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(54) METHOD AND APPARATUS FOR PRODUCING A SHEET OF A MATERIAL CONTAINING ALKALOIDS

VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG EINER BAHN EINES MATERIALS MIT ALKALOIDEN

PROCÉDÉ ET APPAREIL DE PRODUCTION D'UNE FEUILLE D'UN MATÉRIAU CONTENANT DES ALCALOÏDES

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Description

[0001] This invention relates to a casting apparatus and method for producing a cast web of a material containing alkaloids.

[0002] In particular, the material containing alkaloids is homogenized tobacco material, preferably used in an aerosol-generating article such as, for example, a cigarette or a "heat-not-burn" type tobacco containing product.

[0003] Today, in the manufacture of tobacco products, besides tobacco leaves, also homogenized tobacco material is used. This homogenized tobacco material is typically manufactured from parts of the tobacco plant that are less suited for the production of cut filler, like, for example, tobacco stems or tobacco dust. Typically, tobacco dust is created as a side product during the handling of the tobacco leaves during manufacture.

[0004] The most commonly used forms of homogenized tobacco material are reconstituted tobacco sheet and cast leaf (TCL is the acronym for tobacco 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 tobacco 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. A process for making such homogenized tobacco is for example disclosed in European Patent EP 0565360.

[0005] In a "heat-not-burn" aerosol-generating article, an aerosol-forming substrate is heated to a relatively low temperature, in order to form an aerosol but prevent combustion of the tobacco material. Further, the tobacco present in the homogenized tobacco material is typically the only tobacco, or includes the majority of the tobacco, present in the homogenized tobacco material of such a "heat-not burn" aerosol-generating article. This means that the aerosol composition that is generated by such a "heat-not burn" aerosol-generating article is substantially only based on the homogenized tobacco material. Therefore, it is important to have good control over the composition of the homogenized tobacco material, for the control for example, of the taste of the aerosol.

[0006] Due to variations in the physical properties of the slurry, for example, consistency, viscosity, fibre size, particle size, moisture or the age of the slurry, standard casting methods and apparatus may result in unintended variations in the application of the slurry onto a support during the casting of web of homogenized tobacco. A non-optimal casting method and apparatus may lead to inhomogeneity and defects of the cast web of homogenized tobacco.

[0007] An important parameter of the cast sheet is its thickness, which is preferably as homogeneous as possible so that the users' smoking experience can be substantially the same using any final product obtained embedding the cast sheet. Variations in the thickness, even minimal variations, may result in products that need to be discarded, enhancing costs and production time.

[0008] In known processes, the thickness of the sheet is determined by a casting blade which casts the sheet onto a conveyor belt and the distance between the blade and the belt substantially determines the thickness of the sheet. Any imperfection in the blade, in the conveyor belt or in their alignment may cause the production of an uneven sheet.

[0009] US5,501,237 describes an apparatus known in the art.

[0010] There is therefore the need for a method and an apparatus to obtain a cast sheet of a material containing alkaloids having a substantially uniform thickness.

[0011] The invention relates to a method for producing a sheet of a material containing alkaloids, the method comprising: mixing a material containing alkaloids with water to form a slurry; forming a sheet from the slurry; compressing the sheet between a first couple of rollers, wherein at the beginning of the step of compressing the sheet, a water content of the sheet is comprised between about 50 percent and about 80 percent of the total weight of the sheet; and further compressing the sheet compressed by the first couple of rollers between a second couple of rollers.

[0012] The invention also relates to a method for producing a sheet of a material containing alkaloids, the method comprising: mixing a material containing alkaloids with water to form a slurry; forming a sheet from the slurry; compressing the sheet between a first pair of rollers, wherein at the beginning of the step of compressing the sheet, a water content of the sheet is comprised between about 50 percent and about 80 percent of the total weight of the sheet; and further compressing the sheet compressed by the first pair of rollers between a second pair of rollers.

[0013] In the method of the invention, the thickness of the sheet is controlled by subsequent compression steps between rollers. As soon as the sheet is formed, for example by casting or by extrusion, the sheet is compressed between a first couple of rollers and then by a second couple of rollers, to obtain the desired thickness of the sheet. The process is relatively simple, but an accurate control of the thickness is obtained, because the final thickness is not obtained in a "single step", but by at least two steps. More than two couple of rollers can be used as well. The control on the thickness of the sheet is improved.

[0014] In the present text, "pair" and "couple" have the same meaning. Pair of rollers or couple of rollers means two rollers.

[0015] As used herein, the terms "sheet" denotes a laminar element having a width and length substantially

greater than the thickness thereof. The width of the sheet of material containing alkaloids is preferably greater than about 10 millimeters, more preferably greater than about 20 millimeters or about 30 millimeters. Even more preferably, the width of the sheet of material containing alkaloids is comprised between about 60 millimeters and about 2500 millimeters. A continuous "sheet" is herein called "web".

[0016] As used herein, the term "casting blade" denotes a longitudinally shaped element that may have an essentially constant cross-section along major parts of its lengthwise extension. It shows at least one edge that is intended to come into contact with a pasty, viscous or liquid-like substance to be influenced by said edge, such as a slurry. Said edge may have a sharp and knife-like edge. Alternatively, it may have a rectangular or a rounded edge.

[0017] As used herein, the term "movable support" denotes any means comprising a surface that can be moved in at least one longitudinal direction. The movable support may form a closed loop so as to provide an uninterrupted transport in one direction. The movable support may include a conveyor belt. The movable support may be essentially flat and may show a structured or an unstructured surface. The movable support may have no openings on its surface or may include orifices, preferably of such a size that they are impenetrable for the slurry deposited on it. The movable support may comprise a sheet-like movable and bendable band. The band may be made of a metallic material, including but not limited to steel, copper, iron alloys and copper alloys, or of a rubber material. The band may be made of a temperature-resistant material so that it can be heated to speed up the drying process of the slurry.

[0018] As used herein, the term "slurry" denotes a liquid-like, viscous or pasty material that may comprise an emulsion of different liquid-like, viscous or pasty material and that may contain a certain amount of solid-state particles, provided that the slurry still shows a liquid-like, viscous or pasty behaviour.

[0019] A "material containing alkaloids" is a material which contains one or more alkaloids. The alkaloids may comprise nicotine. The nicotine may be found, for example, in tobacco.

[0020] 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.

[0021] 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.

[0022] As used herein, the term "homogenized tobacco material" denotes material formed by agglomerating particulate tobacco, which contains the alkaloid nicotine. The material containing alkaloids can thus be a homogenized tobacco material.

[0023] The most commonly used forms of homogenized tobacco material is 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.

[0024] The term "aerosol-forming substrate" refers to a substrate that is capable of releasing volatile compounds that may form an aerosol. Typically, aerosol-forming substrates release volatile compounds upon heating. The aerosol-forming substrate may include the material containing alkaloids containing volatile alkaloids flavor compounds, which are released from the aerosol-forming substrate upon heating. The aerosol-forming substrate may include homogenized material.

[0025] In the method of the invention, a slurry is formed. The slurry contains a material containing alkaloids and water. It may also preferably comprise a binder and an aerosol former. It may also include cellulose fibers in addition to those contained in the material containing alkaloids.

[0026] The slurry may comprise a number of additional different components or ingredients. These components may influence the properties of the cast web of material containing alkaloids. A first ingredient is the material containing alkaloids, for example in powder form. This material can be for example a tobacco powder blend, which preferably contains the majority of the tobacco present in the slurry. The tobacco powder blend is the source of the majority of tobacco in the homogenized tobacco material and thus gives the flavour to the final product, for example to an aerosol produced heating the homogenized tobacco material. A cellulose pulp containing cellulose fibres is preferably added to the slurry in order to increase the tensile strength of the alkaloids material web, acting as a strengthening agent.

[0027] Preferably, the powder of material containing alkaloids has a size of between about 0.03 millimetres and about 0.12 millimetres. With size of the particle or powder of the material containing alkaloids, the Dv95 size is meant. Each of the values above listed indicates the Dv95 of the particle size. The "v" in Dv95 means that a volume distribution is considered. The use of volume distributions introduces the concept of the equivalent sphere. An equivalent sphere is a sphere which is equal to the real particle in the property which we are measuring. Thus for light scattering methods, it is a sphere which

would produce the same scattering intensities as the real particle. This is substantially a sphere having the same volume of the particle. Further, "95" in Dv95 means the diameter where ninety-five percent of the distribution has a smaller particle size and five percent has a larger particle size. Thus the particle size is that size according to a volume distribution where 95 percent of the particles have a diameter (of the corresponding sphere having substantially the same volume of the particle) smaller than the stated value. A particle size of 60 microns means that 95 percent of the particles have a diameter smaller than 60 microns, where the diameter is the diameter of the sphere having a corresponding volume than the particle.

[0028] The Dv95 size of the particle is measured using a Horiba LA 950 or LA 960 particle size distribution analyser. The HORIBA LA-960 particle size analyser uses the laser diffraction method to measure size distributions. This technique uses first principles to calculate size using light scattered off the particle (edge diffraction) and through the particle (secondary scattering refraction). The LA-960 incorporates the Mie scattering theory.

[0029] A binder is preferably added, in order to enhance the tensile properties of the homogenized sheet. An aerosol-former may be added to the slurry to promote the formation of aerosol. Further, in order to reach a certain viscosity and moisture optimal for casting the web of material containing alkaloids, water may be added to the slurry.

[0030] The quantity of binder added to the slurry may be comprised between about 1 percent and about 5 percent in dry weight of the slurry. More preferably, it is comprised between about 2 percent and about 4 percent. The binder used in the slurry may be any of the gums or pectins described herein. The binder may ensure that the powder of the material containing alkaloids remains substantially dispersed throughout the homogenized web. Although any binder may be employed, preferred binders are natural pectins, such as fruit, citrus or tobacco pectins; guar gums, such as hydroxyethyl guar and hydroxypropyl guar; locust bean gums, such as hydroxyethyl and hydroxypropyl locust bean gum; alginate; starches, such as modified or derivitized starches; celluloses, such as methyl, ethyl, ethylhydroxymethyl and carboxymethyl cellulose; tamarind gum; dextran; pullalon; konjac flour; xanthan gum and the like. The particularly preferred binder for use in the present invention is guar.

