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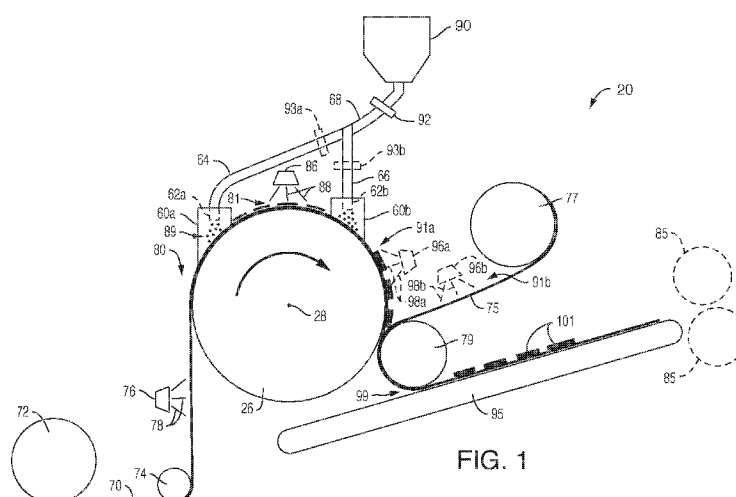


FIG. 1

(57) Abstract: Pulpless absorbent cores and methods of manufacture are disclosed. A first exemplary method may comprise advancing a base carrier sheet in a machine direction, applying a first adhesive onto a top surface of the base carrier sheet, advancing the base carrier sheet within a first particulate material delivery chamber, depositing a first amount of particulate material onto the first adhesive within the first particulate material delivery chamber, applying a second adhesive onto the first amount of particulate material outside of the first particulate material delivery chamber, advancing the base carrier sheet with the first adhesive, the first amount of particulate material, and the second adhesive into a second particulate material delivery chamber, depositing a second amount of particulate material onto the second adhesive within the second particulate material delivery chamber, and applying a top carrier sheet onto the second amount of particulate material.

ABSORBENT CORES AND METHODS FOR FORMING ABSORBENT CORES

FIELD OF THE INVENTION

The field of this disclosure relates generally to absorbent cores and methods of manufacturing absorbent cores for use in absorbent articles, and more specifically to pulpless absorbent cores and methods of forming pulpless absorbent cores for use in absorbent articles, such as diapers, training pants, incontinence products, disposable underwear, medical garments, feminine care articles, absorbent swim wear, and the like.

BACKGROUND

Absorbent cores are used in different types of products to control and contain bodily fluids and other bodily liquid discharge. Many present absorbent cores include pulp fluff, or other cellulosic fibers, which act to absorb the discharged liquids. Present absorbent articles can also contain particulate material, for example superabsorbent material, mixed in with the cellulose fibers to greatly increase the absorbent capacity of the absorbent cores. In these instances, the cellulose fibers help to absorb discharged fluids and also to stabilize the superabsorbent material, for instance maintaining the location of the superabsorbent material within the absorbent cores. However, the presence of cellulose fibers in these absorbent cores imparts a significant amount of bulk to the absorbent cores. Accordingly, absorbent cores that have a high absorbent capacity and do not contain cellulose fibers, or do not contain a substantial amount of cellulose fibers, in order to reduce bulk may be desirable.

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BRIEF SUMMARY OF THE INVENTION

This disclosure relates generally to absorbent cores and methods of manufacturing absorbent cores for use in absorbent articles, and more specifically to pulpless absorbent cores and methods of forming pulpless absorbent cores for use in absorbent articles, such as diapers, training pants, incontinence products, disposable underwear, medical garments, feminine care articles, absorbent swim wear, and the like.

In a first embodiment, a method of forming an absorbent core may comprise advancing a base carrier sheet in a machine direction, applying a first adhesive onto a top surface of the base carrier sheet, advancing the base carrier sheet within a first particulate material delivery chamber, and depositing a first amount of particulate material onto the first adhesive within the first particulate

material delivery chamber. The method may further comprise applying a second adhesive onto the first amount of particulate material outside of the first particulate material delivery chamber, advancing the base carrier sheet with the first adhesive, the first amount of particulate material, and the second adhesive into a second particulate material delivery chamber, depositing a second amount of particulate material onto the second adhesive within the second particulate material delivery chamber, and applying a top carrier sheet onto the second amount of particulate material.

Additionally, or alternatively, in further embodiments according to the first embodiment, the method may further comprise applying a third adhesive onto the second amount of particulate material before applying the top carrier sheet onto the second amount of particulate material, and applying the top carrier sheet onto the third adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the method may further comprise applying a third adhesive onto the top carrier sheet before applying the top carrier sheet onto the second amount of particulate material.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the base carrier sheet and the top carrier sheet may comprise a single carrier sheet.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, wherein the first adhesive, the first amount of particulate material, and the second adhesive may be applied to a first portion of the single carrier sheet to form the base carrier sheet, and a second portion of the single carrier sheet may be folded onto the second amount of particulate material to form the top carrier sheet.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the method may further comprise advancing an assembly of the base carrier sheet, the first adhesive, the first amount of particulate material, the second adhesive, the second amount of particulate material, and the top carrier sheet through a nip assembly.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the method may further comprise advancing the base carrier sheet in the machine direction on a forming drum.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the method may further comprise applying a third adhesive onto the second amount of particulate material, applying a third amount of particulate material onto the third adhesive, applying a fourth adhesive onto the third amount of particulate material, and applying the top carrier sheet onto the fourth adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the first adhesive may be a hot-melt adhesive, and adhesive applied to particulate material is may be a spray-application aqueous binder (SAAB) adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, a type of particulate material in the first amount of particulate material may be different than a type of particulate material in the second amount of absorbent material.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the first amount of particulate material may be dispensed from within the first particulate material delivery chamber from a first particulate material delivery conduit situated within the first particulate material delivery chamber, the second amount of particulate material may be dispensed from within the second particulate material delivery chamber from a second particulate material delivery conduit situated within the second particulate material delivery chamber, and inlet openings of the first particulate material delivery conduit and the second particulate material delivery conduit may be oriented such that the first amount of particulate material and the second amount of particulate material exit the first particulate material delivery conduit and the second particulate material delivery conduit substantially vertical with respect to gravity.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the first embodiment, the base carrier sheet with the applied adhesive may be advanced in the machine direction on a forming drum, and each of the first particulate material delivery chamber and the second particulate material delivery chamber may be disposed over a top third of a circumference of the forming drum.

In a second embodiment, a method for forming an absorbent core may comprise applying a first adhesive onto a top surface of a base carrier sheet, advancing the base carrier sheet with the applied first adhesive in a machine direction, and depositing a first amount of particulate material onto

the first adhesive on the base carrier sheet within a first particulate material delivery chamber, the first amount of particulate material having a first cross-direction width on the base carrier sheet. The method may further comprise applying a second adhesive onto the first amount of particulate material outside of the first particulate material delivery chamber, depositing a second amount of particulate material onto the second adhesive on the base carrier sheet within a second particulate material delivery chamber, the second amount of particulate material having a second cross-direction width on the base carrier sheet, and applying a top carrier sheet onto the second amount of particulate material, wherein the first cross-direction width is different than the second cross-direction width by at least 25 mm.

10 Additionally, or alternatively, in further embodiments according to the second embodiment, the method may further comprise applying a third adhesive onto the second amount of particulate material before applying the top carrier sheet onto the second amount of particulate material and applying the top carrier sheet onto the third adhesive.

15 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the first amount of particulate material may be dispensed from within the first particulate material delivery chamber from a first particulate material delivery conduit situated within the first particulate material delivery chamber, the second amount of particulate material may be dispensed from within the second particulate material delivery chamber from a second particulate material delivery conduit situated within the second particulate material delivery chamber, and inlet openings of the first particulate material delivery conduit and the second particulate material delivery conduit may be oriented such that the first amount of particulate material and the second amount of particulate material exit the first particulate material delivery conduit and the second particulate material delivery conduit substantially vertical with respect to gravity.

25 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the base carrier sheet with the applied adhesive may be advanced in the machine direction on a forming drum, and each of the first particulate material delivery chamber and the second particulate material delivery chamber may be disposed over a top third of a circumference of the forming drum.

30 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the first adhesive may be a hot-melt adhesive, and adhesive applied to particulate material is may be a spray-application aqueous binder (SAAB) adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, a type of particulate material in the first amount of particulate material may be different than a type of particulate material in the second amount of particulate material.

- 5 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, a first one of the first cross-direction width and the second cross-direction width may be between 75 mm and 250 mm, and a second one of the first cross-direction width and the second cross-direction width may be between 50 mm and 200 mm.

- 10 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the method may further comprise applying a third adhesive onto the top carrier sheet before applying the top carrier sheet onto the second amount of particulate material.

- 15 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the base carrier sheet and the top carrier sheet may comprise a single carrier sheet.

- 20 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the first adhesive, the first amount of particulate material, and the second adhesive may be applied to a first portion of the single carrier sheet to form the base carrier sheet, and a second portion of the single carrier sheet may be folded onto the second amount of particulate material to form the top carrier sheet.

- 25 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the second embodiment, the method may further comprise applying a third adhesive onto the second amount of particulate material, applying a third amount of particulate material onto the third adhesive, applying a fourth adhesive onto the third amount of particulate material, and applying the top carrier sheet onto the fourth adhesive.

- 30 In a third embodiment, an apparatus for forming an absorbent core may comprise a forming surface, wherein the forming surface is moveable in a machine direction, a first adhesive applicator configured to apply adhesive to a base carrier sheet, a first particulate material delivery chamber disposed after the first adhesive applicator in the machine direction, the first particulate material delivery chamber including a first particulate material delivery conduit for dispensing particulate material at the forming surface, a second adhesive applicator disposed after the first

particulate material delivery chamber in the machine direction, the second adhesive applicator configured to apply adhesive at the forming surface, and a second particulate material delivery chamber disposed after the second adhesive applicator in the machine direction, the second particulate material delivery chamber including a second particulate material delivery conduit for
5 dispensing particulate material at the forming surface.

Additionally, or alternatively, in further embodiments according to the third embodiment, the method may further comprise a third adhesive applicator disposed after the second particulate material delivery chamber in the machine direction, the third adhesive applicator configured to apply adhesive at the forming surface.

10 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the third embodiment, the first particulate material delivery conduit terminates at a first inlet in the first particulate material delivery chamber and the second particulate material delivery conduit terminates at a second inlet within the second particulate material delivery chamber, and wherein planes of the first inlet and the second inlet are oriented parallel with respect to
15 ground.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the third embodiment, the first adhesive applicator is may be configured to apply hot-melt adhesive to the base carrier sheet, and the second adhesive applicator may be configured to apply a spray-application aqueous binder (SAAB) adhesive onto particulate material
20 disposed at the forming surface.

In a fourth embodiment, an absorbent core may comprise a base carrier sheet having a middle region, a first edge region, and a second edge region, a first adhesive disposed directly onto at least a portion of the base carrier sheet, a first amount of particulate material disposed on the first adhesive, the first amount of particulate material spanning each of the middle region, the first edge region, and
25 the second edge region, a second adhesive disposed on at least a portion of the first amount of particulate material, a second amount of particulate material disposed on the second adhesive, the second amount of particulate material spanning only the middle region, and a top carrier sheet.

Additionally, or alternatively, in further embodiments according to the fourth embodiment, the absorbent core may further comprise a third adhesive disposed between the second amount of
30 particulate material and the top carrier sheet.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the absorbent core may further comprise a third adhesive disposed on the second amount of particulate material, a third amount of particulate material disposed on the third adhesive, and a fourth adhesive disposed between the third amount of
5 particulate material and the top carrier sheet.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the base carrier sheet and the top carrier sheet may comprise a single carrier sheet, and a portion of the single carrier sheet may be folded onto the second amount of particulate material to form the top carrier sheet.

10 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the first adhesive may comprise a of hot-melt adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the second adhesive application may comprise a
15 spray-application aqueous-binder (SAAB) adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the absorbent core may further comprise cellulose fibers in with at least one of the first amount of particulate material and the second amount of particulate material.

20 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the middle region may be between about 1.5 times and about 4.0 times greater than the first edge region.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the middle region may be between about 1.8
25 times and about 2.2 times greater than the first edge region.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the middle region may contain greater than 55%, by weight, of the total particulate material of the absorbent core.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fourth embodiment, the middle region may contain greater than 65%, by weight, of the total particulate material of the absorbent core.

5 In a fifth embodiment, an absorbent core may comprise one or more outer sheets forming an enclosure, the one or more outer sheets having an externally oriented face and an internally oriented face, a middle region, a first edge region, and a second edge region, a first adhesive disposed on at least a portion of the internally oriented face, particulate material disposed within the enclosure, wherein a first portion of the particulate material spans throughout each of the middle region, the first edge region, and the second edge region, wherein a second portion of the particulate material spans
10 throughout only the middle region, and a second adhesive contacting both the first portion of particulate material and the second portion of particulate material.

Additionally, or alternatively, in further embodiments according to the fifth embodiment, the first adhesive and the second adhesive may be different adhesives.

15 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, the first adhesive may be a hot-melt adhesive.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, the second adhesive may be a spray application aqueous-binder (SAAB) adhesive.

20 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, further comprising cellulose fibers disposed within at least one of the first portion of particulate material and the second portion of particulate material.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, the middle region may be between about 1.5 times and about 4.0 times greater than the first edge region.

25 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, the middle region may be between about 1.8 times and about 2.2 times greater than the first edge region.

30 Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, the middle region may contain greater than 55%, by weight, of the total particulate material of the absorbent core.

Additionally, or alternatively, in further embodiments according to any of the above embodiments with respect to the fifth embodiment, the middle region may contain greater than 65%, by weight, of the total particulate material of the absorbent core.

5

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic of an example forming assembly for forming absorbent cores.

Figure 2 is a perspective view of an exemplary forming drum that may be used in the assembly of Figure 1.

Figure 3 is a side view of an example forming drum and associated components that may be used in the assembly of Figure 1.

Figure 4A is a side view of an exemplary particulate material delivery chamber that may be used in the assembly of Figure 1.

Figure 4B is a front view of an exemplary particulate material delivery chamber that may be used in the assembly of Figure 1.

Figure 5 is an illustration of an exemplary absorbent core structure that may be produced by the assembly of Figure 1.

Figure 6A is a cross-section view of an exemplary absorbent core that may be produced by the assembly of Figure 1.

Figure 6B is a cross-section view of an alternative exemplary absorbent core that may be produced by the assembly of Figure 1.

Figure 7 is an alternative schematic of an example forming assembly for forming absorbent cores.

Figure 8 is a cross-section view of an alternative exemplary absorbent core that may be produced by the assembly of Figure 1 or Figure 7.

Figure 9 is a perspective view of a forming drum including a plurality of masking members for forming shaped absorbent cores.

Figure 10 is a top view of a masking member disposed on the forming drum of Figure 9.

Figure 11 is an illustration of an exemplary shaped absorbent core structure that may be produced using the forming drum and masking members of Figures 9 and 10.

Figure 12 is a schematic of an example forming assembly for forming absorbent cores including both cellulose fibers and particulate material.

5 Figure 13 depicts a cross-section of an exemplary absorbent core that may for formed by the forming assembly of Figure 12.

Figures 14A and 14B are illustrations of carrier sheets that may be used to form absorbent cores.

Figures 15A and 15B are side views of exemplary particulate material delivery chambers that
10 may be used to form absorbent cores having differing basis weights, according to the present
disclosure.

Figure 16 is an illustration of an exemplary absorbent core structure that may be produced by an assembly using the exemplary particulate material delivery chamber of Figure 15A or Figure 15B.

15 DETAILED DESCRIPTION OF THE DRAWINGS

When introducing elements of the present invention or the preferred embodiment(s) thereof, the articles "a", "an", "the" and "said" are intended to mean that there are one or more of the elements. The terms "comprising", "including" and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements. Moreover, the use of "top", "bottom", "above", "below" and variations of these terms is made for convenience, and does not require any particular orientation of the components.

With reference now to the drawings, Figure 1 depicts a schematic drawing of an example absorbent core forming apparatus 20, which may be used to form absorbent cores. A few components of apparatus 20 include the forming drum 26 and the particulate material delivery chambers 60a, 60b. Accordingly, in some embodiments, apparatus 20 may be used to form absorbent cores comprising particulate material. Superabsorbent material (SAM) is one example of particulate material contemplated by this disclosure. In at least some of these embodiments, the particulate material content of the formed absorbent cores may comprise the majority, by weight, of the contents of the absorbent cores. In other embodiments, the particulate material content of the formed absorbent cores may comprise between 90%-100%, by weight, of the contents of the absorbent cores. These

absorbent cores may be described herein as pulpless absorbent cores. As used herein, the phrase pulpless absorbent cores may include both absorbent cores that are truly pulpless and absorbent cores that are only substantially pulpless which have cellulose fibers comprising between 0.5%-10%, by weight, of the total contents of the absorbent cores. Pulpless cores may have one or more advantages relative to absorbent cores that have higher cellulose fiber content. For example, pulpless cores can have absorbent properties, such as absorbent capacity, similar to cores with higher cellulose fiber content. However, pulpless cores can have smaller dimensions than cores having cellulose fiber pulp content. In particular, the pulpless cores may have a reduced thickness in comparison to cores with higher cellulose fiber content.

In the exemplary embodiment of Figure 1, a base carrier sheet 70 may be unwound from a carrier sheet roll 72. One or more material handling rollers 74 may be used to transport the base carrier sheet 70 proximate forming drum 26. Once in proximity to forming drum 26, the base carrier sheet 70 may be drawn to forming drum 26 by vacuum pressure, described in more detail below in relation to Figures 2 and 3. The forming drum 26 rotates in the direction of arrow 10, about drive-shaft 28, advancing the base carrier sheet 70 through one or more absorbent core forming stages, ultimately resulting in the absorbent cores 101. Although absorbent cores 101 are shown as discrete pads, in other embodiments, absorbent cores 101 may be formed as a continuous ribbon.

