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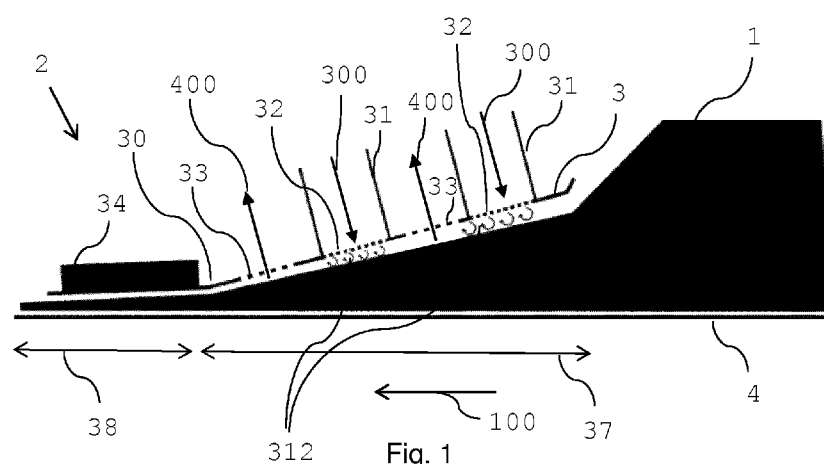
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(54) Title: METHOD FOR SHAPING A CONTINUOUS WEB MATERIAL INTO A ROD



(57) **Abstract:** The method for shaping a continuous web material (1) into a rod comprises providing a continuous web material (1) having a glass transition temperature of below 150 degree Celsius. It further comprises gathering the continuous web material (1) from a flat into a rod-shape by means of a shaping device comprising an airjet shaping element (3) and a closing element (4), wherein the airjet shaping element (3) comprises a funnel portion (30). The method further comprises introducing pressurized fluid into an upstream part of the funnel portion (30) of the airjet shaping element (3) thereby creating a fluid-cushion between a shaping surface of the upstream part of the funnel portion and the continuous web material (1) during gathering. A further step comprises at least partially releasing fluid from the funnel portion (30) of the airjet shaping element (3) downstream of its introduction before gathering partially gathered continuous web material (1) to a final rod shape.



Method for shaping a continuous web material into a rod

The invention relates to a method for shaping continuous web material. In particular, it relates to a method for shaping continuous web material used in the manufacture of aerosol-generating articles.

Aerosol-generating articles or their components such as for example, filter plugs or aerosol-cooling segments may be manufactured from a continuous web material, such as a cellulose or plastic web. Due to the special materials used for the production of these segments, some processing steps in a processing line may provide additional challenges when handling such webs. For example, some plastic materials, such as, for example, polylactic acid webs, tend to be heated upon handling the web. This may lead to irregular folding, for example in a funneling of the web, thereby reducing the reproducibility of the products manufactured from the web.

Thus there is need for a method for shaping continuous web material used in the production of aerosol-generating articles.

According to the invention there is provided a method for shaping a continuous web material into a rod. The method comprises the steps of providing a continuous web material having a glass transition temperature of below 150 degree Celsius and gathering the continuous web material from a flat into a rod-shape by means of a shaping device comprising an airjet shaping element and a closing element. The airjet shaping element comprises a funnel portion, preferably in the form of a half-funnel, such as to give the continuous web material a concave shape. The method further comprises the step of introducing pressurized fluid into an upstream part

of the funnel portion of the airjet shaping element thereby creating an air-cushion between a shaping surface of the upstream part of the funnel portion and the continuous web material during gathering. A further step of the method
5 comprises at least partially releasing pressurized fluid from the funnel portion of the airjet shaping element downstream of its introduction before gathering partially gathered continuous web material to a final rod shape.

Advantageously, the fluid-cushion formed between the web
10 material and the airjet shaping element significantly reduces or preferably substantially eliminates friction between the web material and the funnel portion of the airjet shaping element. By this, a local overheating of the web material due to friction upon gathering in the shaping device may be
15 limited or even prevented. Preferably, a local overheating is prevented or reduced to a temperature of the web material below its melting temperature. Preferably, an overheating is prevented or reduced to a temperature of the web material below its glass transition temperature.