[0031] The introduction of cellulose fibres in the slurry typically increases the tensile strength of the web of material containing alkaloids, acting as a strengthening agent. Therefore, adding cellulose fibres may increase the resilience of the web of material containing alkaloids. Cellulose fibres for including in a slurry for webs of material containing alkaloids are known in the art and include, but are not limited to: soft-wood fibres, hard wood fibres, jute fibres, flax fibres, tobacco fibres and combination thereof. In addition to pulping, the cellulose fibres might be subjected to suitable processes such as refining, mechanical pulping, chemical pulping, bleaching, sulphate pulping and combination thereof. Cellulose fibres may include tobacco stem materials, stalks or other tobacco plant material. Preferably, cellulose fibres such as wood fibres comprise a low lignin content. Alternatively, fibres, such as vegetable fibres, may be used either with the above fibres or in the alternative, including hemp and bamboo. The length of cellulose fibres is advantageously between about 0.2 millimetres and about 4 millimetres. Preferably, the mean length per weight of the cellulose fibres is between about 1 millimetre and about 3 millimetres. Further, preferably, the amount of the cellulose fibres is comprised between about 1 percent and about 7 percent in dry weight basis of the total weight of the slurry (or homogenized tobacco sheet).

[0032] The mean length of the fibers refers to their real length (regardless whether they are curled or have kinks) as measured by MORFI COMPACT commercialised by Techpap SAS. The mean length is the mathematical mean of the measured length of the fibers by MORFI COMPACT over a measurement of N fibers, where N > 5. The MORFI COMPACT is a fiber analyser that measures the length of the fibers following the framework of the fibers, thus measuring their real developed length. Measured objects are considered fibers if their length is comprised between 200 microns and 10000 microns and their width is comprised between 5 microns and 75 microns. Fibers length is measured when deionized water is added to the fibers and Morfi software is used.

[0033] Suitable aerosol-formers for inclusion in slurry for sheet of material containing alkaloids such as homogenised tobacco material are known in the art and include, but are not limited to: monohydric alcohols like menthol, polyhydric alcohols, such as triethylene glycol, 1,3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate.

[0034] Examples of preferred aerosol-formers are glycerine and propylene glycol.

[0035] The slurry may have an aerosol-former content of greater than about 5 percent on a dry weight basis. The slurry may have an aerosol former content of between about 5 percent and about 30 percent by weight on a dry weight basis. More preferably, the aerosol-former is comprised between about 10 percent to about 25 percent of dry weight of the slurry. More preferably, the aerosol-former is comprised between about 15 percent to about 25 percent of dry weight of the slurry.

[0036] The binder and the cellulose fibres are preferably included in a weight ratio comprised between about 1:7 and about 5:1. More preferably, the binder and the cellulose fibres are included in a weight ratio comprised between about 1:1 and about 3:1.

[0037] The binder and the aerosol-former are preferably included in a weight ratio comprised between about 1:30 and about 1:1. More preferably, the binder and the

aerosol-former are included in a weight ratio comprised between about 1:20 and about 1:4.

[0038] Preferably, the alkaloid containing material is tobacco. The binder and the tobacco particles are preferably included in a weight ratio comprised between about 1:100 and about 1:10. More preferably, the binder and the tobacco particles are included in a weight ratio comprised between about 1:50 and about 1:15, even more preferably between about 1:30 and 1:20.

[0039] The aerosol-former and the tobacco particles are preferably included in a weight ratio comprised between about 1:20 and about 1:1. More preferably, the aerosol-former and the tobacco particles are included in a weight ratio comprised between about 1:6 and about 1:2.

[0040] The aerosol former and the cellulose fibres are preferably included in a weight ratio comprised between about 1:1 and about 30:1. More preferably, the aerosol-former and the cellulose fibres are included in a weight ratio comprised between about 5:1 and about 15:1.

[0041] The cellulose fibres and the tobacco particles are preferably included in a weight ratio comprised between about 1:100 and about 1:10. More preferably, the cellulose fibres and the tobacco particles are preferably included in a weight ratio comprised between about 1:50 and about 1:20.

[0042] Further, from the slurry, a sheet is formed. In order to form the sheet, the slurry can be for example casted, preferably on a movable support, along a casting direction. The slurry may be contained in a casting box having an aperture at the bottom and a casting blade. The casting-box is preferably box-shaped.

[0043] A casting blade is preferably arranged perpendicular to the casting direction. The web of material may be formed by means of the casting blade that casts the slurry present from the casting box. The slurry for example falls by gravity from the casting box and comes into contact with the casting blade. The edge of the casting blade edge forms indeed a gap with the surface of the movable support and the slurry passes through the aperture defined by said gap.

[0044] The slurry may be extruded in order to form the sheet. Therefore, the sheet exits an extruder where it is preferably compressed and heated. Also in this case, the slurry is preferably extruded onto a movable support. Any process to form the sheet may be used in this invention, that is, any sheet-forming device can be considered.

[0045] The direction along which the sheet is extruded or casted defines also the transport direction of the sheet. In order to form a continuous sheet or web of material containing alkaloids, the sheet - while formed - needs to be moved so that it can continuously be formed creating a web. Preferably, the sheet is moved along the transport direction by the movable support.

[0046] The formed sheet is then compressed between two rollers, which form a first couple of rollers. The rollers of the first couple are called first and second rollers. The first and second roller form a first gap therebetween, in which the sheet is inserted and compressed. Preferably, the thickness of the sheet after being compressed by the first couple of rollers is smaller than the thickness the sheet had before being compressed by the first couple of rollers.

[0047] Preferably, the first and second rollers have a cylindrical shape and have a first and a second axis of rotation. Preferably, the first and second axes of rotation are parallel to each other. Preferably, the first and second axes of rotation are perpendicular to the transport direction of the sheet. For example, the first and second axes of rotation are parallel to the width of the sheet.

[0048] Before the compression by the first couple of rollers, called in the following first compression, the humidity of the sheet - substantially just formed - is relatively high. The water content of the sheet just before the compression between the first and second rollers of the first couple is comprised between about 50 percent and about 80 percent of the total weight of the sheet. Preferably, the water content of the sheet before the compression between the first and second rollers is comprised between about 50 percent and about 70 percent of the total weight of the sheet, more preferably between about 50 percent and about 65 percent. Even more preferably, it is comprised between about 50 percent and about 60 percent. The first couple of rollers is preferably positioned directly in front of the sheet-forming device, such as the extruder or the casting blade, without any other element therebetween.

[0049] Before the compression of the sheet by the first couple of rollers, the sheet has a first thickness. The first thickness is preferably comprised between about 0.2 millimetres and about 2 millimetres. More preferably, the first thickness is comprised between about 0.3 millimetres and about 1.5 millimetres. More preferably, the first thickness is comprised between about 0.4 millimetres and about 1 millimetre. More preferably, the first thickness is comprised between about 0.5 millimetres and about 0.9 millimetres. Even more preferably, the first thickness is comprised between about 0.5 millimetres and about 0.8 millimetres.

[0050] After the first compression by the first couple of rollers, the thickness of the sheet is preferably decreased. The thickness of the sheet becomes a second thickness, smaller of the first thickness.

[0051] Further, after the first compression, a second compression by a second couple of rollers takes place according to the invention. The second compression is performed by a third roller and fourth roller, which preferably form a second gap therebetween, where the sheet is introduced and compressed by the second couple of rollers.

[0052] The second compression takes place downstream the first compression in the transport direction of the sheet.

[0053] Preferably, the third roller and fourth roller have a cylindrical shape and have a third axis of rotation and a fourth axis of rotation. Preferably, the third axis of ro-

tation and fourth axis of rotation are parallel to each other. Preferably, the third axis of rotation and fourth axis of rotation are perpendicular to the transport direction of the sheet. For example, the third axis of rotation and fourth axis of rotation are parallel to the width of the sheet. Therefore, preferably, the first axis of rotation, second axis of rotation, third axis of rotation and fourth axis of rotation are all parallel to each other.

[0054] After the second compression by the second couple of rollers, the thickness of the sheet is further reduced from the second thickness to a third thickness. After the second couple of rollers, that is, after the second compression by the second couple of rollers, the third thickness of the sheet is preferably comprised between about 0.05 millimetres and about 0.5 millimetres. The third thickness of the sheet is even more preferably comprised between about 0.07 millimetres and about 0.45 millimetres. The third thickness of the sheet is even more preferably comprised between about 0.1 millimetres and about 0.4 millimetres. The third thickness of the sheet is even more preferably comprised between about 0.1 millimetres and about 0.3 millimetres. The third thickness is substantially the final desired thickness of the sheet.

[0055] In the method of the invention, the final thickness, which is preferably equal to the third thickness, of the sheet is obtained in a multi-step process. A better control of the final thickness is therefore obtained, because the rollers' dimensions can be easily controlled. Further, "small" unevenness obtained by the first compression might be corrected by the second compression.

[0056] Further, sheets where a different final thickness is desired can be handled using the same method of the invention, being the gaps defined by the first couple of rollers or by the second couple of rollers easily regulated.

[0057] More than two couples of rollers can be considered in the method of the invention. An even more precise control of the final thickness of the sheet can be obtained. Therefore, from the first - initial - thickness to the third - final - thickness, the sheet may have many intermediate thicknesses. Reaching the final thickness in several steps allows a very precise control of the homogeneity of the sheet itself. In the following, N couple of rollers, where $N \geq 2$, are considered. The first couple of rollers is considered to be the closest to the sheet-forming device, while the second couple of rollers is the last couple of rollers and N-2 additional couples of rollers are placed between the first couple of rollers and the second couple of rollers.

[0058] Preferably, the step of forming a sheet includes the step of casting a sheet. Preferably, the step of forming a sheet includes the step of extruding the sheet. The sheet can be formed by any known method. The invention can be applicable to any forming system or method to form sheets from a slurry.

[0059] Preferably, the first couple of rollers includes a first and a second roller forming a first gap therebetween and the second couple of rollers includes a third and a fourth roller forming a second gap therebetween, the method including the step of changing a width of the first gap or of the second gap. With gap, the distance between the two rollers' surface is defined. This gap or distance is preferably vertical. Advantageously, the gap's width is also preferably adjustable. More preferably, the method includes changing the diameter of a roller of the first couple of rollers or of a roller of the second couple of rollers as a function of a desired thickness of the sheet containing alkaloids. Alternatively or in addition, the gap's width can be changed changing a distance between the first roller and second roller or changing a distance between the third roller and fourth roller as a function of a desired thickness of the sheet containing alkaloids. The sheet can have a different desired thickness depending on the specific destination of the same. The final thickness of the sheet is obtained by the subsequent compression steps. These can be equal to N (where $N \geq 2$) in case of N couple of rollers. In order to obtain sheets having different final thicknesses, according to the invention, it is preferably possible to change or regulate the width of the N gaps present in the N couples of rollers. The width of the gap in each couple of rollers may be changed either changing the diameter of the rollers while keeping the distance between the two fixed, or changing the distance between the rollers of the couple (in this case keeping the diameter of each roller of the couple fixed). Other possibilities of changing the gap between any couple of rollers are comprised as well. As "distance" between the rollers of a couple, a distance between their rotation axes is meant. In order to change the diameter of the rollers, for example inflatable/deflatable rollers can be used. Also, the rollers of the first couple or second couple are removable and rollers of the desired diameter can be selected.