In some embodiments, the base carrier sheet 70 may comprise a nonwoven material such as a meltblown, spunbond-meltblown-spunbond (SMS), spunlace material, or a natural tissue material.

However, in other embodiments, any suitable non-woven material may be used. The base carrier sheet 70 should be at least semi-permeable to air-flow. For instance, the base carrier sheet 70 should be sufficiently permeable such that air is able to move through the base carrier sheet 70 from a top surface disposed away from the forming surface 24 to a bottom surface disposed proximate the forming surface 24, and ultimately through forming surface 24 into the interior of forming drum 26.

Some example suitable dimensions of the base carrier sheet 70 include a width between about 7 cm to about 36 cm. Some example suitable basis weights for the base carrier sheet 70 range from about 5 grams per square meter (gsm) to about 50 gsm. However, the specific dimensions and basis weights used for the base carrier sheet 70 may differ, even outside of these ranges, based on the specific application or desired properties for the absorbent cores 101.

In the example of Figure 1, the base carrier sheet 70 first moves through first adhesive application zone 80, where adhesive applicator 76 applies adhesive 78 to the base carrier sheet 70. In some examples, the adhesive 78 may be a hot-melt adhesive, such as either a contact hot-melt

adhesive or a non-contact hot-melt adhesive. Although, in other examples, adhesive 78 may be any other suitable adhesive for application on a carrier sheet. Further, adhesive 78 may be applied using any suitable application technique or techniques. For instance, adhesive 78 may be applied with a spray application, with a slot-coat application, or by any other appropriate application technique.

5 After exiting first adhesive application zone 80, the base carrier sheet 70, now containing adhesive 78, is brought in proximity to forming drum 26, where the base carrier sheet 70 is drawn to the forming drum through vacuum pressure. The base carrier sheet then enters particulate material delivery chamber 60a. Inside of particulate material delivery chamber 60a, particulate material may be deposited onto the base carrier sheet 70. More specifically, the particulate material may be deposited
10 onto adhesive 78, where the particulate material becomes stabilized, or immobilized on the base carrier sheet 70, by adhesive 78.

 The hopper 90 in Figure 1 may contain particulate material that is delivered to the particulate material delivery chambers 60a, 60b. The connecting pipe 68 may connect directly to the hopper 90 in order to transport the particulate material from the hopper 90 to the particulate material delivery
15 chambers 60a, 60b. In at least some embodiments, the connecting pipe 68 may include metering device 92. The metering device 92 may be any sort of bulk material metering device, based on volumetric, gravimetric, or mass flow principles, or the like. The metering device 92 may ensure that only a specified amount (for instance, by volume or by weight) of particulate material flows through the connecting pipe per unit of time. Some example suitable ranges for the volume of particulate material
20 flowing through the metering device 92 are between about 5,000 grams per minute (g/min) and about 25,000 g/min. In this manner, the metering device 92 can help to ensure a proper amount of particulate material is delivered to particulate material delivery chambers 60a, 60b.

 In the example shown in Figure 1, the connecting pipe 68 may split into delivery pipes 64 and 66. Each of the delivery pipes 64 and 66 may enter the particulate material delivery chambers 60a,
25 60b, forming particulate material delivery conduits 62a, 62b. The particulate material delivered to the particulate material delivery chambers 60a, 60b may exit the particulate material delivery conduits 62a, 62b and be deposited onto the adhesive 78 and the base carrier sheet 70. In some alternative embodiments, instead of a single metering device 92, multiple metering devices may be used to ensure proper delivery of particulate material to each of the particulate material delivery chambers 60a,
30 60b. For example, each of the delivery pipes 64 and 66 may include a metering device, represented by the dashed boxes 93a and 93b in Figure 1, instead the apparatus 20 including metering device 92.

After exiting the particulate material delivery chamber 60a, the base carrier sheet 70, now containing adhesive 78 and particulate material, may enter second adhesive application zone 81. In some embodiments, second adhesive application zone 81 may be similar to first adhesive application zone 80. For example, in second adhesive application zone 81, adhesive applicator 86 may apply
5 adhesive 88 to the base carrier sheet 70. More specifically, adhesive applicator 86 may apply adhesive 88 onto the particulate material that is stabilized on the base carrier sheet 70. In some embodiments, adhesive 88 may be the same as adhesive 78. For instance, adhesive 88 may also be a hot-melt adhesive, such as a non-contact hot-melt adhesive. Adhesive 88 may also be applied to the base carrier sheet 70 in a similar manner as adhesive 78 was applied to the base carrier sheet 70,
10 such as with a spray application. Although, in other embodiments, adhesive 88 may be a different type of adhesive than adhesive 78 and/or may be applied in a different manner than adhesive 78.

In still other embodiments, adhesive 88 may not be a hot-melt adhesive. In some embodiments, adhesive 88 may be a spray-application aqueous binder (SAAB) adhesive. Where adhesive 88 is a SAAB adhesive, adhesive 88 may be applied with a spray-application. Implementing
15 adhesive 88 as a SAAB adhesive may be preferable in certain embodiments, as SAAB adhesives may be able to better penetrate particulate material than hot-melt adhesives, thereby allowing for greater stabilization of the particulate material deposited onto the base carrier sheet 70.

After passing through second adhesive application zone 81, the base carrier sheet 70 now includes a first adhesive, adhesive 78, disposed on the base carrier sheet 70, a first amount of
20 particulate material 89 (as can be seen in further detail in Figure 6A) disposed on the adhesive 78, and a second adhesive, adhesive 88, disposed on the first amount of particulate material. The base carrier sheet 70 then enters the particulate material delivery chamber 60b. In the particulate material delivery chamber 60b, a second amount of particulate material is deposited onto adhesive 88 in a similar manner as particulate material was deposited onto adhesive 78 in the particulate delivery chamber
25 60a.

In some embodiments, the particulate material delivered to the base carrier sheet 70 in the particulate material delivery chambers 60a, 60b may be the same type of particulate material. In other embodiments, however, the type of particulate material delivered to the base carrier sheet 70 in the particulate material delivery chamber 60a may be different than the type of particulate material
30 delivered to the base carrier sheet 70 in the particulate material delivery chamber 60b. In such embodiments, apparatus 20 may have two separate hoppers that each store different types of particulate material, in contrast to the example of Figure 1. Additionally, separate connecting and

delivery pipes may connect to each of the hoppers and to each of the particulate material delivery chambers 60a, 60b to maintain separation of the different particulate material types. Alternatively, apparatus 20 may still include only the single hopper 90 and the connecting and delivery pipes 68, 64, and 66, as shown in Figure 1. In such embodiments, the hopper 90 may have two separate internal compartments to maintain separation of the different particulate material types. Additionally, connecting pipe 68 may include separate internal lumens. A first of the internal lumens may connect to a first internal compartment of the hopper 90 and to delivery pipe 64, while a second of the internal lumens may connect to a second internal compartment of the hopper 90 and to delivery pipe 66.

As mentioned previously, in some embodiments the particulate material may comprise superabsorbent material (SAM). Suitable superabsorbent materials are well known in the art and are readily available from various suppliers. Example suitable superabsorbent materials may include BASF 9700, available from BASF Corporation, a business having offices located in Charlotte, N.C., U.S.A; and Evonik 5600, available from Evonik Industries, a business having offices located in Parsippany, NJ, U.S.A.

In other embodiments, the particulate material may comprise low- or non-absorbent material such as charcoal, sugar (e.g. xylitol or the like), or encapsulated material. Accordingly, this disclosure contemplates in any of the disclosed embodiments that the delivered particulate material may be either an absorbent material, a non-absorbent material, or both. For instance, absorbent particulate material may be mixed with non-absorbent particulate material, or a first of the particulate material delivery chambers 60a, 60b may deliver absorbent particulate material and a second of the particulate material delivery chambers 60a, 60b may deliver non-absorbent particulate material.

Once the second amount of particulate material has been deposited onto the base carrier sheet 70, a top carrier sheet 75 may be applied onto the second amount of particulate material. The top carrier sheet 75 may be unwound from a roll 77 of top carrier sheet material, and may be transported proximate the forming drum 26 via one or more material handling rollers 79. After the top carrier sheet 75 has been applied onto the second amount of particulate material, the edges of the top carrier sheet 75 and the base carrier sheet 70 may be bonded together (not shown) to form the pulpless absorbent cores 101. The absorbent cores 101 may then be transported on conveyer 95 for further processing.

In some embodiments, material handling roller 79 may also perform a function similar to a nip roller. For instance, material handling roller 79 may come into close proximity to conveyer 95 in region 99 and the absorbent core 101 may be compressed to reduce bulk and/or to more securely bond the

portions of the absorbent core 101 together. In other embodiments, however, one or more separate rollers may perform a nip function, such as rollers 85.

In some alternative embodiments, a third adhesive may be applied to the second amount of particulate material before the top carrier sheet 75 is applied to the second amount of particulate material. In some of these embodiments, apparatus 20 may further include third adhesive application zone 91a. Where apparatus 20 includes third adhesive application zone 91a, adhesive applicator 96a may apply adhesive 98a to the second amount of particulate material before the top carrier sheet 75 is applied. In various embodiments, adhesive 98a may be similar to either adhesive 78 or adhesive 88 described previously, and may be applied in any of the previously described methods. In different embodiments, however, apparatus 20 may include third adhesive application zone 91b instead of third adhesive application zone 91a. In these embodiments, adhesive applicator 96b may apply adhesive 98b directly to the top carrier sheet 75, instead of onto the second amount of particulate material. Additionally, adhesive 98b may be similar to either adhesive 78 or adhesive 88 described previously, except that adhesive 98b may not be a SAAB adhesive, as SAAB adhesives may not be suitable for direct application to carrier sheets. Further, adhesive 98a may be applied in any of the previously described methods. This third adhesive, applied by either adhesive applicator 96a or adhesive applicator 96b, may further help to stabilize the second amount of particulate material and/or to more securely attach the top carrier sheet 75 to the second amount of particulate material.

The adhesive applicators 76, 86, and/or 96a or 96b may be configured to apply adhesive in a continuous manner in some embodiments. In other embodiments, however, the adhesive applicators 76, 86, and/or 96a or 96b may be configured to apply adhesive in an intermittent fashion. For instance, the adhesive applicators 76, 86, and/or 96a or 96b may be applied intermittently to target zones on the base carrier sheet 70 to help stabilize the particulate material at locations on the base carrier sheet that will be most effective in absorbing liquid in the resulting absorbent cores due to the placement of the absorbent cores within an absorbent article.

Additionally, in at least some embodiments, the adhesive applicators 76, 86, and/or 96a or 96b may apply adhesive in a coordinated, intermittent fashion. In these embodiments, the adhesive applicator 86 may apply adhesive intermittently in a fashion such that the adhesive applicator 86 applies adhesive on top of the adhesive applied by adhesive applicator 76. After application of adhesive by the adhesive applicator 86, the adhesive applied by the adhesive applicator 86 would overlay the adhesive applied by the adhesive applicator 76. In embodiments that include adhesive applicator 96a or 96b, the adhesive applicator 96a or 96b may apply adhesive in an intermittent

fashion such that the adhesive applied by the adhesive applicator 96a or 96b overlays the adhesive applied by the adhesive applicator 76 and the adhesive applied by the adhesive applicator 86.

Figures 2 and 3 more closely depict portions of apparatus 20, including forming drum 26. The forming drum 26 includes a movable, foraminous forming surface 24, indicated by the hatched pattern in Figure 2, extending around the circumference of the forming drum 26. The forming drum 26 is mounted on a drive shaft 28 and supported by bearings 30 (as can be seen in Figure 3). The forming drum 26 includes a circular drum wall (not shown) operatively connected to and rotated by the drum drive shaft 28. The shaft 28 is driven in rotation by a suitable motor or line shaft (not shown) in a clockwise direction as depicted by the arrows in Figure 3. In some embodiments, the drum wall can be a primary, load-bearing member, and the drum wall can extend generally radially and circumferentially about the drum drive shaft 28.

A vacuum duct 36 located radially inwardly of the forming surface 24 extends over an arc of the interior of the forming drum 26. The vacuum duct 36 is in fluid communication with the forming surface 24 for drawing air through the forming surface 24. The vacuum duct 36 is mounted on and in fluid communication with a vacuum supply conduit 40 connected to a vacuum source 42. The vacuum source 42 may be, for example, an exhaust fan and may create a vacuum within the forming drum which may be between about 2 inches of H₂O to about 40 inches of H₂O. Beyond helping the base carrier sheet 70 adhere to the forming drum 26 as the base carrier sheet 70 advances around the forming drum, the vacuum pressure created by the vacuum source 42 may help to pull the particulate material exiting the particulate material delivery conduits 62a, 62b toward the forming surface 24. This vacuum pressure may help to spread the particulate material out on the forming surface 24 and to help form a more even distribution of the particulate material along the cross-machine direction 56 of the base carrier sheet 70.

The vacuum duct 36 is connected to the vacuum supply conduit 40 along an outer peripheral surface of the vacuum supply conduit 40, and extends circumferentially about at least a portion of the vacuum supply conduit 40. The vacuum duct 36 projects radially outwardly from the vacuum supply conduit 40 toward the forming surface 24 and includes axially spaced side walls 34 and angularly spaced end walls 46.

The shaft 28 extends through the drum wall and into the vacuum supply conduit 40 where it is received in the bearing 30. The bearing 30 is sealed with the vacuum supply conduit 40 so that air is not drawn in around the shaft 28 where it enters the vacuum supply conduit 40.

As representatively shown, the vacuum supply conduit 40 can include a conduit end wall 48 and a peripheral wall 50 that delimit the size and shape of the vacuum supply conduit 40. The vacuum supply conduit 40 can have any suitable cross-sectional shape. In the illustrated configuration, the vacuum supply conduit 40 has a generally circular cross-sectional shape. The vacuum supply conduit 40 can be operatively held in position with any suitable support structure. The support structure can also be joined and connected to further components or members that operatively support the portions of the vacuum supply conduit 40 structure that engage the drum drive shaft 28. For example, in the exemplary embodiment, one or more supports may connect to the bearing 30, and the entire vacuum supply conduit 40 may be supported by an overhead mount (not shown).

In the illustrated embodiment, walls 34 extend generally radially and circumferentially about the vacuum supply conduit 40. A drum rim 52 is joined to the walls 34 and is constructed and arranged to provide a substantially free movement of air through the thickness of the drum rim 52. The drum rim 52 is generally cylindrical in shape and extends along the direction of the drum axis 53, and circumferentially about the drum axis 53. As representatively shown, the drum rim 52 can be supported by and extend between the walls 34.

With reference to Figures 2 and 3, the forming surface 24 can be provided along the outer, cylindrical surface of the forming drum 26, and can extend along the axial and circumferential dimensions of the forming drum. The circumferential dimension is generally in a machine direction 54 and the axial dimension is generally in a cross-machine direction 56. The structure of the forming surface 24 can be composed of an assembly, and can include a foraminous member 58, which is operatively connected and joined to the forming drum 26. In some contemplated embodiments, the foraminous member 58 may be comprised of a system of multiple inserts. Exemplary foraminous members that may be used in conjunction with the present disclosure are further described in U.S. Patent No. 6,630,088, titled "Forming media with enhanced air flow properties", filed on Oct. 23, 2000.

The forming surface 24 can be operatively held and mounted on the drum rim 52 by employing any suitable attachment mechanism. As one representative example, a system of nuts and bolts can be employed to secure the forming surface 24 onto an operative set of mounting rings. In such an example, the mounting rings can be operatively mounted on and secured to the drum rim 52. In other embodiments, the foraminous member 58 may be integral with forming drum 26.

Although not shown in Figure 2, one or more masking plates may be attached to forming drum 26 on top of forming surface 24, as described in more detail below. The masking plates, for example, may be attached to drum rim 52, or alternately to the foraminous forming member 58. The masking

plates may cover a portion of the forming surface 24 in order to block the vacuum in particular portions of the forming surface. The masking plates may allow for differently shaped absorbent cores to be formed on the forming drum 26, as will be explained in more detail below.

Suitable forming drum systems for use with the present disclosure are well known in the art. For example, see U.S. Pat. No. 4,666,647 entitled APPARATUS AND METHOD FOR FORMING A LAID FIBROUS WEB by K. Enloe et al. which issued May 19, 1987; and U.S. Pat. No. 4,761,258 entitled CONTROLLED FORMATION OF LIGHT AND HEAVY FLUFF ZONES by K. Enloe which issued Aug. 2, 1988; the entire disclosures of which are incorporated herein by reference in a manner that is consistent herewith. Other forming drum systems are described in U.S. Pat. No. 6,330,735, entitled APPARATUS AND PROCESS FOR FORMING A LAID FIBROUS WEB WITH ENHANCED BASIS WEIGHT CAPABILITY by J. T. Hahn et al. which issued Dec. 18, 2001, the entire disclosure of which is incorporated herein by reference in a manner that is consistent herewith. Systems for forming surfaces are described in U.S. Pat. No. 6,363,088, entitled FORMING MEDIA WITH ENHANCED AIR FLOW PROPERTIES by Michael Barth Venturino et al. which issued Oct. 7, 2003, the entire disclosure of which is incorporated herein by reference in a manner that is consistent herewith.

