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(54) **METHOD OF PRODUCING HOMOGENEOUS SHEETS OF NICOTINE-FREE VEGETABLE FIBERS**

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(57) **ABSTRACT**

Method for producing homogeneous sheets of nicotine-free vegetable fibers includes:

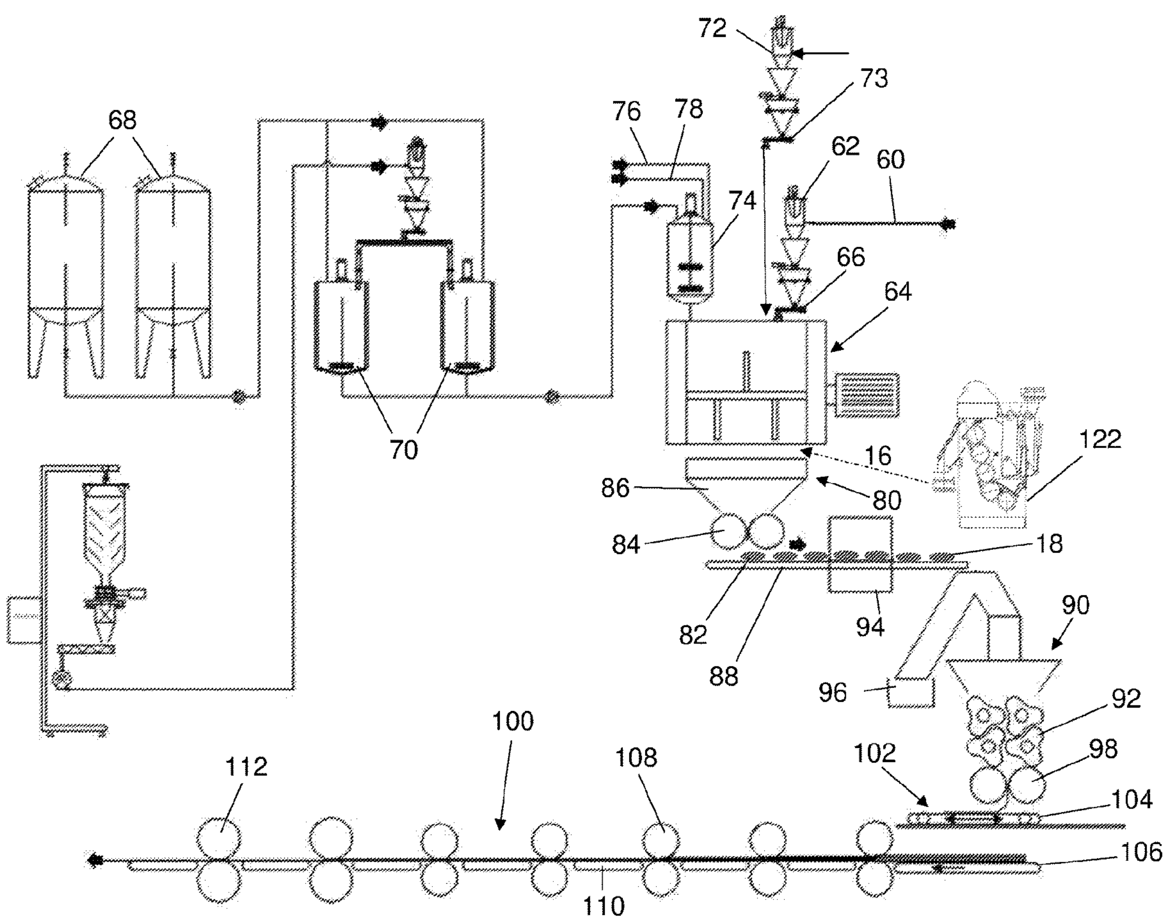
crushing up solid components of a raw material containing the nicotine-free vegetable fibers to bring them to a particle size of about 20-220 μm,

mixing the crushed-up product thus obtained with water, at least one binding agent and at least one material to form an aerosol, until a mixture is obtained with a liquid content of about 30-50%,

subjecting the mixture to a first lamination to obtain a continuous strip with a thickness of about 1-20 mm,

subjecting the strip which has already been subjected to the first lamination to a series of further lamination steps, until a strip having a remarkably constant thickness of about 90-280 μm is obtained, and

drying the strip to a liquid content of about 8-15%.