[0060] In order to change the distance between the rollers of the first couple or of the second couple, one or both the rollers of the couple may be shifted along suitable guides. Preferably, given N couple of rollers, defining N gaps having N widths, the widths of the N gaps decrease along the transport direction of the sheet. Therefore, the first couple of rollers defines a gap having the biggest width, the second couple of rollers (which is the last couple of rollers in the series of N couples of rollers in the transport direction of the sheet) has the smallest gap's width, and the N-2 couple of rollers positioned between the first couple of rollers and the second couple of rollers have a monotonously decreasing width of the gap comprised between the first width and the second width of the gap.

[0061] Preferably, in case of N rollers, the pressure applied to the sheet by the couple of rollers increases from the first couple of rollers, where there is the lowest pressure, to the second couple of rollers (which are the last couple of rollers in the row), where there is the maximum pressure. Preferably, the applied pressure monotonously increases in the N-2 couple of rollers therebetween along the transport direction of the sheet.

[0062] Preferably, the method includes the step of dry-

ing the sheet during the compression step between the first couple of rollers or during the compression step between the second couple of rollers, or between the compression step between the first couple of rollers and the compression step between the second couple of rollers. Preferably, while the thickness of the sheet is regulated by the several-steps compression, the sheet is also dried. Therefore, preferably the N couple of rollers are contained in a dryer. Preferably, the drying is achieved by a combination of hot roller surfaces in direct contact with the sheet and hot fluid present in the dryer. Preferably, each of the rollers of the first couple or each of he rollers of the second couple defines a roller surface. The rollers of the first couple of rollers or the rollers of the second couple of rollers, or both, are heated up by a hot fluid such as steam or vapour. Due to the hot fluid, the roller surface of the rollers of the first couple of rollers or of the second couple of rollers becomes hot. Preferably, the temperature of the roller surface in contact with the drying sheet is comprised between about 40 degrees Celsius and about 250 degrees Celsius, more preferably between about 120 degrees Celsius and about 200 degrees Celsius or around about 160 degrees Celsius. Preferably, the temperature of the hot fluid (for example hot air) is comprised between about 40 degrees Celsius and about 250 degrees Celsius, more preferably between about 120 degrees Celsius and about 200 degrees Celsius or around about 160 degrees Celsius.

[0063] Preferably, in case of N couple of rollers, all rollers of all couples are included in the dryer. Therefore, preferably the drying step takes place during each of the N compression steps and also while the sheet moves from one couple or rollers to the next couple of rollers.

[0064] Preferably, the compression step by the any of the N couple of rollers also improves the efficiency of the drying step. Generally, drying is performed by a hot fluid. The compression may squeeze some water out of the sheet and therefore the overall drying takes less time, or a lower temperature fluid can be used for drying with respect to a case in which the compression does not take place.

[0065] Preferably, the method includes the step of regulating a temperature of the first couple or rollers or of the second couple of rollers. The drying may be further improved in efficiency by heating up the rollers. Alternatively, the rollers can be cooled, for example the temperature of the couple of rollers close to an exit of the dryer can be reduced. Preferably, the temperature of the rollers depending if used for heating or cooling is comprised between about 10 degrees Celsius and about 250 degrees Celsius.

[0066] Preferably, the step of forming the sheet includes forming the sheet on a movable support, the movable support being moved by the first couple of rollers. More preferably, the method includes the step of removing the sheet from the belt before the step of compressing the sheet between the second couple of rollers. The sheet, when formed by any method, is preferably positioned on a movable support, due to its relatively high water content between 50 percent and 80 percent. Without a support, the sheet may break while being "suspended" to reach the first couple of rollers. For this reason, preferably a movable support is provided, where the sheet, high in water content, can lie and be transported towards the first couple of rollers. It is however preferred to remove the sheet from the support as soon as possible in order to improve the control on the drying of the sheet. Indeed, a sheet on a support has one of the sides (the one in contact with the support) that may dry differently from the free side not in contact with the support. In order to obtain a homogeneous drying and thus a homogeneous sheet, the detachment between the sheet and the support takes place between two consecutive couple of rollers, for example between the first and second couple of rollers. In case of N rollers, the removal of the sheet from the support takes place between the first and the (N-2)th couple of rollers. In this way, an optimal drying of the sheet may be achieved. The movable support is further used to move the sheet along the transport direction. The movable support may be for example a conveyor belt. Preferably, a surface of the belt in contact with the sheet is realized in metal.

[0067] Preferably, before removing the sheet from the movable support, the method includes the step of reducing the water content of the sheet to a value below about 35 percent of the total weight of the sheet. In order to detach the sheet from the support and at the same time to minimize possible tears or breakage of the sheet, the sheet is detached when its water content is less than about 35 percent of its total weight. More preferably, the water content of the sheet at detachment is preferably comprised between about 5 percent and about 30 percent of the total weight of the sheet. Even more preferably, the water content of the sheet is preferably comprised between about 7 percent and about 15 percent of the total weight of the sheet.

[0068] Preferably, before removing the sheet from the movable support, the method includes the step of bringing the temperature of the sheet of material containing alkaloids to a value between about 100 degrees Celsius and about 150 degrees Celsius. In order to minimize the damage to the sheet at the removal from the support, preferably the temperature of the sheet is brought within this interval. The fragility of the sheet may depend both on its water content and its temperature.

[0069] The invention also relates to an apparatus for producing a sheet of a material containing alkaloids, the apparatus comprising: a mixer to mix a material containing alkaloids with water to form a slurry; a sheet-forming device to shape a slurry's portion into a sheet; a dryer, said dryer comprising: a first couple of rollers forming a first gap therebetween wherein the sheet can be inserted; and a second couple of rollers forming a second gap therebetween wherein the sheet can be inserted, the second couple of rollers being positioned downstream the first couple of roller in the direction of movement of the

sheet.

[0070] The invention also relates to an apparatus for producing a sheet of a material containing alkaloids, the apparatus comprising: a mixer to mix a material containing alkaloids with water to form a slurry; a sheet-forming device to shape a slurry's portion into a sheet; a dryer, said dryer comprising: a first pair of rollers forming a first gap therebetween wherein the sheet can be inserted; and a second pair of rollers forming a second gap therebetween wherein the sheet can be inserted, the second pair of rollers being positioned downstream the first pair of roller in the direction of movement of the sheet.

[0071] Many advantages of the invention have been stated previously and not repeated herewith. The apparatus of the invention includes N couple of rollers where $N \geq 2$, included in a dryer. Preferably, all N couple of rollers, where $N \geq 2$, are included in a dryer. The compression of the sheet in several steps take place while drying the sheet itself. An efficient drying of the sheet is obtained, while the desired final thickness is achieved.

[0072] Preferably, the second gap is smaller than the first gap. In case of N couple of rollers, where the first couple of roller is the closest to the sheet-forming device and the second couple of rollers is the last couple of rollers in the row, the first gap of the first couple of rollers is the biggest in width and the second gap of the second couple of rollers the smallest. The N-2 remaining couples of rollers have a gap the width of which is comprised between the width of first gap and the width of the second gap.

[0073] Preferably, the first couple of rollers includes a first roller and a second roller and the second couple of rollers includes a third roller and a fourth roller, and wherein the diameter of the first roller is bigger than the diameter of the third roller. In case of N rollers, preferably the diameter of the rollers decreases along the direction of movement of the sheet. A better control of the thickness of the sheet is obtained. Preferably, the decrease in the diameter of the rollers in turn determines a decrease of the contact surface between the rollers and the sheet. A more accurate thickness regulation and control may be achieved.

[0074] Preferably, the diameter of the first roller is equal to the diameter of the second roller.

[0075] Preferably, the diameter of the third roller is equal to the diameter of the fourth roller.

[0076] Preferably, the width of the gap between the rollers of a couple is decreased moving the two rollers close to each other.

[0077] Preferably, the first couple of rollers includes a first roller and a second roller and the second couple of rollers includes a third roller and a fourth roller, and an external surface of the third roller has a higher hardness than an external surface of the first roller. Hardness is a measure of the resistance to localized plastic deformation induced by either mechanical indentation or abrasion. Some materials are harder than others. According to the material of the roller, the hardening process and consequently the final hardness of the roller is different. Depending on the material, the rollers may have a different hardness. Hardness in case of steel rollers is preferably comprised between about 1 and about 50 HRC (Rockwell scale), the hardness in case of plastic rollers is preferably comprised between about D10 and about D100 (shore durometer), the hardness in case of rubber rollers is preferably comprised between about A10 and about A100 (shore durometer). The rollers can be formed in metal, plastic or rubber. The surface of the first couple of rollers or of the second couple of rollers can be coated with layers of different materials having a different hardness. Preferably, in case of N couple of rollers, the hardness of the couple of rollers increases from the first couple of rollers towards the Nth couple of rollers in the transport direction.

[0078] Preferably, the hardness of the first roller is equal to the hardness of the second roller.

[0079] Preferably, the hardness of the third roller is equal to the hardness of the fourth roller.

[0080] Preferably, the apparatus comprises a movable support, the movable support being driven by a first roller or a second roller of the first couple of rollers. Preferably, a movable support is present to transport the sheet along a transport direction. Preferably, the movable support is driven by one of the rollers of the first couple couple of rollers. Preferably, the movable support ends after the first couple of rollers. Preferably, in case of N pair of rollers, the movable support extends in the transport direction of the sheet passing through a given number of couple of rollers. Preferably, after the first couple of rollers or second couple of rollers the sheet is "solid enough" so it is self-supporting and driven at least by motorized couple of rollers through the next rollers. Preferably, the movable support ends between the first couple of rollers and the second couple of rollers.

[0081] Specific embodiments will be further described, by way of example only, with reference to the accompanying drawings in which:

- Figure 1 shows a flow diagram of a method to produce slurry for homogenized tobacco material according to the invention;
- Figure 2 shows a block diagram of a method for production of a homogenized tobacco material according to the invention;
- Figure 3 shows an apparatus for the production of a homogenized tobacco material according to the invention;
- Figure 4 shows a detail of an apparatus for the production of homogenized tobacco material according to the invention;
- Figure 5 shows a schematic view of an apparatus for performing the method of Figures 1 and 2; and

- Figure 6 shows a schematic view of an apparatus for performing the method of figures 1 and 2.