Excess heat may change the specification of a material.
20 By preventing or reducing an overheating of materials having low glass transition temperatures or low melting temperatures or both, the materials are prevented from getting tacky or are prevented from at least partial melting. Thus, it may be
25 prevented that individual folds of such a material stick together or fuse upon gathering. Advantageously, a variation of the resistance to draw of a plug formed by the material from an intended value for the resistance to draw is reduced or entirely avoided, increasing the reproducibility of the
30 production. In addition, a sticking of a partially molten or tacky material to apparatus parts may be avoided. Thus,

possible apparatus blockage and displacement or damage to the material may be avoided. Advantageously, these effects are prevented by the provision of a fluid-cushion in the shaping device. Advantageously, the local overheating of the material is thereby prevented preferably such that the temperature of the material does not exceed a critical temperature. Yet further, the tensile strength of the material may be reduced by heating. This in turn may require to reduce the machine speed in order to prevent rupture of the material. Machine stops and waste due to rupture of the material with reduced tensile strength can thus be avoided. Preventing or reducing the overheating of the material is therefore particularly advantageous for materials with a low glass transition temperature or low melting temperature, such as for example a web of polylactic acid.

At the glass transition temperature or transformation temperature a solid material changes into the rubbery-elastic state and the solid material turns into a gummy and pasty melted material. For example, an amorphous or semi-crystalline plastic material may get tacky and may undergo changes in its stability. A transition to the rubbery-elastic state or yield range is continuous. At the glass transition temperature the material does not undergo a phase transition. Thus, the glass transition temperature is not related to an exact temperature but to a temperature range. Such a temperature range may be within a few degree Celsius, for example 5 degree Celsius, or within a few tens degree Celsius, for example plus or minus 20 degree Celsius around a specific glass temperature.

Advantageously, in the method according to the invention overheating is reduced such that separate cooling means for

cooling the web material upon gathering may be omitted. Alternatively or in addition, the shaping speed may be increased.

It has been found that reducing friction in funnel shaped devices, in particular static funnel shaped devices, provides very good results in preventing an overheating of web material having low glass transition temperatures such as for example polylactic acid material upon gathering. It has been found that also in metallic funnel shaped devices reducing friction between the web material having a low glass transition temperature and the metallic funnel shaped device may effectively reduce or prevent the overheating of the material upon gathering at production speeds of about 300 to 500 meters per minute.

Pressurized fluid for creating a fluid-cushion in the present invention may be a gas or a liquid or a combination of both. If the fluid is a liquid, preferably the liquid is a volatile or highly volatile liquid that evaporates at room temperature or at the elevated temperatures reached during the shaping process. Such volatile liquid may be, for example, alcohol.

Volatile liquids bear the advantage that an extra liquid removal step after shaping of the continuous web material can be omitted. In addition, evaporation of the liquid has a cooling effect such that a fluid cushion not only reduces frictional overheating of the gathered material but the evaporating additionally cools the continuous material while in contact with the continuous material.

Preferably, pressurized fluid is pressurized gas, for example pressurized air.

The pressurized fluid forming the fluid-cushion may, for

example, have a pressure between about 2 bar and about 5 bar. Preferably, the pressurized fluid has a fluid pressure between about 3 bar and about 5 bar. Thus, if the fluid is a gas, the gas pressure is preferably between about 2 bar and about 5 bar, more preferably between about 3 bar and about 5 bar.

The pressurized fluid is introduced into an upstream part of the funnel portion of the airjet shaping device. Preferably, the pressurized fluid is introduced in an upper 10 50 percent of a length of the funnel portion. More preferably, the pressurized fluid is introduced in an upper 80 percent of the length of the funnel portion.

Preferably, a releasing of pressurized fluid, in particular gas, occurs upstream of 20 percent of the length 15 of the funnel portion of the airjet shaping element. More preferably, a releasing of pressurized liquid, in particular gas occurs upstream of 10 percent of the length of the funnel portion of the airjet shaping element. Even more preferably, a releasing of pressurized fluid occurs upstream 5 percent of 20 the length of the funnel portion of the airjet shaping element.

Accordingly, preferably, no pressurized fluid is introduced into a downstream 20 percent of the length of the funnel portion of the airjet shaping element. More 25 preferably, no pressurized fluid is introduced into a downstream 10 percent of the length of the funnel portion of the airjet shaping element. Even more preferably, no pressurized fluid is introduced into a downstream 5 percent of the length of the funnel portion of the airjet shaping 30 element.

As a general rule, whenever the term "about" is used in

connection with a particular value throughout this application this is to be understood such that the value following the term "about" does not have to be exactly the particular value due to technical considerations. However, the term "about" used in connection with a particular value is always to be understood to include and also to explicitly disclose the particular value following the term "about". Typically, variations of plus-minus 5 percent of the value are included in the "about" value.

By limiting an introduction of pressurized fluid into an upstream part of the funnel portion and releasing the pressurized fluid in an upstream part of the funnel portion, the formation of a fluid-cushion may be limited to said upstream part of the funnel portion.