With respect to Figure 3, additional features of the particulate material delivery chambers 60a, 60b are evident. For instance, the particulate material delivery chambers 60a, 60b further depict the particulate material delivery conduits 62a, 62b terminating in inlets 61a, 61b. The inlets 61a, 61b, e.g. the plane of the opening of the particulate material delivery conduits 62a, 62b, may be positioned within the particulate material delivery chambers 60a, 60b such that the inlets 61a, 61b are generally parallel with ground 94 and/or with the base of the forming drum 87. In these embodiments, the particulate material delivered from the inlets 61a, 61b may exit the inlets 61a, 61b in a stream that is substantially perpendicular to the ground 94 and/or the base of the forming drum 87. Additionally, the particulate material delivery chambers 60a, 60b are both situated on the top half of the forming drum 26. In this configuration, the particulate material delivered from the particulate material delivery chambers 60a, 60b may fall with gravity towards the forming drum, instead of requiring additional energy to push the particulate material to the forming drum 26 against gravity.

However, in other embodiments, the inlets 61a, 61b may be tilted with respect to the ground 94 and/or the base of the forming drum 87. For instance, the inlets 61a, 61b may form an angle 97 with respect to the ground 94 and/or the base of the forming drum 87 (shown only with respect to inlet 61a in Figure 3) having a value of between about 1 degree and about 45 degrees. In even further

embodiments, the inlets 61a, 61b may form an angle 97 with respect to the ground 94 and/or the base of the forming drum 87 such that the inlets 61a, 61b are tangential to the forming drum 26.

Figures 4A and 4B depict different close-up views of particulate material delivery chamber 60a. Figure 4A depicts a close-up of particulate material delivery chamber 60a as viewed in the machine direction 54. Figure 4A further depicts individual particulate material particles 89 exiting inlet 61a of particulate material delivery conduit 62a and being deposited onto the base carrier sheet 70. The individual particulate material particles 89 can also be seen disposed and stabilized on the portion of the base carrier sheet 70 after the particulate material delivery chamber 60a in the machine direction 54.

As mentioned previously, the particulate material may be delivered through particulate material delivery conduit 62a from the hopper 90, which results in the particulate material being gravity fed to inlet 61a. In some embodiments, the individual particulate material particles 89 exiting inlet 61a may exit with a velocity that is less than 1200 meters per minute (m/min). In other embodiments, the individual particulate material particles 89 exiting inlet 61a may exit with a velocity that is less than 900 m/min. In still other embodiments, the individual particulate material particles 89 exiting inlet 61a may exit with a velocity that is less than 600 m/min. In yet other embodiments, the individual particulate material particles 89 exiting inlet 61a may exit with a velocity that is less than 300 m/min. These velocities are in contrast to particulate material that is introduced to a forming chamber pneumatically. Where particulate material is introduced pneumatically, the minimum possible introduction velocity is over 1200 m/min, because that is the velocity at which air needs to move in order to move particulate material particles. Accordingly, gravity feeding the particulate material into the particulate material delivery chamber 60a allows the individual particulate material particles 89 to be introduced proximate the forming drum 26 with a relatively lower velocity than if the particulate material were to be pneumatically introduced. This lower introduction velocity may allow the individual particulate material particles 89 to be influenced to a greater extent by the vacuum pressure of the forming drum 26. In this manner, the apparatus 20 may be able to achieve a more even distribution of the individual particulate material particles 89 on the base carrier sheet 70 throughout the cross-machine direction 56 than if the individual particulate material particles 89 were introduced into the particulate material delivery chamber 60a pneumatically.

Figure 4B depicts an internal view of particulate material delivery chamber 60a as viewed from the cross-machine direction 56. As can be seen in Figure 4B, the forming drum 26 may have a drum width 110, and the forming surface 24 may have a forming surface width 111. Generally, the drum

width 110 will be greater than the forming surface width 111, as the forming drum 26 will include drum rim 52. However, this is not necessary in all embodiments. Figure 4B also depicts the forming surface 24 as a relatively uniform and continuous surface. As mentioned previously, as will be described in more detail below, in different embodiments one or more masking plates may obscure portions of the forming surface 24.

Also shown in Figure 4B is the particulate material delivery conduit 62a and inlet 61a having an inlet width 112. In some embodiments, the inlet width 112 may be the same as the forming surface width 111. However, in other embodiments, the inlet width 112 may be smaller or greater than the forming surface width 111. For instance, the inlet width 112 may be the same as the drum width 110. In other examples, the inlet width 112 may be smaller than the forming surface width 111, such as be between about one-quarter and about nine-tenths of the forming surface width 111. Additionally, inlet width 112 may be different for each of particulate material delivery conduits 62a, 62b.

The particulate material delivery conduit 62a may further have a vertical conduit spacing 114 comprising an amount of space between the inlet 61a of the particulate material delivery conduit 62a and the forming surface 24. In some examples, the vertical conduit spacing 114 may be between about 15 cm to about 100 cm.

As shown in Figure 4B, the particulate material delivery chamber 60a may not be sealed against the forming drum 24. For instance, there may be a gap between the bottom edges 113 of the particulate material delivery chamber 60a and the forming surface 24 or the forming drum 26. The gap may have a gap space 116 that can be between about 0.5 cm and about 5 cm. In these embodiments, air may be able to enter into the particulate material delivery chamber 60a through gap space 116, as shown by arrows 117. Entry of air into the particulate material delivery chamber 60a may push the particulate material 89 toward a center of the forming surface 24 as the particulate material falls from the inlet 61a to the forming surface 24. This may result in a cross-direction 56 width of the particulate material 89 deposited at the forming surface 24 that is less than inlet width 112. This may result in more particulate material 89 present in a central region of formed absorbent cores than if there were no gap space 116. In some alternative embodiments, gap space 116 may not be disposed between the bottom edges 113 of the particulate material delivery chamber 60a and the forming surface 26. Rather, the bottom edges 113 of the particulate material delivery chamber 60a may be sealed against the forming drum 26, and a separate hole may be disposed through a side wall of the particulate material delivery chamber 60a to allow entry of air into the particulate material delivery chamber 60a.

Accordingly, in other embodiments, there may not be a gap space 116 between the bottom edges 113 of the particulate material delivery chamber 60a and the forming surface 24 or the forming drum 26. For instance, the bottom edges 113 of the particulate material delivery chamber 60a may contact the forming surface 24 or the forming drum 26, or one or more gap fillers (not shown) may be positioned to close up the gap space 116. In these embodiments, there may be no air entering gap space 116. Accordingly, there may be no air impinging on the stream of particulate material 89 and pushing the particulate material 89 inward from the edges of the forming surface 24. In these embodiments, the cross-direction 56 width of the particulate material 89 deposited at the forming surface 24 may be close or equal to the inlet width 112.

10 In some additional or alternative embodiments, an upper region of the particulate material delivery chamber 60a may be open and may allow air to flow into the particulate material delivery chamber 60a as shown by arrows 119. In these embodiments, the inflow of air may cause the particulate material 89 to fall toward the forming surface 24 in a more linear path. For instance, as air enters the particulate material delivery chamber 60a, the air may be pulled toward the forming surface 15 24 by the vacuum pressure in the chamber 60a, and may travel in a generally linear manner. The air may pull the particulate material 89 toward the forming surface 24, and the location of the particulate material 89 deposited at the forming surface 24 may be more heavily influenced by individual starting positions of the particulate material 89 at the inlet 61a.

However, in still other additional or alternative embodiments, an upper region of the particulate material delivery chamber 60a may be sealed and may prevent air from entering the particulate material delivery chamber 60a. In these embodiments, the air within the particulate material delivery chamber 60a may be more turbulent than in the embodiments where the upper region of the particulate material delivery chamber 60a allows entry of air, as represented by arrows 121. In these embodiments, the relatively greater turbulence may cause the particulate material 89 to fall in much less linear paths and, therefore, the location of the particulate material 89 deposited at the forming surface 24 may be less dependent on their initial starting position at the inlet 61a than where the upper region of the particulate material delivery chamber 60a is open to the air. In at least some of these embodiments, the resulting formed absorbent cores may have a relatively more even distribution of particulate material 89 throughout both the cross-machine direction 56 and the machine direction 54.

30 Although Figures 4A-B only depict particulate material delivery chamber 60a, it should be understood that particulate material delivery chamber 60b may be similar to the depicted particulate material delivery chamber 60a. However, it should also be understood that contemplated

embodiments of the present disclosure include apparatuses including particulate material delivery chambers 60a, 60b that differ from each other. For instance, particulate material delivery chamber 60a may include a first set of features that were described above with respect to Figures 4A-B, while particulate material delivery chamber 60b includes a second, different set of features. As one
5 illustrative example, particulate material delivery chamber 60a may include an inlet, e.g. inlet 61a, that is oriented generally parallel with respect to ground 94 and/or the base of the forming drum 87 while particulate material delivery chamber 60b may include an inlet, e.g. inlet 61b, that is oriented at an angle of 45 degrees with respect to ground 94 and/or the base of the forming drum 87. Of course, this is just one example. More generally, each of the particulate material delivery chambers 60a, 60b may
10 include any of the features described above with respect to Figures 4A-B, and the specific set of features of each of particulate material delivery chambers 60a, 60b may not be the same.

Figure 5 depicts pulpless absorbent cores 101 as they may appear when exiting apparatus 20. In some examples, the absorbent cores 101 may be formed on a continuous carrier sheet, for instance the base carrier sheet 70 as shown in Figure 1. As the base carrier sheet 70 including the various
15 adhesives and particulate material exit off of the forming drum 26, another continuous carrier sheet, for instance the top carrier sheet 75, may be applied over the top of the base carrier sheet 70. In this manner, a continuous length of absorbent core may be formed by apparatus 20. However, as mentioned previously, in some embodiments, the forming surface 24 may include one or more masking members which may block a portion of the forming surface 24. In such embodiments,
20 portions of the resulting length of the absorbent core may include gaps where there is no, or relatively little, particulate material content. These gaps are represented by gap regions 115 in Figure 5. As the absorbent cores 101 were being formed on the forming surface 24, the applied vacuum would have been blocked by the masked portions of the forming surface such that little to no particulate material would have been drawn to the base carrier sheet 70 in gap regions 115. Accordingly, in such
25 embodiments, discrete absorbent cores 101 may be formed on the continuous base carrier sheet 70, as shown in Figure 5. The base carrier sheet 70 and the top carrier sheet 75 may later be cut, for instance along cut lines 118, in order to form separated absorbent cores. In at least some embodiments, a knife roll may be used to cut the base carrier sheet 70 and the top carrier sheet 75 into separated absorbent cores.

30 Figure 6A depicts an example cross-section of an absorbent core 101 taken along line A-A' in Figure 5. In the example of Figure 6A, the absorbent core 101 was formed using only two adhesives. For instance, the absorbent core 101 of Figure 6A includes the base carrier sheet 70. On top of the base carrier sheet 70 is the first adhesive 120, represented by the 'x's. The first adhesive 120, in

some embodiments, may comprise an adhesive such as adhesive 78 described with respect to Figure 1. Adhesive 120 may have been applied to the base carrier sheet 70, for instance, in the first adhesive application zone 80 of Figure 1.

On top of the first adhesive 120 is the first amount of particulate material 122, represented by particulate material particles 89. The first amount of particulate material 122 may have been applied to the first adhesive 120, for example, in the particulate material delivery chamber 60a of Figure 1. The first amount of particulate material 122 may have a thickness of between about 0.1 mm and about 1 mm.

On top of the first amount of particulate material 122 is the second adhesive 124, represented by the 'w's. The second adhesive 124, in some embodiments, may comprise an adhesive such as adhesive 88 described with respect to Figure 1. The second adhesive 124 may have been applied to the first amount of particulate material 122, for instance, in the second adhesive application zone 81 of Figure 1.

On top of the second adhesive 124 is the second amount of particulate material 126. The second amount of particulate material 126 may have been formed, for example, in the particulate material delivery chamber 60b of Figure 1. The second amount of particulate material 126 may have a thickness of between about 0.1 mm and about 1 mm. Finally, the top carrier sheet 75 is shown disposed on top of the second amount of particulate material 126.

In some embodiments, some of the adhesive 124 may penetrate into the first amount of particulate material 122. For instance, in the example of Figure 6A, strands of the first adhesive 124 (as represented by the 'w's) are shown penetrating the first amount of particulate material 122 a distance 130. In some examples, distance 130 may range from between about 0.1 mm to about 1 mm. Generally, where the adhesive 124 is a SAAB adhesive, the distance 130 may be on the higher end of the range, as SAAB may be more effective at penetrating the first amount of particulate material 122 than other types of adhesives, such as hot-melt adhesive. The greater penetration distance of SAAB may allow for relatively greater stabilization of the particulate material 89 than other types of adhesive that have lesser penetrating ability.

Figure 6B depicts an example cross-section of an alternative absorbent core 101' taken along line A-A' in Figure 5. In the example of Figure 6B, the absorbent core 101' was formed using three separate adhesive applications. For instance, the absorbent core 101' of Figure 6B may be the same as the absorbent core 101 of Figure 6A except that the absorbent core 101' of Figure 6B further

includes third adhesive 128, which is also represented by 'w's. This is because in the embodiment of Figure 6B, the second adhesive 124 and the third adhesive 128 are the same adhesive, such as a SAAB adhesive, but may have been applied in separate process steps.

5 The third adhesive 128, in some embodiments, may comprise adhesive 98a of Figure 1. In these examples, the third adhesive 128 may have been applied to the second amount of particulate material 126 in the third adhesive application zone 91a. As with the second adhesive 120, the third adhesive 128 may penetrate at least partially into the particulate material 89. The penetration distance of the third adhesive 120 is shown by penetration distance 136, which may range from about 0.1 mm to about 2 mm. In at least some embodiments, the third adhesive 128 may penetrate throughout the
10 entire laminate structure of absorbent core 101'.

In other embodiments, however, the third adhesive 128 may not be the same as the second adhesive 124. For instance, in at least some contemplated embodiments, the third adhesive may be applied to the top carrier sheet 75 rather than the second amount of particulate material 126. In these embodiments, the third adhesive may be a hot-melt adhesive rather than a SAAB adhesive, as SAAB
15 adhesives may not be suitable for application to carrier sheets. Accordingly, the third adhesive 128 may be applied to the top carrier sheet such as in third adhesive application zone 91b of Figure 1 instead of in third adhesive zone 91a.

In general, as shown in Figures 6A and 6B, absorbent cores 101 and 101' may have overall thicknesses 123, 125, respectively. Some suitable values for thicknesses 123, 125 range from
20 between about 0.2 mm to about 2.0 mm. However, as will be described in more detail with respect to Figure 8, the processes described herein may further include additional applications of adhesive and of particulate material, forming even larger laminate structures.

In even further additional or alternative embodiments, one or more tissue or other non-woven sheets may be interspersed between the adhesives and particulate material of the absorbent cores
25 101, 101'. With specific respect to Figure 6A, for instance, in some embodiments an intermediate tissue or other non-woven material (not shown) may be placed on top of the first amount of particulate material 122. Then, the second amount of particulate material 126 may be deposited onto that intermediate tissue or other non-woven material. In further embodiments, an adhesive may then be applied to the laminate structure, as shown in Figure 6B. Although only shown with two separate
30 application of particulate material, as will be described in more detail with respect to Figure 8, contemplated absorbent cores may include any suitable number of applications of particulate material.

Accordingly, in such embodiments, an intermediate tissue or other non-woven sheet may be disposed between each adjacent application of particulate material.

Figure 7 depicts an alternative pulpless absorbent core forming apparatus 200. Pulpless absorbent core forming apparatus 200 may generally be similar to apparatus 20, except that instead of using a forming drum, pulpless absorbent core forming apparatus 200 uses a planer forming conveyer 226. Although the apparatus 200 may be slightly different from the apparatus 20, the method of forming pulpless absorbent cores with the apparatus 200 is very similar to the process described with respect to apparatus 20. For instance, the base carrier sheet 270 is first fed onto the forming conveyer 226. The base carrier sheet 270 then encounters adhesive application zone 281, where adhesive applicator 276 applies adhesive 278 to the base carrier sheet 270.

Next, the base carrier sheet 270 may enter particulate material delivery chamber 260a. Particulate material may be delivered to the particulate material delivery chamber 260a from the hopper 290 through connecting pipe 268 and delivery pipe 264. Delivery pipe 264 may enter the particulate material delivery chamber 260a and form particulate material delivery conduit 262a. The particulate material delivered to the particulate material delivery conduit 262a ultimately exits the particulate material delivery conduit 262a through inlet 261a. In some embodiments, a metering device 292 may be present to meter out a specific amount of particulate material from the hopper 290 to ensure a predetermined amount of particulate material flows to particulate material delivery conduit 262a.

Additionally, in at least some of these embodiments, a vacuum chamber 228a may be present under the forming conveyer. For instance, the forming conveyer may have a foraminous forming surface (not shown) and air may be able to move across the foraminous forming surface. In the region of vacuum chamber 228a, air may be moving from within the particulate material delivery chamber 260a through the foraminous forming surface and into a duct (not shown) coming out of the forming conveyer 226. This movement of air may pull particulate material exiting inlet 261a toward the forming conveyer to be deposited onto the adhesive 278 and the base carrier sheet 270 forming a layer comprising a first particulate material. Although vacuum ducts 228a and 228b are shown only in the vicinity of the particulate material delivery chambers 260a, 260b, in other embodiments, vacuum chambers 228a, 228b may extend outside of the region around the particulate material delivery chambers 260a, 260b and over a greater extent of the forming conveyer 226 than is shown in Figure 7.

After exiting the particulate material delivery chamber 260a, the base carrier sheet 270, now including adhesive 278 and a first amount of particulate material, encounters adhesive application

zone 281. Within adhesive application zone 281, an adhesive applicator 286 applies adhesive 288 onto the first amount of particulate material that was deposited onto adhesive 278 and the base carrier sheet 270 within the particulate material delivery chamber 260a.

The base carrier sheet 270 may then enter the particulate material delivery chamber 260b.