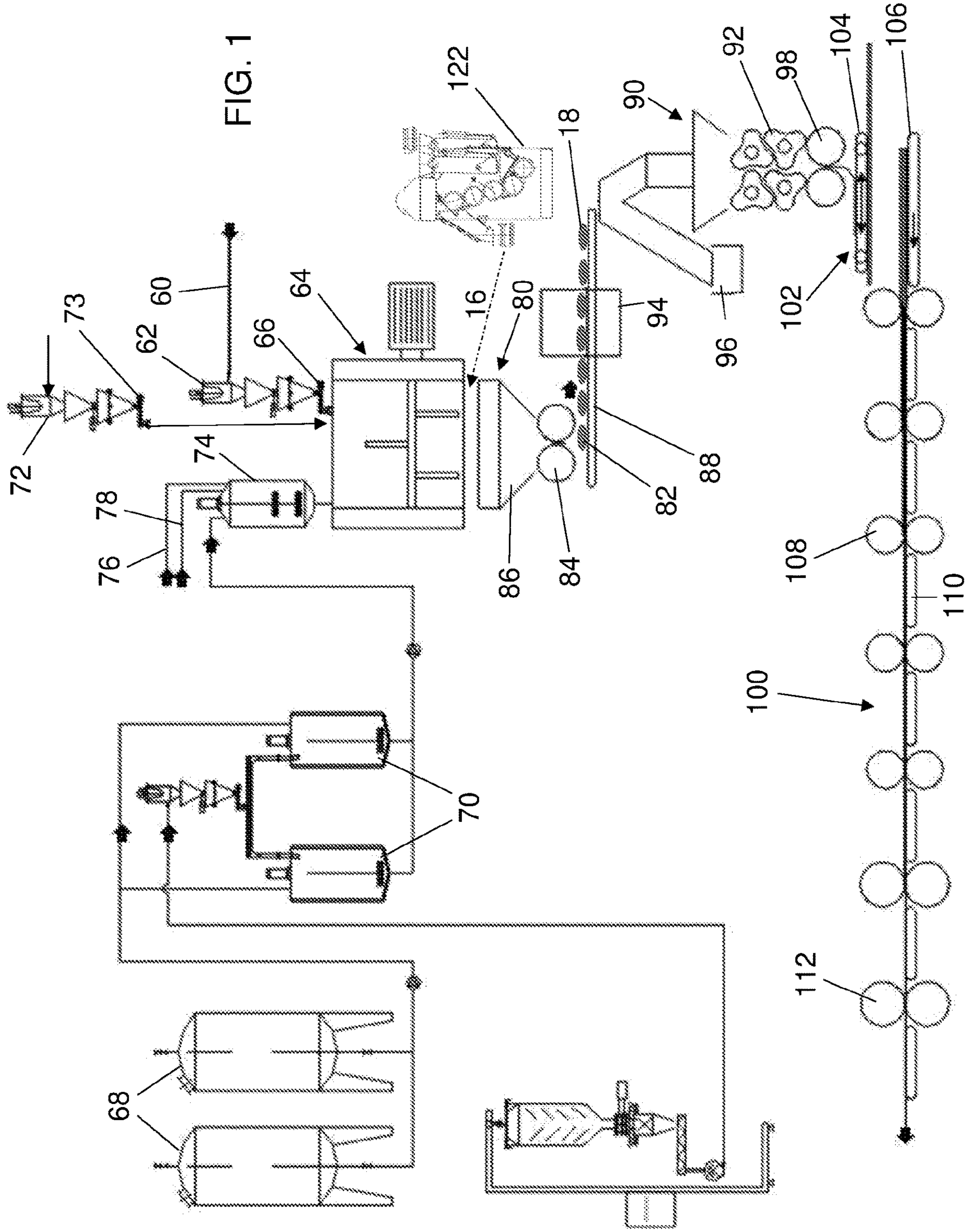

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