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(54) **Title:** A METHOD AND AN APPARATUS FOR MANUFACTURING A CRIMPED SHEET OF MATERIAL

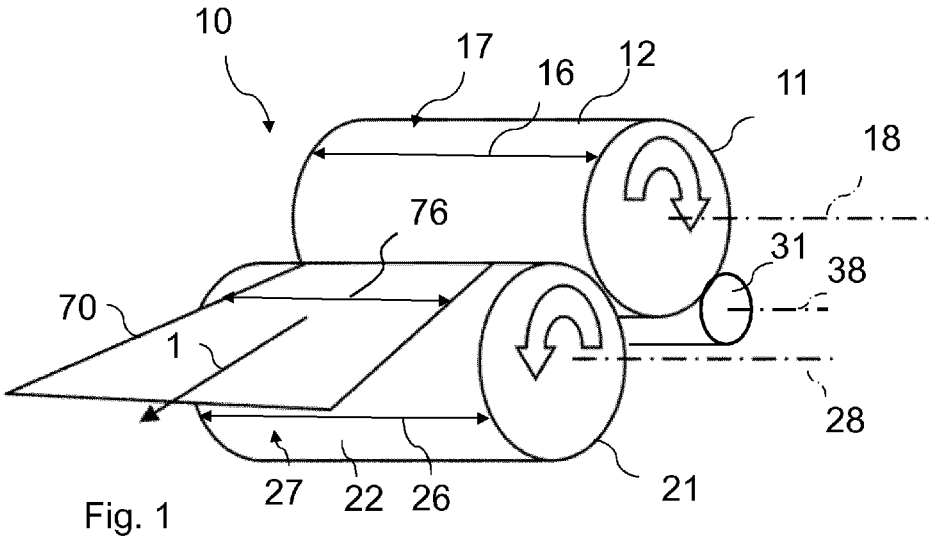

Fig. 1

(57) **Abstract:** The present invention relates to a method of manufacturing a crimped sheet (70) of material, the method comprising the steps of: feeding a substantially continuous sheet of material to a set of crimping rollers (11, 21) in a transport direction (1), the set of crimping rollers comprising a first main crimping roller (11), a second main crimping roller (21) and a first pre-crimping roller (31), the first and second main crimping rollers including a first and a second plurality of ridges (17, 27) across at least a portion of their width (26) having a first and a second given pattern and the first pre-crimping roller including a third plurality of ridges across at least a portion of its width, the third plurality of ridges having a third given pattern different from the second given pattern; pre-crimping the substantially continuous sheet of material to form a pre-crimped sheet by feeding the substantially continuous sheet between the first main crimping roller and the first pre-crimping roller such that the first plurality of ridges of the first main crimping roller and the third plurality of ridges of the first pre-crimping roller apply a first pattern of crimp corrugations to the substantially continuous sheet; and crimping the pre-crimped sheet of material to form a crimped sheet by feeding the pre-crimped sheet between the first main crimping roller and the second main crimping roller such that the first and second plurality of ridges of the first and second main crimping rollers apply a second pattern of crimp corrugations to the pre-crimped sheet. The invention also relates to an apparatus for the production

WO 2018/215467 A1

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of such a crimped sheet.

A METHOD AND AN APPARATUS FOR MANUFACTURING A CRIMPED SHEET OF MATERIAL

The present invention relates to a method and an apparatus for the manufacturing of a sheet of material, for example for the fabrication of a component of an aerosol generating article. Preferably, the invention relates to an apparatus and a method for producing sheet-like tobacco material for use in an aerosol-generating article such as, for example, a cigarette or a "heat-not-burn" type tobacco containing product.

Today, in the manufacture of tobacco products, besides tobacco leaves, also homogenized tobacco material is used. This homogenized tobacco may be manufactured from parts of the tobacco plant, such as tobacco stems or tobacco dust. Typically, tobacco dust is created as a side product during the handling of the tobacco leaves during manufacture.

The most commonly used forms of homogenized tobacco material are reconstituted tobacco sheet and cast leaf. The process to form homogenized tobacco material sheets commonly comprises a step in which tobacco dust and a binder are mixed to form a slurry. The slurry is then used to create a tobacco web, for example by casting a viscous slurry onto a moving metal belt to produce so called cast leaf. Alternatively, a slurry with low viscosity and high water content can be used to create reconstituted tobacco in a process that resembles paper-making. Once prepared, homogenized tobacco webs may be cut in a similar fashion as whole leaf tobacco to produce tobacco cut filler suitable for cigarettes and other smoking articles. The function of the homogenized tobacco for use in conventional cigarettes is substantially limited to physical properties of tobacco, such as filling power, resistance to draw, tobacco rod firmness and burn characteristics. This homogenized tobacco is typically not designed to have taste impact. A process for making such homogenized tobacco is for example disclosed in European Patent EP 0565360.

In a typical manufacturing process of aerosol generating articles, at least one component comprises a material, usually in a sheet or foil format, that goes through a crimping process. The crimped material is then compressed into a rod which is cut into parts, usually tubular. These cut rods are components of the aerosol generating articles.

The crimping process is helpful for compressing and folding the sheet of material

into rods that will fit into the aerosol generating articles. The crimping process may also influences the amount of air contact, the Resistance To Draw (RTD), and the experience by the users of the aerosol generating articles.

As a consequence, applying an adequate crimping pressure is an important aspect of the crimping process. While a too low crimping pressure may decrease the positive effects of the crimping, a too high pressure could damage the sheet of material or decrease its tensile strength, which in turn may increase tearing occurrence and can even cause shredding.

The crimping process generally uses two rotating cylindrical rollers between which the sheet of material is pressed. These rollers may have matching textured ridge-and-trough patterns on their outside surfaces that crimp the sheet.

The overall production process may be run at high speed. The shorter the crimping time, the more pressure has to be applied to assure a proper crimping of the sheet of material, which increases the risk to damage the sheet during the crimping process.

There is therefore a need for an apparatus and a method for crimping a sheet of material with which an improved consistency in the final product, in particular when high crimping speeds are used, may be achieved.

In a first aspect, the invention relates to a method of manufacturing a crimped sheet of material, the method comprising the steps of:feeding a substantially continuous sheet of material to a set of crimping rollers in a transport direction, the set of crimping rollers comprising a first main crimping roller, a second main crimping roller and a first pre-crimping roller, the first and second main crimping rollers including a first and a second plurality of ridges across at least a portion of their width having a first and a second given pattern and the first pre-crimping roller including a third plurality of ridges across at least a portion of its width, the third plurality of ridges having a third given pattern different from the second given pattern; pre-crimping the substantially continuous sheet of material to form a pre-crimped sheet by feeding the substantially continuous sheet between the first main crimping roller and the first pre-crimping roller such that the first plurality of ridges of the first main crimping roller and the third plurality of ridges of the first pre-crimping roller apply a first pattern of crimp corrugations to the substantially continuous sheet; and crimping the pre-crimped sheet of material

to form a crimped sheet by feeding the pre-crimped sheet between the first main crimping roller and the second main crimping roller such that the first and second plurality of ridges of the first and second main crimping rollers apply a second pattern of crimp corrugations to the pre-crimped sheet, the first pattern being different from the second pattern.

In a second aspect, the invention relates to an apparatus for crimping a sheet of material, the apparatus comprising: a transport device to transport the sheet of material along a transport direction; a first and a second main crimping rollers, defining a first and a second rotational axis and being faced one in front of the other, the first main crimping roller including a first plurality of ridges having a first given pattern, and the second crimping roller having a second plurality of ridges having a second given pattern; and a first pre-crimping roller facing the first main crimping roller and having a third plurality of ridges, the first pre-crimping roller being positioned so that it is located upstream the first and second main crimping roller in the direction of transport of the sheet of material, and wherein at least one of the following applies: the third plurality of ridges has a third given pattern different from the second pattern of the second plurality of ridges; or a distance between the first main crimping roller and the first pre-crimping roller is different from a distance between the first main crimping roller and the second main crimping roller.

In a second aspect, preferably the invention relates to an apparatus for crimping a sheet of material, the apparatus comprising: a transport device to transport the sheet of material along a transport direction; a first and a second main crimping rollers, defining a first and a second rotational axis and being faced one in front of the other, the first main crimping roller including a first plurality of ridges having a first given pattern, and the second main crimping roller having a second plurality of ridges having a second given pattern; and a first pre-crimping roller facing the first main crimping roller and having a third plurality of ridges, the first pre-crimping roller being positioned so that it is located upstream the first and second main crimping roller in the direction of transport of the sheet of material, and wherein the third plurality of ridges has a third given pattern different from the second pattern of the second plurality of ridges.