- 5 Particulate material may be delivered to the particulate material delivery chamber 260b through connecting pipe 268 and through delivery pipe 266. Delivery pipe 266 may enter the particulate material delivery chamber 260b and form particulate material delivery conduit 262b, which in turn may end at inlet 261b. Particulate material delivered from the hopper 290 may exit inlet 261b and be drawn toward the adhesive 288 due to vacuum chamber 228b. Ultimately, a second amount of particulate
10 material may be deposited onto the adhesive 288.

- Further processing steps may be included to ultimately form pulpless absorbent cores 301. For instance, in some embodiments, a top carrier sheet (not shown) may be applied over the second amount of particulate material. Additionally, a third adhesive zone 291 may be included where adhesive applicator 296 applies a third adhesive, adhesive 298 onto the second amount of particulate
15 material, or, alternatively, onto the top carrier sheet before the top carrier sheet is applied to the second amount of particulate material. In still further embodiments, the resulting pulpless absorbent cores may be further processed, for example by delivery through a nip roller, or separation by a knife roll. Generally, any of the additional or alternative process steps described with respect to apparatus 20 may also be implemented with respect to apparatus 200.

- 20 In further alternative embodiments, it should be understood that the pulpless absorbent cores contemplated by this disclosure are not limited to only two particulate material applications. For instance, Figure 8 depicts a generic pulpless absorbent core 101" that may be formed according to the techniques disclosed herein and having any suitable number of particulate material applications. The pulpless absorbent core 101" includes a base carrier sheet 140, a top carrier sheet 145, and a first
25 amount of particulate material 150 and a second amount of particulate material 151. The pulpless absorbent core 101" further includes a first adhesive 152 and a second adhesive 153. The adhesives 152, 153 and the first and second amounts of particulate material 150, 151 may be applied in a manner similar to that described with respect to apparatus 20 or 200.

- However, pulpless absorbent core 101" may be formed from any suitable number of additional
30 adhesive and particulate material applications. For instance, each pair of an additional application of adhesive and another amount of particulate material may be thought as a unit building up the absorbent core 101". Accordingly, apparatus 20 or 200 may be modified to include additional

adhesive application zone and particulate material delivery chamber units situated after second adhesive application zone 81 and particulate material delivery chamber 60b or adhesive application zone 281 and particulate material delivery chamber 260b. For each additional adhesive application zone and particulate material delivery chamber unit, pulpless absorbent core 101" may include another
5 adhesive and amount of particulate material. Although the pulpless absorbent core 101" is contemplated to include any number of suitable additional units of adhesive and particulate material, as indicated by dots 156, some example suitable number of adhesive and particulate material units include 3, 4, 5, 6, and 7.

As mentioned previously, in some embodiments, one or more masking members may be used
10 in order to form shaped pulpless absorbent cores. Figure 9 depicts forming drum 26 including example masking members 160, although similar masking members may be used with forming conveyer 226. Masking members 160 mask portions of the forming surface 24, creating a pattern of shaped un-masked areas of the forming surface 24. These shaped un-masked areas will affect a distribution of particulate material within the resulting absorbent cores, thereby helping to create the
15 shaped absorbent cores.

Although only shown with one example shape in Figures 9 and 10, in other suitable embodiments, the masking members 160 can have any number of different patterns. In still further embodiments, each of the masking members 160 can have different patterns and may be arranged in any order on the forming drum 26. The illustrated system of masking members 160 in Figure 9
20 includes substantially identical masking members 160 arranged consecutively around the circumference of the forming drum 26. The masking members 160 can be joined and assembled to the forming drum 26 and/or the forming surface 24 by employing any conventional attaching or mounting mechanisms. For example, the masking members 160 may be secured to the forming surface 24 by a plurality of bolts inserted through holes in the masking members 160 and the forming
25 surface 24.

The masking members 160 may have any shape suitable for mounting onto the forming surface 24. For example, the masking members 160 may have an outer perimeter that forms a substantially rectangular shape. Additionally, the masking members 160 may have a slight curve along their length in the machine direction 54 to form an arc for fitting on the cylindrical forming surface
30 24. In other suitable embodiments, the masking members 160 may be substantially flat for fitting on planar forming surfaces, such as the planar forming conveyer 226 of apparatus 200. The curve of each masking member 160 may have a radius substantially equal to the radius of the forming surface

24 such that the masking members 160 fit on the forming surface 24. When joined together, a series of masking members 160 can completely concentrically encircle the circumference of the forming surface 24.

Figure 10 depicts a close-up of one exemplary masking member 160 disposed over the forming surface 24. As can be seen in Figure 10, masking member 160 includes both masking end portions 162 and masking side portions 164. Masking side portions 164 may extend along the masking member 160 for a distance 166. Some example values of distance 166 may range from about 10 cm to about 30 cm. Additionally, masking side portions 164 may extend inward from the edges of the masking member 160 a distance 168. Some example values of distance 168 may range from about 1 cm to about 5 cm. The masking side portions 164 may act to form a crotch region 170 in the resulting formed absorbent cores.

When the masking members 160 are used within the processes described with respect to apparatus 20 and apparatus 200, the masking members 160 may affect a distribution of particulate material within a resulting absorbent core. As described previously, as the base carrier sheet travels around the forming drum 26, the base carrier sheet may be drawn to the forming surface 24 by the use of a vacuum drawing air through forming surface 24 and into an interior of the forming drum 26. Additionally, as the base carrier sheet travels through a particulate material delivery chamber, the particulate material may be drawn to the base carrier sheet by the vacuum. Where masking members 160 are used, the base carrier sheet travels around the forming drum 26 on top of the masking members 160, which effectively block air moving through the forming surface 24 in the masked areas. Accordingly, as the base carrier sheet travels through a particulate material delivery chamber, the particulate material will be drawn preferentially onto the base carrier sheet over the un-masked areas of the forming surface 24.

Figure 11 depicts example shaped absorbent cores 201 that may be formed using the masking members 160. In the example of Figure 11, different regions of the shaped absorbent cores 201 are shown with dashed lines. The shaped absorbent cores 201 may include regions of relatively higher average basis weights, such as within the crotch regions 170 and other regions where the forming surface 24 was un-covered by the masking members 160. The shaped absorbent cores 201 may also include regions of relatively lower average basis weights, such as in end regions 171 and leg regions 173. In embodiments contemplated by this disclosure, the areas of relatively higher average basis weights may have average basis weights ranging from between about 100 grams per meter (gsm) to about 1000 gsm. The areas of relatively lower average basis weights may have average

basis weights ranging from between about 0 gsm to about 100 gsm. In some embodiments, the shaped absorbent cores 201 may be separated into individual shaped absorbent cores by cutting the length of resulting shaped absorbent cores 201 in the end regions 171.

5 The shaped absorbent cores 201 formed using masking members, such as masking members 160, may have some benefits over non-shaped absorbent cores. For instance, the regions of lower basis weights of particulate material may allow the shaped absorbent cores 201 to have a lower overall particulate material content than non-shaped cores, resulting in lower manufacturing costs. However, because of the locations of the areas of higher basis weights, overall absorption performance of the shaped absorbent cores 201 may be at least the same as corresponding non-shaped absorbent cores.

10 As mentioned previously, the pulpless absorbent cores of the present disclosure may be truly pulpless, or the pulpless absorbent cores may have a relatively small pulp content. For example, some of the pulpless absorbent cores of the present disclosure may include an amount of cellulose fibers that is between about 0.5% and about 10%, by weight, of the total contents of the cores. The addition of a small amount of cellulose fibers to the absorbent cores the present disclosure may impart
15 a greater feeling of softness or provide other beneficial properties to the absorbent cores. Figure 12 depicts one example apparatus, apparatus 300, which may be used to form the pulpless absorbent cores that have a small pulp content.

Apparatus 300 is very similar to apparatus 20 of Figure 1. For instance, a base carrier sheet 370 may be fed onto forming drum 326. The base carrier sheet 370 may then advance through a
20 series of adhesive applications zone 380, 381 (and, possibly 391a or 391b) and particulate material delivery chambers 360a, 360b. A top carrier sheet 375 may then be applied to form the resulting absorbent cores 399.

One difference between apparatus 20 and apparatus 300 is that apparatus 300 may further include fiberizer 340. In the embodiment of Figure 12, the fiberizer 340 may be fed pulp or cellulose
25 sheets and break up the cellulose sheets into many individual fibers. The fiberizer 340 may be a hammer mill-type fiberizer, or any other suitable type of fiberizer known in the art. The cellulose fibers may exit the fiberizer 340 into delivery ducts 341 and 342. The delivery ducts may ultimately form material delivery chambers 360a, 360b.

The material delivery chambers 360a, 360b may differ from the particulate material delivery
30 chambers 60a, 60b of apparatus 20 in that the material delivery chambers 360a, 360b may deliver both particulate material and cellulose fibers to the base carrier sheet. For example, cellulose fibers

may travel through the delivery ducts 341, 342 and enter the material delivery chambers 360a, 360b. Gravity, along with the vacuum pressure within the material delivery chambers 360a, 360b will cause the cellulose fibers to deposit onto the base carrier sheet 370.

Particulate material may also be delivered to the material delivery chambers 360a, 360b. For instance, particulate material may be stored in hopper 390 and may be delivered to the material delivery chambers 360a, 360b through delivery pipes 364, 366. The delivery pipes 364, 366 may ultimately form particulate material delivery conduits 362a, 362b within the material delivery chambers 360a, 360b. The delivered particulate material may exit the particulate material delivery conduits 362a, 362b within the material delivery chambers 360a, 360b. Similar to the pulp fibers, gravity and the vacuum pressure within the material delivery chambers 360a, 360b will cause the particulate material to be deposited onto the base carrier sheet 370. In this manner, apparatus 300 may be used to form pulpless absorbent cores containing an amount of cellulose fibers representing between about 0.5% and about 10% of the total weight of the materials within the pulpless absorbent cores.

Figure 13 depicts a cross-section of an example absorbent core 399 that may be formed by the apparatus 300. Figure 13 depicts absorbent core 399 including base carrier sheet 370 and top carrier sheet 375. Absorbent core 399 also includes adhesives 378 and 388, represented by 'x's and 'w's, respectively. In general, the absorbent core 399 may be similar to, and may be formed similarly to, the other absorbent cores of the present disclosure, such as absorbent cores 101, 101', and 101". Unlike the previous absorbent cores, however, absorbent core 399 further includes cellulose fibers 393a, 393b. As can be seen, cellulose fibers 393, 393b are disposed intermixed with the individual particulate material particles 389. Cellulose fibers 393a may be deposited, for instance, along with a first amount of particulate material particles 389, such as in particulate material delivery chamber 360a of Figure 12. Cellulose fibers 393b may be deposited, for instance, along with a second amount of particulate material particles 389, such as in particulate material delivery chamber 360b of Figure 12. As mentioned previously the addition of cellulose fibers may impart a greater softness to absorbent cores of the present disclosure, and the cellulose fibers may further help to stabilize the particulate material particles 389 between the base carrier sheet 370 and the top carrier sheet 375.

Again, it should be understood that Figure 12 only represents one contemplated embodiment. In further embodiments, apparatuses 20 and/or 200 may be modified to include only a single particulate material delivery chamber that further intermixes cellulose fibers with the particulate material before deposition at a forming surface, instead of the two shown with respect to Figure 12. In general, the apparatuses 20 and/or 200 may include a number of particulate material delivery

chambers that allow for the intermixing of cellulose fibers and particulate material that is less than all of the particulate material delivery chambers of the apparatuses. In these alternative embodiments, then, a relatively smaller proportion of the formed absorbent cores may include cellulose fibers. For instance, if the cellulose fibers were intermixed with a first amount of particulate material, the mixture of cellulose fibers and particulate material may be located proximate the base carrier sheet. However, if the cellulose fibers were intermixed with a second (or third, fourth, etc.) amount of particulate material, the mixture of cellulose fibers and particulate material may be located closer to the top carrier sheet than the first amount of particulate material.

In alternative embodiments, instead of forming the pulpless absorbent cores of the present disclosure with both a base carrier sheet and a top carrier sheet, as described previously, some contemplated methods may only use a single carrier sheet. Figures 14A and 14B depict example embodiments where a single carrier sheet may be used instead of both a base carrier sheet and a top carrier sheet.

Figure 14A depicts carrier sheet 405. In some embodiments, carrier sheet 405 may have a first edge region 402 having a first edge 403 and a second edge region 406 having a second edge 407, with a middle region 404 disposed between the first edge region 402 and the second edge region 406. In the embodiment of Figure 14A, particulate material and adhesive may only be applied within the middle region 404. After application of adhesive and particulate material, instead of applying a second carrier sheet as described herein previously, the second edge region 406 may be folded over the middle region 404 and onto the first edge region 402 such that the second edge 407 is disposed proximate the first edge 403. The edges 403, 407 may then be bonded together to create an enclosed pulpless absorbent core. Bonding the edges 403 and 407 together may be done by any suitable method, such as by pressure bonding, adhesive bonding, ultrasonic bonding, or the like. The apparatuses described herein may be modified to produce such pulpless absorbent cores. For instance, instead of machinery to apply the top carrier sheets, the apparatuses described herein may include folding and bonding machinery, which are well known in the art, to fold the second edge region 406 onto the first edge region 402 and to bond the regions 402, 406 together.

In some embodiments according to Figure 14A, the carrier sheet 405 may have a width 410. Width 410 may be greater than twice the width of a forming surface used to create pulpless absorbent cores, or alternatively greater than twice the width of an un-masked portion of a forming surface used to create pulpless absorbent cores. In some specific examples, width 410 may range between about 25 cm and about 60 cm.

The middle region 404 may have a width 412. The width 412 may range from between about 40% to about 50% of the overall width 410 of the carrier sheet 405. Additionally, the first edge region 402 may have a width 414 that is between about 0.5% and about 10% of the overall width 410 of the carrier sheet 405.

5 Figure 14B depicts another example embodiment of a single carrier sheet that may be used to form the pulpless absorbent cores of the present disclosure. In the example of Figure 14B, the carrier sheet 450 may have an overall width 460. The overall width 460 may have values similar to those described with respect to width 410. Additionally, the carrier sheet 450 may have a first edge region 452, a middle region 454, and a second edge region 456. As with the embodiment of Figure 14A,
10 adhesive and particulate material may only be applied to the carrier sheet 450 within the middle region 454. After application of adhesive and particulate material to the middle region 454, one of the first edge region 452 or the second edge region 456 may be folded over onto the middle region 454. Then, the other of the first edge region 452 or the second edge region 456 may be folded over the middle region 454. In some embodiments, the edge regions 452, 456 may overlap over the middle region
15 454, and at least a portion of each of the first edge region 452 and the second edge region 456 may be bonded together to form an enclosed pulpless absorbent core.

 Similarly to carrier sheet 405, in some embodiments the width 460 of the carrier sheet 450 may be greater than twice the width of a forming surface used to create pulpless absorbent cores, or greater than an un-masked portion of a forming surface used to create pulpless absorbent cores.
20 However, this is not necessary in all embodiments. In at least some embodiments, width 460 may range between about 25 cm and about 60 cm.

 The region 454 of the carrier sheet 450 may have a width 462. The width 462 may range from between about 33% to about 50% of the overall width 460 of the carrier sheet 450. In some embodiments, each of the first edge region 452 and the second edge region 456 may have a width
25 (not shown) that is between about 25% and about 33% of the overall width 460. However, the widths of the first edge region 452 and the second edge region 456 do not necessarily need to be equal. For example, the width of the first edge region 452 may be between about 35% and about 40% of the overall width 460 and the width of the second edge region 456 may be between about 10% and about 25% of the overall width of 460, or vice versa.

30 Figures 15A and 15B depict alternative particulate material delivery chamber configurations that may be used in any of the above described apparatuses to form absorbent cores that have differing basis weights between a middle region of the absorbent cores and edge regions of the

absorbent cores. For instance, Figure 15A illustrates a side view of exemplary particulate material delivery chamber 960a.

As can be seen in Figure 15A, particulate material delivery chamber 960a is situated over forming surface 924. The particulate material delivery chamber 960a includes particulate material delivery conduit 962a terminating in inlet 961a. The inlet 961a has an inlet width 912 that is generally less than the forming surface width 910. Figure 15A further depicts bottom edges 913 of the particulate material delivery chamber 960a and gap space 116 depicting a distance between the bottom edges 913 of the particulate material delivery chamber 960a and the forming surface 924.

In the embodiment of Figure 15A, gap space 116 may be zero. For instance, the bottom edges 913 of the particulate material delivery chamber 960a may be disposed about the forming surface 924 such that no gap exists (not shown), or one or more sealing members (not shown) may be disposed so as to block air from entering the particulate material delivery chamber 960a through gap space 116.

Additionally, particulate material 989 can be seen exiting the inlet 961a and depositing at the forming surface 924. As the particulate material 989 exits the inlet 961a, the particulate material may travel in a relatively straightforward manner toward the forming surface 924. Accordingly, the particulate material 989 may have a deposited width 920 that represents a width of the deposited particulate material on the forming surface 924. In some embodiments, the deposited width 920 may be similar to the inlet width 912. However, the deposited width may generally be less than the forming surface width 924. Accordingly, in the embodiment of Figure 15A, the particulate material 989 being deposited at the forming surface may be deposited preferentially within a middle region of the forming surface as opposed to edge regions of the forming surface.

Figure 15B illustrates another side view of an alternative exemplary particulate material delivery chamber for depositing particulate material at a forming surface at a width that is less than a width of the forming surface. Figure 15B depicts particulate material delivery chamber 960a', including particulate material delivery conduit 962a' having an inlet 961a'. Figure 15B additionally depicts bottom edges 913' of the particulate material delivery chamber 960a', along with gap space 916'.