FIG. 1

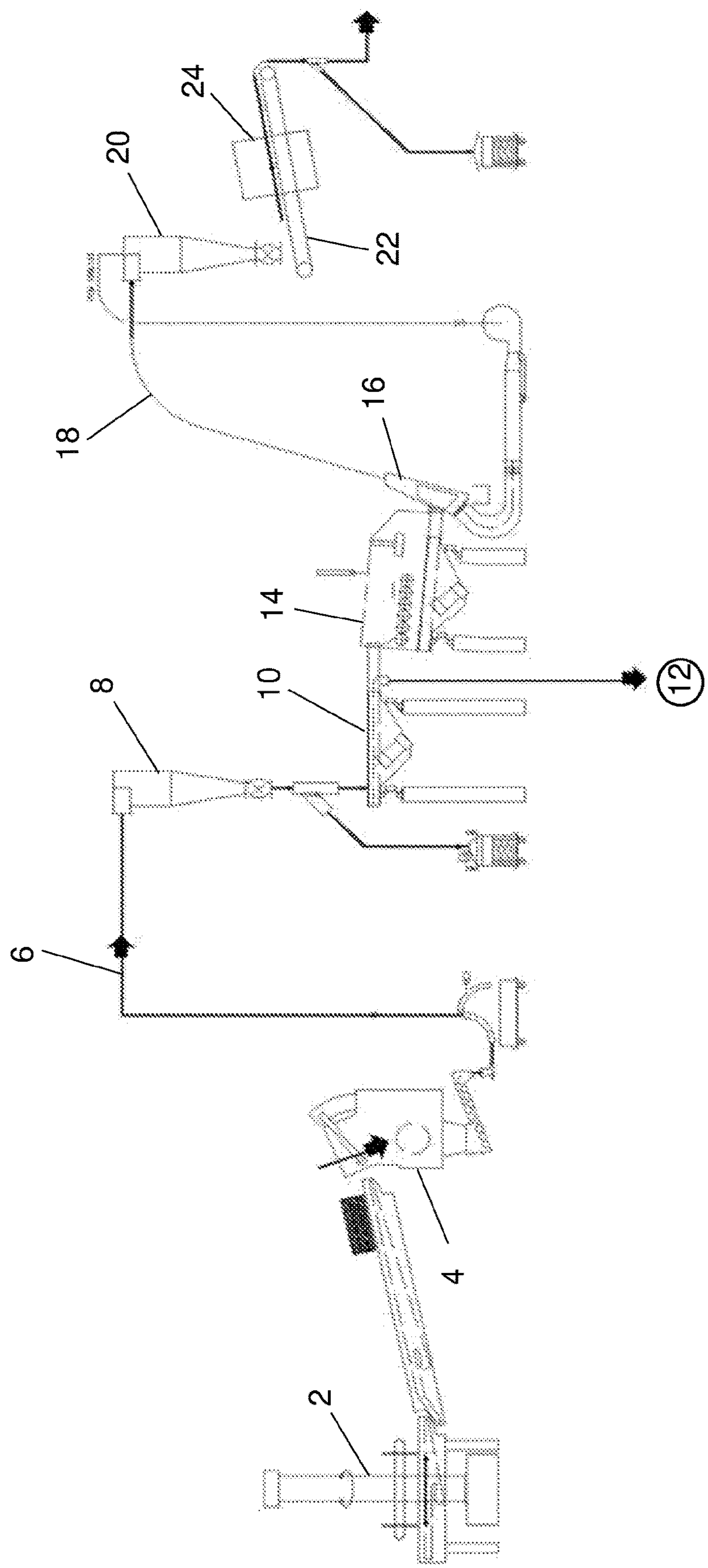


FIG. 2

