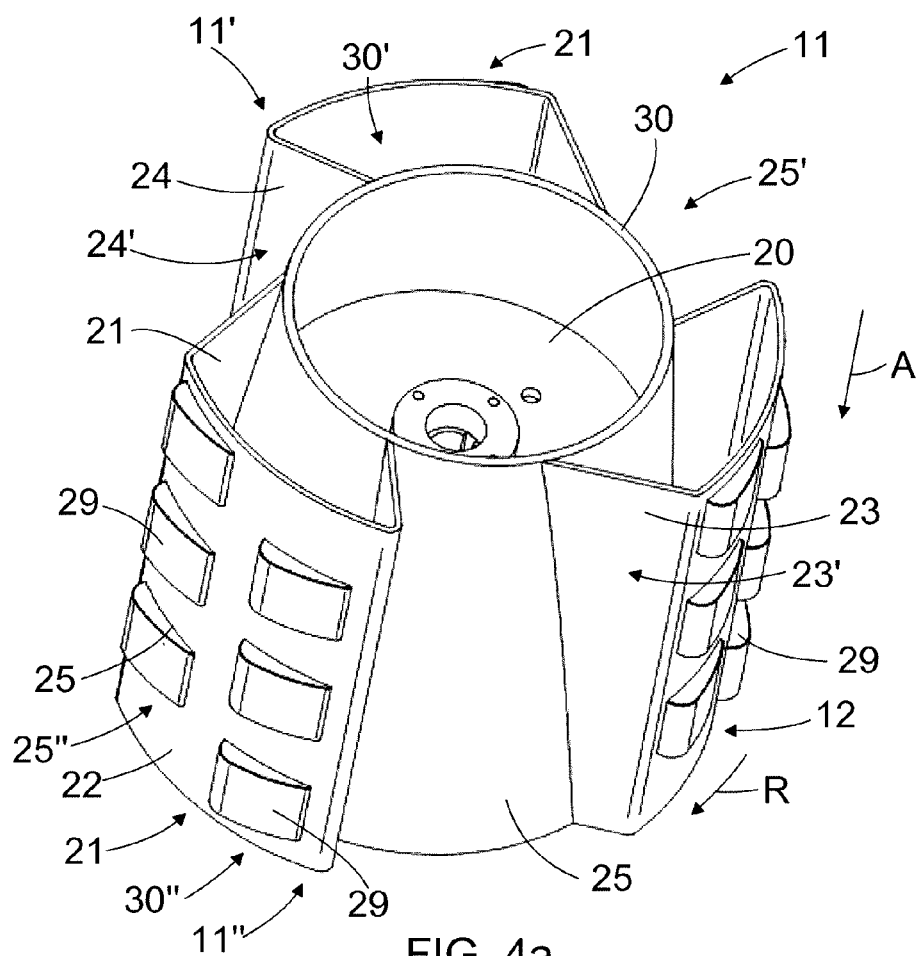
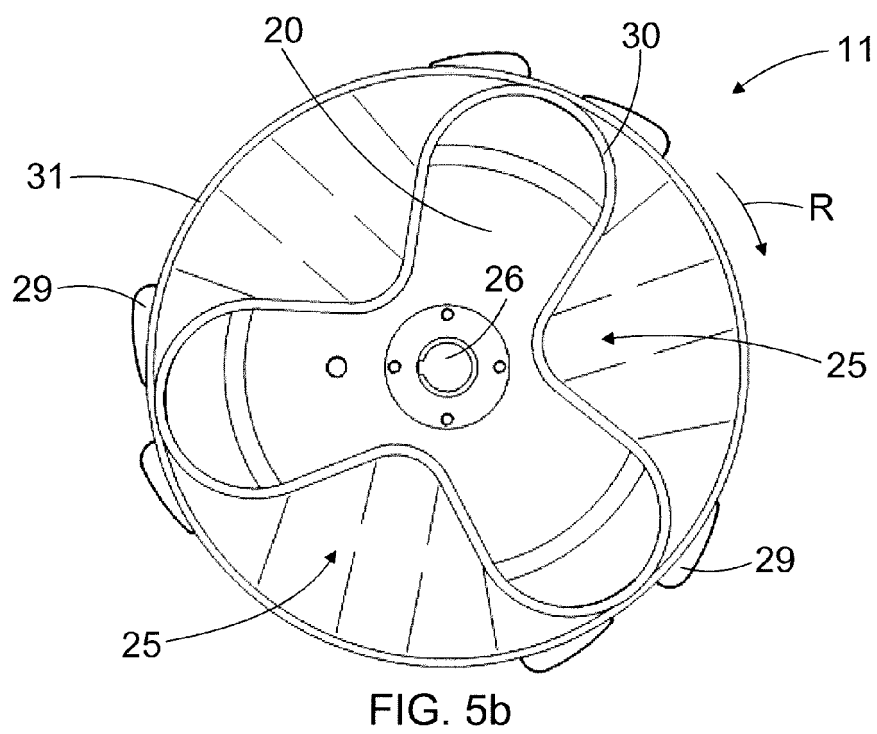
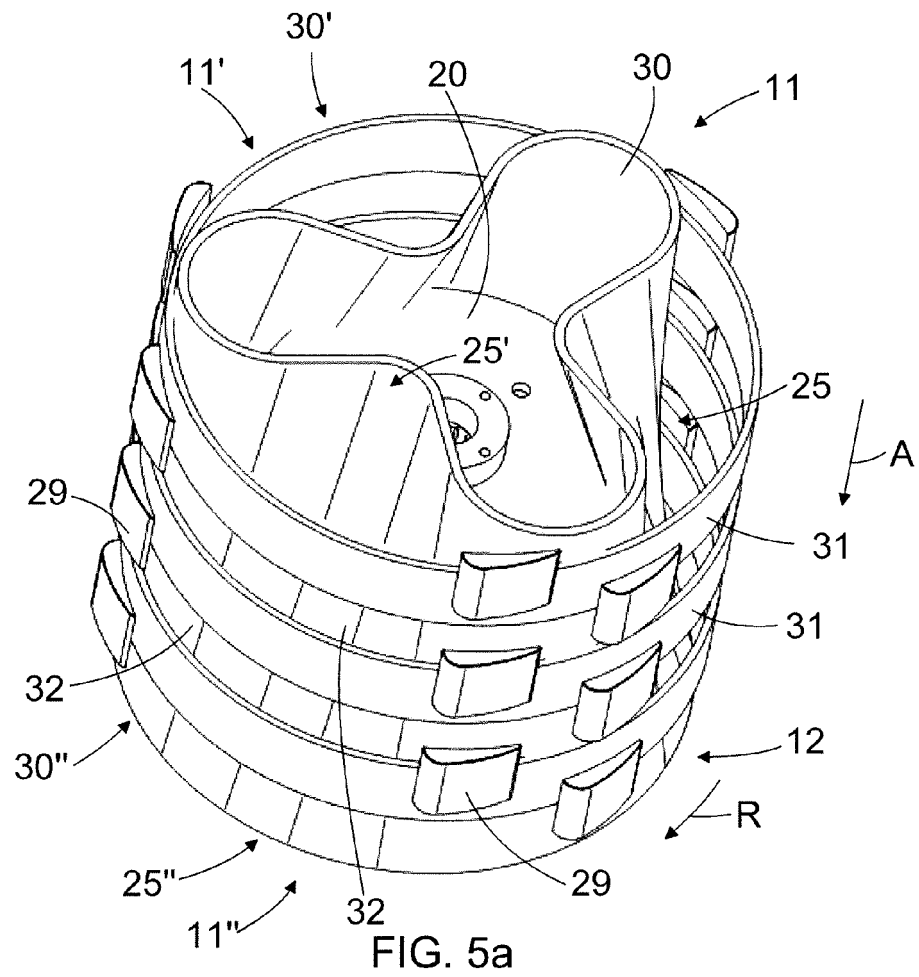