In the example of Figure 15B, gap space 916' may be wide enough such that air may flow into the particulate material delivery chamber 960a' through gap space 916', as shown by arrows 926. As the particulate material 989' falls from the inlet 961a' toward the forming surface 924', the air 926 may impinge on the edges of the falling stream of particulate material 989'. This may have the effect of

narrowing the width of the stream of the particulate material 989' before the particulate material 989' is deposited at the forming surface 924'. For instance, as can be seen, particulate material 989' may exit the inlet 961a', where the inlet 961a' has an inlet width 912'. As the particulate material 989' falls toward the forming surface 924', the stream of particulate material 989' narrows and is deposited at the forming surface 924' at a deposited width 922.

As can be seen, the deposited width 922 may generally be less than the inlet width 912'. Additionally, the deposited width 922 may be less than the forming surface width 910'. In some embodiments, the inlet width 912' may be the same as the forming surface width 910', but this is not necessary. In at least some embodiments, the inlet width 912' may be less than the forming surface width 910'.

In general, either of these configurations of particulate material delivery chambers, or particulate material delivery chambers having any combination of these described features, may be used as at least one of the particulate material delivery chambers of the apparatuses disclosed herein. For instance, in one exemplary embodiment, one of the disclosed apparatuses may have a first particulate material delivery chamber that deposits particulate material at a forming surface at a width approximately equal to the width of the forming surface. The apparatus may additionally have a second particulate material delivery chamber that deposits particulate material at the forming surface at a width that is less than the width of the forming surface, e.g. the particulate material delivery chamber may preferentially deposit the particulate material within a middle region of the forming surface. In at least some embodiments, the difference in widths may be at least 25 mm. For instance, the width of the middle region of the absorbent core may be at least 25 mm less than an overall width of the absorbent core. In more specific embodiments, the middle region width may be between about 25 mm and about 150 mm less than an overall width of the absorbent core.

Accordingly, in these embodiments, the middle region of an absorbent core formed using such an apparatus may have a higher basis weight of particulate material disposed in the middle region than in the edge regions. This is because an additional amount of particulate material has been disposed in the middle region than in the edge regions. Of course, this is just one example. In other contemplated embodiments, the order to particulate material delivery chambers may be flipped, or the apparatus may include additional particulate material delivery chambers.

In this manner, the disclosed apparatuses may be used to form absorbent cores such as absorbent cores 1000 as described below with respect to Figure 16, wherein the absorbent cores have differing basis weights between a middle region of the core and edge regions of the core. Figure 16

depicts a length of connected absorbent cores 1000 comprising connected individual absorbent cores 931a-c. The connected absorbent cores 931a-c may later be cut, for example along cut lines 950, to form individual absorbent cores.

Figure 16 depicts the absorbent cores 931a-c as having a middle region 934, a first edge region 932, and a second edge region 936. The middle region may have a middle region width 944, while the first edge region 932 has a first edge region width 942 and the second edge region 936 has a second edge region width 946. In some embodiments, the middle region width 944 may be between about 1.5 and about 4.0 times greater than the first edge region width 942 and/or the second edge region width 946. In more specific embodiments, the middle region width 944 may be about 1.5 times, 2.0 times, 2.5 times, 3.0 times, 3.5 times, or 4.0 times the first edge region width 942 and/or the second edge region width 946. In even more specific examples, the middle region width 944 may be between about 1.8 and about 2.2 times greater than the first edge region width 942 and/or the second edge region width 946. It should also be understood that in some embodiments, the first edge region width 942 and the second edge region width 946 do not have to have the same value. For instance, the first edge region width 942 may be smaller than, or greater than, the second edge region width 946.

In general, the middle region width 944 may correspond to the region of higher average basis weight. For instance, the middle region width 944 may be equal to the deposited width 920 of Figure 15A, or the deposited width 922 of Figure 15B. In some embodiments, the differences in average basis weights between the middle region 934 and the first edge region 932 and the second edge region 936 may be such that the middle region 934 contains an amount of particulate material that is greater than 55%, greater than 60%, greater than 65%, greater than 70%, or greater than 75%, by weight, of the total amount of the particulate material of the absorbent cores 931a-c. In other embodiments, the average basis weight of the middle region 934 may be between 55% and 75% of the average basis weight of the first edge region 932 and/or the second edge region 936.

The pulpless absorbent cores the present disclosure may be used in many different absorbent articles. For example, pulpless absorbent cores the present disclosure may be used in diapers and/or training pants in order to help absorb urine and other liquid discharge from babies and toddlers. The pulpless absorbent cores the present disclosure may additionally, or alternatively, be used in incontinence products, disposable underwear, and/or medical garments to help absorb liquid discharge from people who may not be able to control their ability to urinate or defecate. Even further, the pulpless absorbent cores the present disclosure may additionally, or alternatively, be used in feminine care articles to help absorb vaginal discharges. These are just some example absorbent articles in

which the pulpless absorbent cores the present disclosure may be used. In general, the pulpless absorbent cores the present disclosure may be used in any suitable absorbent article application.

As various changes could be made in the above without departing from the scope of the invention, it is intended that all matter contained in the above description and shown in the
5 accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

WE CLAIM:

1. A method for forming an absorbent core, the method comprising:
advancing a base carrier sheet in a machine direction;
applying a first adhesive onto a top surface of the base carrier sheet;
5 advancing the base carrier sheet within a first particulate material delivery chamber;
depositing a first amount of particulate material onto the first adhesive within the first
particulate material delivery chamber;
applying a second adhesive onto the first amount of particulate material outside of the first
particulate material delivery chamber;
10 advancing the base carrier sheet with the first adhesive, the first amount of particulate
material, and the second adhesive into a second particulate material delivery chamber;
depositing a second amount of particulate material onto the second adhesive within the
second particulate material delivery chamber; and
applying a top carrier sheet onto the second amount of particulate material.
15
2. The method of claim 1, further comprising:
applying a third adhesive onto the second amount of particulate material before applying the
top carrier sheet onto the second amount of particulate material; and
applying the top carrier sheet onto the third adhesive.
20
3. The method of claim 1, further comprising applying a third adhesive onto the top
carrier sheet before applying the top carrier sheet onto the second amount of particulate material.
4. The method of claim 1, wherein the base carrier sheet and the top carrier sheet
25 comprise a single carrier sheet.

5. The method of claim 4, wherein the first adhesive, the first amount of particulate material, and the second adhesive are applied to a first portion of the single carrier sheet to form the base carrier sheet, and wherein a second portion of the single carrier sheet is folded onto the second amount of particulate material to form the top carrier sheet.

5

6. The method of claim 1, further comprising advancing an assembly of the base carrier sheet, the first adhesive, the first amount of particulate material, the second adhesive, the second amount of particulate material, and the top carrier sheet through a nip assembly.

10

7. The method of claim 1, further comprising advancing the base carrier sheet in the machine direction on a forming drum.

8. The method of claim 1, further comprising:
applying a third adhesive onto the second amount of particulate material;
15 applying a third amount of particulate material onto the third adhesive;
applying a fourth adhesive onto the third amount of particulate material; and
applying the top carrier sheet onto the fourth adhesive.

9. A method for forming an absorbent core, the process comprising:
20 applying a first adhesive onto a top surface of a base carrier sheet;
advancing the base carrier sheet with the applied first adhesive in a machine direction;
depositing a first amount of particulate material onto the first adhesive on the base carrier sheet within a first particulate material delivery chamber, the first amount of particulate material having a first cross-direction width on the base carrier sheet;
25 applying a second adhesive onto the first amount of particulate material outside of the first particulate material delivery chamber;

depositing a second amount of particulate material onto the second adhesive on the base carrier sheet within a second particulate material delivery chamber, the second amount of particulate material having a second cross-direction width on the base carrier sheet; and

applying a top carrier sheet onto the second amount of particulate material, and

5 wherein the first cross-direction width is different than the second cross-direction width by at least 25 mm.

10. The method of claim 9, further comprising:

applying a third adhesive onto the second amount of particulate material before applying the
10 top carrier sheet onto the second amount of particulate material; and

applying the top carrier sheet onto the third adhesive.

11. The method of claim 9, wherein:

the first amount of particulate material is dispensed from within the first particulate material
15 delivery chamber from a first particulate material delivery conduit situated within the first particulate material delivery chamber;

the second amount of particulate material is dispensed from within the second particulate material delivery chamber from a second particulate material delivery conduit situated within the second particulate material delivery chamber; and

20 wherein inlet openings of the first particulate material delivery conduit and the second particulate material delivery conduit are oriented such that the first amount of particulate material and the second amount of particulate material exit the first particulate material delivery conduit and the second particulate material delivery conduit substantially vertical with respect to gravity.

25 12. The method of claim 9, wherein the base carrier sheet with the applied adhesive is advanced in the machine direction on a forming drum, and wherein each of the first particulate material delivery chamber and the second particulate material delivery chamber are disposed over a top third of a circumference of the forming drum.

13. The method of claim 9, wherein the first adhesive is a hot-melt adhesive, and wherein adhesive applied to particulate material is a spray-application aqueous binder (SAAB) adhesive.

5 14. The method of claim 9, wherein a type of particulate material in the first amount of particulate material is different than a type of particulate material in the second amount of particulate material.

10 15. The method of claim 9, wherein a first one of the first cross-direction width and the second cross-direction width is between 50 mm and 250 mm, and wherein a second one of the first cross-direction width and the second cross-direction width is between 25 mm and 150 mm.

16. An apparatus for forming for forming an absorbent core, the apparatus comprising:
a forming surface, wherein the forming surface is moveable in a machine direction;
15 a first adhesive applicator configured to apply adhesive to a base carrier sheet;
a first particulate material delivery chamber disposed after the first adhesive applicator in the machine direction, the first particulate material delivery chamber including a first particulate material delivery conduit for dispensing particulate material at the forming surface;
a second adhesive applicator disposed after the first particulate material delivery chamber in
20 the machine direction, the second adhesive applicator configured to apply adhesive at the forming surface; and
a second particulate material delivery chamber disposed after the second adhesive applicator in the machine direction, the second particulate material delivery chamber including a second particulate material delivery conduit for dispensing particulate material at the forming surface.

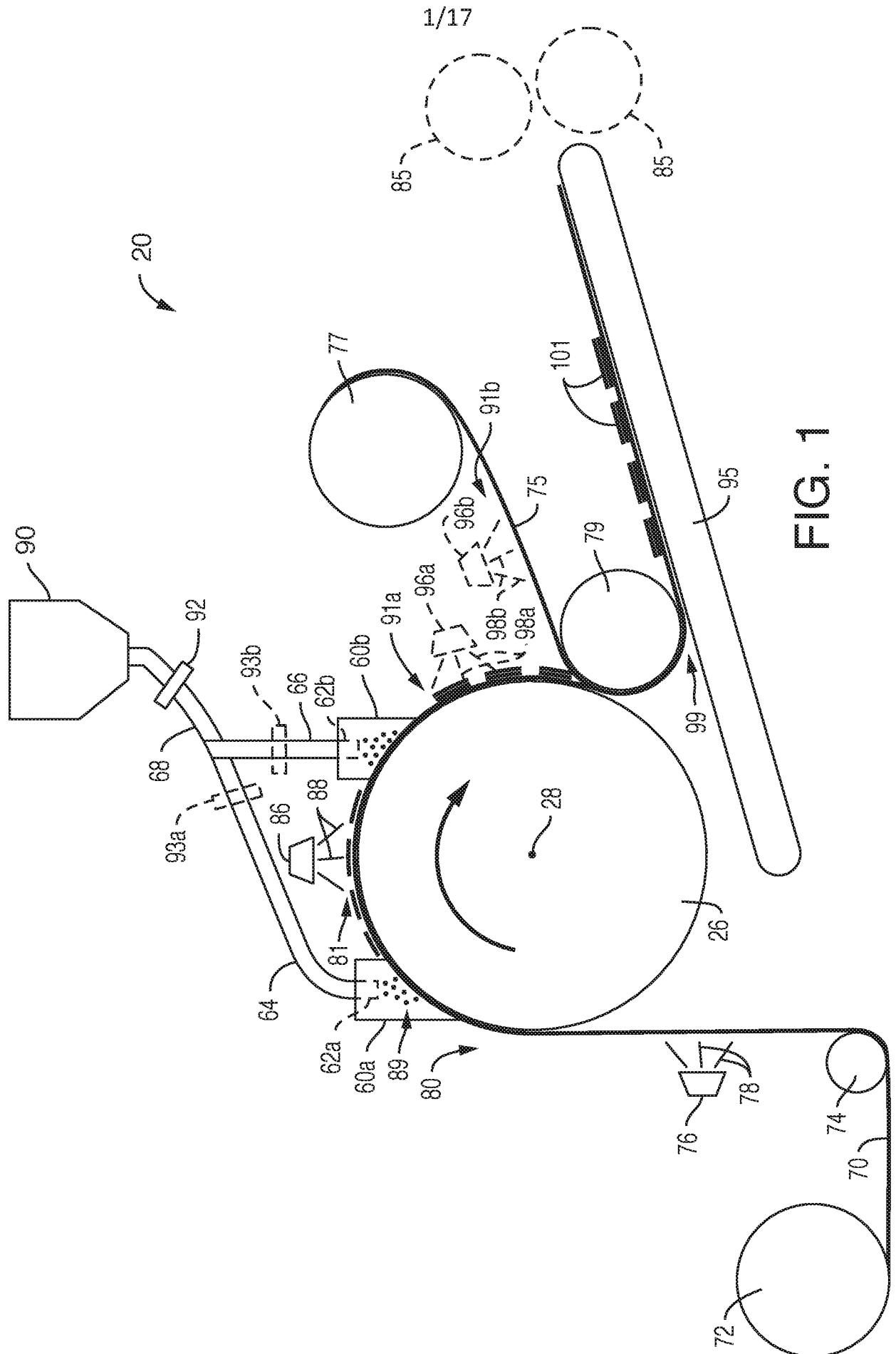
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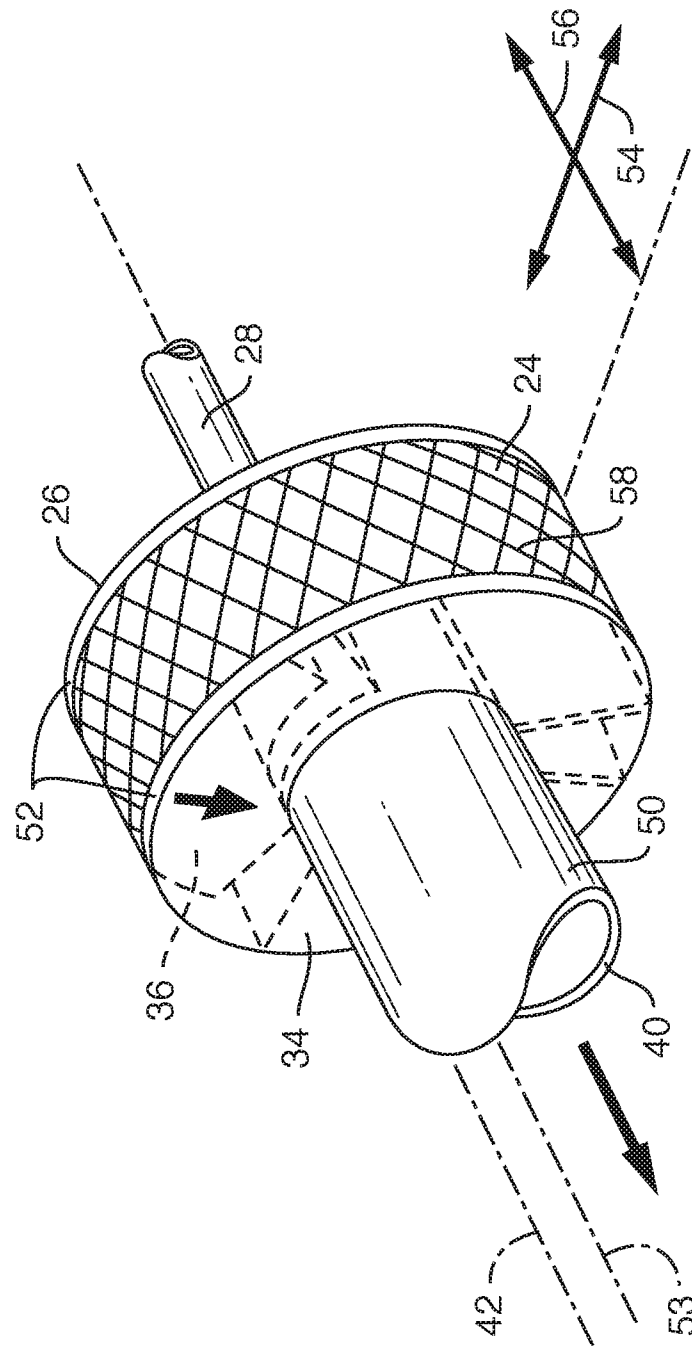
17. The apparatus of claim 16, further comprising a third adhesive applicator disposed after the second particulate material delivery chamber in the machine direction, the third adhesive applicator configured to apply adhesive at the forming surface.

18. The apparatus of claim 16, wherein the first particulate material delivery conduit terminates at a first inlet in the first particulate material delivery chamber and the second particulate material delivery conduit terminates at a second inlet within the second particulate material delivery chamber, and wherein planes of the first inlet and the second inlet are oriented parallel with respect to ground.

19. The apparatus of claim 16, wherein the first adhesive applicator is configured to apply hot-melt adhesive to the base carrier sheet, and wherein the second adhesive applicator is configured to apply a spray-application aqueous binder (SAAB) adhesive onto particulate material disposed at the forming surface.

20. The apparatus of claim 16, further comprising a fiberizer connected to at least one of the first particulate material delivery chamber and the second particulate material delivery chamber for supplying cellulose fibers to the at least one of the first particulate material delivery chamber and the second particulate material delivery chamber.