According to the invention, the sheet of material is first pre-crimped and then crimped, that is, the crimping is performed in two different steps. By pre-

crimping the sheet of material by means of a pre-crimping roller, before crimping it between the first and second main crimping rollers, a gentle preparation of the sheet of material for the crimping process is obtained and, hence, the crimping damage may be reduced and a better control on the outcome of the crimping process may be possible.

This may be in particular advantageous when the crimped sheet of material is used for the manufacture of an aerosol generating article, for example for the manufacture of a component of the aerosol generating article, such as a filter, because a better control of the crimping process may in turn allow a better control on the characteristics of the aerosol generating article.

As used herein, the term "aerosol-generating article" refers to an article comprising an aerosol-forming substrate that is capable of releasing volatile compounds that can form an aerosol, for example by heating, combustion or a chemical reaction. As used herein, the term 'aerosol-forming substrate' is used to describe a substrate capable of releasing volatile compounds, which can form an aerosol. The aerosols generated from aerosol-forming substrates of aerosol-generating articles according to the invention may be visible or invisible and may include vapours (for example, fine particles of substances, which are in a gaseous state, that are ordinarily liquid or solid at room temperature) as well as gases and liquid droplets of condensed vapours.

An aerosol-generating article may be a heated aerosol-generating article, which is an aerosol-generating article comprising an aerosol-forming substrate that is intended to be heated rather than combusted in order to release volatile compounds that can form an aerosol. A heated aerosol-generating article may comprise an on-board heating means forming part of the aerosol-generating article, or may be configured to interact with an external heater forming part of a separate aerosol-generating device.

An aerosol-generating article may resemble a combustible smoking article, such as a cigarette. An aerosol-generating article may comprise tobacco. An aerosol-generating article may be disposable. An aerosol-generating article may alternatively be partially-reusable and comprise a replenishable or replaceable aerosol-forming substrate.

Preferably, the aerosol-forming substrate is formed from or comprises a homogenised tobacco material having an aerosol former content of greater than

5 percent on a dry weight basis and water. For example the homogenised tobacco material may have an aerosol former content of between 5 percent and 30 percent by weight on a dry weight basis. An aerosol generated from such aerosol-forming substrates may be perceived by a user to have a particularly high temperature and the use of a high surface area, low resistance to draw aerosol-cooling element may reduce the perceived temperature of the aerosol to an acceptable level for the user.

The aerosol-generating article may be substantially cylindrical in shape. The aerosol-generating article may be substantially elongate. The aerosol-generating article may have a length and a circumference substantially perpendicular to the length. The aerosol-forming substrate may be substantially cylindrical in shape. The aerosol-forming substrate may be substantially elongate. The aerosol-forming substrate may also have a length and a circumference substantially perpendicular to the length. The aerosol-forming substrate may be received in the aerosol-generating device such that the length of the aerosol-forming substrate is substantially parallel to the airflow direction in the aerosol-generating device. The aerosol-cooling element may be substantially elongate.

The aerosol-generating article may have a total length between about 30 millimeters and about 100 millimeters. The aerosol-generating article may have an external diameter between about 5 millimeters and about 12 millimeters.

The aerosol-generating article may comprise a filter or mouthpiece. The filter may be located at the downstream end of the aerosol-generating article. The filter may be a cellulose acetate filter plug. The filter may have a length of between about 5 millimeters and about 10 millimeters and may be about 7 millimeters in length. The aerosol-generating article may comprise a spacer element located downstream of the aerosol-forming substrate.

Preferably, the sheet is a sheet of alkaloids containing material. More preferably, the sheet is a sheet of homogenised tobacco material.

An "alkaloids containing material" is a material which contains one or more alkaloids. Among alkaloids, nicotine is a preferred one, which can be found in tobacco.

Alkaloids are a group of naturally occurring chemical compounds that mostly contain basic nitrogen atoms. This group also includes some related compounds

with neutral and even weakly acidic properties. Some synthetic compounds of similar structure are also termed alkaloids. In addition to carbon, hydrogen and nitrogen, alkaloids may also contain oxygen, sulfur and, more rarely, other elements such as chlorine, bromine, and phosphorus.

Alkaloids are produced by a large variety of organisms including bacteria, fungi, plants, and animals. They can be purified from crude extracts of these organisms by acid-base extraction. Caffeine, nicotine, theobromine, atropine, tubocurarine are examples of alkaloids.

As used herein, the term "homogenized tobacco material" denotes material formed by agglomerating particulate tobacco.

A homogenized tobacco material may be in the form of a sheet. The homogenized tobacco material may have an aerosol-former content of greater than about 5 percent on a dry weight basis. The homogenized tobacco material may have an aerosol former content of between about 5 percent and about 30 percent by weight on a dry weight basis. Sheets of homogenized tobacco material may be formed by agglomerating particulate tobacco obtained by grinding or otherwise comminuting one or both of tobacco leaf lamina and tobacco leaf stems; alternatively, or in addition, sheets of homogenized tobacco material may comprise one or more of tobacco dust, tobacco fines and other particulate tobacco by-products formed during, for example, the treating, handling and shipping of tobacco. Sheets of homogenized tobacco material may comprise one or more intrinsic binders, that is tobacco endogenous binders, one or more extrinsic binders, that is tobacco exogenous binders, or a combination thereof to help agglomerate the particulate tobacco. Sheets of homogenized tobacco material may comprise additives including, but not limited to, tobacco and non- tobacco fibers, aerosol-formers, humectants, plasticizers, flavourants, fillers, aqueous and non-aqueous solvents and combinations thereof.

As used herein, the term "sheet" denotes a laminar element having a width and length substantially greater than the thickness thereof.

As used herein, the term "crimped" denotes a sheet or web with a plurality of corrugations.

As used herein, the term "corrugations" denotes a plurality of substantially parallel ridges formed from alternating peaks and troughs joined by corrugation flanks. This includes, but is not limited to, corrugations having a square wave

profile, sinusoidal wave profile, triangular profile, sawtooth profile, or any combination thereof.

As used herein, the term "crimp corrugations" refers to the corrugations on a crimped sheet or web.

As used herein, the term "substantially interleave" denotes that the corrugations of the first and second rollers at least partially mesh. This includes arrangements in which the corrugations of one or both of the rollers are symmetrical or asymmetrical. The corrugations of the rollers may be substantially aligned, or at least partially offset. The peak of one or more corrugations of the first or second rollers may interleave with the trough of a single corrugation of the other of the first and second rollers. Preferably, the corrugations of the first and second rollers interleave such that substantially all of the corrugation troughs of one of the first and second rollers each receive a single corrugation peak of the other of the first and second rollers.

As used herein, the term "longitudinal direction" refers to a direction extending along, or parallel to, the length of a sheet or web.

As used herein, the term "width" refers to a direction perpendicular to the length of a web or sheet, or in the case of a roller, parallel to the axis of the roller.

As used herein, the term "pitch value" refers to the lateral distance between the troughs at either side of the peak of a particular corrugation.

As used herein, the term "rod" denotes a generally cylindrical element of substantially circular or oval cross-section.

As used herein, the terms "gathered" or "gathering" denote that a web or sheet is convoluted, or otherwise compressed or constricted substantially transversely to the cylindrical axis of the rod.

As used herein, the term "amplitude value" refers to the height of a corrugation from its peak to the deepest point of the deepest directly adjacent trough.

As used herein, the term "corrugation angle" refers to the angle between the corrugation flanks of a particular corrugation. One or more of the corrugations may be symmetrical about the radial direction. That is, the angle between each flank of a corrugation and the radial direction, or the "flank angle", may be the same and equal to half the corrugation angle. One or more of the corrugations may be asymmetrical about the radial direction. That is, the flank angles of both flanks of a corrugation may be different.

The apparatus and the method of the invention may be used to crimp a sheet of material. For example, such a sheet could be a sheet of an alkaloids containing material, such as a homogenized tobacco material.

In order to crimp the sheet, the apparatus includes a first and a second main crimping roller to perform a crimping of the sheet, as well as a pre-crimping roller, which, together with the first main crimping roller, perform a pre-crimping of the sheet. The sheet of material is inserted between the pre-crimping roller and the first main crimping roller, in order to pre-crimp the sheet, that is, in order to form corrugations on the same according to a first pattern. Then, the pre-crimped sheet is inserted between the first and second main roller to crimp the same, that is, to form again corrugations on the sheet according to a second pattern.