FIG. 2d







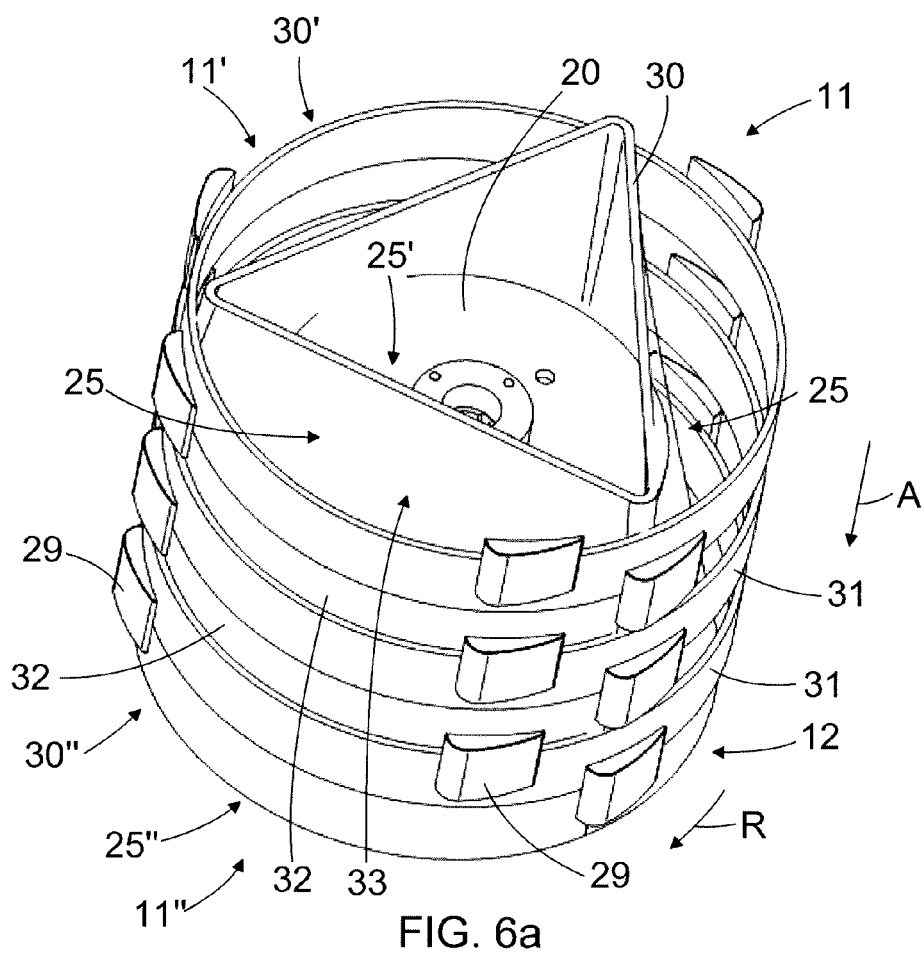


FIG. 6a

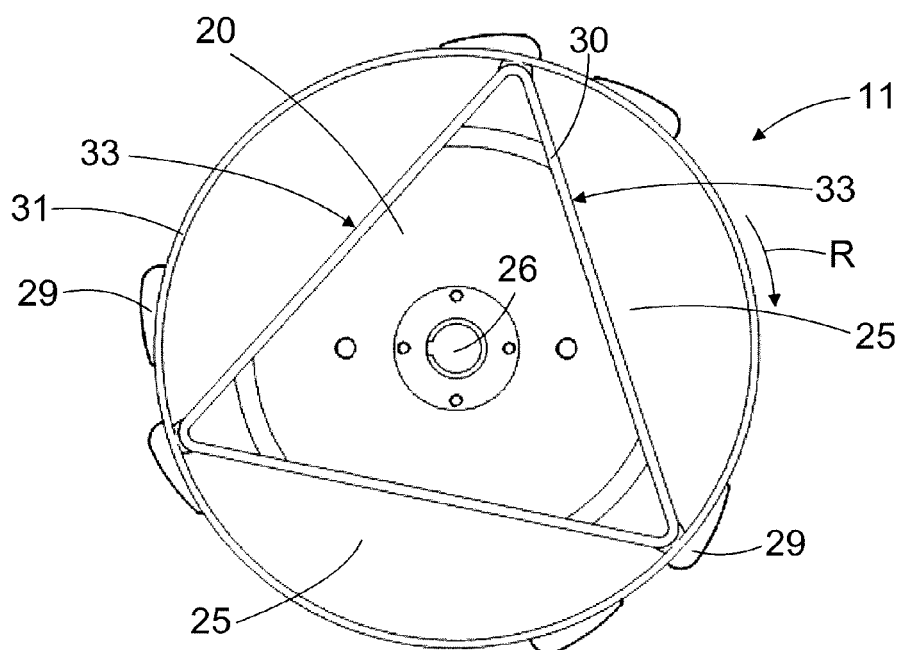