It has been found that introduction of pressurized fluid and an accordingly formed fluid-cushion compresses the web material according to the form of the fluid-cushion and the funnel portion. However, in a downstream part of the funnel portion, where the gathered web material has almost achieved its final rod shape, there is basically no space for the fluid-cushion. Thus, a variable compression strength would act on the gathered web and a variable shape would be formed. However, in a progressed stage of the rod forming process and with the gathered web material almost in its final rod shape, shape requirements such as diameter requirements of the final rod are strict. Strict shape requirements are difficult to achieve by a fluid-cushion. Thus, in these downstream parts of the funnel portion, the gathered web material is preferably in direct contact with the shaping device. Preferably, upon achieving the final rod shape the gathered web material is in contact with the funnel portion of the

airjet shaping element as well as of the closing element.

Preferably, the last 20 percent of the downstream funnel portion, more preferably, the last 10 percent of the downstream funnel portion, most preferably only the last 5 percent of the downstream funnel portion are in direct contact with the continuous web material. These downstream portions of the shaping device in contact with the continuous web material may be used for a contact cooling with the web material as will be described further below.

To further reduce, prevent or limit the overheating of the web material upon gathering, the web material may be cooled.

The cooling may be integrated into the shaping device. By this, the gathered continuous web material is cooled while being gathered in the shaping device. The cooling may also be arranged downstream of the shaping when seen in a transport direction of the continuous web material or of the gathered continuous material. In such embodiments, preferably, the gathered continuous material is cooled immediately after having been gathered to its final rod shape.

Throughout the specification, the term "cooling" is used to refer to an active step to limit, maintain or reduce the temperature of the continuous web material or of an element that is in contact with the continuous web material or both, thus preventing the further increase of temperature of the continuous web material.

The terms "upstream" and "downstream" are used herein in view of the transport direction of the continuous web material in an apparatus or in individual elements of an apparatus performing the method, wherein downstream is in the direction of production.

Preferably, the pressurized fluid is used as cooling means. This may be achieved by using a pressurized fluid having a fluid temperature lower than the temperature of the web material that is being or has been partially or entirely gathered. This may, for example, be achieved by using a pressurized gas having a gas temperature lower than the temperature of the web material that is being or has been partially or entirely gathered.

For a good cooling of the web material, pressurized gas preferably has a gas temperature of about 20 degree Celsius or less. More preferably, the gas temperature is between about 10 degree and about 20 degree Celsius.

This temperature may also be achieved by using a liquid that is volatilized while forming a fluid cushion. Thereby, the pressurized liquid may have, for example, room temperature at a fluid inlet of the airjet shaping element. The lower temperature of the liquid is then achieved by the volatilization process of the liquid in the funnel portion.

Preferably, the temperature is measured at a fluid inlet into the funnel portion of the airjet shaping element. A temperature of the fluid may additionally or in particular in case of a liquid alternatively, also be measured at a fluid outlet of the funnel portion where the fluid is released from the airjet shaping element.

The web material may also be cooled by contacting a cool contact or shaping surface.

For example, the method may comprise cooling the continuous web material by a cooled contact surface in contact with the partially gathered continuous web material, preferably downstream of releasing pressurized fluid. Thus, preferably, downstream of a fluid-cushion formed by a

pressurized fluid, a cooling is performed by cooling a shaping surface of the shaping device.

Preferably, the web material is in contact with the cooled contact surface during the final gathering into the final rod shape. For example, the cooled contact surface may extend over the last 20 percent of the downstream length of the airjet shaping element. Preferably, the cooled contact surface extends over the last 10 percent of the downstream length of the airjet shaping element.

A cooled contact surface may, for example, be formed by cooling a cooling device comprising the contact surface by a cooling medium, for example water. For example, water having a water temperature of about or less than 20 degree Celsius may be used for cooling the contact surface.

Preferably, the cooled contact surface is arranged downstream of a fluid release zone in the funnel portion of the airjet shaping element.

The cooled contact surface may, for example, be a wall portion of the airjet shaping element. Preferably, the cooled contact surface is a wall portion of the funnel portion of the airjet shaping element. The cooled contact surface may also be a cooled transport surface of a closing element. Cool contact surfaces may also be wall portions of the funnel portion or of the airjet shaping element that do not directly contact the continuous web material. For example, funnel portions where a fluid-cushion is formed inside may be cooled. By this, the fluid of the fluid-cushion is cooled by the cooled walls, thus supporting a cooling of the pressurized fluid forming the fluid-cushion.

Alternatively, the cooled contact surface may, for example, be a surface of a separate cooling element arranged

adjacent a downstream end of the funnel portion of the airjet shaping element. Such a separate cooling element may cool the gathered web material immediately after its gathering. Preferably, the cooling element is a part of the airjet
5 shaping element, wherein the final gathering of the web material into its final rod shape occurs.