25

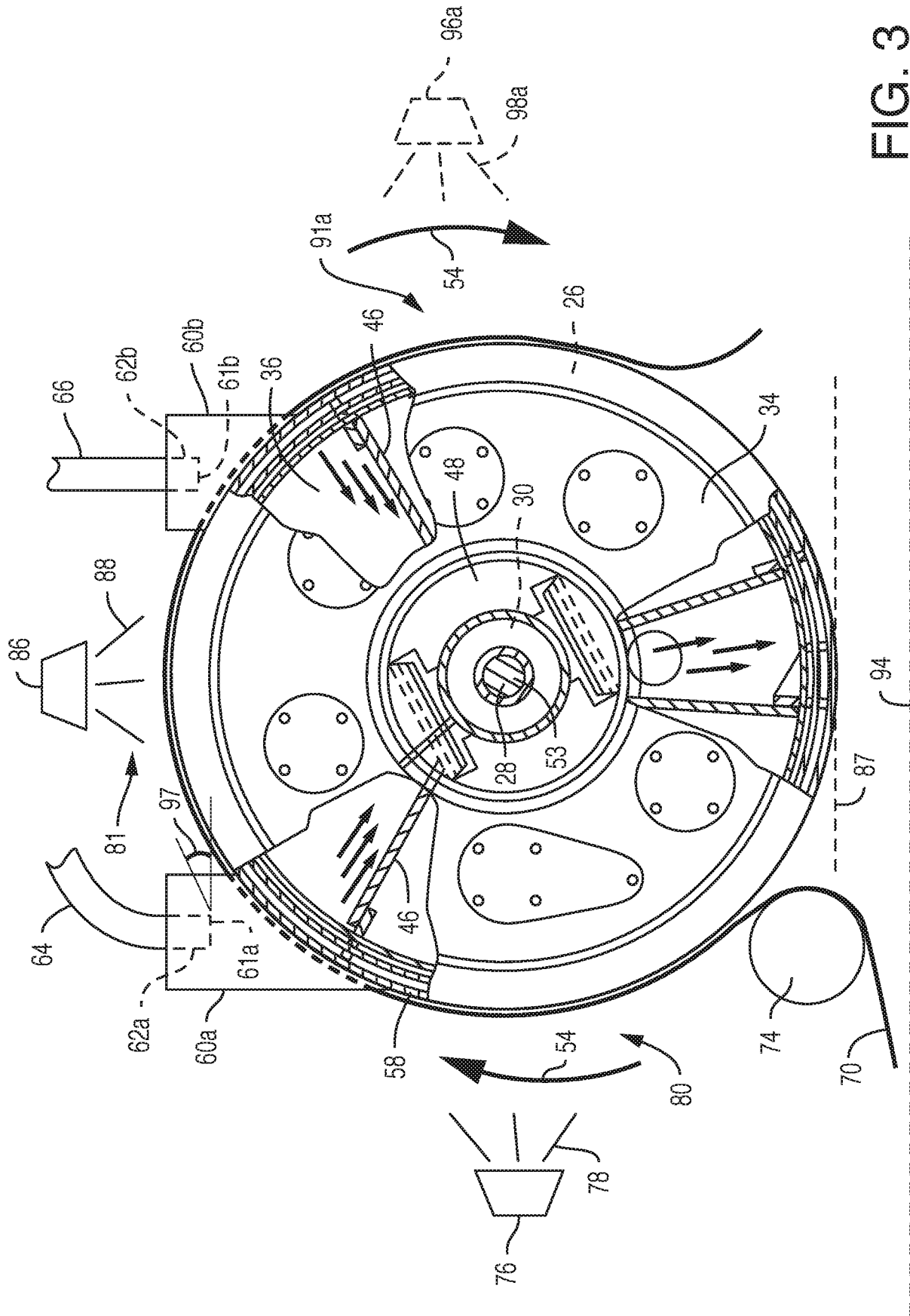


FIG. 3

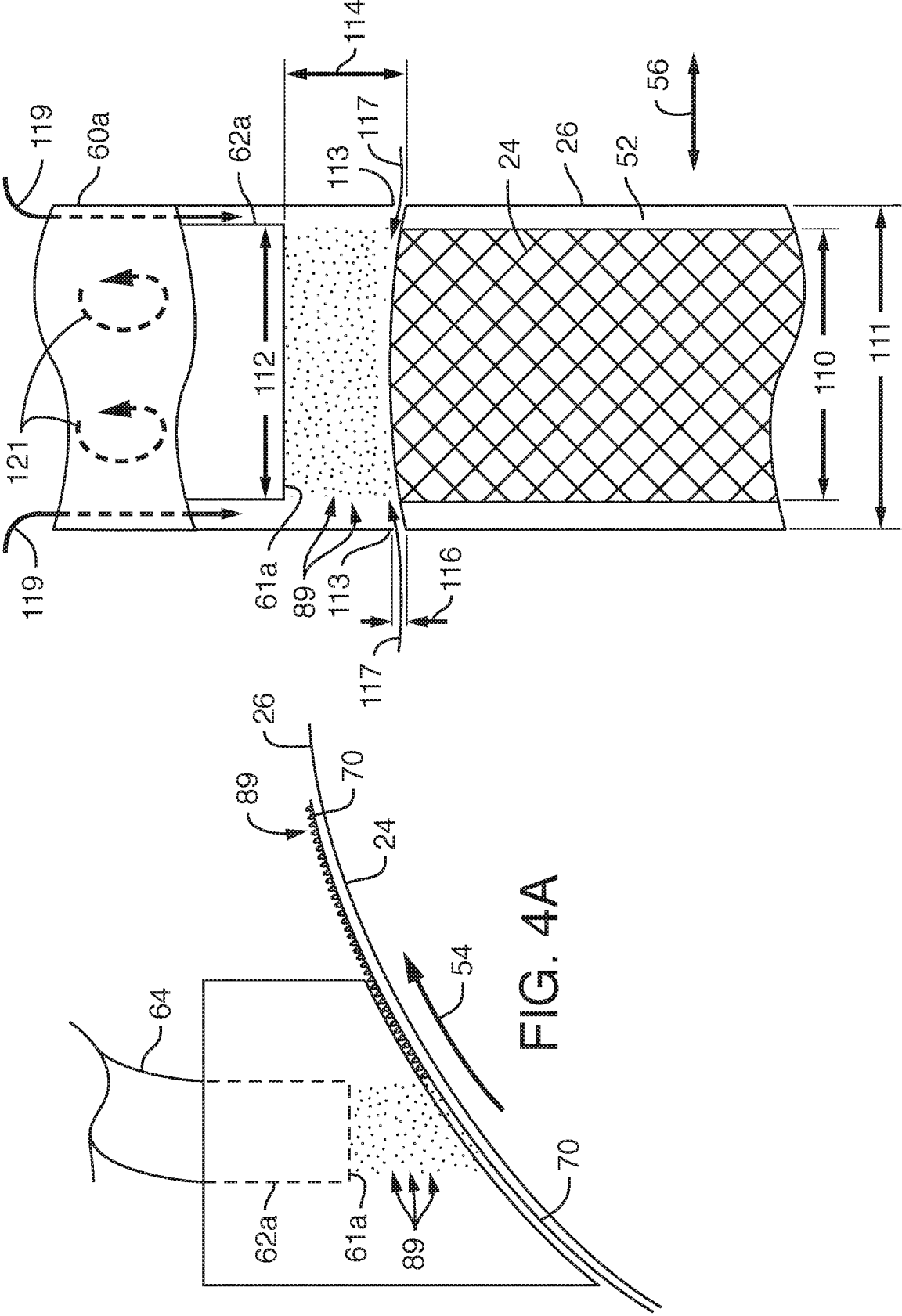


FIG. 4B

FIG. 4A

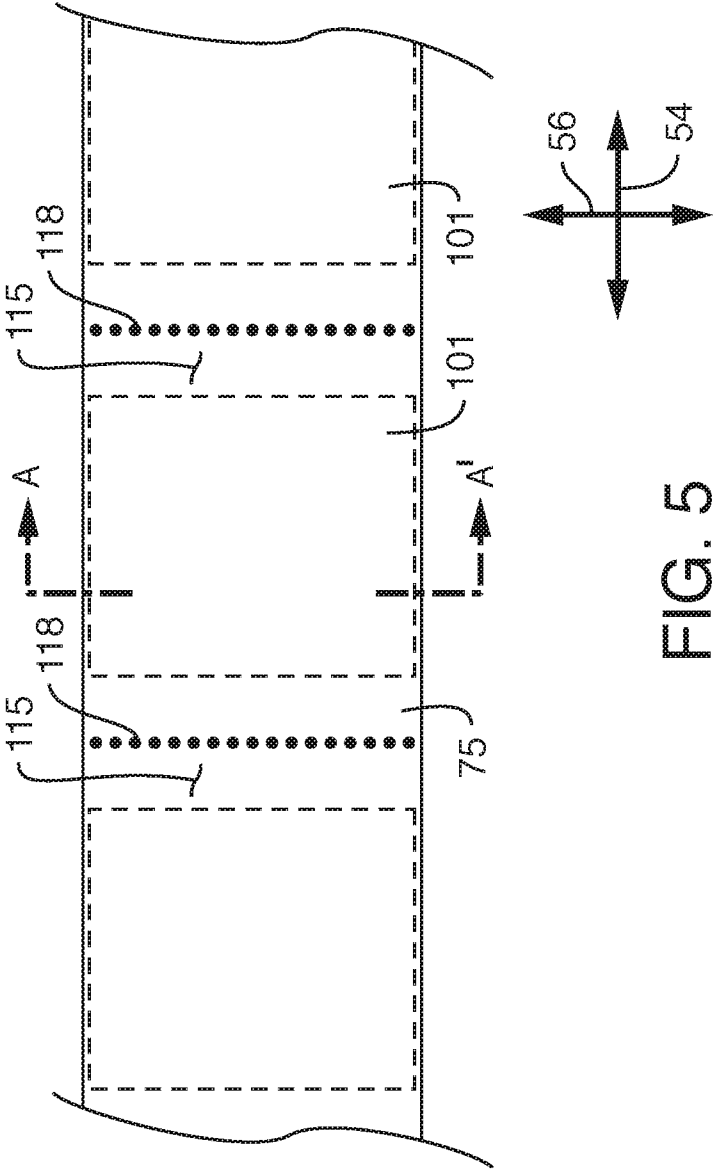


FIG. 5

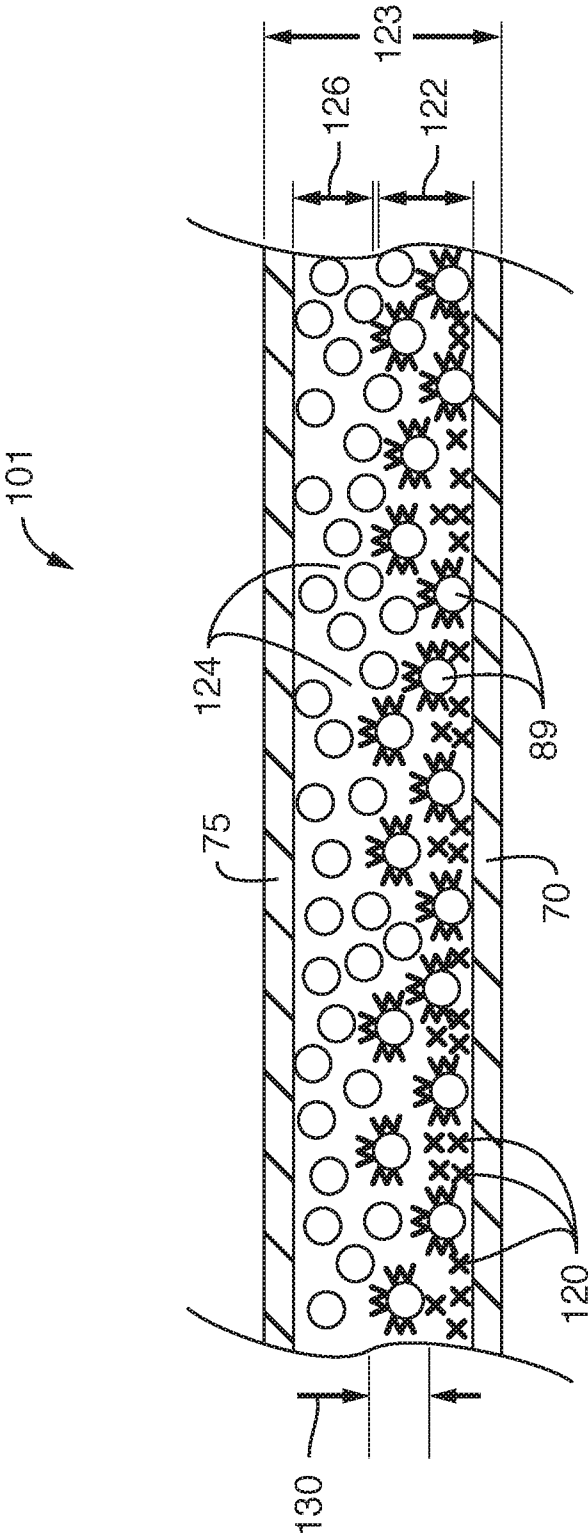


FIG. 6A

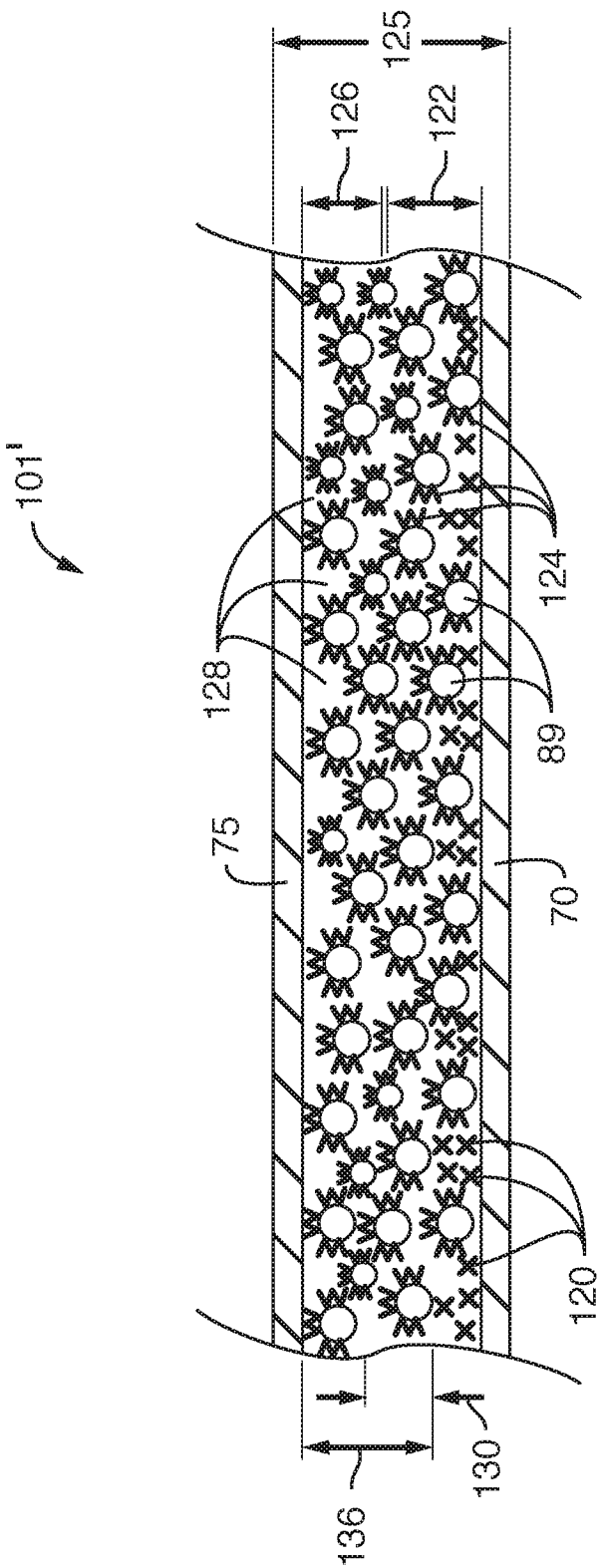
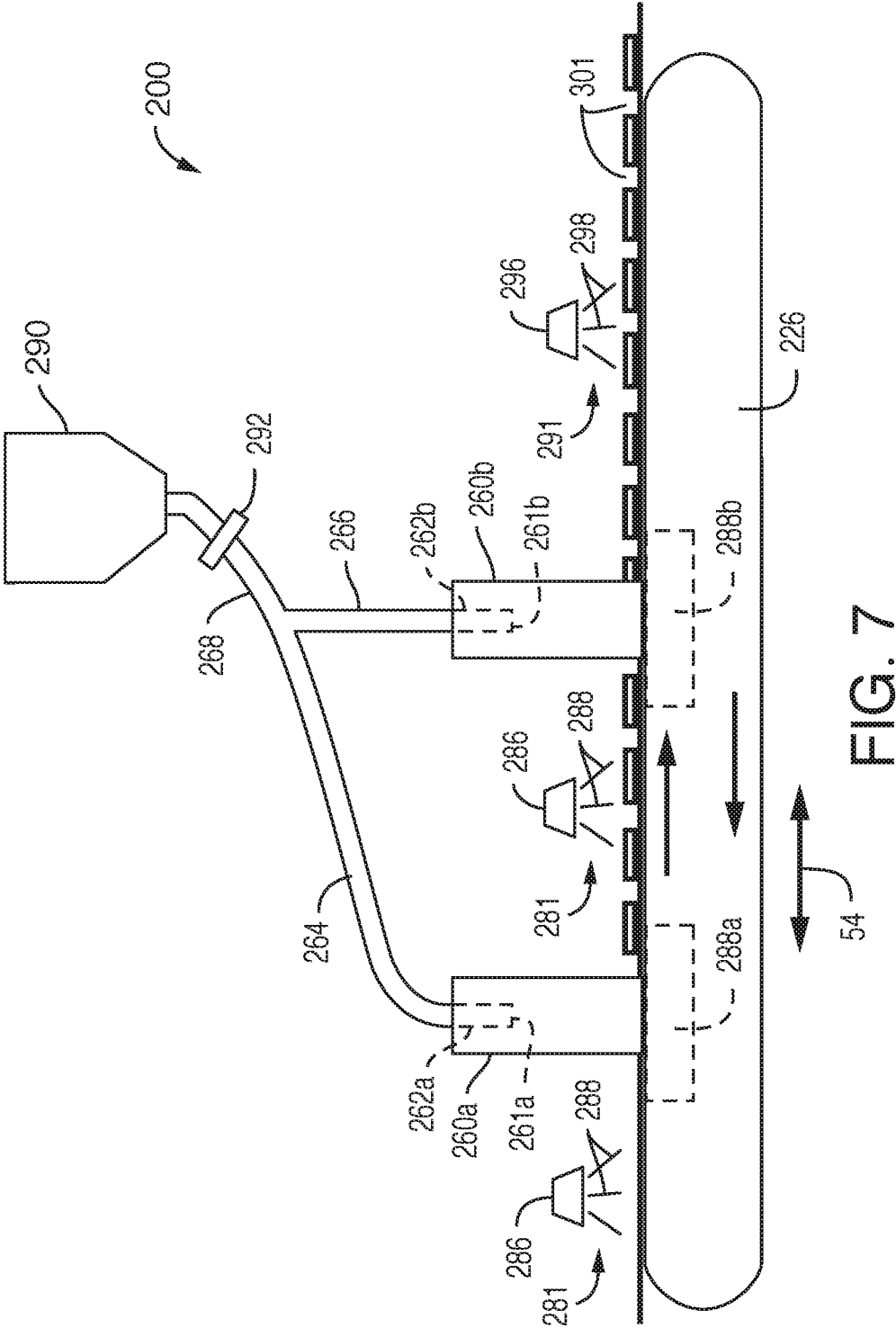