[0082] With initial reference to fig. 1, a method for the production of a sheet of material containing alkaloids, in the present example a homogenized tobacco sheet, from a slurry according to the present invention is represented. The first step of the method of the invention is the selection 100 of the tobacco types and tobacco grades to be used in the tobacco blend for producing the homogenized tobacco material. Tobacco types and tobacco grades used in the present method are for example bright tobacco, dark tobacco, aromatic tobacco and filler tobacco.

[0083] Only the selected tobacco types and tobacco grades intended to be used in the production of the homogenized tobacco material undergo the processing according to following steps of the method of the invention.

[0084] The method includes a further step 101 in which the selected tobacco is laid down. This step may comprise checking the tobacco integrity, such as grade and quantity, which can be for example verified by a bar code reader for product tracking and traceability. After harvesting and curing, the leaf of tobacco is given a grade, which describes the stalk position, quality, and colour.

[0085] Further, the lay down step 101 might also include, in case the tobacco is shipped to the manufacturing premises for the production of the homogenized tobacco material, de-boxing or case opening of the tobacco boxes. The de-boxed tobacco is then preferably fed to a weighing station in order to weight the same.

[0086] Moreover, the tobacco lay down step 101 may include bale slicing, if needed, as the tobacco leaves are normally transported in bales when boxed and shipped.

[0087] The tobacco bales are separated depending on the tobacco type. For example there may be a processing line for each tobacco type. Therefore, the following steps are performed for each tobacco type, as detailed below. These steps may be performed subsequently per grade such that only one production line is required. Alternatively, the different tobacco types may be processed in separate lines. This may be advantageous where the processing steps for some of the tobacco types are different. For example, in conventional primary tobacco processes bright tobaccos and dark tobaccos are processed at least partially in separate processes, as the dark tobacco often receives an additional casing. However, according to the present invention, preferably, no casing is added to the blended tobacco powder before formation of the homogenized tobacco web.

[0088] Further, the method of the invention includes a step 102 of coarse grinding of the tobacco leaves.

[0089] According to a variant of the method of the invention, after the tobacco lay down step 101 and before the tobacco coarse grinding step 102, a further shredding step is performed, not depicted in the drawings. In the shredding step, the tobacco is shredded into strips having a mean size comprised between about 1 millimetre and about 100 millimetres.

[0090] Preferably, after the shredding step, a step of removal of non-tobacco material from the strips is performed (not depicted in fig. 1).

[0091] Subsequently, the shredded tobacco is transported towards the coarse grinding step 102. The flow rate of tobacco into a mill to coarse grind the strips of tobacco leaf is preferably controlled and measured.

[0092] In the coarse grinding step 102, the tobacco strips are reduced to a particle size of between about 0.25 millimetres and about 2 millimetres. At this stage, the tobacco particles are still with their cells substantially intact and the resulting particles do not pose relevant transport issues.

[0093] Preferably, after the coarse grinding step 102, the tobacco particles are transported, for example by pneumatic transfer, to a blending step 103. Alternatively, the step of blending 103 could be performed before the step of coarse grinding 102, or where present, before the step of shredding, or, alternatively, between the step of shredding and the step of coarse grinding 102.

[0094] In the blending step 103, all the coarse grinded tobacco particles of the different tobacco types selected for the tobacco blend are blended. The blending step 103 therefore is a single step for all the selected tobacco types. This means that after the step of blending there is only need for a single process line for all of the different tobacco types.

[0095] In the blending step 103, preferably mixing of the various tobacco types in particles is performed.

[0096] After the blending step 103, a fine grinding step 104 to a tobacco powder size of between about 0.03 millimetres and about 0.12 millimetres is performed. This fine grinding step 104 reduces the size of the tobacco down to a powder size suitable for the slurry preparation. After this fine grinding step 104, the cells of the tobacco are at least partially destroyed and the tobacco powder may become sticky.

[0097] The so obtained tobacco powder can be immediately used to form the tobacco slurry. Alternatively, a further step of storage of the tobacco powder, for example in suitable containers may be inserted (not shown).

[0098] With now reference to fig. 2, a method of the invention for a manufacture of a homogenized tobacco web is shown. From step 104 of fine grinding, the tobacco powder is used in a subsequent slurry preparation step 105. Prior to or during the slurry preparation step 105, the method of the invention includes two further steps: a pulp preparation step 106 where cellulose fibres 5 and water 6 are pulped to uniformly disperse and refine the fibres in water, and a suspension preparation step 107, where an aerosol-former 7 and a binder 8 are premixed. Preferably, the aerosol-former 7 includes glycerol and the binder 8 includes guar. Advantageously, the suspension preparation step 107 includes premixing guar and glycerol without the introduction of water.

[0099] The slurry preparation step 105 preferably comprises transferring the premix solution of the aerosol-former and the binder to a slurry mixing tank and trans-

ferring the pulp to the slurry mixing tank. Further, the slurry preparation step comprises dosing the tobacco powder blend into the slurry mixing tank with pulp, and the guar - glycerol suspension. More preferably, this step also includes processing the slurry with a high shear mixer to ensure uniformity and homogeneity of the slurry.

[0100] Preferably, the slurry preparation step 105 also includes a step of water addition, where water is added to the slurry to obtain the desired viscosity and moisture.

[0101] In order to form the homogenized tobacco web, preferably the slurry formed according to step 105 is transported to a casting box where it is mixed and then it is cast in a casting step 108. Preferably, this casting step 108 includes transporting the slurry to a casting station and casting the slurry into web on a support. Preferably, during casting, the cast web thickness, moisture and density are controlled immediately after casting and more preferably are also continuously monitored and feedback-controlled using slurry measuring devices during the whole process.

[0102] A desired thickness of the sheet is preferably selected.

[0103] The homogenized cast web is then dried in a drying step 111 comprising a uniform and gentle drying of the cast web, for example in an endless, stainless steel belt. The endless, stainless steel belt may comprise individually controllable zones. Preferably, the drying step comprises monitoring the cast leaf temperature at each drying zone to ensure a gentle drying profile at each drying zone and heating the support where the homogenized cast web is formed. Preferably, the drying profile is a so called TLC drying profile.

[0104] During the drying step 111, a first and a second compression step 109 and 110 takes place. The first and second compression steps are one consecutive to the other. The first compression step takes place when the sheet is on the belt. The compression is realized between two rollers which form a first gap therebetween, where the sheet is inserted and compressed. After the first compression, the sheet might be removed from the belt so that the sheet is afterwards freestanding. The sheet undergoes a second step of compression, also between two rollers forming a second gap therebetween. Preferably, the second gap is smaller than the first. This second compression preferably takes place while drying also takes place. Preferably, also a third step of compression 110a is present between the first and the second, using a third set of two rollers forming a third gap therebetween, preferably smaller than the first gap, but bigger than the second gap. Also, the third compression step preferably takes place while drying. At the end of the compression steps, the desired thickness of the sheet is obtained. This thickness may be further changed due to the drying process.

[0105] At the conclusion of the web drying step 111, a monitoring step (not shown) is executed to measure the moisture content and number of defects present in the dried web.

[0106] The homogenized tobacco web that has been dried to a target moisture content is then preferably wound up in a winding step 112, for example to form a single master bobbin. This master bobbin may be then used to perform the production of smaller bobbins by slitting in a small bobbin forming process. The smaller bobbins may then be used for the production of an aerosol-generating article (not shown).

[0107] In case a sheet having a different thickness is desired in a further process, the distance between the rollers used in the first, second and third compression steps may be changed, that is, the width of the first, second and third gap may be varied in order to alter the thickness of the sheet after the drying step 111.

[0108] The method of production of a slurry for the homogenized tobacco material according to figure 1 is performed using an apparatus for the production of a slurry 200 depicted schematically in figure 3. The apparatus 200 includes a tobacco receiving station 201, where accumulating, de-stacking, weighing and inspecting the different tobacco types takes place. Optionally, in case the tobacco has been shipped into cartons, in the receiving station 201 removal of cartons containing the tobacco is performed. The tobacco receiving station 201 also optionally comprises a tobacco bale splitting unit.

[0109] In fig. 3 only a production line for one type of tobacco is shown, but the same equipment may be present for each tobacco type used in the homogenised tobacco material web according to the invention, depending on when the step of blending is performed. Further the tobacco is introduced in a shredder 202 for the shredding step. Shredder 202 can be for example a pin shredder. The shredder 202 is preferably adapted to handle all sizes of bales, to loosen tobacco strips and shred strips into smaller pieces. The shreds of tobacco in each production line are transported, for example by means of pneumatic transport 203, to a mill 204 for the coarse grinding step 102. Preferably a control is made during the transport so as to reject foreign material in the tobacco shreds. For example, along the pneumatic transport of shredded tobacco, a string removal conveyor system, heavy particle separator and metal detector may be present, all indicated with 205 in the appended drawing.

[0110] Mill 204 is adapted to coarse grind the tobacco strips up to a size of between about 0.25 millimetres and about 2 millimetres. The rotor speed of the mill can be controlled and changed on the basis of the tobacco shreds flow rate.

[0111] Preferably, a buffer silo 206 for uniform mass flow control, is located after the coarse grinder mill 204. Furthermore, preferably mill 204 is equipped with spark detectors and safety shut down system 207 for safety reasons.

[0112] From the mill 204, the tobacco particles are transported, for example by means of a pneumatic transport 208, to a blender 210. Blender 210 preferably includes a silo in which an appropriate valve control system is present. In the blender, all tobacco particles of all the

different types of tobacco which have been selected for the predetermined blend are introduced. In the blender 210, the tobacco particles are mixed to a uniform blend. From the blender 210, the blend of tobacco particles is transported to a fine grinding station 211.

[0113] Fine grinding station 211 is for example an impact classifying mill with suitable designed ancillary equipment to produce fine tobacco powder to the right specifications, that is, to a tobacco powder between about 0.03 millimetres and about 0.12 millimetres. After the fine grinding station 211, a pneumatic transfer line 212 is adapted to transporting the fine tobacco powder to a buffer powder silo 213 for continuous feed to a downstream slurry batch mixing tank where the slurry preparation process takes place.

[0114] The slurry which has been prepared using the tobacco powder above described in steps 100 - 105 of the method of the invention is preferably also cast in a casting station 300 as depicted in fig. 4.

[0115] Slurry from a buffer tank (not shown), is transferred by means of suitable pump with precision flow rate control measurement to the casting station 300. Casting station 300 comprises preferably the following sections. A precision slurry casting box and knife assembly 301 where slurry 11 is cast onto a support 303, such as a stainless steel belt with the required uniformity and thickness for proper web formation, receives the slurry from the pump. A main dryer 302, having drying zones or sections is provided to dry the cast tobacco web. Preferably, the individual drying zones have steam heating on the bottom side of the support with heated air above the support and adjustable exhaust air control. Within the main dryer 302, the homogenized tobacco web is dried to desired final moisture on the support 303.