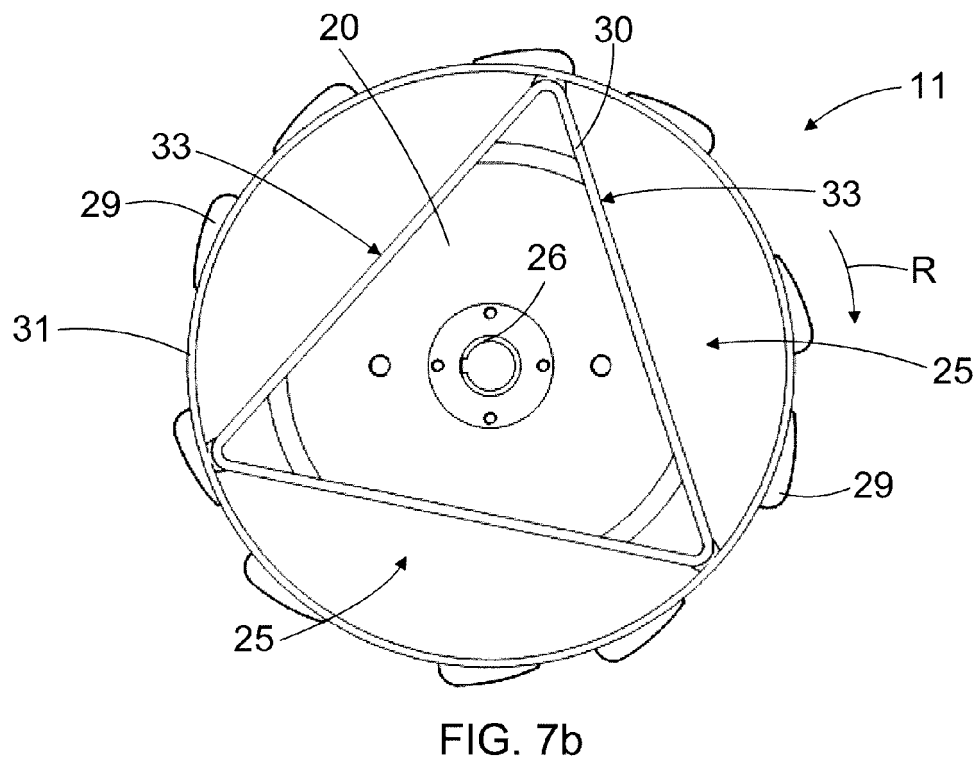
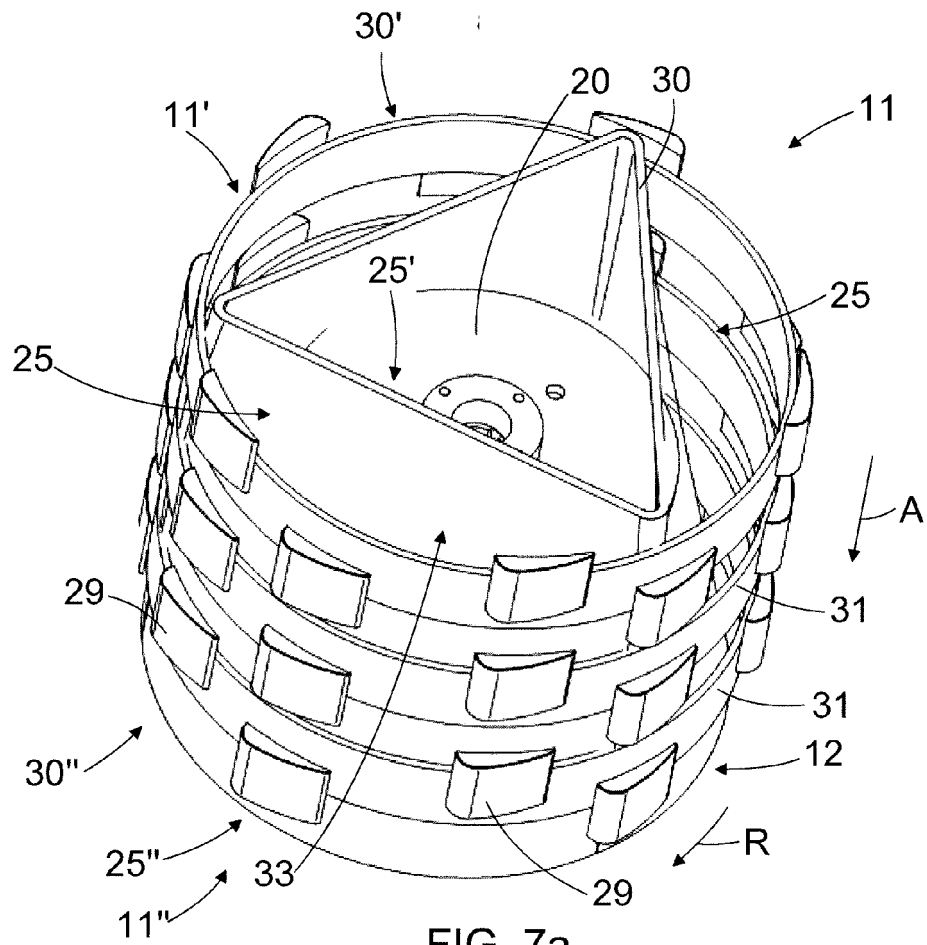
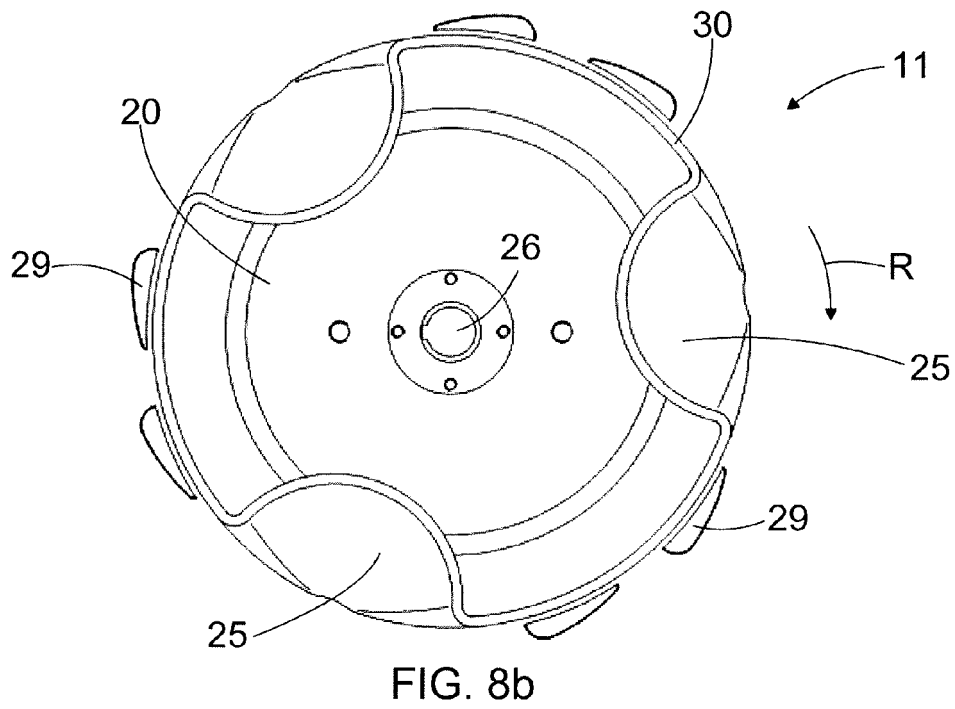