Gathering the continuous web material from a flat into a rod shape preferably comprises successively gathering the continuous web material in a direction perpendicular to a
10 transport direction of the continuous web material. Such a gathering is preferably done by a static shaping device. Preferably, the airjet shaping element and closing element are static shaping elements. This is a particular simple way of gathering web material compared to, for example, using
15 moving shaping devices.

Preferably, the airjet shaping element and the closing element are arranged opposite each other with respect to a transport plane of the continuous web material. Preferably, the airjet shaping element and the closing element are
20 arranged opposite each other along an entire length of the airjet shaping device. More preferably, the airjet shaping element and the closing element have a same length such that airjet shaping element and closing element are arranged opposite each other along their entire length.

The term "gathering" is used throughout the specification to refer to a reduction in a width of the continuous web material. By the gathering the continuous material is reduced in a lateral direction of the material, thus transversal to the longitudinal and transport direction of the material. A
30 gathering may, for example, be a compression, a funnelling and a rod-shaping of the material or combinations of the

aforementioned processes. A gathering includes a reduction in width of the continuous web material by, for example, a simple pushing the sides of the continuous material versus a longitudinal central axis of the continuous material.

5 A gathering may be performed continuously or stepwise. A gathering may be performed in one or in several portions of a shaping device.

Partially gathered material has a reduced width compared to the continuous web material as supplied to an apparatus performing the method according to the invention. Partially gathered material may also have a reduced width compared to a partially gathered material that has already passed a previous portion of the shaping device. Partially gathered material has a larger width than the width of a final rod shape of the continuous material. Frequently, a reduction in width of the web material leads to increase in height of the gathered material.

Preferably gathering includes the formation of longitudinal folds forming channels in the longitudinal direction of the gathered web material.

The method according to the invention may comprise introducing pressurized fluid and releasing pressurized fluid in alternating manner along a transport direction of the continuous web material.

25 Advantageously, the sequential fluid inlet and release requires less fluid than the continuous fluid inlet and release. Accordingly, this facilitates removal of the fluid. A sequential fluid inlet and release is preferably performed in bursts, needing less fluid than a continuous fluid flow. In addition, with bursts the generation or keeping up of high pressure at an inlet nozzle is easier than with a

continuously open nozzle.

Preferably, fluid is introduced into the funnel portion in bursts.

5 The method may comprise varying a fluid pressure of the pressurized fluid between subsequent fluid introductions. For example, the method may comprise reducing or enhancing the fluid pressure of the pressurized fluid between subsequent fluid introductions in a downstream direction.

10 Preferably, the method comprises introducing pressurized fluid along a circumferential line of the funnel portion. This allows to create a fluid-cushion over that entire portion of the circumference of gathered web material that would otherwise contact the funnel portion of the airjet shaping element. The fluid-cushion is formed immediately
15 downstream of the location of fluid introduction. Preferably, pressurized fluid is introduced along an entire circumferential line of the funnel portion. More preferably, pressurized fluid is introduced along several subsequently arranged circumferential lines, advantageously along several
20 entire circumferential lines, of the funnel portion. This allows to form a fluid-cushion along a section of the funnel portion of the airjet shaping element. Length and width of the section may be chosen by the arrangement of width and number of circumferential introduction lines.

25 The pressure of the pressurized fluid may be varied along a circumferential line. By this, for example a thicker or more stable fluid-cushion may be formed along lateral sides of the web material to take into account the asymmetry of the gathering process.

30 Preferably, the method comprises releasing pressurized fluid along a circumferential line of the funnel portion.

Preferably, pressurized fluid is released from the funnel portion along an entire circumferential line of the funnel portion. More preferably, pressurized fluid is released along several subsequently arranged circumferential lines, advantageously along several entire circumferential lines, of the funnel portion.

This enables a releasing of pressurized fluid over a section of the funnel portion of the airjet shaping element. This may facilitate a complete release of pressurized fluid from the shaping device. Length and width of the release section may be chosen by the arrangement of width and number of circumferential release lines.

An introduction direction of a pressurized fluid may be perpendicular to a wall of the funnel portion of the airjet shaping element. An introduction direction may, for example, be perpendicular to a transport direction of the web material. Due to the angle between funnel portion and transport direction, the introduced fluid then has a component into a downstream direction.

Preferably, an introduction direction of a pressurized fluid is selected to have a component in a downstream direction. This downstream component facilitates the creation a fluid-cushion between web material and funnel portion.

Preferably, the airjet shaping element and the closing element together form the shaping device. The airjet shaping element and the closing element may also at least partly form the shaping element. Thus further shaping elements may be provided to form the shaping device, for example a separate final rod-shaping element at the downstream end of the shaping device or a crimping device or extra funnel portion upstream of the shaping device.