FIG. 6B



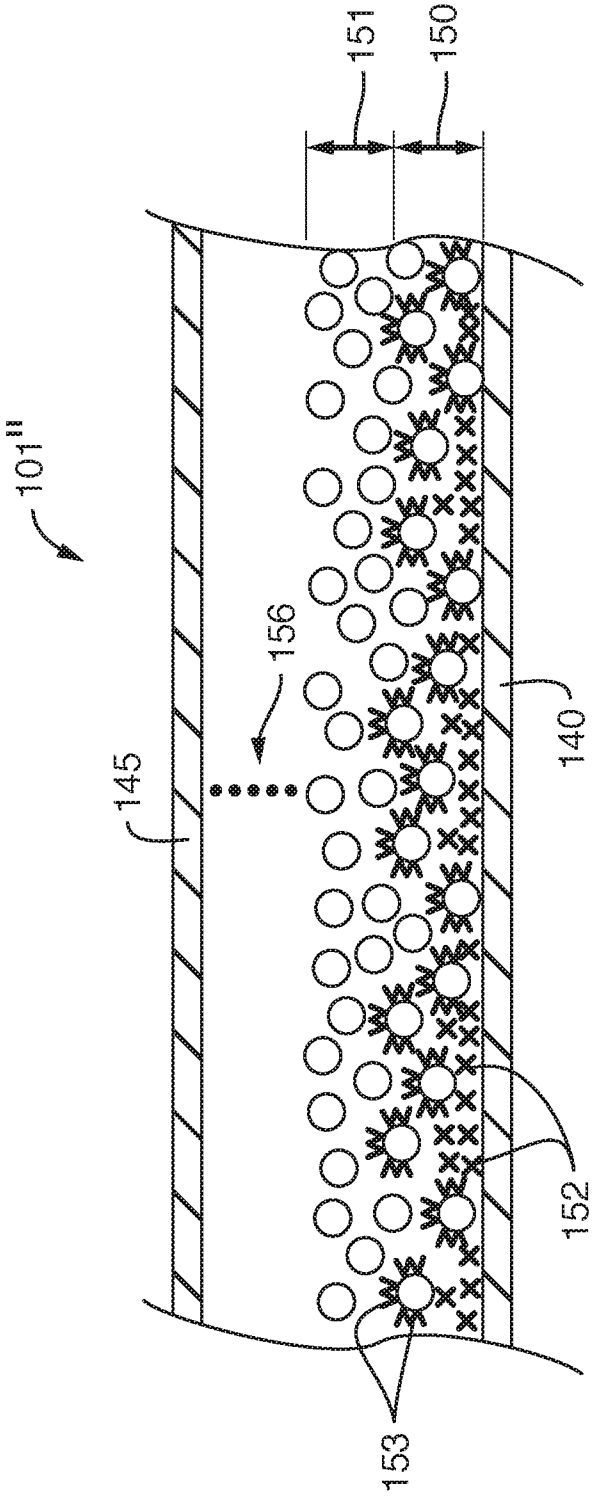


FIG. 8

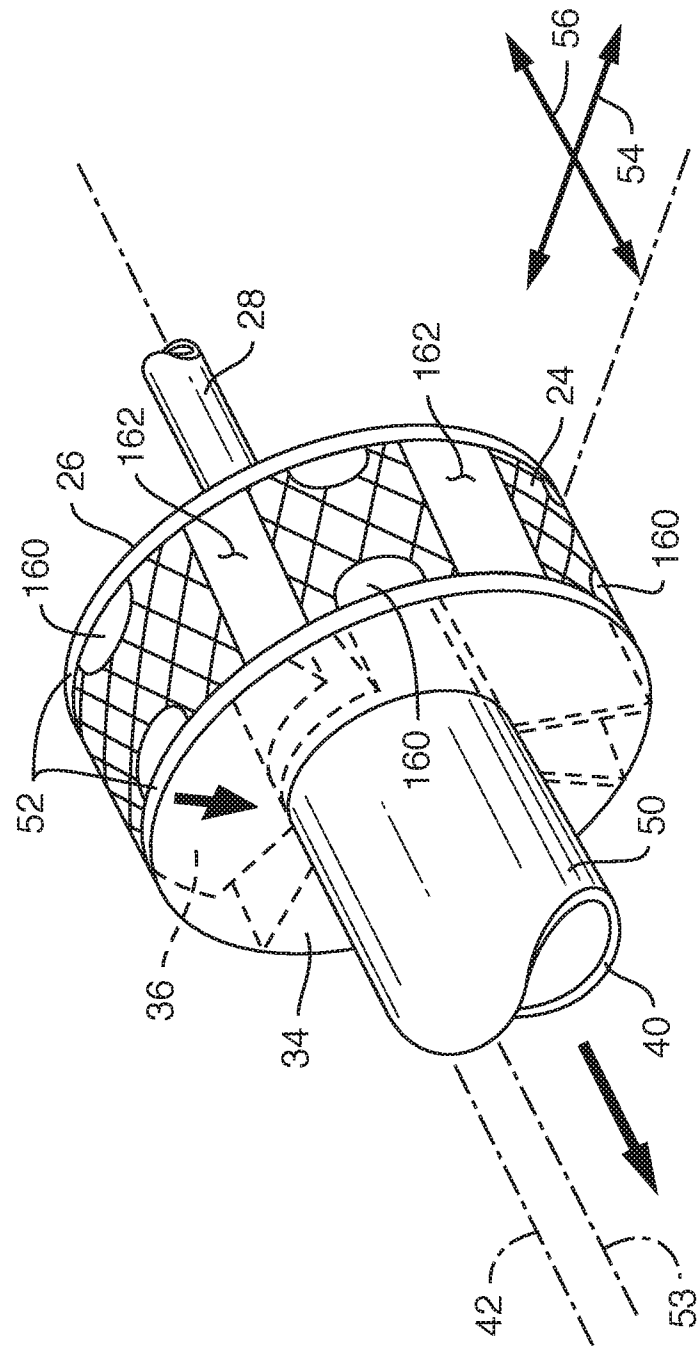


FIG. 9

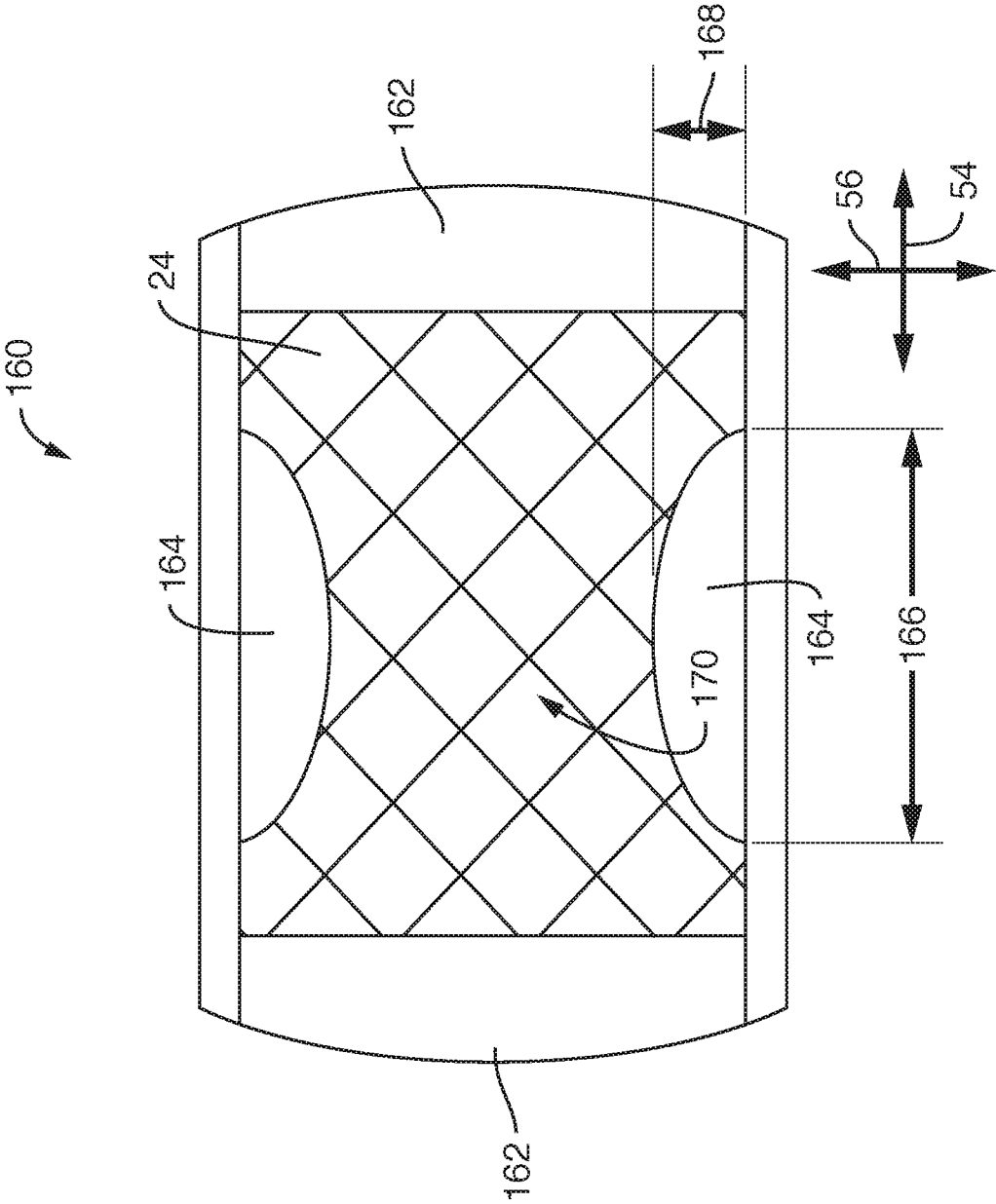
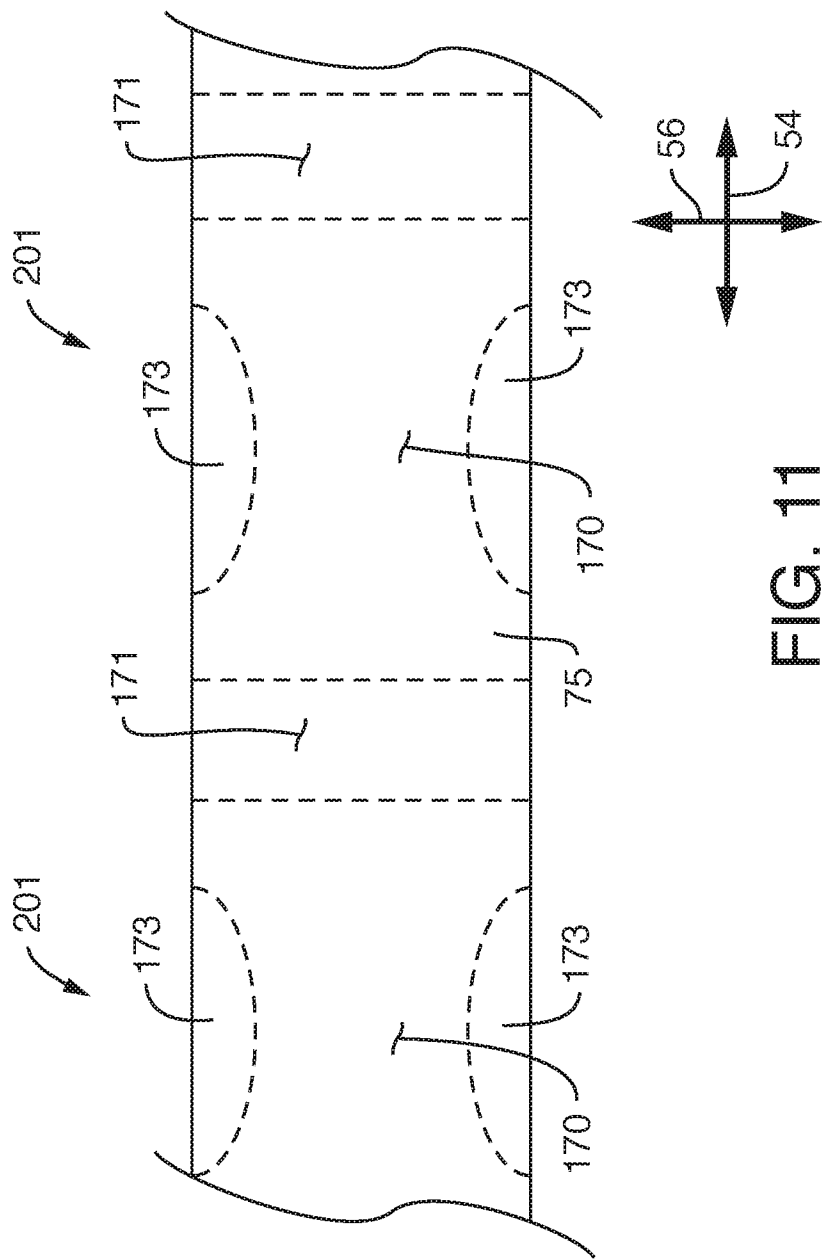
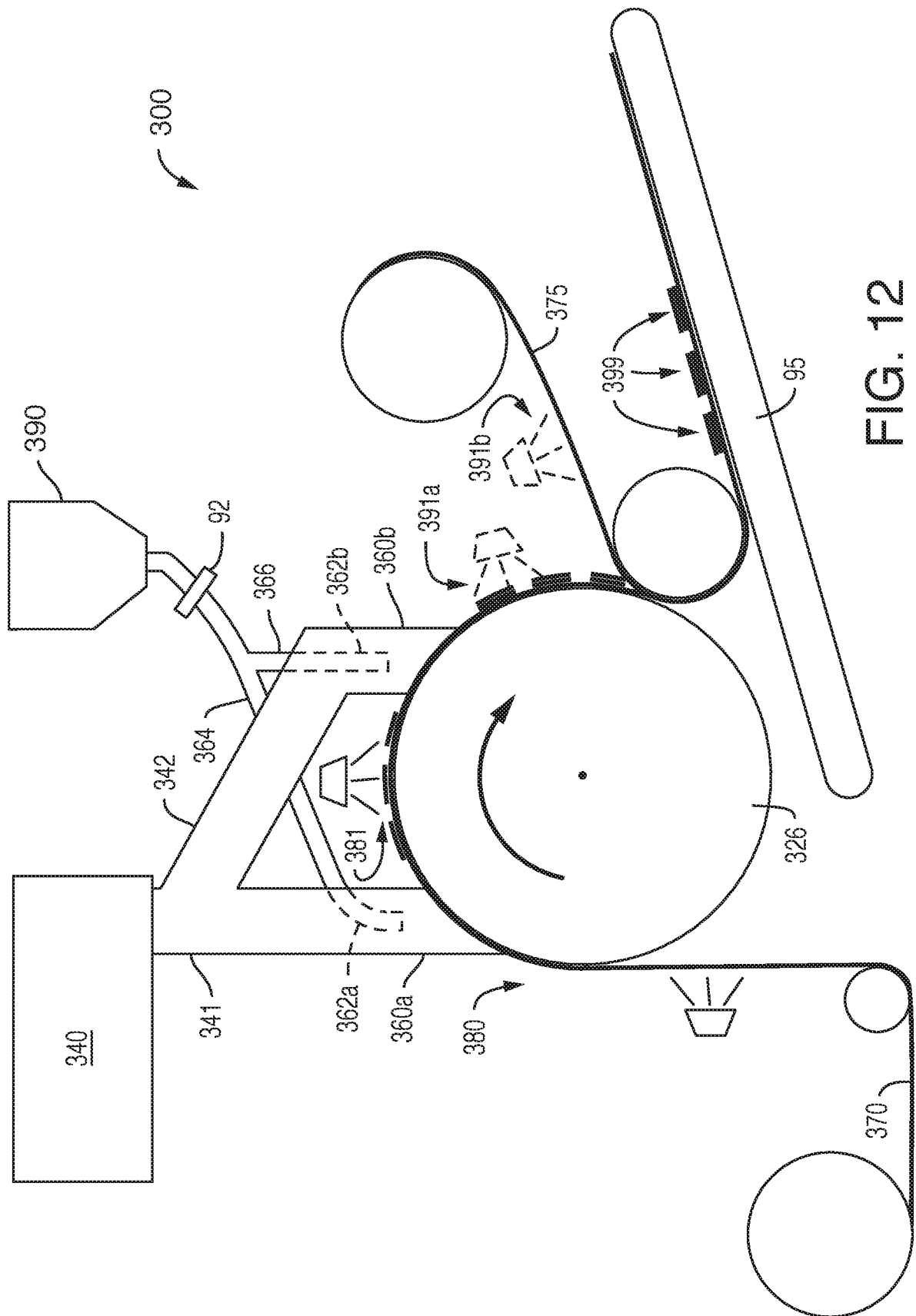