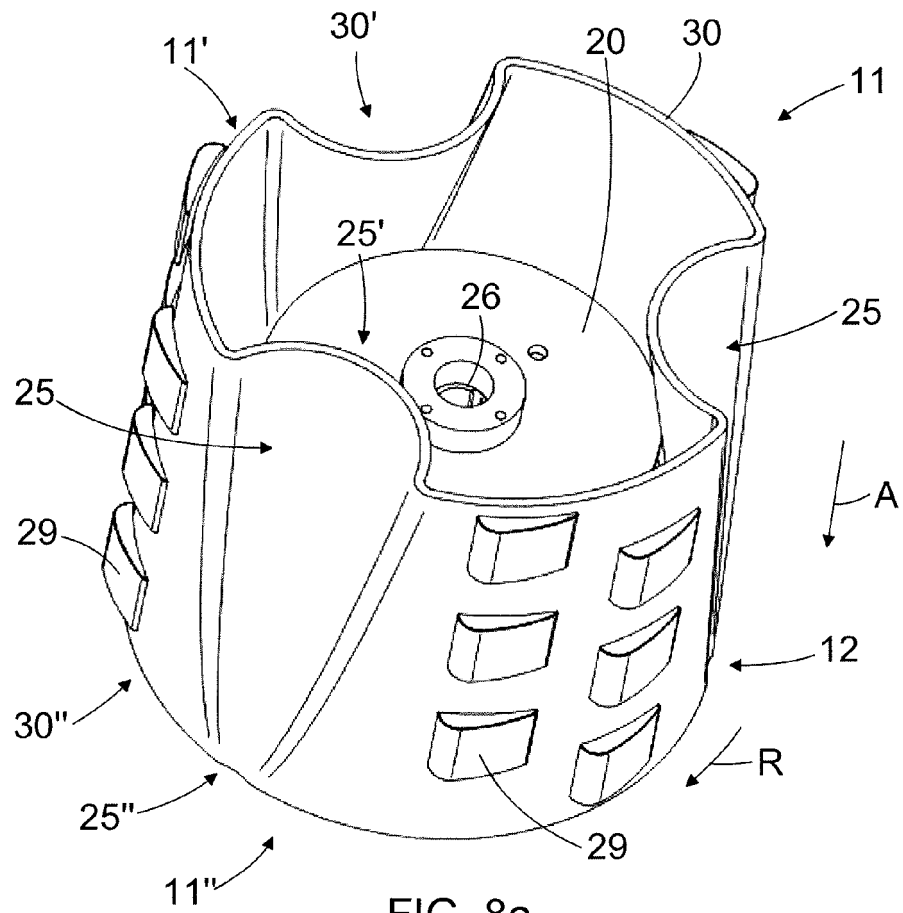
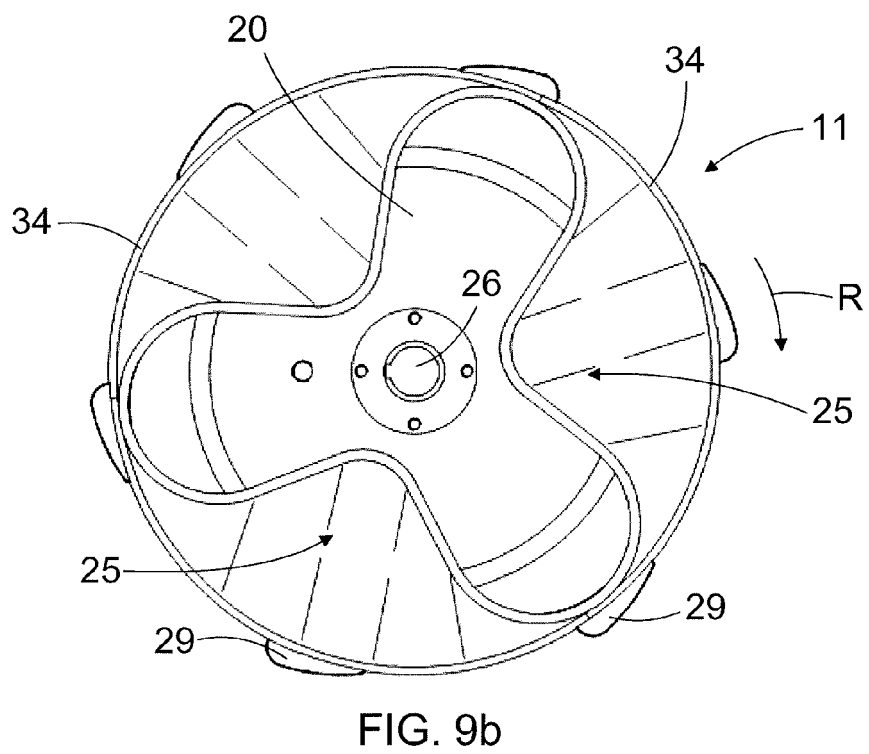
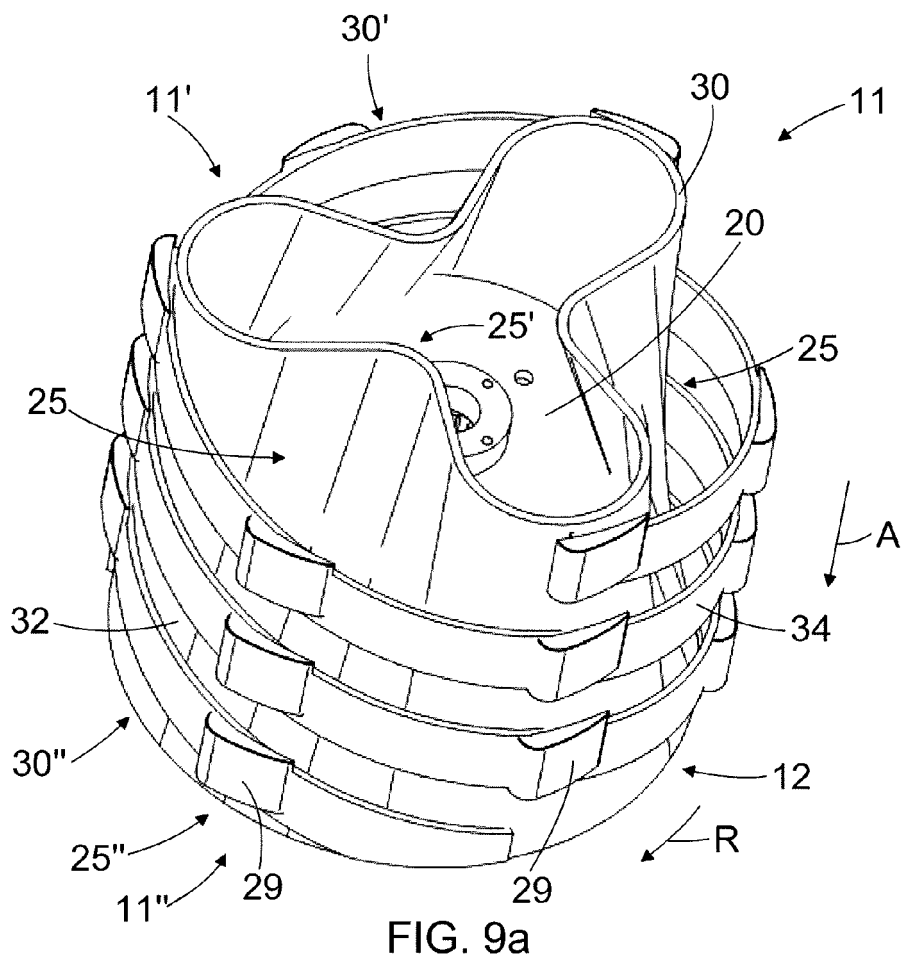