The corrugations according to the first or second pattern are formed by the apparatus or according to the method of the invention by means of ridges formed in the main crimping rollers or in the pre-crimping roller.

Preferably, the first pattern of the crimp corrugation on the sheet is different from the second pattern of the crimp corrugation on the sheet.

Advantageously, the pre-crimping roller is located upstream the first and second main roller in the direction of transport of the sheet of material.

The crimp corrugations on the sheet are preferably realized by corresponding corrugations formed on the main crimping rollers and in the pre-crimping roller. The corrugations on the main and pre-crimping rollers are preferably formed by ridges realized on at least a portion of the surface of the first and second main roller, and on the pre-crimping roller. Ridges are realized on an external surface of the first and second main rollers, therefore forming a corresponding first and a second plurality of ridges, and on the external surface of the pre-crimping roller, forming a third plurality of ridges. The ridges preferably extend circumferentially around the roller' surface itself.

Preferably, the ridges of the first, second or third plurality are parallel one to the other.

The ridges of the first, second or third plurality may be formed in the whole external surface of the first main roller, second main roller or pre-crimping roller or only in a part thereof.

Each roller defines a rotation axis around which the roller (first main roller,

second main roller or pre-crimping roller) is adapted to rotate. The first main roller, the second main roller or the pre-crimping roller may have a cylindrical shape. In this case, the rotation axis coincides with the axis of the cylinder. A length of the roller is thus defined as its extension along the direction defined by its rotation axis.

The surfaces of the main crimping rollers or pre-crimping roller may be made of hard material such as steel.

Preferably, the diameter of the pre-crimping roller is smaller than the diameter of the first or the second main crimping roller. Preferably, the diameter of the pre-crimping roller is smaller than about 100 millimeters. More preferably, the preferred diameter is comprised between about 20 millimeters and about 60 millimeters, even more preferably between about 30 millimeters and about 50 millimeters. Preferably, the diameter of the first main roller is above about 100 millimeters, more preferably between about 150 millimeters and about 300 millimeters, more preferably of about 200 millimeters.

The ridges of the first, second or third plurality can be perpendicular to the respective rotation axis or they can be even slightly inclined with respect to the same.

The ridges of the first, second or third plurality may have a constant pitch value. Preferably, the ridges of the first, second or third plurality have a constant amplitude along their extension, and even more preferably this constant amplitude is the same for all ridges in a roller. However, the amplitude of the ridges of the first plurality may differ from the amplitude of the third plurality or of the second plurality.

Preferably, the ridges of the first and the third plurality interleave. Therefore, when the sheet of material is inserted between the pre-crimping roller and the first main crimping roller, the first and third plurality of ridges form corrugations onto the surfaces of the sheet. The corrugations have a given pattern – called first pattern - which depends, among others, on the pattern of the the first and third plurality of ridges and on their pitches.

Preferably, the ridges of the first and second plurality interleave. Therefore, when the sheet of material is inserted between the first and the second main crimping roller, the first and second plurality of ridges form corrugations onto the surfaces of the sheet. The corrugations have a given pattern – called second

pattern - which depends, among others, on the pattern of the first and second plurality of ridges.

The corrugations formed on the sheet at the end of the whole crimping process are therefore given by the sum of the corrugations formed when the sheet has been deformed by the first and third plurality of ridges and of the corrugations formed when the sheet has been deformed by the first and second plurality of ridges.

Due to the fact that the pre-crimping of the sheet between the first main crimping roller and the pre-crimping roller takes place before the crimping of the sheet between the first and the second main crimping roller, the pattern formed by the first and second main roller on the surfaces of the sheet of material is formed on the pattern already formed by the pre-crimping roller and first main roller.

The desired final pattern therefore is the result of two different steps, which takes place at different times and not at the same time, in each of which the deformation imparted to the sheet to form the corrugations is "less" than the total deformation.

Preferably the corrugations formed by the first and second plurality of ridges are formed on at least some corrugations formed by the first and third plurality of ridges, that is, preferably some corrugations formed according to the second pattern coincide in location with some corrugations formed according to the first pattern. In this way, the first and second plurality of ridges deepen or reinforce the already present corrugations formed by the first and third plurality of ridges.

The "double-step" crimping limits the stress to which the sheet is subject at each single step and therefore reduces the possible damages.

The corrugations formed by the first main roller and pre-crimping roller on the sheet are according to a first pattern. The corrugations formed by the first and second main rollers on the sheet are according to a second pattern. Preferably, the two patterns are different from each other. Having two different patterns means that at least a characteristic of the two patterns is different.

The first and second pattern of the corrugation on the sheet can be different because the pattern of the ridges on the rollers, such as the pattern of the first, second and third pattern may be different.

For example, the corrugations of the first pattern may be less deep than those

of the second pattern.

The second pattern may include more corrugations per unit width of the sheet than the first pattern.

The corrugations of the second pattern may have smaller flank angles than the corrugations of the first pattern.

Many other characteristics may be different from one pattern to the other.

Two different patterns may be obtained in a plurality of different ways.

For example, the corrugations (ridges) on the rollers themselves may be different. The arrangement of ridges on the surface of the roller is also called pattern. In this case, the term "pattern" refers to the arrangement of corrugations on the roller and not on the sheet. In order to form a pattern on the sheet, a pattern of corrugations need to be formed in at least one of the rollers. For example, a first pattern of corrugations is formed on the first main roller, a second pattern of corrugations is formed on the second main roller and a third pattern of corrugations is formed on the pre-crimping roller. For example, if the ridges' pattern (third pattern) on the first pre-crimping roller is different from the ridges' pattern in the second main roller (second pattern), corrugations having different patterns are obtained in the sheet.

The difference may be one or more of:

- Amplitude of the ridges (for example, the amplitude of the ridges in the pre-crimping roller can be smaller than in the second main roller).
- Flank angle.
- Number of ridges per unit width of the surface of the roller.
- Material in which the ridges are formed. A softer material corrugates the sheet less than a hard one and thus creates a different pattern.

Preferably, the third plurality of ridges having a third given pattern different from the second given pattern of the second plurality of ridges includes one or more of the following:

- a shape of the ridges of the third plurality is different from a shape of ridges of the second plurality;
- an amplitude of the ridges of the third plurality is different from an amplitude of ridges of the second plurality;

- a thickness of the ridges of the third plurality is different from an thickness of the ridges of the second plurality;
- a material in which the third plurality of ridges is formed is different from a material in which the second plurality of ridges is formed;
- a pitch of the ridges of the third plurality is different from a pitch of ridges of the second plurality;
- a number of ridges of the second plurality per unit length of the second main crimping roller is different from a number of ridges of the third plurality per unit length of the pre-crimping roller;
- a flank angle of ridges of the second plurality is different from a flank angle of ridges of the third plurality.

Thus, having different patters may mean any of the above, that is, the second and third pattern of ridges may be different by one or more of the above characteristics.

Alternatively, different patterns of corrugations on the sheet may be obtained putting the rollers at different distances one from the other. For example, the distance between the first and second main rollers may be different from the distance between the first main roller and the pre-crimping main roller. Even more preferably, the distance between the first main roller and pre-crimping roller is larger than the distance between the first and second main crimping rollers.

The distance between two crimping rollers is defined as the smallest distance between the outer surfaces of the two rollers. That is, the distance between two rollers is the distance between the two closets points belonging to the two different rollers. In other words, it is the smallest gap formed between the two rollers and the smallest gap experienced by the sheet of material crimped by the rollers. This distance is also called "nip" in the tehnical field of interest.

The distance between two rollers – as defined above - is thus preferably constant while the two rollers rotate around their respective axes.

Having different patterns on the sheet obtained by means of different patterns of ridges or different distances among rollers may allow a better control of the crimping process and a reduced damage on the sheet.

Preferably, the first and second crimp patetters are caused by the different patters in the corrugations formed in the rollers.

Preferably, a ridge of the second plurality of ridges defines a second ridge amplitude and a ridge of the third plurality of ridges defines a third ridge amplitude, and the third ridge amplitude is shorter than the second ridge amplitude. A ratio between the second amplitude and the third amplitude is preferably comprised between about 0.2 and about 2. More preferably, it is comprised between about 0.2 and about 0.9. Favourably, the sheet of material is less deformed during the pre-crimping than during the crimping, allowing for a gentle pre-treatment of the sheet.

Preferably, a number of ridges of the second plurality per unit length of the second main roller is higher than a number of ridges of the third plurality per unit length of the pre-crimping roller.