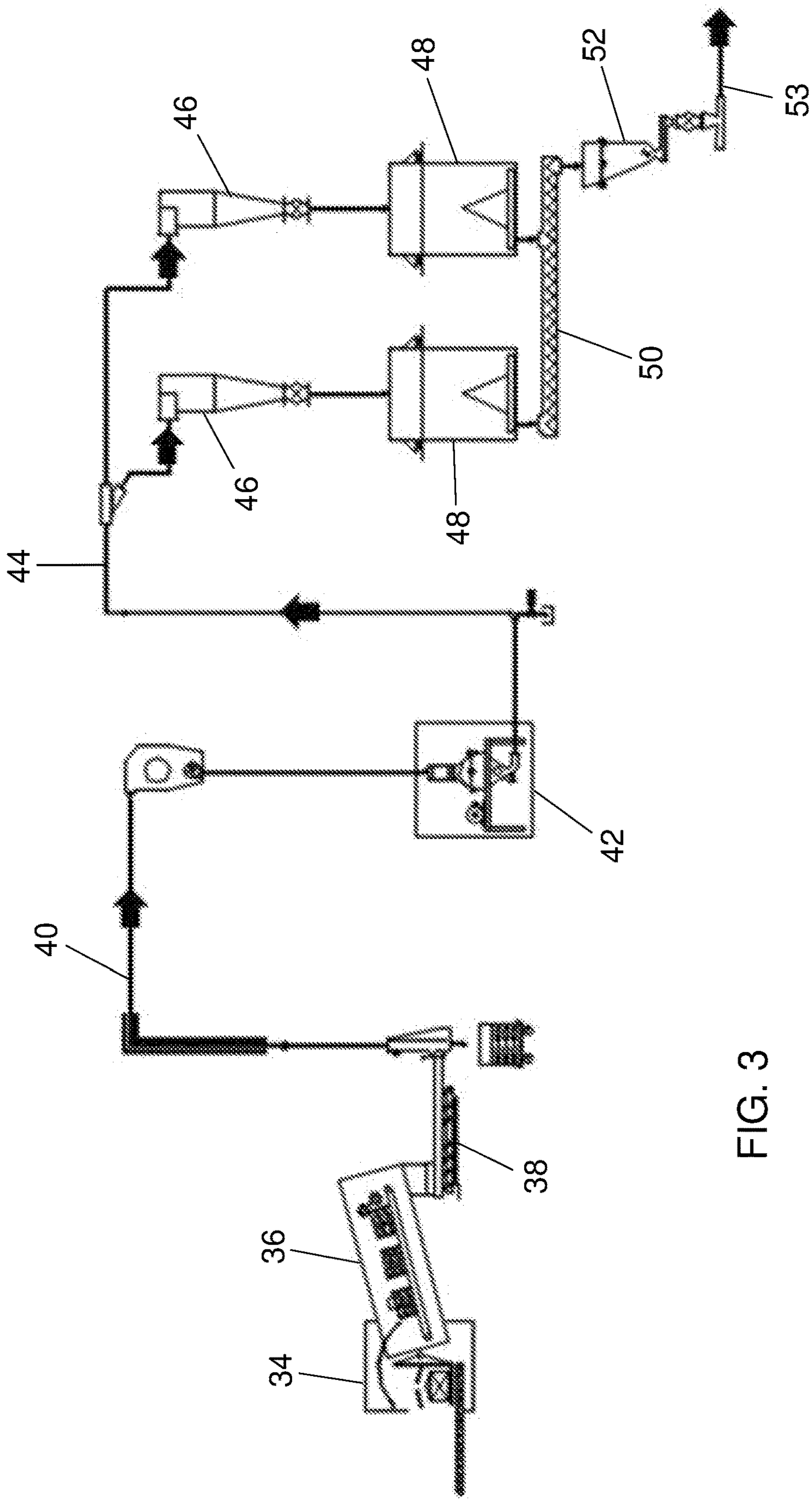


FIG. 3

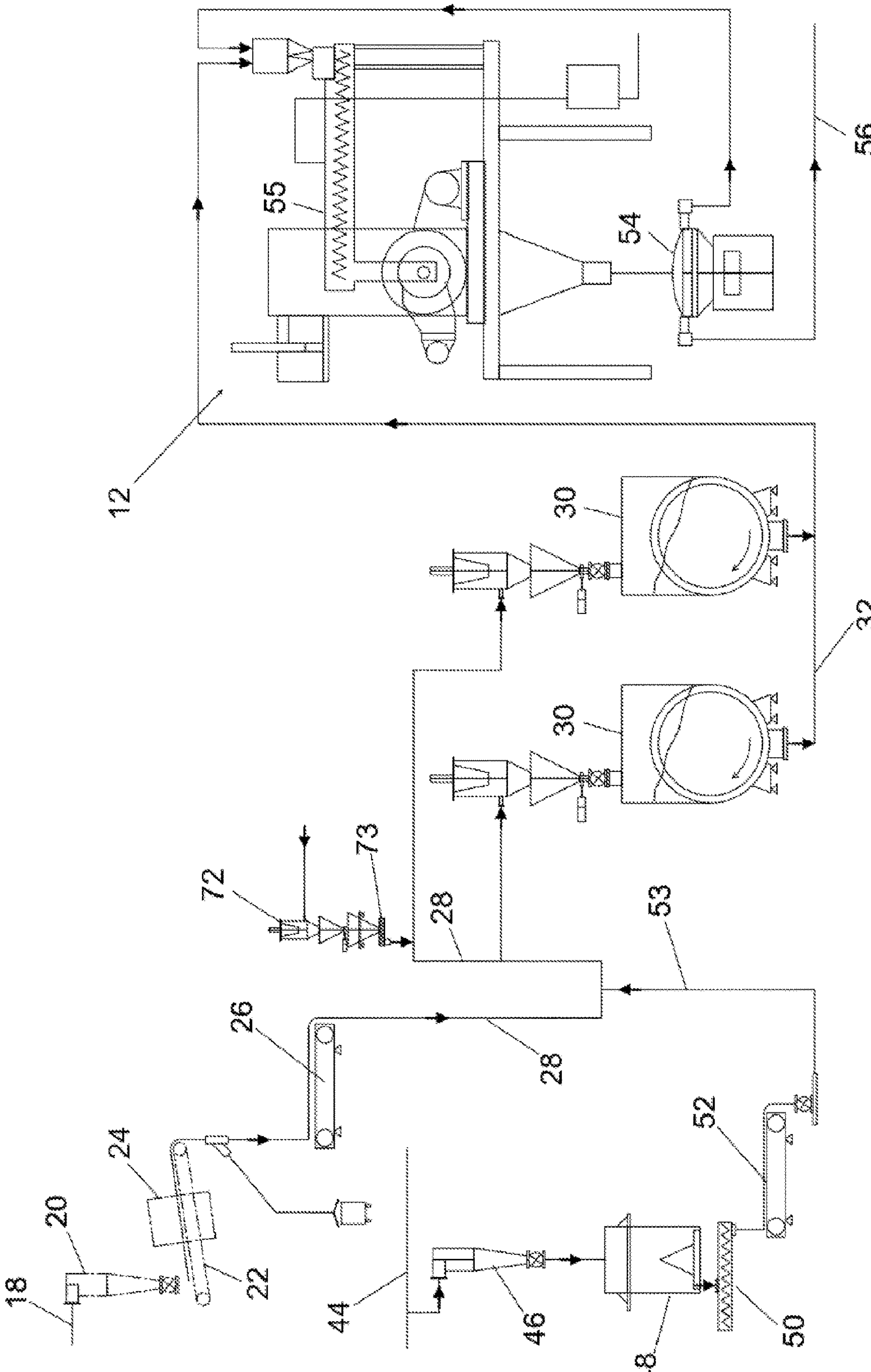