FIG. 6b







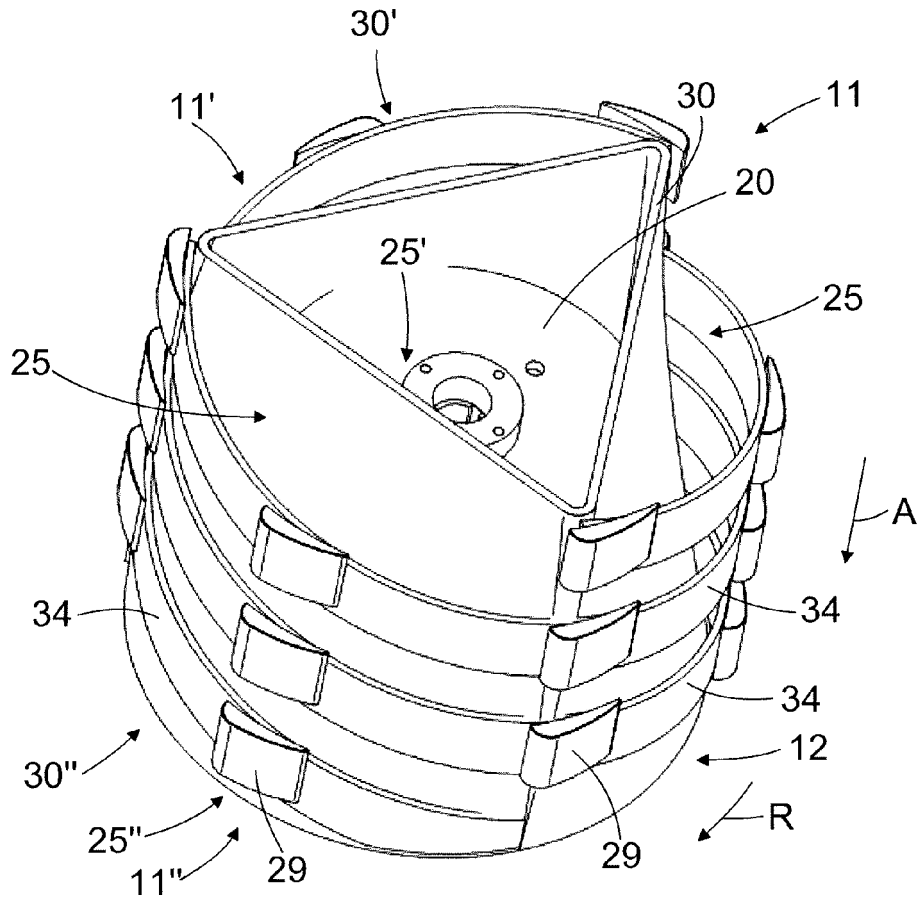


FIG. 10a

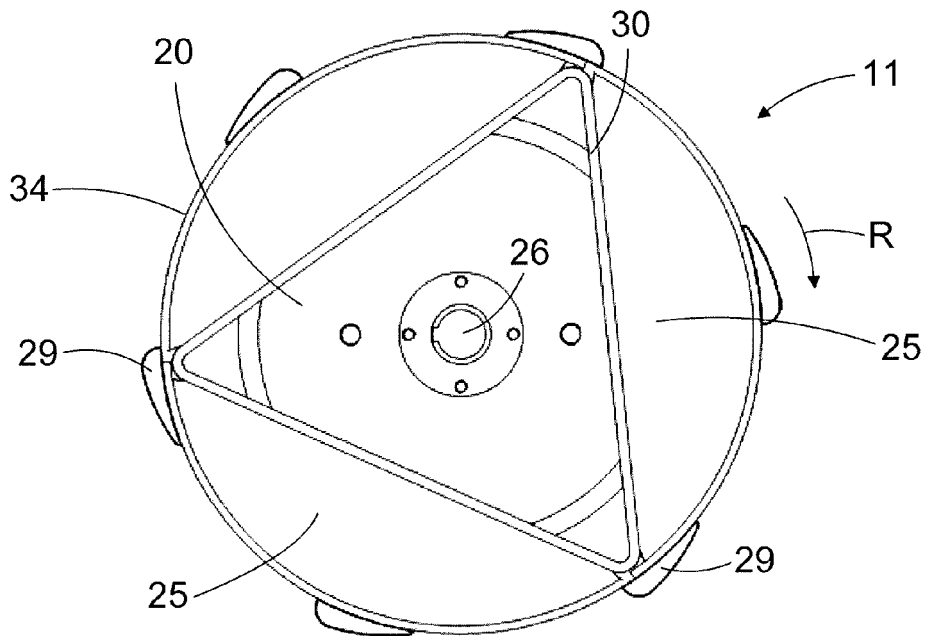
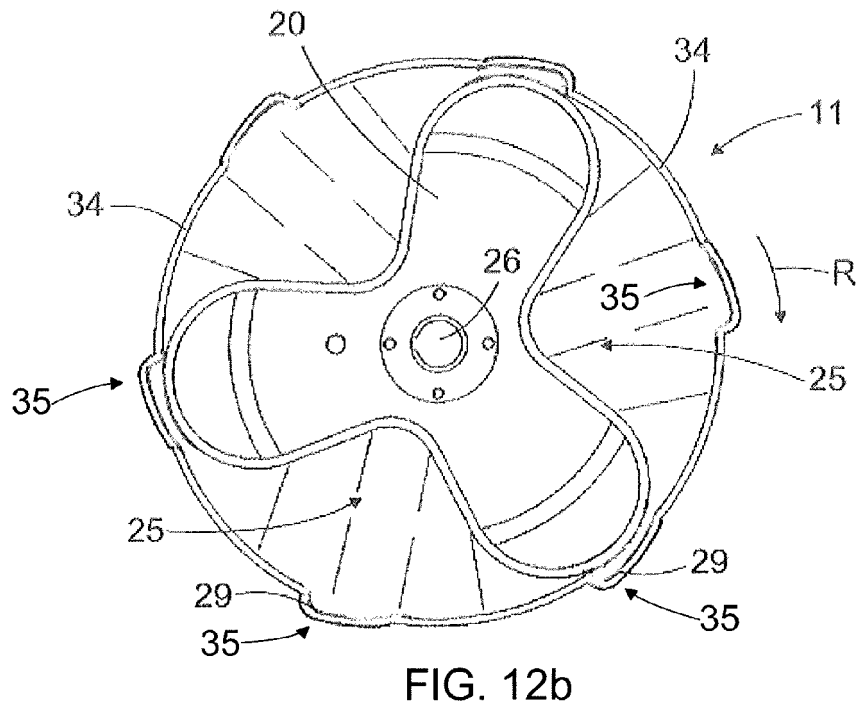