. Preferably, the ratio of the number of number of ridges per unit length of the third plurality and the number of ridges per unit length of the second plurality is comprised between about 1 and about 10, more preferably between about 1 and about 5, even more preferably between about 1 and about 3. Favourably, the sheet of material is less deformed during the pre-crimping than during the crimping, allowing for a gentle pre-treatment of the sheet. The number of ridges per unit length in a roller means the following: the ridges are preferably parallel to each other. Thus the number of ridges per unit length means the number of ridges which are present in a given unit length of the length of the roller along its rotation axis. For example, it may mean the number of ridges present each 10 cm of the length of the roller along its rotational axis. This means that per unit of length, there are less ridges in the pre-crimping roller than in the main crimping rollers.

Preferably, the apparatus includes a second pre-crimping roller facing the first main crimping roller, the second pre-crimping roller being positioned upstream the first pre-crimping roller along the transport direction. Preferably, each of the pre-crimping rollers performs a pre-crimping action and therefore the deformation of the sheet is even gentler.

More preferably, the second pre-crimping roller includes a fourth plurality of ridges having a fourth pattern. Even more preferably, the fourth pattern is different from the third pattern of the third plurality of ridges. The meaning of

having a fourth pattern different from the third pattern is one or more of the following:

- a shape of the ridges of the third plurality is different from a shape of ridges of the fourth plurality;
- an amplitude of the ridges of the third plurality is different from an amplitude of ridges of the fourth plurality;
- a thickness of the ridges of the third plurality is different from an thickness of the ridges of the fourth plurality;
- a material in which the third plurality of ridges is formed is different from a material in which the fourth plurality of ridges is formed;
- a pitch of the ridges of the third plurality is different from a pitch of ridges of the fourth plurality;
- a number of ridges of the fourth plurality per unit length of the second pre-crimping roller is different from a number of ridges of the third plurality per unit length of the pre-crimping roller;
- a flank angle of ridges of the fourth plurality is different from a flank angle of ridges of the third plurality.

The pre-crimping action onto the sheet can also be divided in a plurality of sub-steps, each sub-step being performed by one of the pre-crimping rollers together with the first main roller. In each sub-step, a deformation of the sheet is performed. The total deformation, that is, the total crimping of the sheet, is given by the sum of all deformation caused during the sub-steps of the pre-crimping and the main crimping between the first and second main roller. Less damage to the sheet can be obtained. Preferably, each of the pre-crimping rollers may deform the sheet of material differently from the others.

Preferably, a distance between the first main crimping roller and the second pre-crimping roller is different from a distance between the first main crimping roller and the first pre-crimping roller. More preferably, the distance between the first main crimping roller and the second pre-crimping roller is larger than the distance between the first main crimping roller and the first pre-crimping roller. The pre-crimping process can be performed with increasing intensity towards the main rollers.

Preferably, the ridge of the fourth plurality of ridges defines a fourth ridge

amplitude and wherein the fourth ridge amplitude is different from the third ridge amplitude. More preferably, the fourth ridge amplitude is shorter than the third ridge amplitude. The intensity of the pre-crimping process can be gently increased towards the main rollers.

Preferably, the apparatus includes a plurality of pre-crimping rollers, each pre-crimping roller facing the first main crimping roller, and the plurality of pre-crimping rollers being placed adjacent the first main crimping roller within an angular range centred at a rotational axis of the first main roller of less than about 180°. The arrangement is compact and space saving. The path of the sheet of material remains unchanged compared to conventional crimping where the sheet of material runs on the first roller before being transported between the first and second rollers and, subsequently runs on the second roller. By maintaining the transport path of the sheet of material, additional stress to the sheet can be avoided and the risk of damage to the sheet is reduced.

Preferably, a diameter of the main crimping roller is larger than a diameter of the first pre-crimping roller.

Advantageously, a diameter of the first main roller is substantially equal to a diameter of the second main roller. This allows for a conventional crimping process between the two main rollers. Preferably, the first and second main crimping roller are identical.

Preferably, the distance between the first and the pre-crimping roller is larger than the distance between the first and the second main roller. Favourably, the sheet of material is crimped less on the side facing the third roller than on the side facing the first roller. Favourably, the first and the pre-crimping rollers exert less pressure onto the sheet of material than the first and second main rollers, thus pre-crimping the sheet in a gentle manner.

Preferably, the sheet of material comprises an alkaloids containing material, a plastic sheet or a sheet containing cellulose.

More preferably, the alkaloids containing material sheet includes a homogenized tobacco sheet.

Preferably, the crimp corrugations according to the third pattern have a smaller amplitude than the crimp corrugations according to the second pattern.

Preferably, the crimp corrugations according to the third pattern are less in number per unit width than the crimp corrugations according to the second

pattern.

Preferably, the method includes the steps of: forming a rod using the crimped sheet of material. The crimping process is preferably used for the production of rods which are preferably used in the manufacturing of aerosol generating articles.

More preferably, the method includes: wrapping the rod. Preferably, the rod is wrapped in wrapping paper.

Preferably, the method comprises the step of: cutting the continuous rod into a plurality of rod-shaped components, each rod-shaped component having a gathered crimped sheet formed from a cut portion of the crimped sheet, the crimp corrugations of the crimped sheet defining a plurality of channels in the rod-shaped component.

According to a third aspect, the invention relates to a component for an aerosol generating article, formed using the crimped sheet realized according to the second aspect.

According to a fourth aspect, the invention relates to an aerosol generating article comprising the component of the third aspect. The method and apparatus of the invention may allow an improved control over the crimping process, therefore it may be possible to obtain an enhanced homogeneity of final product and thus of users' experience of the final product.

The invention will be further described, by way of example only, with reference to the accompanying drawings in which:

- Figure 1 shows an isometric view of an apparatus having two main rollers and a pre-crimping roller between which a sheet of material is treated according to the invention;
- Figure 2 shows a two-dimensional representation of a surface of a roller having a ridge-and-trough pattern;
- Figure 3 shows in a side view an arrangement of two main rollers and a set of pre-crimping rollers between which a sheet of material is transported;
- Figure 4 shows a schematic top view of a treated sheet according to the invention where gathering and forming a rod and sticks is indicated;
- Figure 5 shows a flow chart of a method for crimping a sheet of material according to the invention; and

- Figure 6 shows a detail of the apparatus of figure 1.

With initial reference to fig. 1, the Figure shows an isometric view of an apparatus 10 comprising a first and second facing main crimping rollers 11, 21 between which a sheet 70 of material having width 76 is treated according to the invention. The transport direction 1 of the sheet 70 is indicated with an arrow 1 in the figure 1.

The first and second facing crimping roller 11, 21 define a first and second rotation axis 18, 28, respectively. The surfaces of the main crimping rollers 11, 21 are provided with corrugations, where ridge-and trough pattern or corrugations 17, 27 comprises typically circumferential ridges on the surface of each roller 11, 21. The circumferential ridges may be perpendicular with respect to the rotation axes 18, 28 or may be slightly inclined. Preferably, the corrugation pattern on the first main roller 11, called first corrugation pattern, is identical to the corrugation pattern of the second main roller, called second corrugation pattern.

Preferably, the diameter of the first main crimping roller is identical to the diameter of the second main crimping roller. The diameter of the first and second crimping roller is of about 208 millimeters.

The corrugations 17, 27 of the first and second rollers 11, 21 at least partially mesh. The corrugations of the first or second rollers 11, 21 interleave. Preferably, the corrugations 17, 27 of the first and second rollers 11, 21 interleave such that substantially all of the corrugation troughs of one of the first and second rollers 11, 21 each receive a single corrugation peak of the other of the first and second rollers 11, 21. The surface patterns of both rollers 11, 21 are transmitted to the surfaces of the sheet 70 when transported between the two rollers 11, 21.

As can be seen in fig. 2, where the first roller 11 is depicted as a two dimensional area for clarity, the surface 12 of the roller 11 has a conventional ridge-and-trough pattern 17. The ridge-and-trough pattern 17 is comprised of circumferential ridges, each ridge defining a ridge amplitude. The ridges can be oriented perpendicular to the rotation axis 18 or can be slightly inclined, e.g. by not more than 10°.

The crimping realized on the sheet 70 is characterized - among others - by the number of lines of the corrugation pattern of the main crimping rollers 11, 21

and the depth of the troughs and the amplitude of the ridges of the corrugations 17, 27. Further, it may be characterized by a flank angle of the corrugations.