[0116] With now reference to the more detailed figure 5, further details of the casting stations 300 are shown. The precision slurry casting box and knife assembly 301 comprises the casting blade 304 and the casting box 305. The movable support 303 comprises a continuous stainless steel belt including a drum assembly. Preferably, the steel belt 303 is wound around a pair of opposite drums 306, 307. The slurry is casted on the steel belt - at the drum 306 - through the casting blade 304, which creates a continuous sheet 10 of homogenized tobacco material.

[0117] The casted slurry 10 is driven by the steel belt 303 along a casting or transport direction indicated with an arrow 24 in figure 5 and enters the dryer 302, where it is progressively heated and homogeneously dried. In figure 5, the dryer 302 is only partially depicted.

[0118] The incoming slurry 11 is introduced into the casting box 305 from an inlet (not depicted), in particular a pipe, connected to a side wall 14 of the casting box 305, which puts this incoming slurry 11 close to the bottom of the casting box 305.

[0119] Slurry 11 from buffer tanks (not shown in the drawings) is transferred into the casting box 305 usually by means of a pump (not shown in the drawings). Preferably, the pump comprises a control (not visible in the drawing) of flow rate to control the amount of slurry 11 introduced in the casting box 305. The pump is advantageously designed to ensure that slurry transfer times are kept to the minimum necessary.

[0120] The amount of slurry 11 in the casting box 305 has a pre-determined level, which is preferably kept substantially constant or within a given range. In order to keep the amount of slurry 11 substantially at the same level, the pump controls the flow of slurry 11 to the casting box 305.

[0121] The casting blade 304 is associated to the casting box 305 in order to cast the slurry. The casting blade 304 has a dominant dimension which is its longitudinal width. The casting blade defines a first axis which is positioned along its longitudinal direction.

[0122] Between the casting blade 304 and the steel belt 303 a gap is present, the dimensions of which determine - among others - the initial thickness of the cast web 10 of homogenized tobacco material, at casting, called initial thickness. This initial thickness is preferably checked, for example by means of suitable sensor 15 (visible in figure 4) which has preferably a feedback loop with the casting blade 304. The gap formed between the casting blade and the steel belt may be modified on the basis of the signals outputted by sensor 15 (see figure 4).

[0123] Casting blade 304 and belt 303 face each other and the belt is partially positioned below the casting blade 304. The drum 306 transports belt 303 preferably rotates in the directions depicted by arrows 24 and 26.

[0124] Casting station 300 also includes a first couple of rollers 310, formed by the second drum 307 as a first roller and a second roller 308. The first roller 307 and second roller 308 form a first gap 311 therebetween.

[0125] The belt is also wound around the second drum 307. The second drum 307 forms part of the first couple of rollers 310, first roller 307 being the second drum and the second roller 308, being positioned vertically above the first roller 307. The two rollers form the first gap 311 therebetween, having a changeable thickness. The first couple of rollers 310 is positioned inside dryer 302. The sheet is inserted into the gap 311 and compressed, so that water is removed from the sheet. The thickness of the sheet after the first couple of rollers 310 is called first thickness and it is indicated with t_1. The first couple of rollers 310 is a first of a series of N couples of rollers, where $N \geq 2$. In figure 6 an example where N = 3 couples of rollers is shown. The casting station 300 includes the first couple of rollers 310, a second couple of rollers 312 (the last couple before the sheet exits the dryer 302) and a third couple of rollers 313 positioned in between the first couple of rollers and the second couple of rollers. Each couple of rollers defines a gap between the rollers forming the couple. The second couple of rollers 312 includes a third roller 316 and a fourth roller 317 forming a second gap 318 therebetween. The thickness of the sheet after the second couple of rollers is called third thickness and indicated with t_2. The third couple of rollers 313 includes a fifth roller 319 and a sixth roller 320 forming

a third gap 321 therebetween. The thickness of the sheet after the third couple of rollers is called third thickness and indicated with t_3. The width of the gaps between the rollers of the couples monotonously decreases from the first couple of roller to the second roller, that is the width of the first gap 311 is bigger than the width of the third gap 321 which is bigger than the width of the second gap 318. In the same manner, the first thickness of the sheet 10 diminishes from the thickest t_1 after the first couple of rollers 310 to the thinnest t_2 after the second couple of rollers 312.

[0126] In other words $t_1 > t_3 > t_2$. Preferably, one or more of rollers positioned below the sheet 10 of couples 310, 312, 313 can change its diameter.

[0127] Preferably, the diameters of the rollers also diminishes from the first couple of rollers 310 to the second couple of rollers 312 (which have the smallest diameter). The third couple of rollers 313 has an intermediate diameters between that of the first and second couple of rollers.

[0128] The thickness t_2 of the sheet after the second couple of rollers 312 is preferably checked, for example by means of a suitable sensor 16 positioned downstream the dryer 302 (see figure 4) in the direction of movement of the belt 303. A feedback loop is preferably present between the sensor 16 checking thickness t3 and the first gap 311, second gap 318 and third gap 321 between the first couple of rollers 310, second couple of rollers 312 and third couple of rollers 313. These gaps can be adjusted according to signals sent by sensor 16.

[0129] Downstream dryer 302, the dried sheet can be wound in a bobbin (not shown) to be stored and further used to produce aerosol generating articles.

Claims

1. Method for producing a sheet of a material containing alkaloids, the method comprising:

    ◦ mixing a material containing alkaloids with water to form a slurry;
    ◦ forming a sheet (10) from the slurry;
    ◦ compressing (109) the sheet between a first pair of rollers (307, 308), wherein at the beginning of the step of compressing (109) the sheet (10), a water content of the sheet is comprised between about 50 percent and about 80 percent of the total weight of the sheet; **characterised in that** the method comprises
    ◦ further compressing (110) the sheet (10) compressed by the first pair of rollers (307, 308) between a second pair of rollers (317, 318), to obtain a desired thickness (t3) of the sheet (10) of material containing alkaloids.

2. The method according to claim 1, wherein the step of forming a sheet includes the step of casting a sheet (108).

3. The method according to claim 1, wherein the step of forming a sheet includes the step of extruding the sheet (10).

4. The method according to any of the preceding claims, wherein the first pair of rollers (307, 308) includes a first roller (307) and a second roller (308) and the second pair of rollers (317, 318) includes a third roller (317) and a fourth roller (318), the method including the step of:

    ◦ changing a width of the first gap (311) or a width of the second gap (318).

5. The method according to claim 4, including the step of:

    ◦ changing the diameter (17, 18) of a roller of the first pair of rollers (307, 308) or the diameter (27, 28) of a roller of the second pair of rollers (317, 318) as a function of a desired thickness of the sheet (10) containing alkaloids; or
    ◦ changing a distance between the first roller (307) and second roller (308) or changing a distance between the third roller (317) and fourth roller (318) as a function of a desired thickness of the sheet (10) containing alkaloids.

6. The method according to any of the preceding claims, including the step of:

    ◦ Drying (111) the sheet (10) during the compression step between the first pair of rollers (307, 308) or during the compression step between the second pair of rollers (317, 318), or between the compression step between the first pair of rollers (307, 308) and the compression step between the second pair of rollers (317, 318).

7. The method according to any of the preceding claims, including the step of:

    ◦ regulating a temperature of the first pair or rollers (307, 308) or a temperature of the second pair of rollers (317, 318).

8. The method according to any of the preceding claims, wherein the step of forming the sheet includes:

    ◦ forming the sheet on a movable support (7), the movable support (7) being moved by the first pair of rollers (307, 308).

9. The method according to claim 8, including the step

of:

◦ removing the sheet (10) from the movable support (7) before the step of compressing the sheet (10) between the second pair of rollers (317, 318).

10. The method according to claim 9, wherein, before removing the sheet from the movable support (7), it includes the step of:

◦ reducing the water content of the sheet to a value below about 35 percent of the total weight of the sheet.

11. Apparatus for producing a sheet of a material containing alkaloids, the apparatus comprising:

◦ a mixer (301) to mix a material containing alkaloids with water to form a slurry (11);
◦ a sheet-forming device (300) to shape a slurry's portion into a sheet (10);
◦ a dryer, said dryer comprising:

▪ a first pair of rollers (307, 308) forming a first gap (311) therebetween wherein the sheet (10) can be inserted; and **characterised in that** it is provided
▪ a second pair of rollers (317, 318) forming a second gap (318) therebetween wherein the sheet (10) can be inserted, the second pair of rollers (317, 318) being positioned downstream the first pair of rollers (307, 308) in the direction of movement of the sheet (10); and
▪ the first pair of rollers (307, 308) or the second pair of rollers (317, 318) being heated by hot fluid.

12. Apparatus according to claim 11, wherein the second gap (318) is smaller than the first gap (311).

13. Apparatus according to claim 11 or 12, wherein the first pair of rollers (307, 308) includes a first roller (307) and a second roller (308) and the second pair of rollers (317, 318) includes a third roller (317) and a fourth roller (318), and wherein the diameter (17) of the first roller (307) is bigger than the diameter (27) of the third roller (317).

14. Apparatus according to one or more of claims 11 - 13, wherein the first pair of rollers (307, 308) includes a first roller (307) and a second roller (308) and the second pair of rollers (317, 318) includes a third roller (317) and a fourth roller (318), and wherein an external surface of the third roller (317) has a higher hardness than an external surface of the first roller (307).

15. Apparatus according to one or more of claims 11 - 14, comprising a movable support (7), the movable support (7) being driven by a first roller (307) or by a second roller of the first pair of rollers (307, 308).

Patentansprüche

1. Verfahren zur Herstellung einer Folienbahn aus einem alkaloidhaltigen Material, wobei das Verfahren umfasst:

◦ Mischen eines alkaloidhaltigen Materials mit Wasser zur Bildung einer Aufschlämmung;
◦ Bilden einer Folienbahn (10) aus der Aufschlämmung;
◦ Verdichten (109) der Folienbahn zwischen einem ersten Walzenpaar (307, 308), wobei zu Beginn des Schrittes des Verdichtens (109) der Folienbahn (10) ein Wassergehalt der Folienbahn zwischen etwa 50 Prozent und etwa 80 Prozent des Gesamtgewichtes der Folienbahn aufweist; **dadurch gekennzeichnet, dass** das Verfahren das
◦ weitere Verdichten (110) der durch das erste Walzenpaar (307, 308) verdichteten Folienbahn (10) zwischen einem zweiten Walzenpaar (317, 318), um eine gewünschte Dicke (t3) der Folienbahn (10) aus alkaloidhaltigem Material zu erhalten, umfasst.