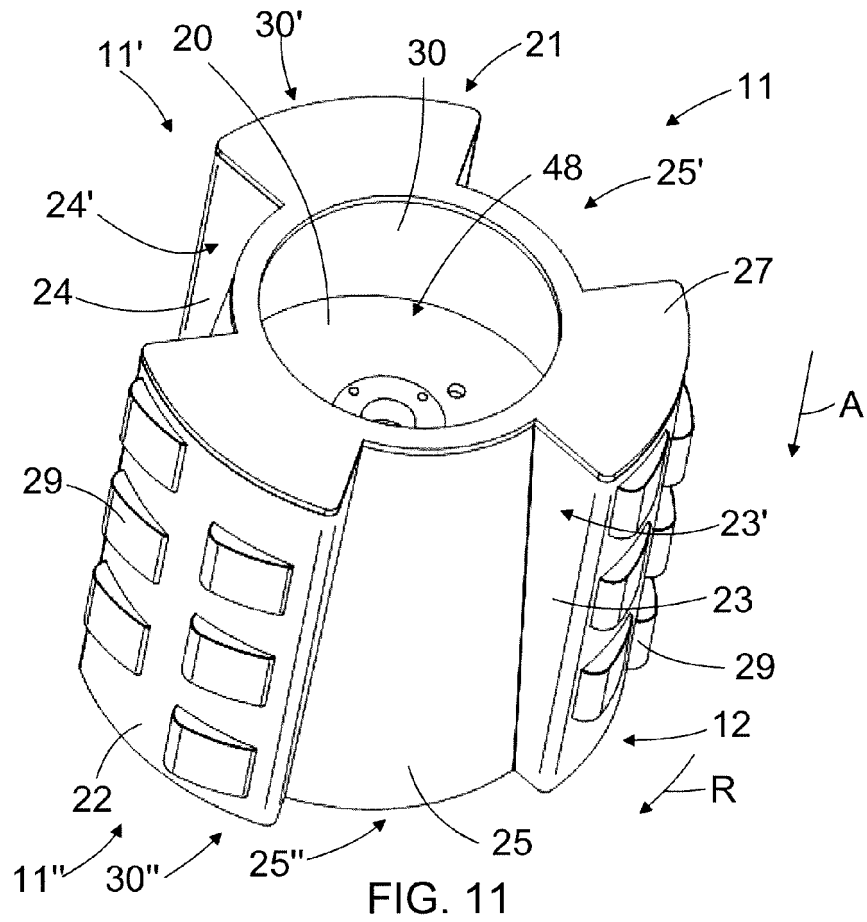
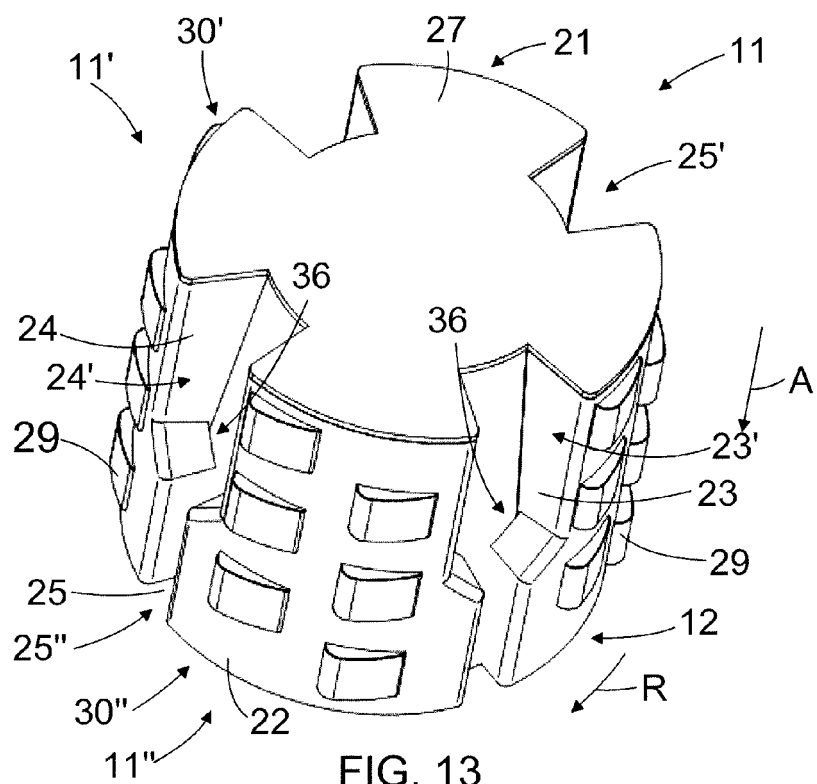
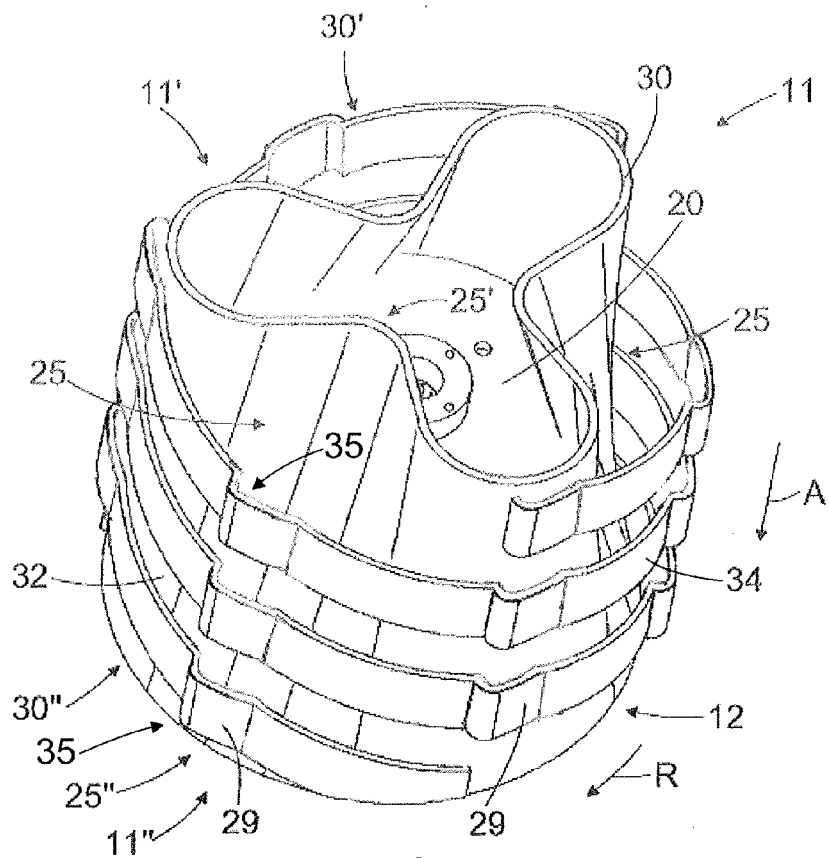