A more detailed partial view of the first and second main crimping rollers is given in figure 6, where the main first and second rollers 11, 21 are shown. The distance between the rollers is indicated with 81, while the pitch of the roller with 82. The diameter of the rollers is indicated with 83 and the amplitude of the corrugations with 85. Preferably, the corrugations of first and second roller are identical, thus all these parameters coincide for first and second plurality of corrugations 17 and 27.

The amplitude of the corrugations in the first and second roller is equal to about 0.67 millimeters.

The apparatus 10 also comprises a pre-crimping roller 31, which defines a rotation axis 38 parallel to the rotation axes 18, 28 of the main rollers 11, 21, and which at least partially meshes with the first main roller 11. The pre-crimping roller 31 rolls on the first main crimper 11 prior to crimping. The surface of the pre-crimping roller 31 is provided with corrugations, where ridge- and trough pattern or corrugations comprises typically circumferential ridges on the surface of the roller (the corrugations on the pre-crimping roller are not visible in the drawings). The circumferential ridges may be perpendicular with respect to the rotation axis 38 or may be slightly inclined. The corrugation pattern on the pre-crimping roller is named a third corrugation pattern. Preferably, the diameter of the pre-crimping roller is smaller than the diameter of the first or second main crimping roller.

The pre-crimping roller 31 includes corrugations having an amplitude of 0.67 millimeters.

Accordingly, the sheet 70 moves between the pre-crimping roller 31 and the first main roller 11 to be pre-crimped prior to the main crimping process which takes place between the two main crimping rollers 11, 21. For example, the sheet 70 runs on the first main roller 11 and is then transported between the pre-crimping roller 31 and the first main roller 11 and subsequently transported between the two main rollers 11, 21.

Preferably, the distance between the pre-crimping roller 31 and the first main crimping roller is bigger than the distance between the first and second main crimping rollers 11, 21, so the ridges of the pre-crimping roller 31 do not go as

deep in the sheet 70 as those of the first and second roller when the sheet is in the crimping phase.

For example, the distance between the first and second main crimping rollers is such that the corrugations formed in the sheet of material have a depth preferably comprised between about 0.36 millimeters and about 0.4 millimeters.

For example, the distance between the first main crimping roller and the pre-crimping roller 31 is such that the corrugations formed in the sheet of material have a depth preferably comprised between about 0.25 millimeters and about 0.35 millimeters.

Alternatively or in addition, the number of ridges of the third pattern of the pre-crimping roller 31 may differ from the number of ridges of the first or second pattern of the main crimping rollers 11, 21.

Alternatively or in addition, the amplitude of ridges of the pre-crimping roller 31 is smaller than the amplitude of the ridges of the first or second main crimping roller.

Alternatively or in addition, the number of ridges per unit length of the pre-crimping roller is smaller than the number of ridges per unit length of the first or second crimping roller.

Figure 3 shows in a side view a detail of a schematically depicted further embodiment of an apparatus 99 for crimping the sheet 70. Detail analog to apparatus 10 are indicated with the same reference number. The apparatus 99 comprises an arrangement of the first and second main crimping rollers 11, 21 and a set of pre-crimping rollers 31, 41, 51, 61 between which a sheet 70 of material is transported. The pre-crimping rollers 31, 41, 51, 61 are rolling on the first main roller 11 so that the sheet 70 of material is transported between the pre-crimping rollers 31, 41, 51, 61 and the first main roller 11 before being crimped between the first and second main crimping rollers.

Each pre-crimping roller 31, 41, 51, 61 includes a plurality of corrugations having a specific pre-crimping pattern. The pre-crimping pattern of each of the pre-crimping roller is selected preferably according to the crimping pattern of the main crimping rollers 11, 21 and according to the patterns of the other pre-crimping rollers 31, 41, 51, 61. As a result, the cumulative and successive action of the pre-crimping rollers 31, 41, 51, 61 on the sheet 70 create a progressive crimping action on the sheet 70, for gently preparing the sheet 70 for the

crimping, decreasing the crimping damage.

Optionally, each pre-crimping roller 31, 41, 51, 61 includes only a part of the total crimping corrugations 17 of the crimp pattern of the first or second main crimping roller 11, 21 e.g. each pre-crimping roller 31, 41, 51, 61 has a pitch value which is larger than the pitch value of the first main crimping roller. For instance, in case of four pre-crimping rollers 31, 41, 51, 61, each pre-crimping roller 31, 41, 51, 61 may have only one crimping ridge in a unit length where the main roller 11 has four crimping ridges, so that the sum-up pattern of the four pre-crimping rollers 31, 41, 51, 61 is similar to the crimp corrugation of the main crimper 11. The crimping deformation on the sheet 70 material during the pre-crimping phase is only of 1/4th for each pre-crimping roller 31, 41, 51, 61. Optionally, each pre-crimping roller 31, 41, 51, 61 may have only one crimping ridge in a unit length where the first or second main crimping roller 11, 21 has five crimping ridges (or above), so that the sum-up pattern of the four pre-crimping rollers 31, 41, 51, 61 crates less corrugations than the pattern created by the first and second main crimping rollers 11, 21.

The pitch value can be the same for each pre-crimping roller 31, 41, 51, 61. Optionally, the pitch value can be different among the pre-crimping rollers 31, 41, 51, 61. For instance, the first pre-crimping roller 31 that encounters the incoming sheet 70 may have only one crimping ridge in a unit length where the main roller has four or more crimping ridges, the second pre-crimping roller 41 may have two crimping ridges in the unit length etc. up to the last pre-crimping roller which has the same number of crimping ridges in the unit length as the first or second main crimping roller 11, 21.

Optionally, each pre-crimping roller 31, 41, 51, 61 may have the same number of crimping ridges as the first or second main roller 11, 21 but the amplitude of the ridges of the crimping pattern increases from one pre-crimping roller 31, 41, 51, 61 to the next. In such embodiments, the troughs in the sheet 70 of material are progressively extended up to a depth slightly inferior to the crimping depth caused by the main rollers 11, 21. For instance in case of four pre-crimping rollers 31, 41, 51, 61, the first pre-crimping roller 31 that encounters the incoming sheet 70 may have a smooth or slightly textured surface, the second pre-crimping roller 41 may have a ridge amplitude of only 25% of the ridge amplitude of the main first or second main crimping roller 11,

21 the third pre-crimping roller 51 of 50% and the fourth pre-crimping roller 61 of 75% of the ridge amplitude of the first or second main crimping roller 11, 21.

Optionally, each pre-crimping roller 31, 41, 51, 61 may have the same number of ridges per unit length as the first or second main crimping roller 11, 21 with the same ridge amplitude, but a distance between each of the pre-crimping rollers 31, 41, 51, 61 and the main roller 11 decreases progressively. For instance, the distance between the first main crimping roller 11 and the pre-crimping rollers 31, 41, 51, 61 may be reduced from the first pre-crimping roller 31 up to the last one for which the distance is slightly higher than the final distance between the two first and second main crimping rollers 11, 21.

In a preferred embodiment, the diameter of the pre-crimping rollers 31, 41, 51, 61 is about 1/10th of the diameter of the first or second main crimping roller 11, 21. For instance the diameter of the pre-crimping rollers 31, 41, 51, 61 may be selected between about 0.015 meters and about 0.03 meters (up to 0.05 meters) when the main roller 11 has a diameter of 0.20 meters. This allows arranging the pre-crimping rollers 31, 41, 51, 61 in less than 180° of the main roller 11.

The corrugation pattern of each pre-crimping roller 31, 41, 51, 61 and the corrugation pattern of the main roller 11 is preferably realized so that the number of ridges formed on the surface of the main roller 11 is N times the number of corrugations realized on the surface of the pre-crimping roller 31, 41, 51, 61.

Figure 5 shows a flow chart of a method for crimping a sheet of material according to the invention.

In a first step 100 a substantially continuous sheet 70 of material is fed to a set of crimping rollers in a transport direction. The set of rollers comprise a first main roller, a second main roller 11, 21 and at least a pre-crimping roller 31. The first and second main rollers 11, 21 include a first and a second plurality of ridges 17, 27 across at least a portion of its width and the pre-crimping roller includes a third plurality of ridges across a portion of its width.

In step 102, the substantially continuous sheet 70 of material is pre-crimped between the first main roller 11 and the pre-crimping roller 31 to form the pre-crimped sheet by feeding the substantially continuous sheet between the first main roller and the at least one pre-crimping roller. The first plurality of ridges

of the first main roller and the third plurality of ridges of the pre-crimping roller apply a given pressure on the sheet which forms a first pattern of crimp corrugations onto the substantially continuous sheet.