2. Verfahren nach Anspruch 1, wobei der Schritt des Bildens einer Folienbahn den Schritt des Gießens einer Folienbahn (108) beinhaltet.

3. Verfahren nach Anspruch 1, wobei der Schritt des Bildens einer Folienbahn den Schritt des Extrudierens der Folienbahn (10) beinhaltet.

4. Verfahren nach einem beliebigen der vorhergehenden Ansprüche, wobei das erste Walzenpaar (307, 308) eine erste Walze (307) und eine zweite Walze (308) beinhaltet und das zweite Walzenpaar (317, 318) eine dritte Walze (317) und eine vierte Walze (318) beinhaltet, wobei das Verfahren den folgenden Schritt beinhaltet:

◦ Ändern einer Breite des ersten Spalts (311) oder einer Breite des zweiten Spalts (318).

5. Verfahren nach Anspruch 4, das den folgenden Schritt beinhaltet:

◦ Ändern des Durchmessers (17, 18) einer Walze des ersten Walzenpaares (307, 308) oder des Durchmessers (27, 28) einer Walze des zweiten Walzenpaares (317, 318) in Abhängigkeit von einer gewünschten Dicke der alkaloid-

haltigen Folienbahn (10); oder

◦ Ändern eines Abstands zwischen der ersten Walze (307) und der zweiten Walze (308) oder Ändern eines Abstands zwischen der dritten Walze (317) und der vierten Walze (318) in Abhängigkeit von einer gewünschten Dicke der alkaloidhaltigen Folienbahn (10).

6. Verfahren nach einem der vorstehenden Ansprüche, einschließend den Schritt:

◦ Trocknen (111) der Folienbahn (10) während des Verdichtungsschritts zwischen dem ersten Walzenpaar (307, 308) oder während des Verdichtungsschritts zwischen dem zweiten Walzenpaar (317, 318), oder zwischen dem Verdichtungsschritt zwischen dem ersten Walzenpaar (307, 308) und dem Verdichtungsschritt zwischen dem zweiten Walzenpaar (317, 318).

7. Verfahren nach einem der vorstehenden Ansprüche, einschließend den Schritt:

◦ Regeln einer Temperatur des ersten Walzenpaares (307, 308) oder einer Temperatur des zweiten Walzenpaares (317, 318).

8. Verfahren nach einem beliebigen der vorhergehenden Ansprüche, wobei der Schritt des Bildens der Folienbahn umfasst:

◦ Bilden der Folienbahn auf einer beweglichen Unterlage (7), wobei die bewegliche Unterlage (7) durch das erste Walzenpaar (307, 308) bewegt wird.

9. Verfahren nach Anspruch 8, das den folgenden Schritt beinhaltet:

◦ Entfernen der Folienbahn (10) von der beweglichen Unterlage (7) vor dem Schritt des Verdichtens der Folienbahn (10) zwischen dem zweiten Walzenpaar (317, 318).

10. Verfahren nach Anspruch 9, wobei vor dem Entfernen der Folienbahn von der beweglichen Unterlage (7) der folgende Schritt beinhaltet ist:

◦ Reduzieren des Wassergehalts der Folienbahn auf einen Wert unter etwa 35 Prozent des Gesamtgewichts der Folienbahn.

11. Vorrichtung zur Herstellung einer Folienbahn aus einem alkaloidhaltigen Material, die Vorrichtung umfassend:

◦ einen Mischer (301) zum Mischen eines alkaloidhaltigen Materials mit Wasser zur Bildung einer Aufschlämmung (11);

◦ eine Folienbahnbildungsvorrichtung (300) zum Bilden einer Folienbahn (10) aus einem Teil der Aufschlämmung;

◦ einen Trockner, wobei der Trockner umfasst:

- ein erstes Walzenpaar (307, 308), das einen ersten Spalt (311) zwischen sich bildet, in den die Folienbahn (10) eingeführt werden kann; und **dadurch gekennzeichnet, dass**
- ein zweites Walzenpaar (317, 318), das einen zweiten Spalt (318) zwischen sich bildet, in den die Folienbahn (10) eingeführt werden kann, vorgesehen ist, wobei das zweite Walzenpaar (317, 318) in Bewegungsrichtung der Folienbahn (10) dem ersten Walzenpaar (307, 308) nachgelagert positioniert ist; und
- wobei das erste Walzenpaar (307, 308) oder das zweite Walzenpaar (317, 318) durch ein heißes Fluid erwärmt wird.

12. Vorrichtung nach Anspruch 11, wobei der zweite Spalt (318) kleiner ist als der erste Spalt (311).

13. Vorrichtung nach Anspruch 11 oder 12, wobei das erste Walzenpaar (307, 308) eine erste Walze (307) und eine zweite Walze (308) beinhaltet und das zweite Walzenpaar (317, 318) eine dritte Walze (317) und eine vierte Walze (318) beinhaltet, und wobei der Durchmesser (17) der ersten Walze (307) größer ist als der Durchmesser (27) der dritten Walze (317).

14. Vorrichtung nach einem oder mehreren der Ansprüche 11 bis 13, wobei das erste Walzenpaar (307, 308) eine erste Walze (307) und eine zweite Walze (308) beinhaltet und das zweite Walzenpaar (317, 318) eine dritte Walze (317) und eine vierte Walze (318) beinhaltet, und wobei eine Außenfläche der dritten Walze (317) eine höhere Härte aufweist als eine Außenfläche der ersten Walze (307).

15. Vorrichtung nach einem oder mehreren der Ansprüche 11 bis 14, umfassend eine bewegliche Unterlage (7), wobei die bewegliche Unterlage (7) von einer ersten Walze (307) oder von einer zweiten Walze des ersten Walzenpaares (307, 308) angetrieben wird.

Revendications

1. Procédé de production d'une feuille d'un matériau contenant des alcaloïdes, le procédé comprenant :

◦ le mélange d'un matériau contenant des alca-

loïdes avec de l'eau pour former une suspension ;

◦ la formation d'une feuille (10) à partir de la suspension ;

◦ la compression (109) de la feuille entre une première paire de rouleaux (307, 308), dans lequel au début de l'étape de compression (109) de la feuille (10), une teneur en eau de la feuille est comprise entre environ 50 pour cent et environ 80 pour cent du poids total de la feuille ; **caractérisé en ce que** le procédé comprend

◦ la compression supplémentaire (110) de la feuille (10) comprimée par la première paire de rouleaux (307, 308) entre une deuxième paire de rouleaux (317, 318), pour obtenir une épaisseur souhaitée (t3) de la feuille (10) de matériau contenant des alcaloïdes.

2. Procédé selon la revendication 1, dans lequel l'étape de formation d'une feuille comporte l'étape de coulage d'une feuille (108).

3. Procédé selon la revendication 1, dans lequel l'étape de formation d'une feuille comporte l'étape d'extrusion de la feuille (10).

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première paire de rouleaux (307, 308) comporte un premier rouleau (307) et un deuxième rouleau (308) et la deuxième paire de rouleaux (317, 318) comporte un troisième rouleau (317) et un quatrième rouleau (318), le procédé comportant l'étape de :

◦ modification d'une largeur du premier espace (311) ou d'une largeur du deuxième espace (318).

5. Procédé selon la revendication 4, comportant l'étape de :

◦ modification du diamètre (17, 18) d'un rouleau de la première paire de rouleaux (307, 308) ou le diamètre (27, 28) d'un rouleau de la deuxième paire de rouleaux (317, 318) en fonction d'une épaisseur souhaitée de la feuille (10) contenant des alcaloïdes ; ou

◦ modification d'une distance entre le premier rouleau (307) et le deuxième rouleau (308) ou modification d'une distance entre le troisième rouleau (317) et le quatrième rouleau (318) en fonction d'une épaisseur souhaitée de la feuille (10) contenant des alcaloïdes.

6. Procédé selon l'une quelconque des revendications précédentes, comportant l'étape de :

◦ séchage (111) de la feuille (10) pendant l'étape de compression entre la première paire de rouleaux (307, 308) ou pendant l'étape de compression entre la deuxième paire de rouleaux (317, 318), ou entre l'étape de compression entre la première paire de rouleaux (307, 308) et l'étape de compression entre la deuxième paire de rouleaux (317, 318) .

7. Procédé selon l'une quelconque des revendications précédentes, comportant l'étape de :

◦ régulation d'une température de la première paire de rouleaux (307, 308) ou d'une température de la deuxième paire de rouleaux (317, 318).

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape de formation de la feuille comporte :

◦ la formation de la feuille sur un support mobile (7), le support mobile (7) étant déplacé par la première paire de rouleaux (307, 308).

9. Procédé selon la revendication 8, comportant l'étape de :

◦ retrait de la feuille (10) du support mobile (7) avant l'étape de compression de la feuille (10) entre la deuxième paire de rouleaux (317, 318).

10. Procédé selon la revendication 9, dans lequel, avant de retirer la feuille du support mobile (7), il comporte l'étape de :

◦ réduction de la teneur en eau de la feuille jusqu'à une valeur inférieure à environ 35 pour cent du poids total de la feuille.

11. Appareil pour la production d'une feuille de matériau contenant des alcaloïdes, l'appareil comprenant :

◦ un mélangeur (301) destiné à mélanger un matériau contenant des alcaloïdes avec de l'eau pour former une suspension (11) ;

◦ un dispositif de formation de feuille (300) destiné à former une partie de suspension en une feuille (10) ;

◦ un séchoir, ledit séchoir comprenant :

▪ une première paire de rouleaux (307, 308) formant un premier espace (311) entre eux dans lequel la feuille (10) peut être insérée ; et **caractérisé en ce qu'**il est prévu

▪ une deuxième paire de rouleaux (317, 318) formant un deuxième espace (318) entre eux dans lequel la feuille (10) peut être

insérée, la deuxième paire de rouleaux (317, 318) étant positionnée en aval de la première paire de rouleaux (307, 308) dans la direction de déplacement de la feuille (10) ; et

- la première paire de rouleaux (307, 308) ou la deuxième paire de rouleaux (317, 318) étant chauffée par un fluide chaud.

12. Appareil selon la revendication 11, dans lequel le deuxième espace (318) est plus petit que le premier espace (311).

13. Appareil selon la revendication 11 ou 12, dans lequel la première paire de rouleaux (307, 308) comporte un premier rouleau (307) et un deuxième rouleau (308) et la deuxième paire de rouleaux (317, 318) comporte un troisième rouleau (317) et un quatrième rouleau (318), et dans lequel le diamètre (17) du premier rouleau (307) est supérieur au diamètre (27) du troisième rouleau (317).