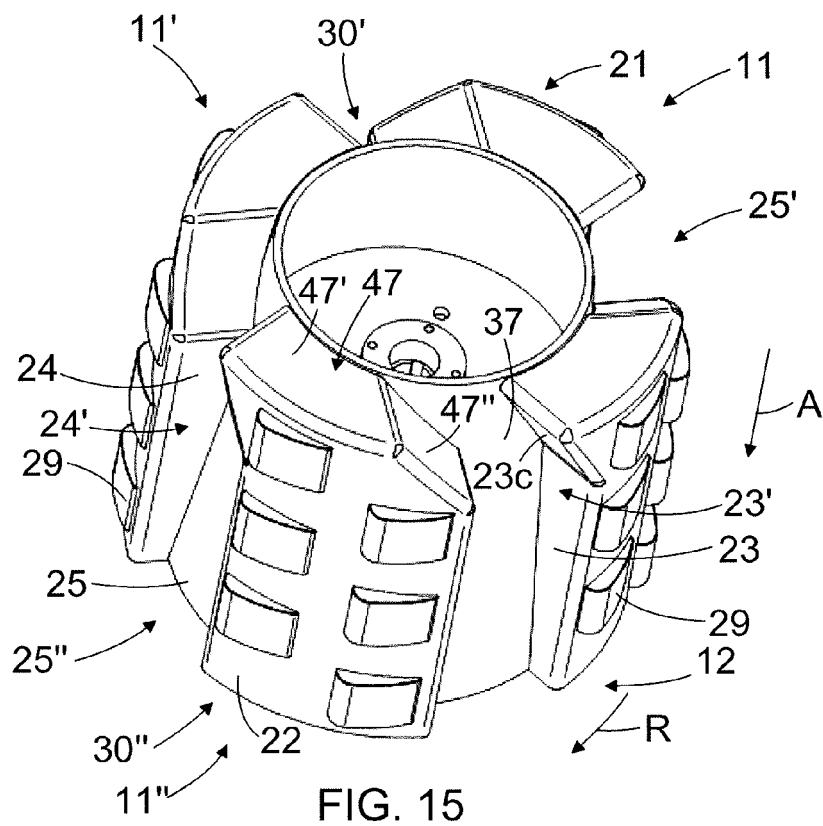
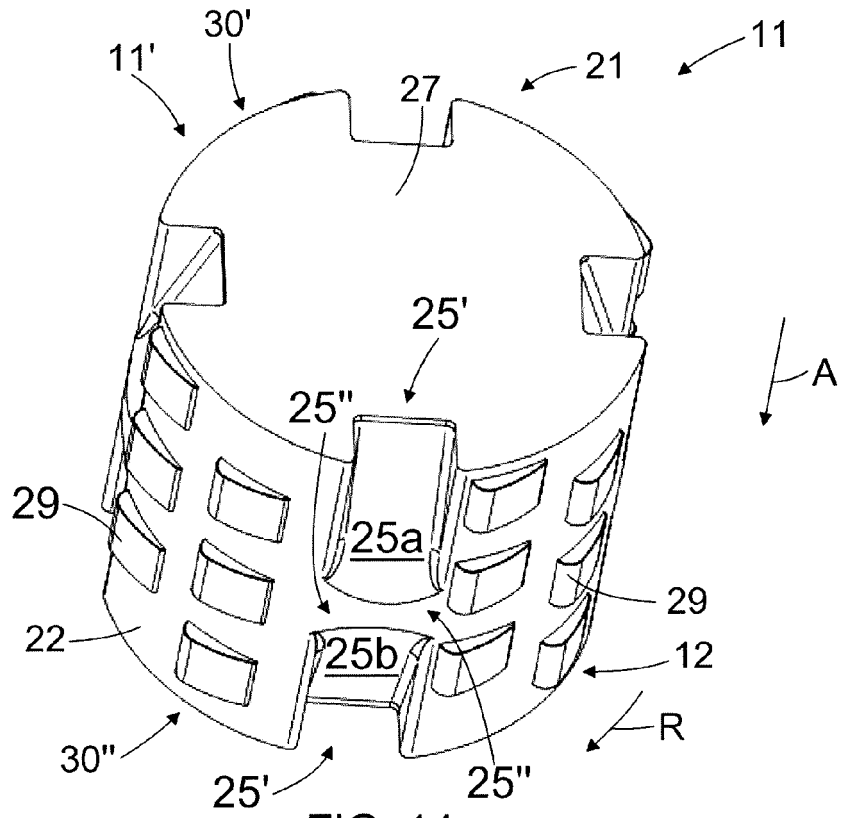
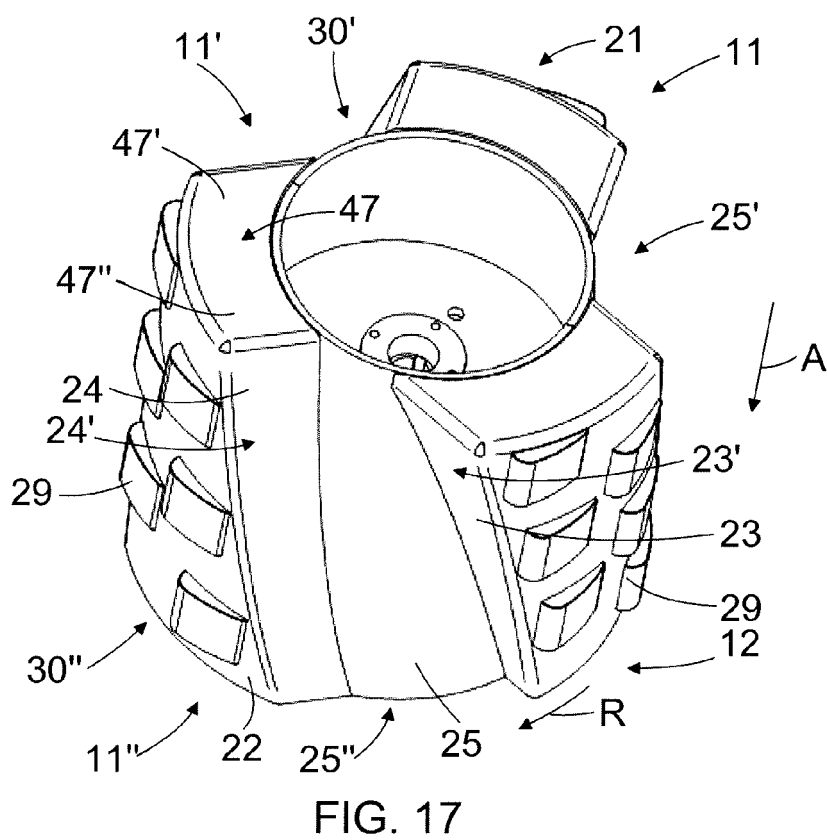
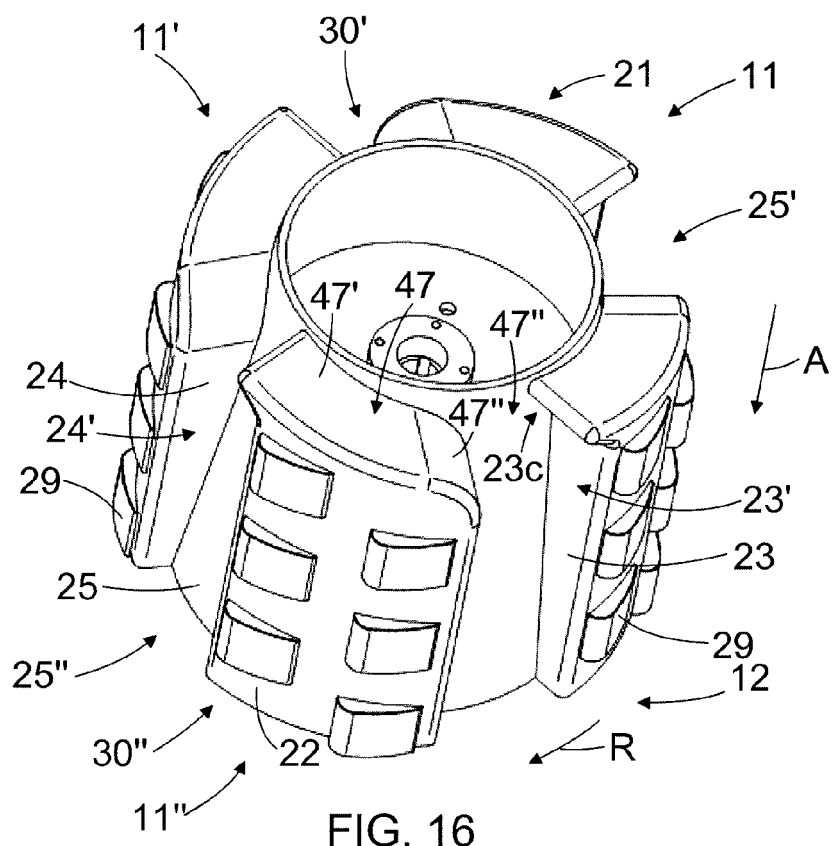