In case a plurality of pre-crimping rollers is present, the step above described is repeated for the number of pre-crimping rollers.

This results in a gently pre-crimping of the sheet 70 before the main crimping process is performed between the two main rollers 11, 21, thus allowing a higher processing speed without damaging the sheet 70.

In step 104 the pre-crimped sheet of material is crimped to form a crimped sheet by feeding the sheet between the first main roller and the second main roller 11, 21. In this "proper" crimping step the first and second plurality of ridges of the first and second main rollers apply a second pattern of crimp corrugations to the pre-crimped sheet. The first and second pattern are different one from the other. Preferably the first pattern can be considered as a gentler crimping than the second pattern. The first and second pattern may differ is the amplitude of the corrugations formed on the sheet, in their pitch, in the flank angle formed or a combination of the above.

In step 106, the crimped sheet of material is gathered, and a continuous rod is formed using the crimped sheet of material in step 108. In step 110, the continuous rod is wrapped, e.g. in cigarette paper.

In step 112, the continuous wrapped rod is cut into a plurality of rod-shaped components (sticks), each rod-shaped component having a gathered crimped sheet formed from a cut portion of the crimped sheet, the crimp corrugations of the crimped sheet defining a plurality of channels in the rod-shaped component.

Figure 4 shows a schematic top view of a crimped sheet 70 according to the invention where gathering and forming a rod 80 and sticks 82 is indicated.

The surface of the sheet 70 shows corrugations which reproduce the corrugations on the surface of roller 11 in fig. 2, for instance. The crimped sheet 70 of material is gathered and formed into a rod 80. The crimp corrugations of the crimped sheet 70 define a plurality of channels in the rod 80. The rod 80 is then wrapped and cut into sticks 82 having a stick length 84.

This stick may be used as a component in an aerosol forming article (not shown).

Claims

1. Apparatus for crimping a sheet of material, the apparatus comprising:
   - a transport device to transport the sheet of material along a transport direction;
   - a first and a second main crimping rollers, defining a first and a second rotational axis and being faced one in front of the other, the first main crimping roller including a first plurality of ridges having a first given pattern, and the second main crimping roller having a second plurality of ridges having a second given pattern; and
   - a first pre-crimping roller facing the first roller and having a third plurality of ridges, the first pre-crimping roller being positioned so that it is located upstream the first and second main crimping roller in the direction of transport of the sheet of material, and wherein
     - the third plurality of ridges has a third given pattern different from the second given pattern of the second plurality of ridges.

2. Apparatus according to claim 1, wherein the third plurality of ridges having a third given pattern different from the second given pattern of the second plurality of ridges includes one or more of the following:
   - a shape of the ridges of the third plurality is different from a shape of ridges of the second plurality;
   - an amplitude of the ridges of the third plurality is different from an amplitude of ridges of the second plurality;
   - a thickness of the ridges of the third plurality is different from an thickness of the ridges of the second plurality;
   - a material in which the third plurality of ridges is formed is different from a material in which the second plurality of ridges is formed;
   - a pitch of the ridges of the third plurality is different from a pitch of ridges of the second plurality;
   - a number of ridges of the second plurality per unit length of the second main crimping roller is different from a number of ridges of the third plurality per unit length of the pre-crimping roller;

- a flank angle of ridges of the second plurality of the second main crimping roller is different from a flank angle of ridges of the third plurality per unit length of the pre-crimping roller.

3. Apparatus according to claim 2, wherein a ridge of the second plurality of ridges defines a second ridge amplitude and a ridge of the third plurality of ridges defines a third ridge amplitude, and wherein the third ridge amplitude is shorter than the second ridge amplitude.

4. Apparatus according to any of the preceding claims, wherein a number of ridges of the second plurality per unit length of the second main roller is higher than a number of ridges of the third plurality per unit length of the pre-crimping roller.

5. Apparatus according to any of the preceding claims, including a second pre-crimping roller facing the first main crimping roller, the second pre-crimping roller being positioned upstream the first pre-crimping roller along the transport direction.

6. Apparatus according to claim 5, wherein the second pre-crimping roller includes a fourth plurality of ridges having a fourth pattern.

7. Apparatus according to claim 6, wherein the fourth pattern is different from the third pattern of the third plurality of ridges.

8. Apparatus according to any of claims 5 - 7, wherein a distance between the first main crimping roller and the second pre-crimping roller is different from a distance between the first main crimping roller and the first pre-crimping roller.

9. Apparatus according to claim 8, wherein the distance between the first main crimping roller and the second pre-crimping roller is larger than the distance between the first main crimping roller and the first pre-crimping roller.

10. Apparatus according to any of claims 5 – 9, wherein the ridge of the fourth plurality defines a fourth ridge amplitude and wherein the fourth ridge amplitude is different from the third ridge amplitude.

11. Apparatus according to any of claims 5 – 10, including a plurality of pre-crimping rollers, each pre-crimping roller facing the first main crimping roller, and the plurality of pre-crimping rollers being placed adjacent the first main crimping roller within an angular range centred at a rotational

axis of the first main roller of less than about 180°.

12. The method according to any of the preceding claims, wherein the distance between the first main crimping roller and the first pre-crimping roller is larger than the distance between the first main crimping roller and the second main crimping roller.

13. A method of manufacturing a crimped sheet of material, the method comprising the steps of:

- feeding a substantially continuous sheet of material to a set of crimping rollers in a transport direction, the set of crimping rollers comprising a first main crimping roller, a second main crimping roller and a first pre-crimping roller, the first and second main crimping rollers including a first and a second plurality of ridges across at least a portion of their width having a first and a second given pattern and the first pre-crimping roller including a third plurality of ridges across at least a portion of its width, the third plurality of ridges having a third given pattern different from the second given pattern;
- pre - crimping the substantially continuous sheet of material to form a pre-crimped sheet by feeding the substantially continuous sheet between the first main crimping roller and the first pre-crimping roller such that the first plurality of ridges of the first main crimping roller and the third plurality of ridges of the first pre-crimping roller apply a first pattern of crimp corrugations to the substantially continuous sheet; and
- crimping the pre-crimped sheet of material to form a crimped sheet by feeding the pre-crimped sheet between the first main crimping roller and the second main crimping roller such that the first and second plurality of ridges of the first and second main crimping rollers apply a second pattern of crimp corrugations to the pre-crimped sheet.

14. Method according to claim 13, wherein the third plurality of ridges having a third given pattern different from the second given pattern of the second plurality of ridges includes one or more of the following:

- a shape of the ridges of the third plurality is different from a shape of ridges of the second plurality;
- an amplitude of the ridges of the third plurality is different from an amplitude of ridges of the second plurality;
- a thickness of the ridges of the third plurality is different from an thickness of the ridges of the second plurality;
- a material in which the third plurality of ridges is formed is different from a material in which the second plurality of ridges is formed;
- a pitch of the ridges of the third plurality is different from a pitch of ridges of the second plurality;
- a number of ridges of the second plurality per unit length of the second main crimping roller is different from a number of ridges of the third plurality per unit length of the pre-crimping roller;
- a flank angle of ridges of the second plurality of the second main crimping roller is different from a flank angle of ridges of the third plurality.

15. The method according to any of claim 13 - 14, wherein the sheet of material comprises an alkaloids containing material, a plastic sheet or a sheet including cellulose.

16. The method according to claim 15, wherein the alkaloids containing material sheet includes a homogenized tobacco sheet.

17. The method according to any of claims 13 – 16, wherein the crimp corrugations according to the third pattern have a smaller amplitude than the crimp corrugations according to the second pattern.

18. The method according to claims 13 - 17, including the steps of:
- forming a rod using the crimped sheet of material.

19. The method according to claim 18, including:
- wrapping the rod.

20. The method according to claim 18 or 19, comprising the step of:
- cutting the continuous rod into a plurality of rod-shaped components, each rod-shaped component having a gathered crimped sheet formed from a cut portion of the crimped sheet, the crimp corrugations of the crimped sheet defining a plurality of channels in the rod-shaped component.

21. Component for an aerosol generating article, formed using the crimped sheet realized according to one or more of claims 13 – 20.
22. Aerosol generating article comprising the component of claim 21.