In some embodiments the airjet shaping element forms a half of the shaping device, for example an upper half. In these embodiments, the closing element forms the other half of the shaping device, for example a lower half of the shaping device.

The airjet shaping element comprises a funnel portion to give a portion of the continuous material a concave circumferential shape or a part of a rod shape. The closing element closes the funnel portion along the remaining circumference, such that the continuous material is guided within the shaping device.

Preferably, the funnel portion has a convex shape for giving the continuous web material a concave circumferential shape. In particular, the shaping surface of an upper part of the funnel portion preferably has a convex shape. Thus, the funnel portion partially gathers the continuous web material into a rod shape, while a gathering into a final rod shape preferably occurs in a most downstream part of the shaping device.

Preferably, a rod manufactured with the method of the present invention has a circular or elliptic cross section. Preferably, the closing element comprises a transport plane for transporting the continuous web material along the transport plane.

Preferably, a closing element does not correspond to the airjet shaping element in shape and size, except for the transport direction and position of the web material. Preferably, a closing element comprises a transport plane comprising a longitudinally extending and converging groove. The transport plane serves to support a continuous wrapping material. The continuous web material may be arranged on the

wrapping material and may be transported on the wrapping material in a downstream transport direction. Preferably, the groove is of a u-shape, which converges in a transverse direction. The groove may extend along the entire length or
5 only along a part of the length of the transport plane. Preferably, the groove does not extend along the entire length of the transport plane.

The wrapping material forms an inner liner of the groove partially wrapping the continuously gathered web material.
10 After the continuous web material has been gathered to its final rod shape, the wrapping material is entirely wrapped around the rod, fixing the rod in its rod shape. Such a continuous or merged rod forming and wrapping is particularly favorable with resilient web materials tending to unfold,
15 such as for example many kind of plastic foils.

The method may further comprise guiding a continuous strip of wrapping material along the transport plane of the closing element.

A continuous web material as used herein is, for example,
20 a web of material such as for example a plastic web that is used in the manufacture of aerosol generating articles for electronic smoking devices. Preferably, the continuous web material is a continuous web of polylactic acid. Preferably, the continuous web material is formed into an endless rod for
25 future manufacture of individual plugs. Preferably, the continuous material has been pretreated before being formed in the apparatus according to the invention. A pretreatment is, for example, a crimping or embossing or both.

Preferably, the method comprises providing a crimped
30 continuous web material having longitudinally arranged crimps. The crimps are arranged in a transport direction of

the web material. Upon gathering the continuous web material forms longitudinal channels along the crimps. The longitudinal channels define a resistance to draw of an article formed by the gathered web material or comprising a plug of gathered web material. Preventing fusion of such longitudinal channels by a melting of the web material upon gathering allow to achieve a reproducibility of a resistance to draw of the gathered web material. Preventing fusion of longitudinal channels is in particular advantageous when using an otherwise gas-tight web material.

The continuous web material used in the method according to the invention has a glass transition temperature of below 150 degree Celsius. Preferably, the continuous web material has a glass transition temperature below 100 degree Celsius. Since a glass transition temperature is below a melting temperature, the continuous web material also has a melting temperature, which is preferably around 150 degree Celsius or lower. Since glass transition temperatures refer to ranges rather than exact temperatures, a glass transition temperature preferably comprises plus or minus 20 degree Celsius around a specific glass temperature, more preferably, plus or minus 5 degree Celsius around the specific glass transition temperature.

Preferably, the continuous web material is a plastic material, for example polylactic acid.

Preferably, the continuous web material has a porosity of less than about 5 percent, preferably of less than about 2 percent. Most preferably, the continuous web material is gas-tight, for example air-tight.

Preferably, a material used to form a continuous rod has low porosity or substantially no porosity.

Porosity is defined herein as a measure of pores or openings extending through the web material. For example, if the web material comprised openings or pores adding up to 50 percent of the web area, then the porosity would be 50 percent. Likewise, a web material has a porosity of 0 percent if the web material was completely dense having no pores extending through the web. The porosity may be calculated using known methods.