14. Appareil selon une ou plusieurs des revendications 11 à 13, dans lequel la première paire de rouleaux (307, 308) comporte un premier rouleau (307) et un deuxième rouleau (308) et la deuxième paire de rouleaux (317, 318) comporte un troisième rouleau (317) et un quatrième rouleau (318), et dans lequel le une surface externe du troisième rouleau (317) a une dureté supérieure à une surface externe du premier rouleau (307).

15. Appareil selon une ou plusieurs des revendications 11 à 14, comprenant un support mobile (7), le support mobile (7) étant entraîné par un premier rouleau (307) ou par un deuxième rouleau de la première paire de rouleaux (307, 308).

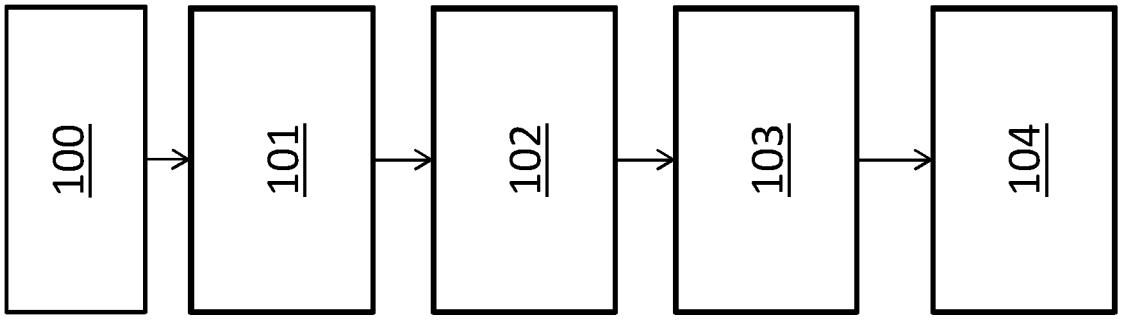


FIG. 1

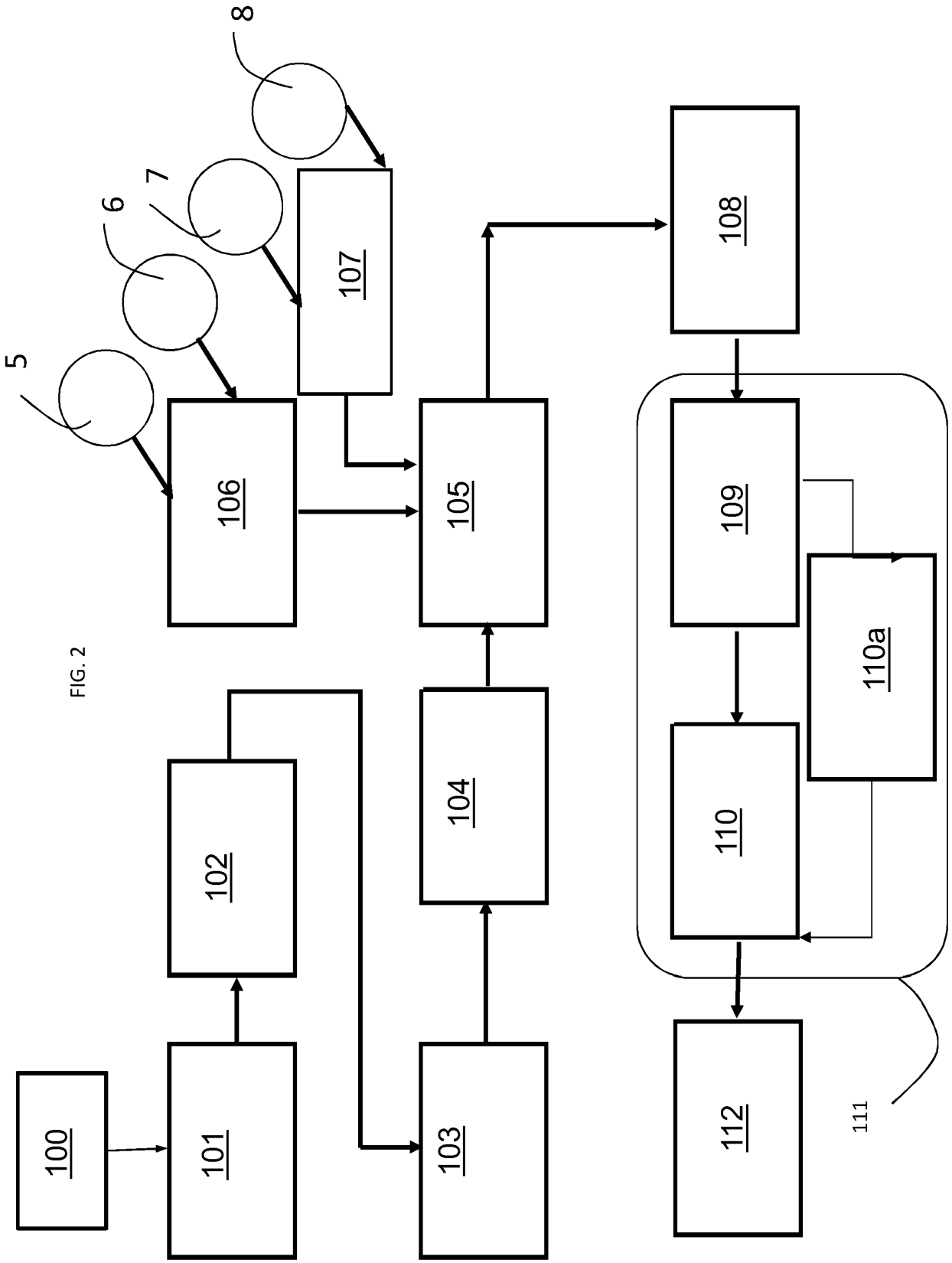


FIG. 2

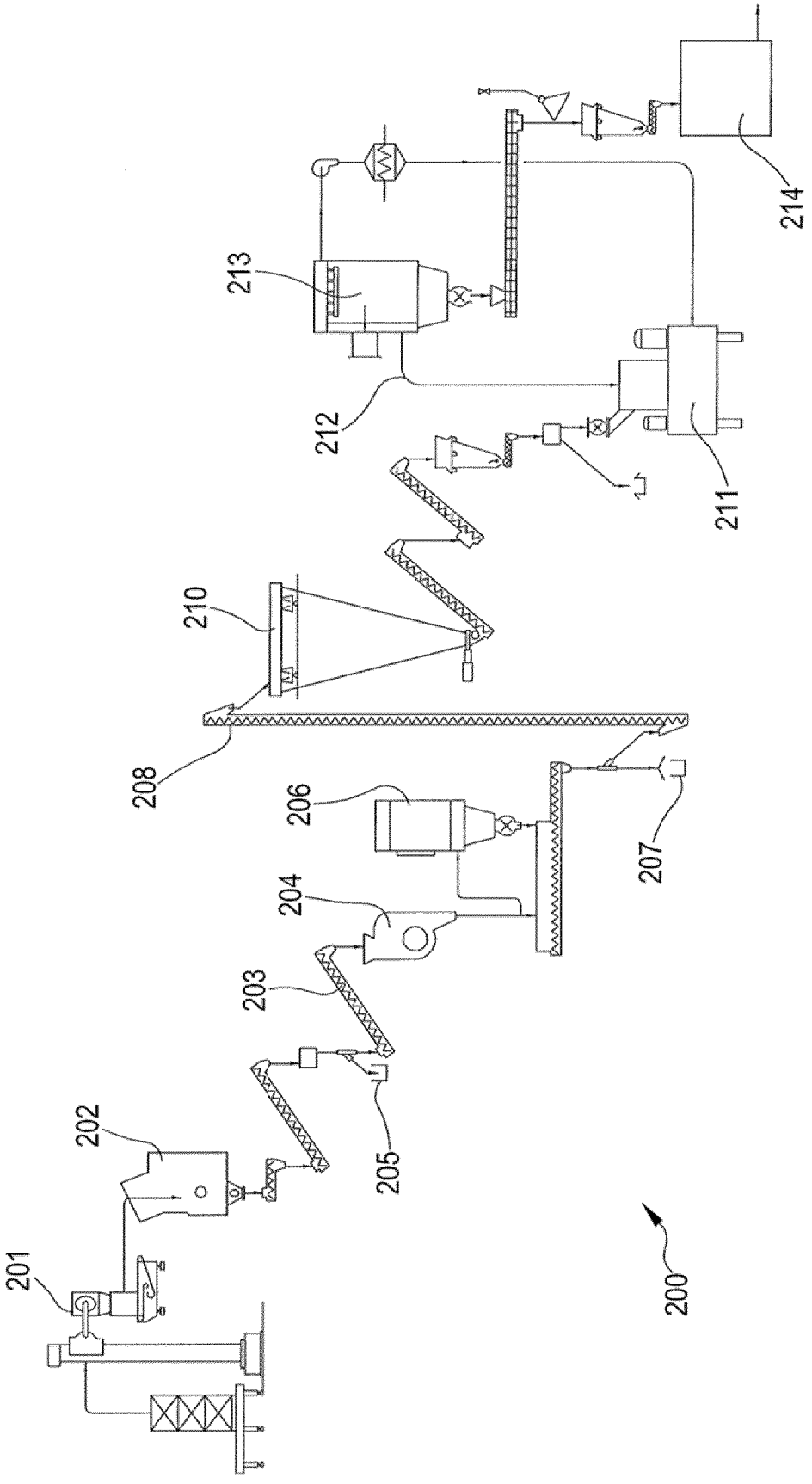
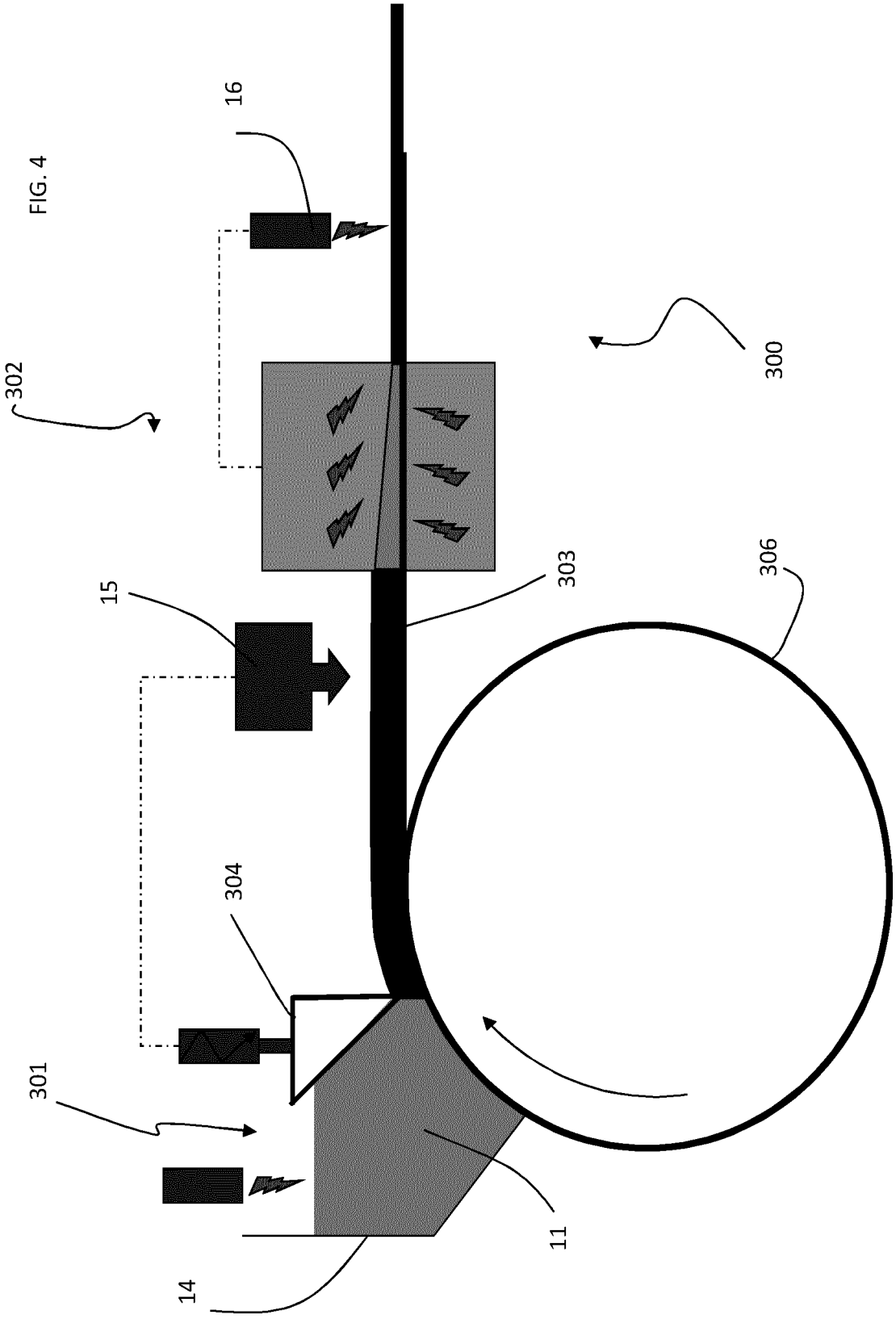