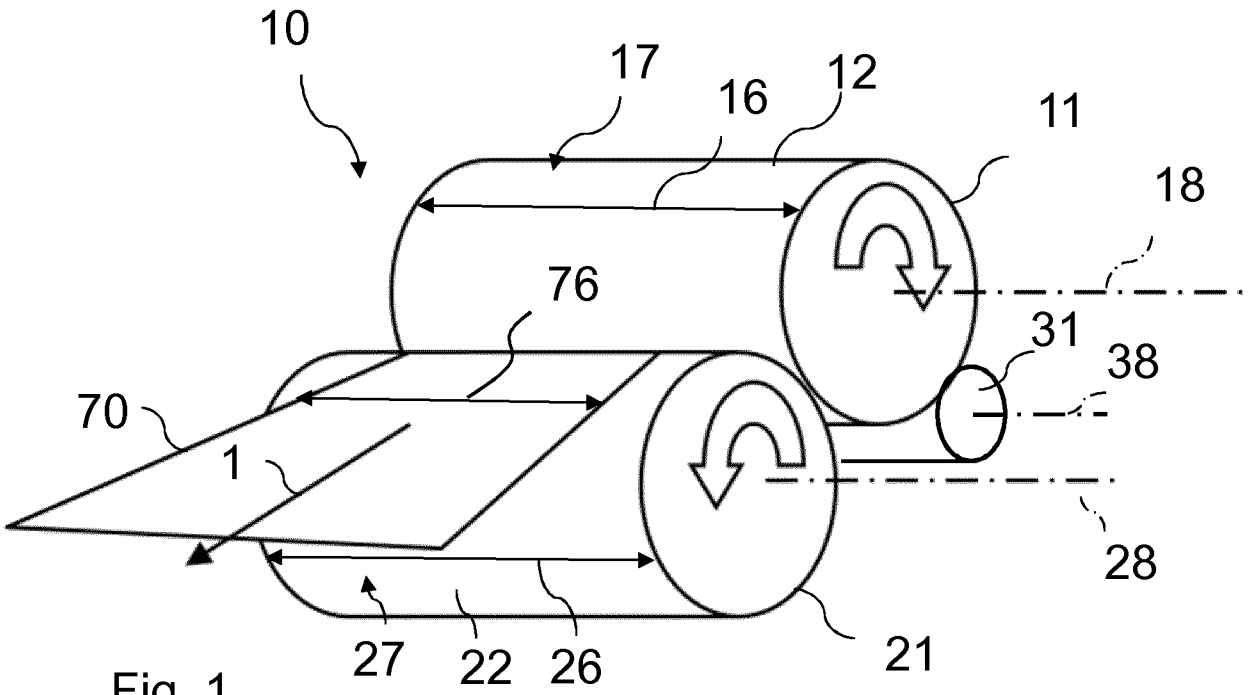

Fig. 1

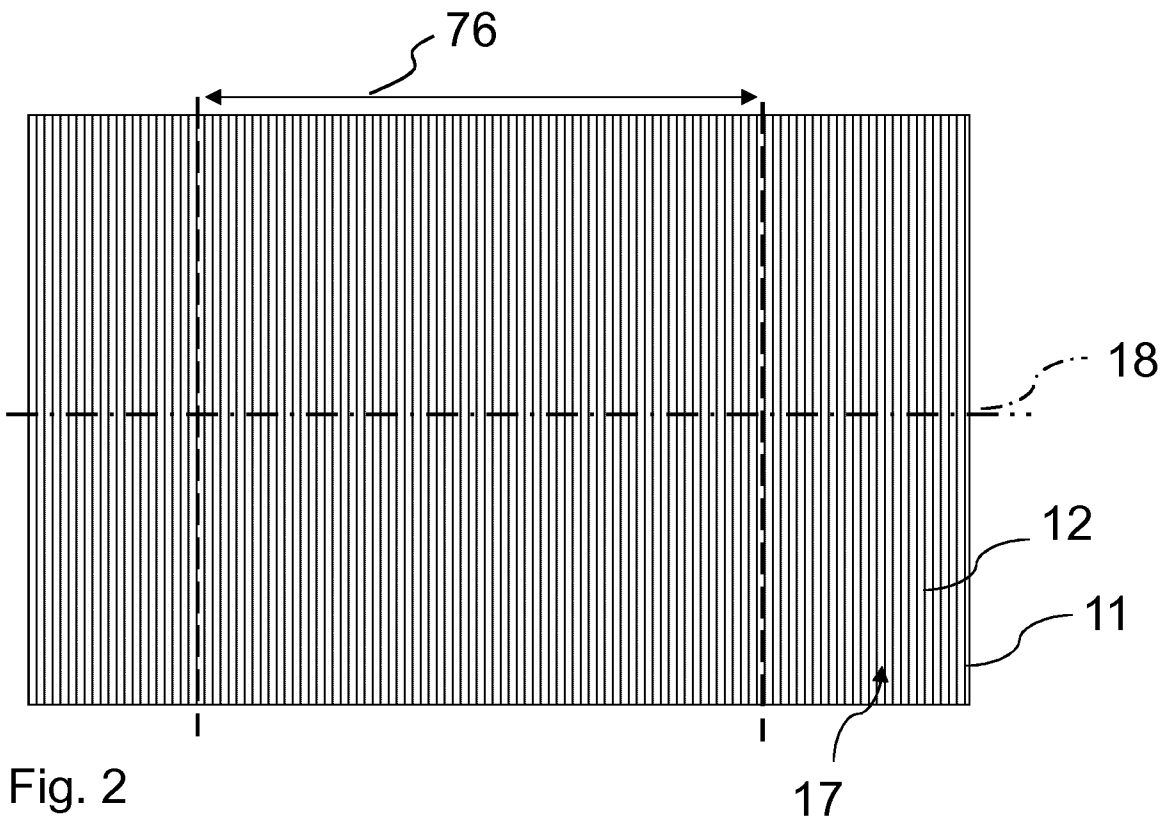

Fig. 2

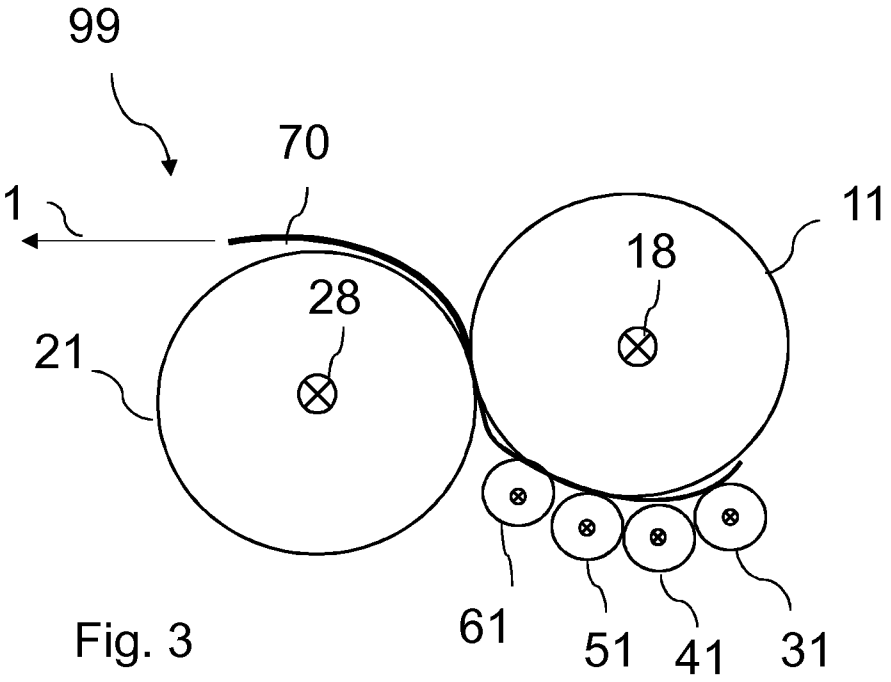

Fig. 3

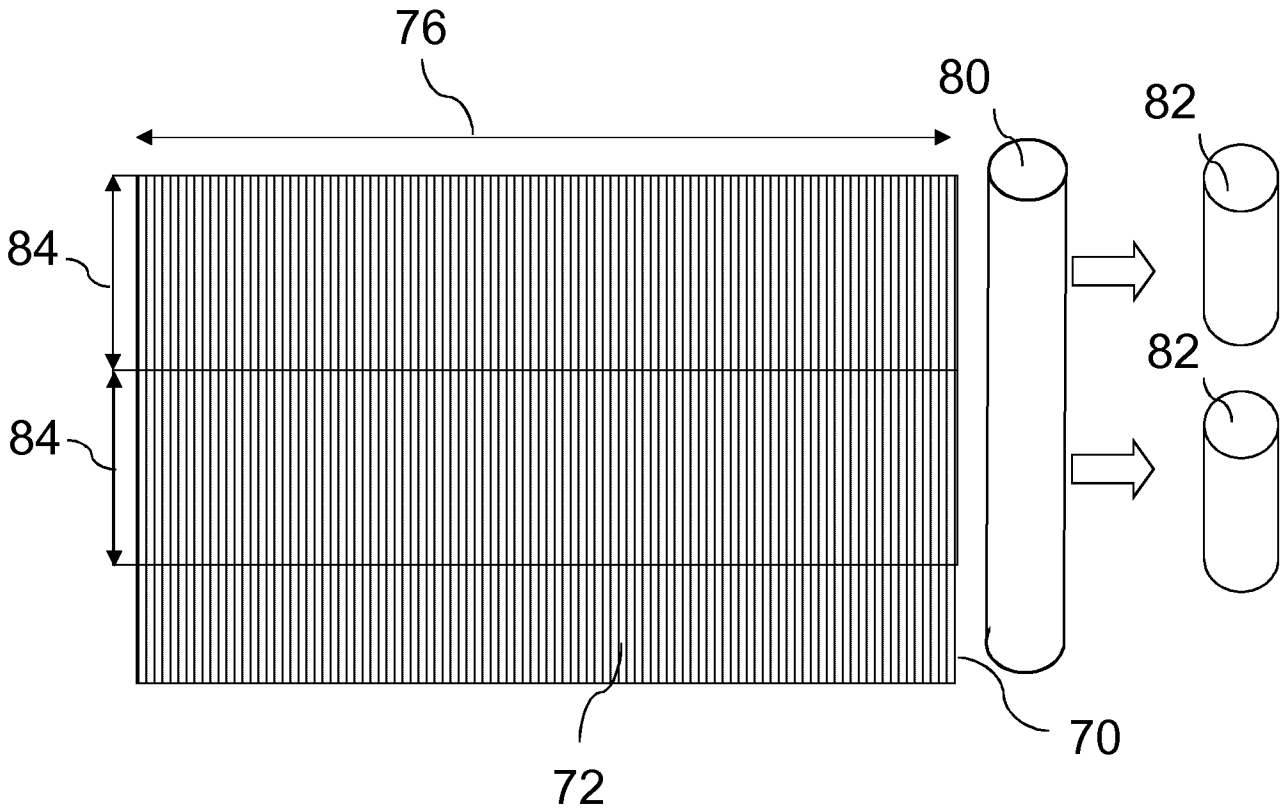

Fig. 4

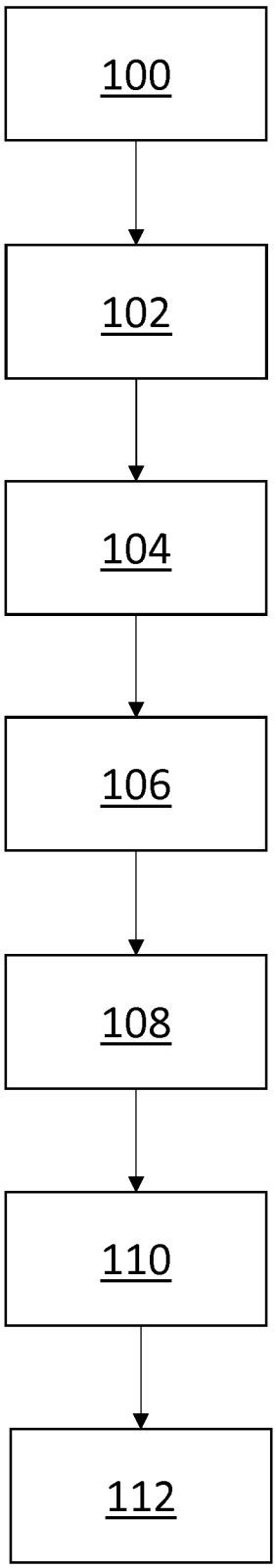

Fig. 5

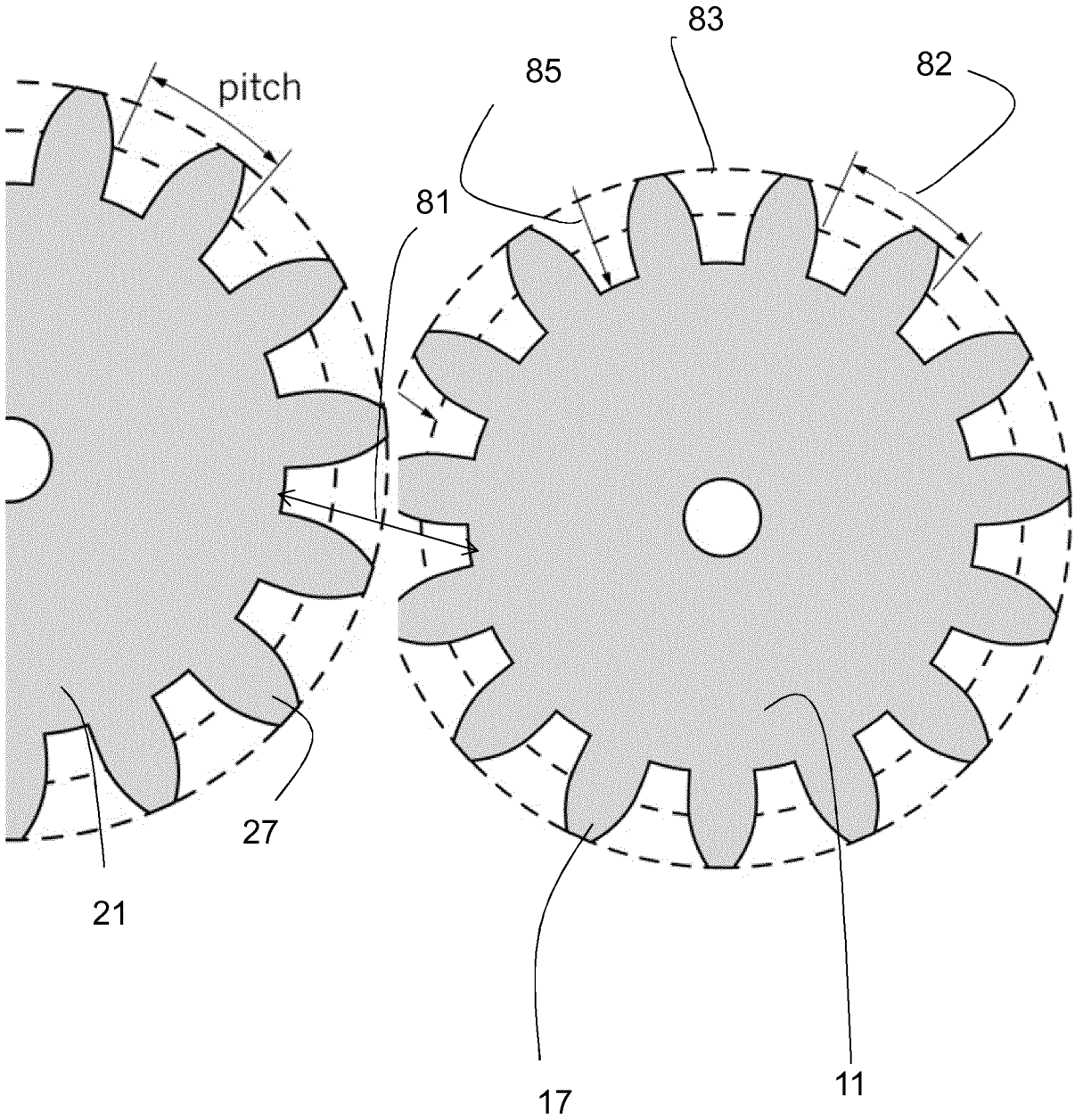

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/063387

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24B3/14 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)
A24B A24D D21F

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 3 466 358 A (MULLER PAUL ADOLF) 9 September 1969 (1969-09-09) column 1, line 46 - line 62; figures 1,2 column 3, line 62 - column 4, line 9 column 4, line 55 - column 5, line 15; figures 6,7	1,4,13, 15-22 2,3, 5-12,14

X A	GB 1 276 933 A (CELFIL CO [LI]) 7 June 1972 (1972-06-07) page 6, line 126 - page 7, line 122; figures	1,4,13, 15-22 2,3, 5-12,14

X A	GB 1 124 434 A (CELFIL CO) 21 August 1968 (1968-08-21) page 6, line 115 - page 8, line 5; figures	1,4,13, 15-22 2,3, 5-12,14

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 June 2018	10/07/2018

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