The rod may, for example, be formed from a web material such as for example a polymeric web or a web material selected from the group consisting of polyethylene (with a glass transition temperature between about minus 130 degrees Celsius and about minus 80 degrees Celsius; melting temperature between about 115 and about 130 degrees Celsius), polypropylene (with a glass transition temperature between about minus 20 degrees Celsius and about zero degrees Celsius; melting temperature between about 130 degrees Celsius and about 170 degrees Celsius), polyvinylchloride (with a glass transition temperature between about 60 degrees Celsius and about 87 degrees Celsius; melting temperature between about 160 degrees Celsius and about 260 degrees Celsius), polyethylene terephthalate (with a glass transition temperature at about 70 degrees Celsius; melting temperature below about 250 degrees Celsius), polylactic acid (with a glass transition temperature between about 50 degrees Celsius and about 65 degrees Celsius; melting temperature of about 155 degrees Celsius), cellulose acetate (with a glass transition temperature between about 100 degrees Celsius and about 130 degrees Celsius; melting temperature between about 170 degrees Celsius and about 240 degrees Celsius).

The invention is further described with regard to

embodiments, which are illustrated by means of the following drawings, wherein:

Fig. 1 schematically shows a rod-forming process of a continuous web material including separate cooling element;

Fig. 2 shows a rod-forming process of a continuous web material.

In the manufacturing process shown in Fig. 1 a continuous web material 1, for example polylactic acid, is unwound from a storage bobbin (not shown). The web of polylactic acid is preferably conveyed through different processes, for example a crimping process up to a shaping process in the shaping device 2, where the web material 1 is gathered and compressed into a continuous rod.

The web material 1 enters inside the half-funnel 30 of an airjet shaping element 3 in the processing and transport direction indicated by arrow 100.

The rod-shaping is performed via the upper airjet shaping element 3 and the lower closing element 4. The airjet shaping element 3 is arranged opposite the closing element 4. The airjet shaping element 3 is a half-funnel 30 and shapes the web material 1 from the top. The closing element 4 is a transport plane comprising a groove, wherein a wrapping paper is guided along for wrapping the rod-shaped web material 1. On the bottom of the shaping device 2, the web material 1 comes in contact with the wrapping paper also moving along arrow 100 at the same speed as the web material 1. The groove in the transport plane typically takes progressively a U-shape that supports compressing and shaping the web material 1. The wrapping paper is then folded and closed on itself, forming a continuous cylindrical rod, preferably a polylactic

acid rod wrapped in paper. The rod may subsequently be cut into individual plugs thereby generating a component or segment used in the manufacturing process of an aerosol-generating article.

5 At a transport speed of between about 100 meters per minute and about 500 meters per minute, friction between the web material 1 and the preferably metallic but static funnel portion 30 of the airjet shaping element 3, heats the web material passing the funnel. Thus, in order to avoid or
10 reduce friction and avoiding a related overheating of the web material 1 possibly above its glass transition temperature or even above its melting temperature, air-cushions 312 are created between web material 1 and funnel portion 30.

 The funnel portion comprises two entrance zones 32 and
15 two exit zones 33 formed by holes in the wall of the funnel portion 30.

 Each entrance zone 32 is arranged upstream of an exit zone 33 in the funnel portion in transport direction 100 of the web material 1. Thus, each exit zone 33 is arranged
20 downstream of an entrance zone 32. Entrance and exit zones are alternately arranged in the funnel portion in transport direction of the web material.

 The entrance zones 32 are each connected to an inlet pipe 31 and an air source or air sources (not shown) for guiding
25 pressurized air through the inlet pipes 31 and entrance zones 32 into the funnel portion 30 as indicated by arrows 300. The pressurized air is pushed inside the half funnel, passes along the funnel portion until the downstream arranged exit zones 33.

30 The air inside the half funnel leaves the half funnel via the holes of the exit zones as indicated by arrows 400. The

compressed air inside the half funnel creates an air-cushion 312 between each of the entrance zones and the corresponding exit zone. The air cushions prevent or at least reduce friction of the web material on the material of the funnel portion. At the same time the air-cushions 312 compress the web material according to the funnel shape.

The pressurized air may be cooled to temperatures below room temperature or below a temperature of the web material in the half funnel, such that the temperature of the web material is kept below its melting temperature or even below its glass transition temperature. For a web of polylactic acid, the temperature of the material is preferably kept below 100 degrees Celsius.

By using cooled air, the compressed air also cools down the web material further preventing an overheating of the web material to its melting temperature or its glass transition.

In the embodiment illustrated in Fig. 1, a further cooling system for the web material is provided. A cooling element 34 is arranged at an end portion of the funnel portion 30 of the airjet shaping device 3 downstream of the last exit zone 33. In this end portion the diameter of the half funnel is so small that the pressurized air could no longer prevent the web material to be in contact with the funnel. In addition, in such a final rod-shaping region accuracy requirements are difficult to maintain under the varying compression strengths of the air-cushion.