FIG. 4

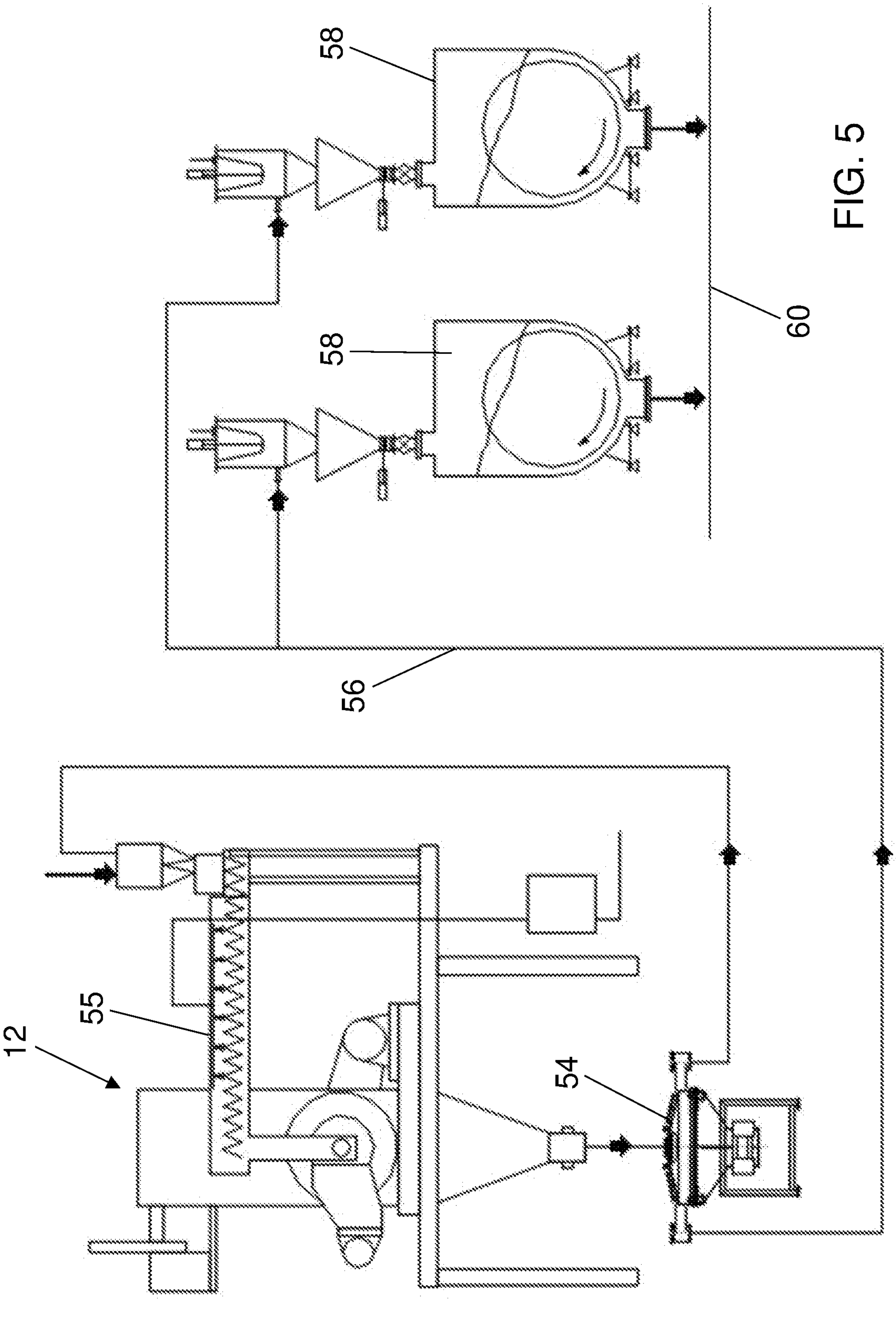


FIG. 5