FIG. 10





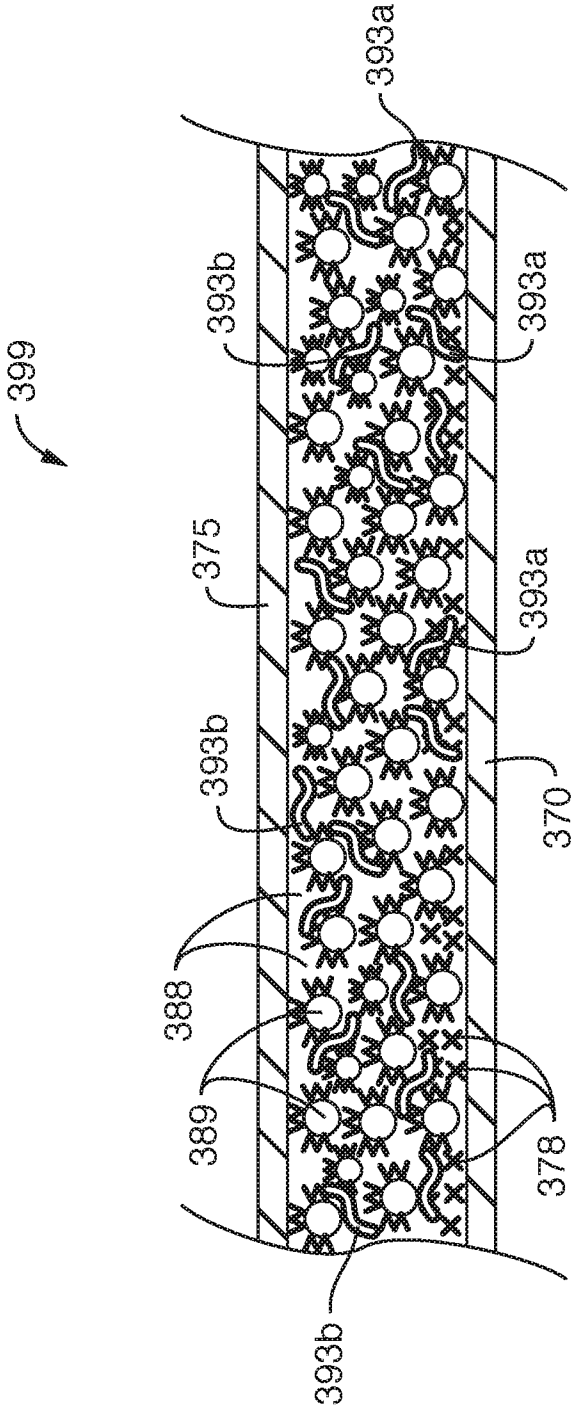
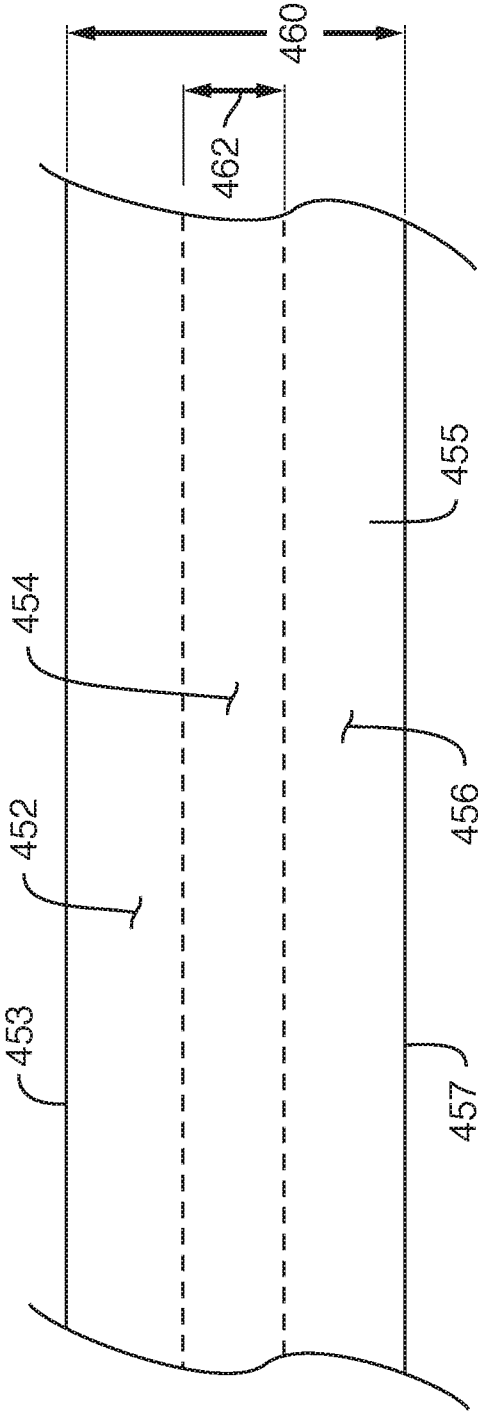
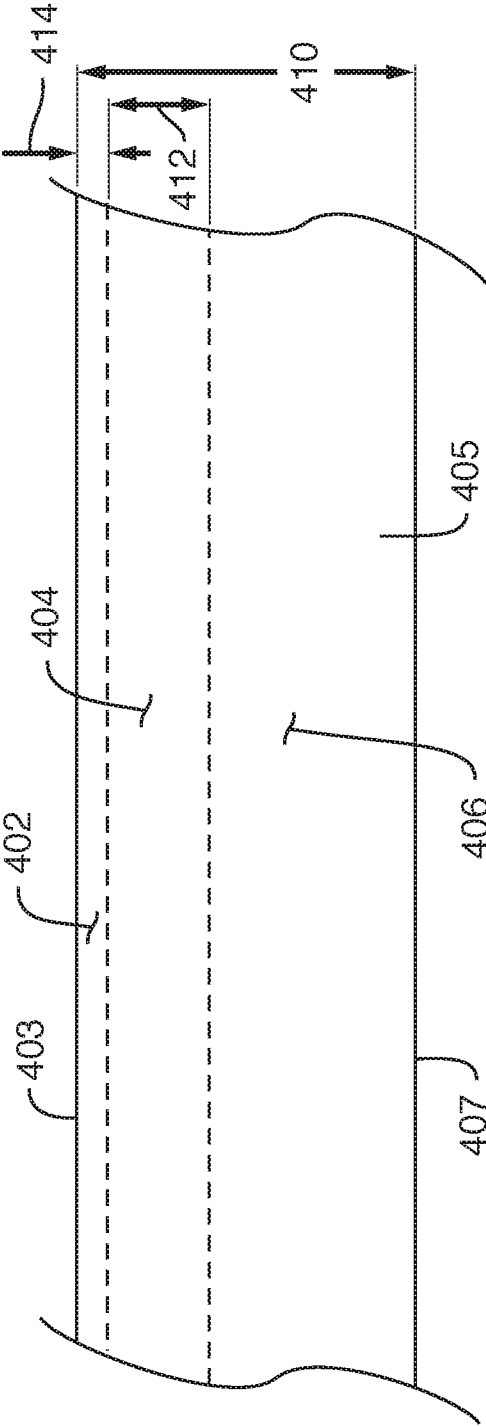


FIG. 13



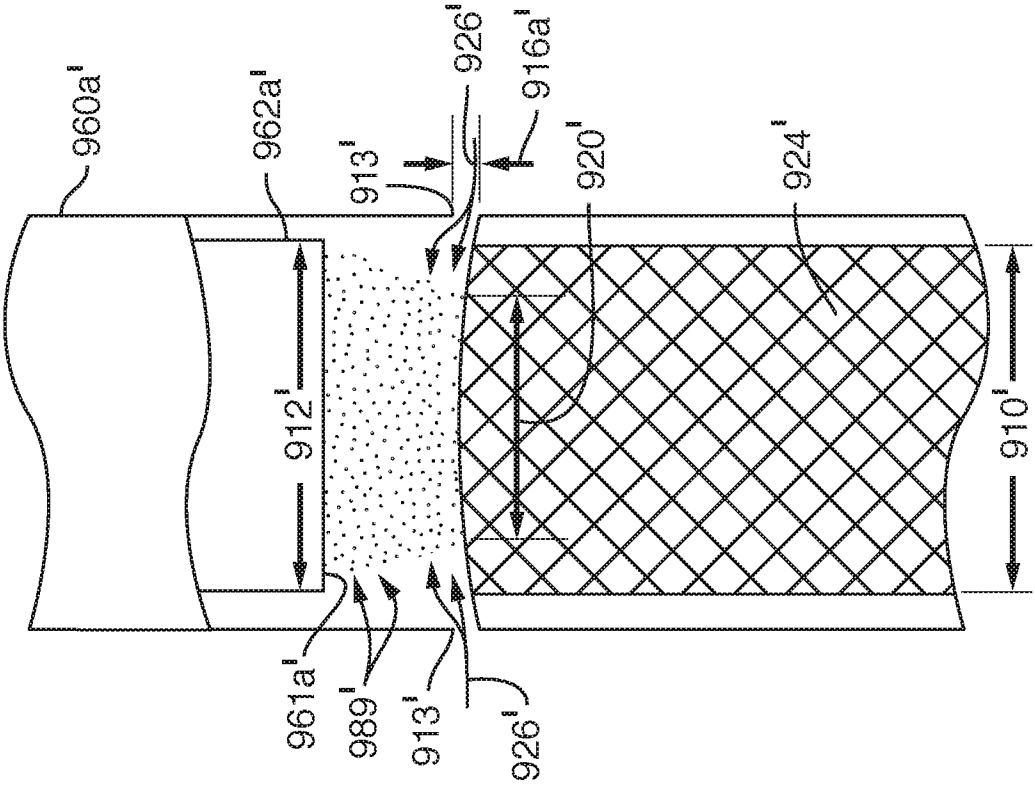


FIG. 15B

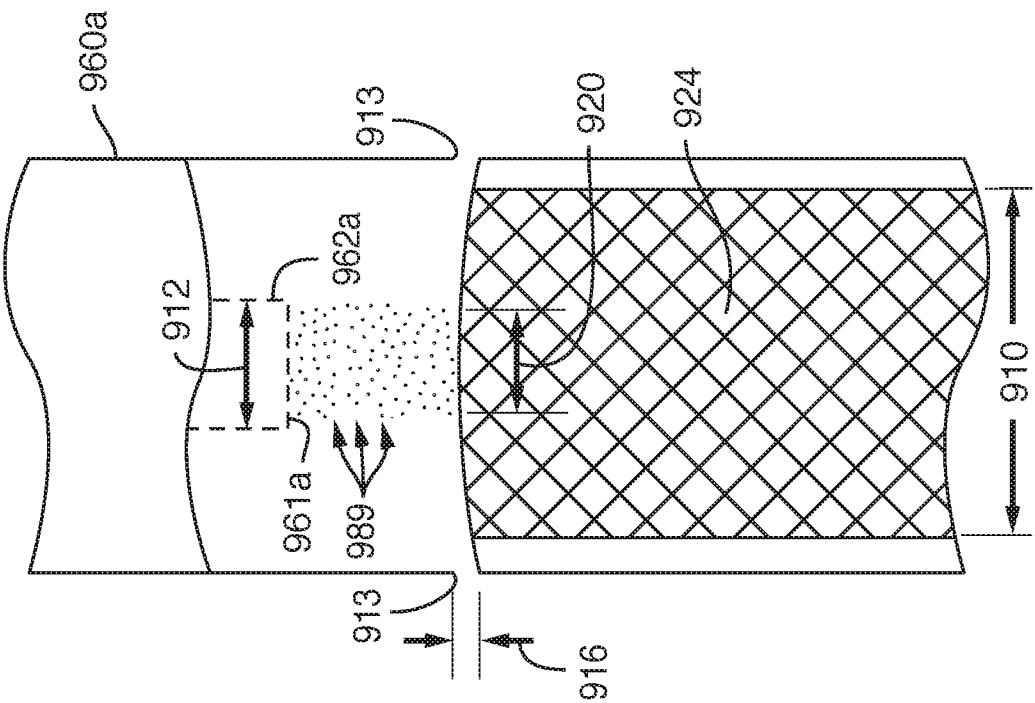
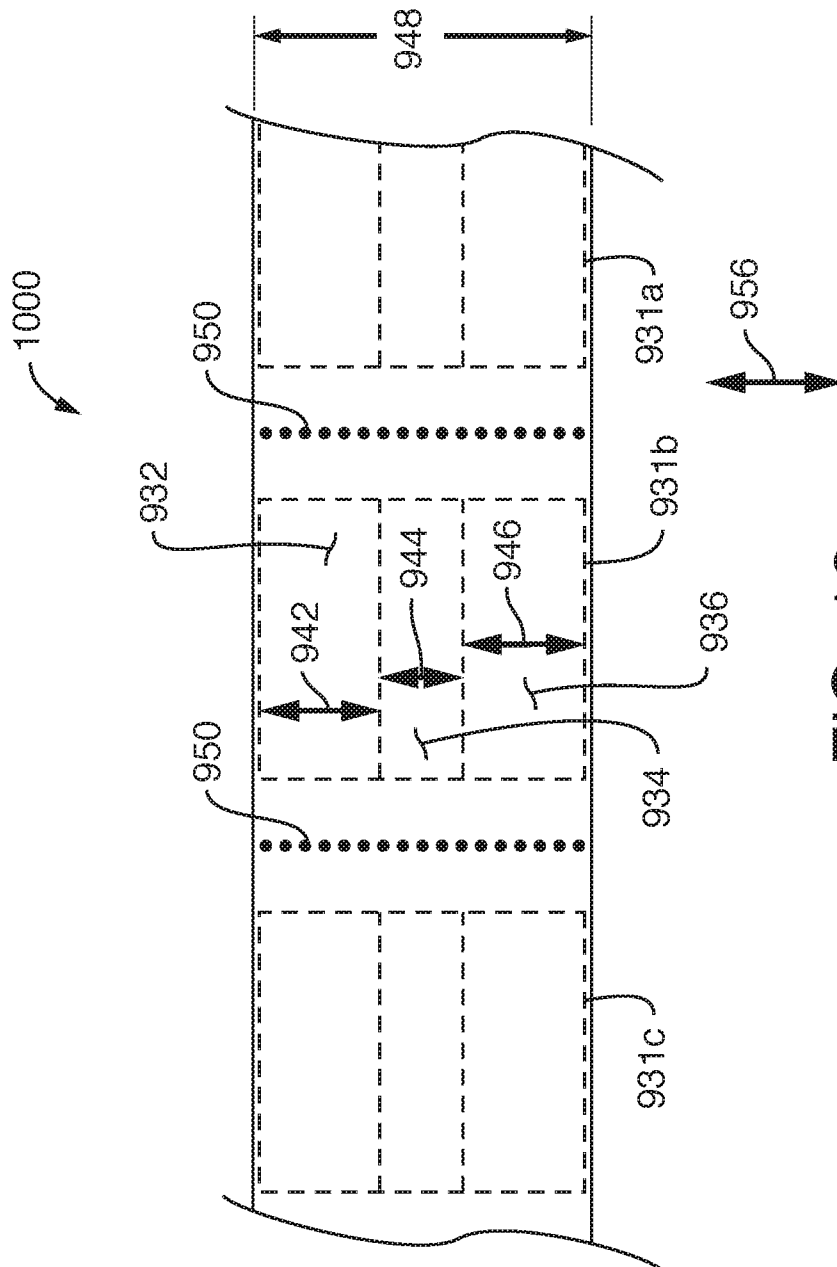


FIG. 15A



6154

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/025156**A. CLASSIFICATION OF SUBJECT MATTER****D04H 1/425(2012.01)i, D04H 13/00(2006.01)i, A61F 13/15(2006.01)i, A61F 13/49(2006.01)i**

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)

D04H 1/425; A61F 13/534; B32B 7/02; A61F 13/15; A61F 13/536; A01K 1/015; A61F 13/532; D04H 13/00; A61F 13/49

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: absorbent, core, sheet, layer, adhesive, chamber, conduit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1110528 A2 (MCNEIL-PPC, INC.) 27 June 2001 See abstract, paragraphs [0059], [0061], [0063], claim 24, and figures 1, 9, 12.	1-20
Y	JP 11-320742 A (UNI HARTS K. K.) 24 November 1999 See paragraph [0051] and figure 5.	1-20
Y	CN 1406566 A (UNI CHARM CORP.) 02 April 2003 See page 11 and figure 4.	2-3, 8, 10, 17
Y	US 2014-0324008 A1 (THE PROCTER & GAMBLE COMPANY) 30 October 2014 See paragraph [0096].	13, 19
A	EP 2532330 A1 (THE PROCTER & GAMBLE COMPANY) 12 December 2012 See paragraphs [0027]-[0030], [0080]-[0099] and figure 4.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

08 December 2016 (08.12.2016)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/025156

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