The cooling element 34 is a funnel cooling system, wherein the end portion of the funnel portion 30 is cooled, for example, via a water circuit surrounding the top of the funnel. The cooling element 34 keeps the wall of the funnel at a low temperature, in particular at a temperature lower

than the glass transition temperature or lower than the melting temperature of the web material. Via direct contact of the web material with the wall of the funnel in this end portion, the web material is cooled via contact surface of the funnel wall.

Examples of a length 37 over which the web material is subjected to air and air-cushion is between about 0.3 meter and 0.5 meter.

The end portion, where no air-cushion is formed but a cooling via direct contact with a cooling surface of the cooling element 34 is provided has a length 38 of about 0.05 meter and 0.2 meter of the funnel portion 30 of the airjet shaping element 3.

In the example of Fig. 1, in the end portion the web material is further shaped into a rod but with a lesser converging angle than in the more upstream portions of the funnel portion.

In Fig. 2 the same reference signs are used for the same or similar elements. In Fig. 2, the web material 1 enters inside a half-funnel following the direction of arrow 100. The top half of the web material 1 is formed by the funnel portion 30 of the airjet shaping element 3 of the shaping device 2. The bottom of the web material is formed by a groove (not shown) in a transport plane 4. On the transport plane a wrapping paper is guided along the transport direction 100 at the same speed as the web material 1.

For creating air-cushions between the web material 1 and the half funnel, air is pressed into and released from the funnel portion via openings 320, 330 in the wall of the funnel portion.

Also in Fig. 2 there are as many exit zones 33 as there

are entrance zones 32. Two entrance zones 32 are connected to two inlet pipes 31 for providing pressurized air into different part of the funnel portion 30. The two exit zones 33 are each arranged downstream of an entrance zone 32.

5 Entrance and exit zones are alternately arranged in the funnel portion in transport direction 100 of the web material.

Each entrance zone 32 and each exit zone 33 comprises openings 320,330 arranged along several circumferential lines along the circumference of the funnel portion, forming so

10 called fluid release lines. In the example of Fig.2 each entrance zone 32 comprises three circumferentially arranged fluid inlet lines. The first more upstream arranged exit zone 33 comprises six circumferentially arranged fluid release

15 lines. The second more downstream arranged exit zone 33 comprises four circumferentially arranged fluid release lines. Length, distance as well as number and sizes of openings 320,330 of circumferential fluid inlet lines in an entrance zone 32 and corresponding exit zone 33 may be varied

20 and adapted to the form and compression force of an air-cushion to be achieved.

Sizes and number of openings, distances between openings in a circumferential line or length of a zone may be the same or may be different between an entrance zone and an exit

25 zone.

Claims

1. Method for shaping a continuous web material into a rod, the method comprising:
providing a continuous web material having a glass
5 transition temperature of below 150 degree Celsius;
gathering the continuous web material from a flat
into a rod-shape by means of a shaping device
comprising an airjet shaping element and a closing
element, the airjet shaping element comprising a
10 funnel portion giving the continuous material a
concave circumferential shape;
introducing pressurized fluid into an upstream part
of the funnel portion of the airjet shaping element
thereby creating a fluid-cushion between a shaping
15 surface of the upstream part of the funnel portion
and the continuous web material during gathering; and
at least partially releasing fluid from the funnel
portion of the airjet shaping element downstream of
its introduction before gathering partially gathered
20 continuous web material to a final rod shape.
2. Method according to claim 1, wherein the pressurized
fluid is a gas, and wherein the gas has a gas
pressure between 2 bar and 5 bar, preferably between
3 bar and 5 bar.
- 25 3. Method according to any one of the preceding claims,
wherein the pressurized fluid has a fluid temperature
of 20 degree Celsius or less.

4. Method according to any one of the preceding claims,
comprising
introducing pressurized fluid and releasing
pressurized fluid in alternating manner along a
5 transport direction of the continuous web material.
5. Method according to any one of the preceding claims,
introducing pressurized fluid along a circumferential
line of the funnel portion.
6. Method according to any one of the preceding claims,
10 further comprising
cooling the continuous web material by a cooled
contact surface in contact with the partially
gathered continuous web material.
7. Method according to claim 6, wherein the cooled
15 contact surface is a wall portion of the airjet
shaping element.
8. Method according to any one of claims 6 or 7, wherein
the cooled contact surface is arranged downstream of
a fluid release zone in the funnel portion of the
20 airjet shaping element.
9. Method according to any one of the preceding claims,
wherein the closing element comprises a transport
plane comprising a longitudinally extending
converging groove.
- 25 10. Method according to claim 9, further comprising

guiding a continuous strip of wrapping material along the transport plane of the closing element.