FIG. 3

FIG. 4



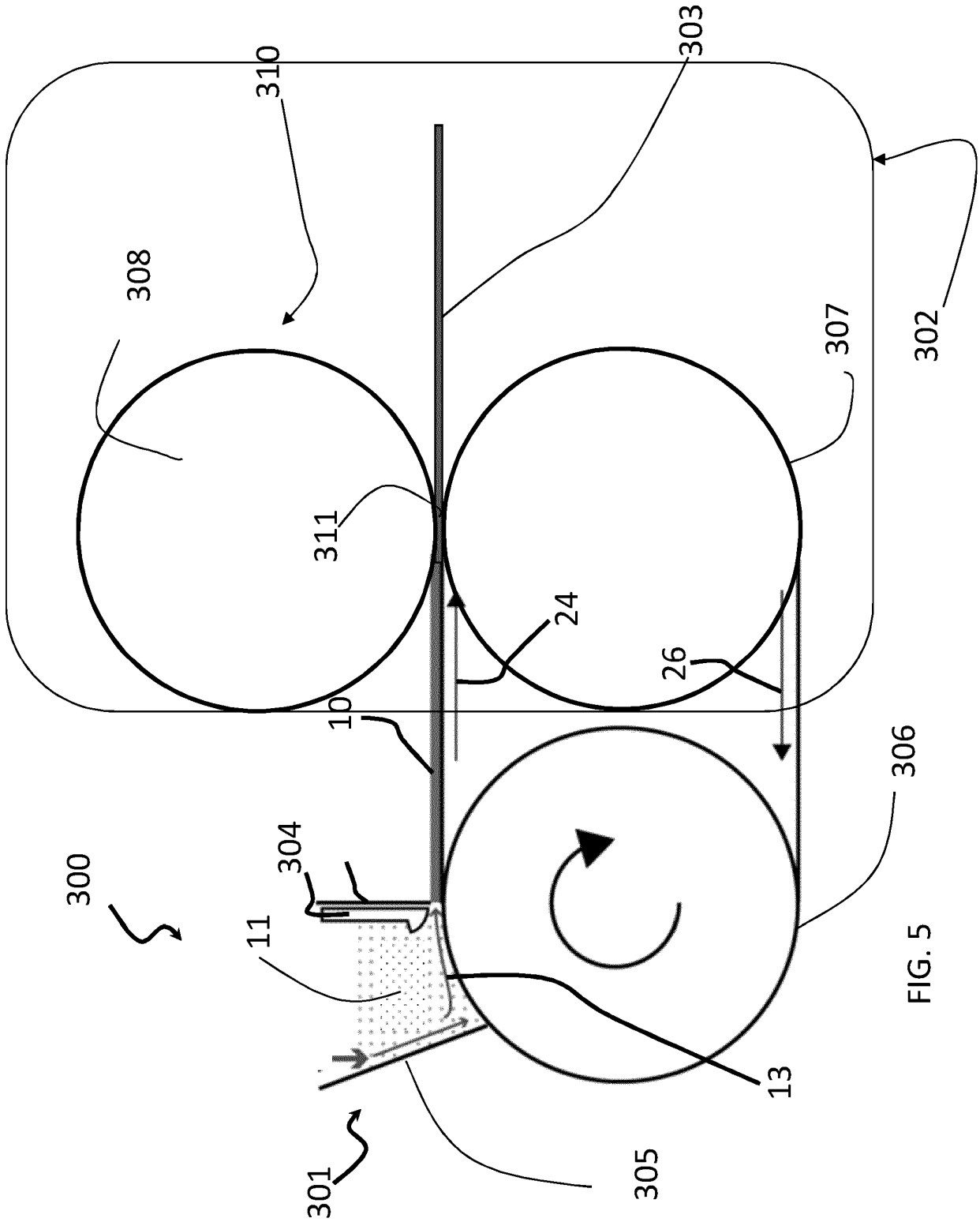


FIG. 5

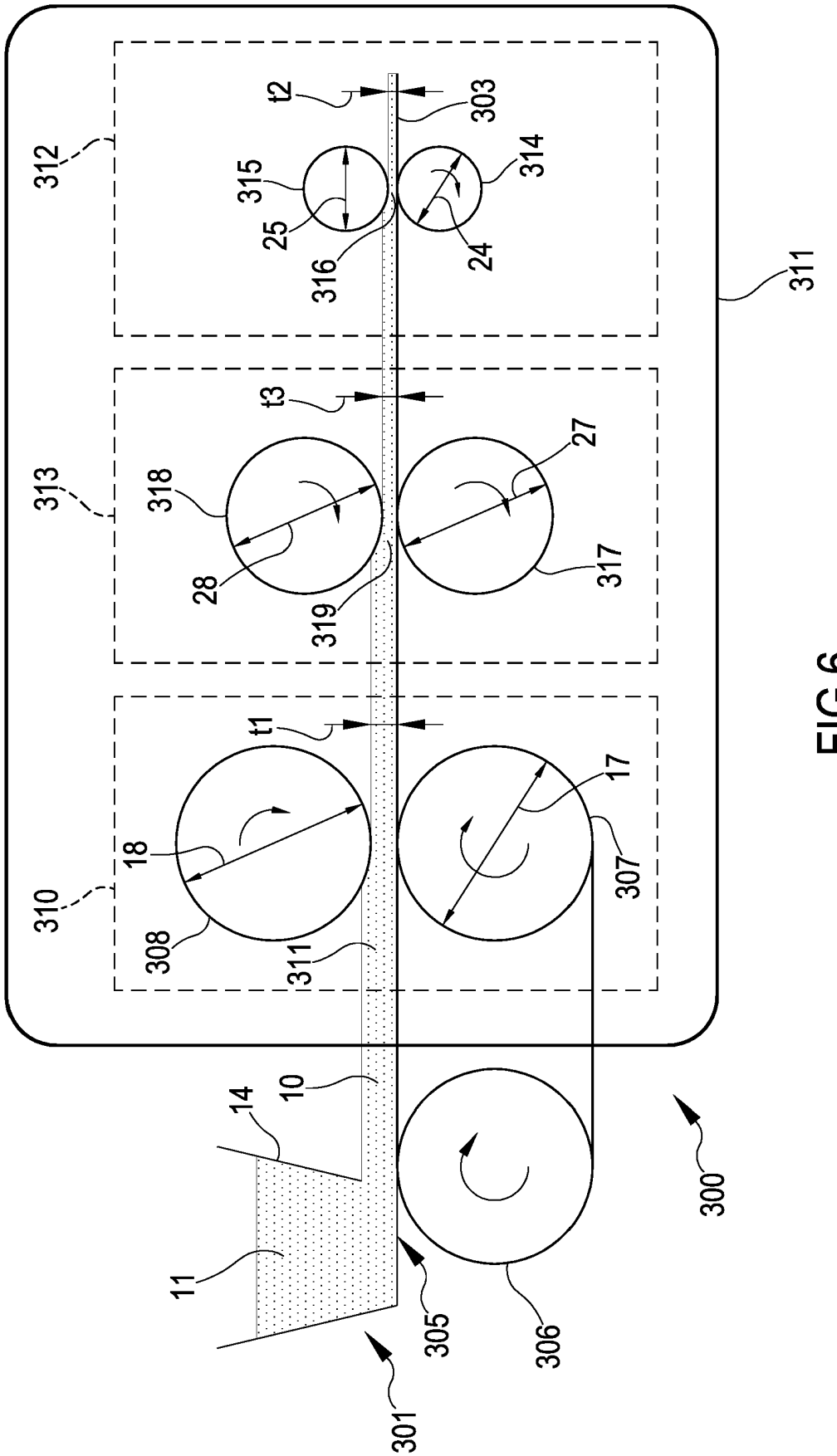

312
t2
303
315
314
25
316
24
311
313
t3
318
27
28
317
319
310
t1
18
17
308
307
311
14
10
11
305
306
301
300

FIG.6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 5501237 A **[0009]**