FIG. 10b









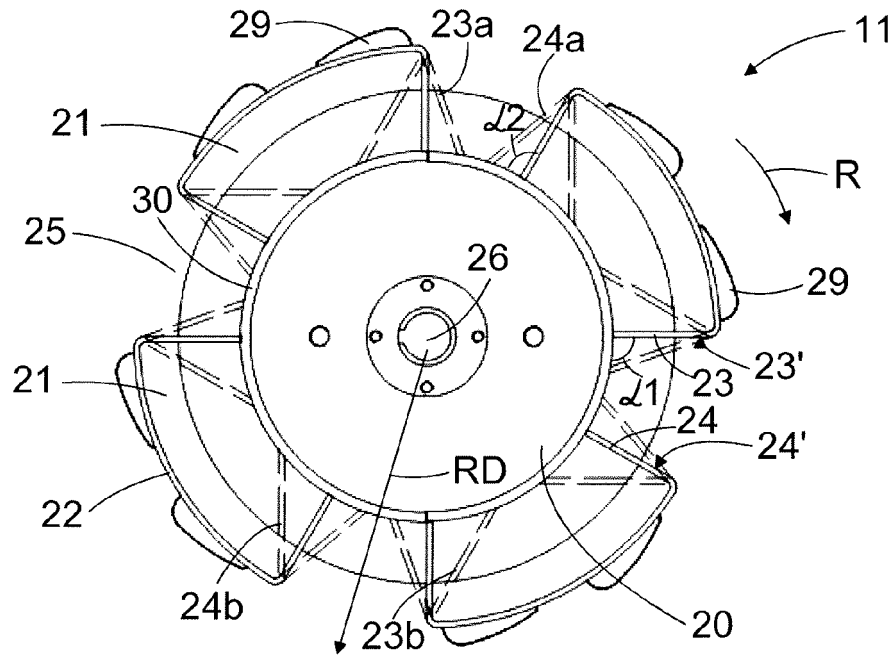


FIG. 18

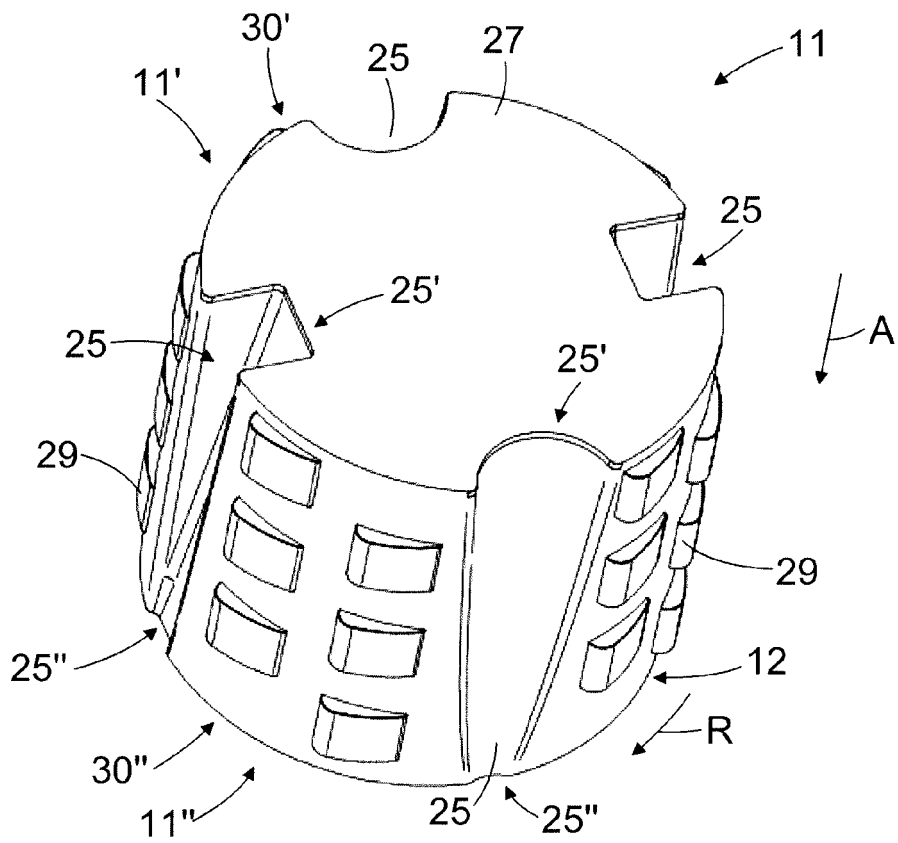


FIG. 19a

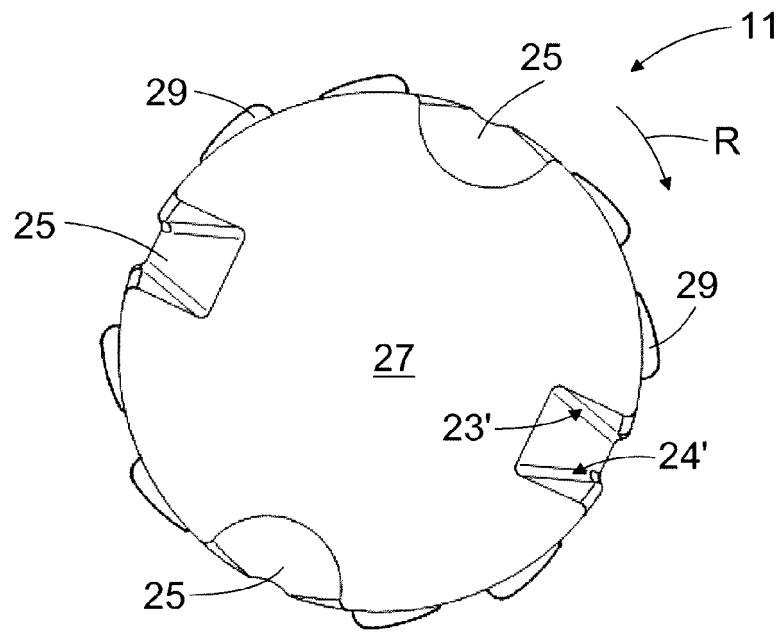


FIG. 19b

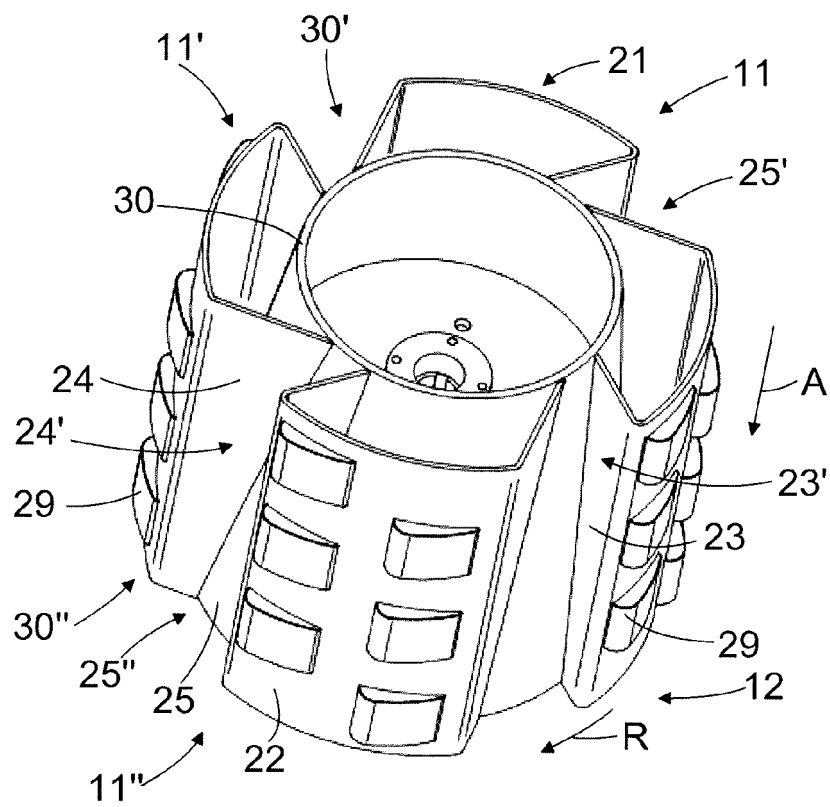


FIG. 20



EUROPEAN SEARCH REPORT

Application Number
EP 14 16 9284

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 02/064884 A1 (COMER SPA [IT]; NICOLI STEFANO [IT]) 22 August 2002 (2002-08-22) * page 4, line 20 - page 5, line 17; figures 1-3 *	1-3,8, 10-12, 14,15	INV. D21D5/02
X	JP H03 19988 A (MITSUBISHI HEAVY IND LTD) 29 January 1991 (1991-01-29) * abstract * * figures 1-7 *	1-3,8-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			D21D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 October 2014	Examiner Maisonnier, Claire
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 14 16 9284

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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22-10-2014

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