11. Method according to any one of the preceding claims, comprising

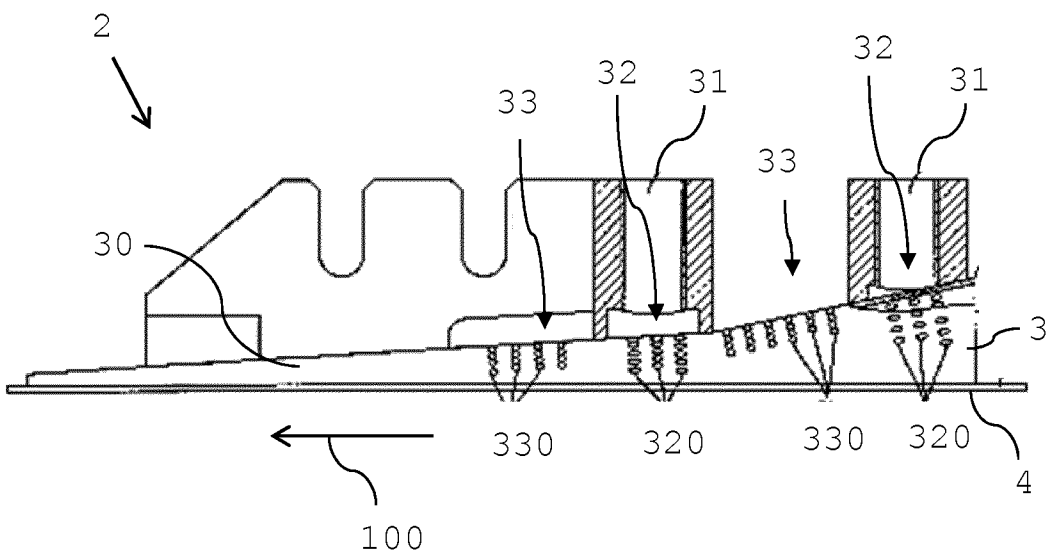
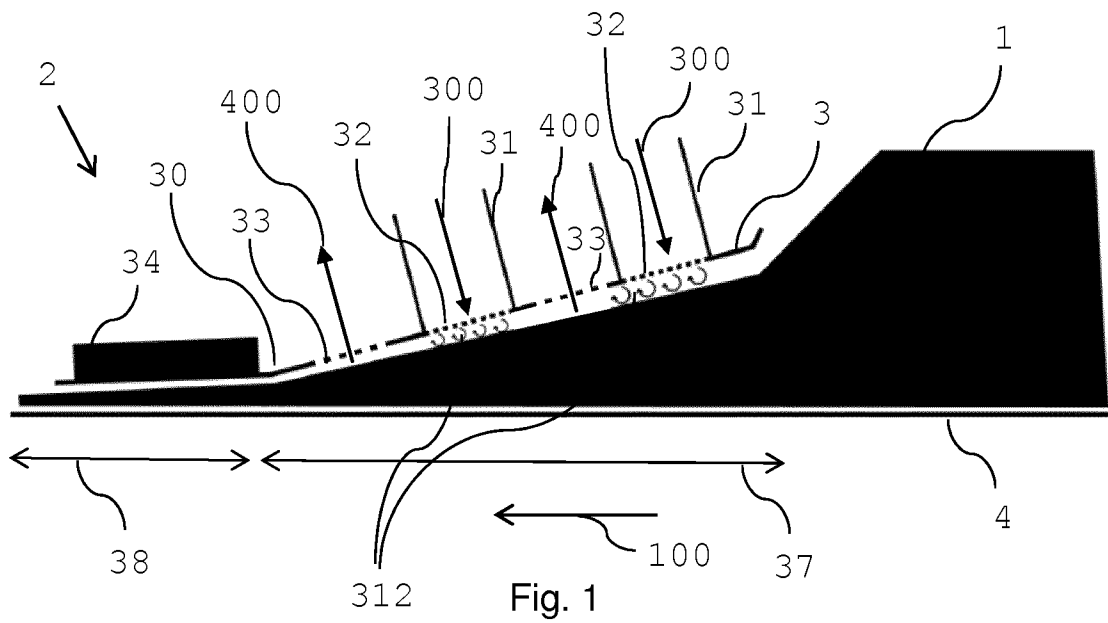
5 providing a crimped continuous web material having longitudinally arranged crimps.

12. Method according to any one of the preceding claims, wherein the continuous web material has a glass transition temperature below 100 degree Celsius.

10 13. Method according to any one of the preceding claims, wherein the continuous web material is a plastic material, for example polylactic acid.

14. Method according to any one of the preceding claims, wherein the continuous web material has a porosity of
15 less than 5 percent.

15. Method according to claim 14, wherein the continuous web material is gas-tight.



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/062832

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24D3/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24D

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

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

EP0-Internal, WPI Data

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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

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"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/062832

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

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