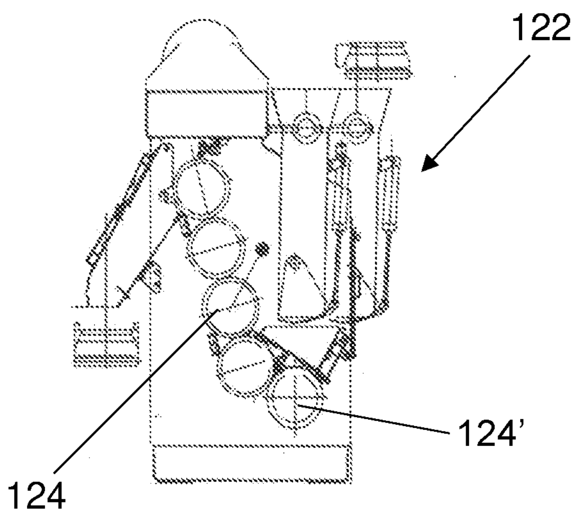


FIG. 6

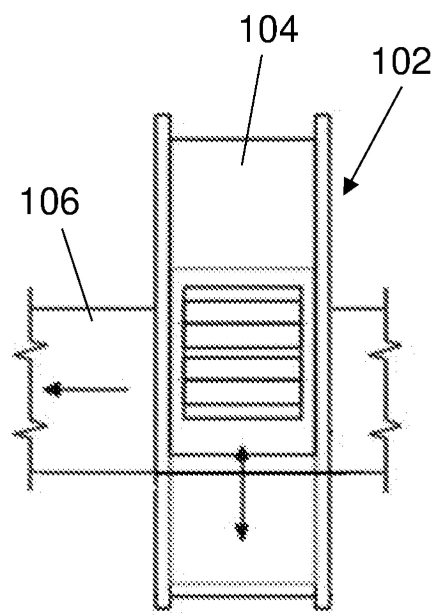
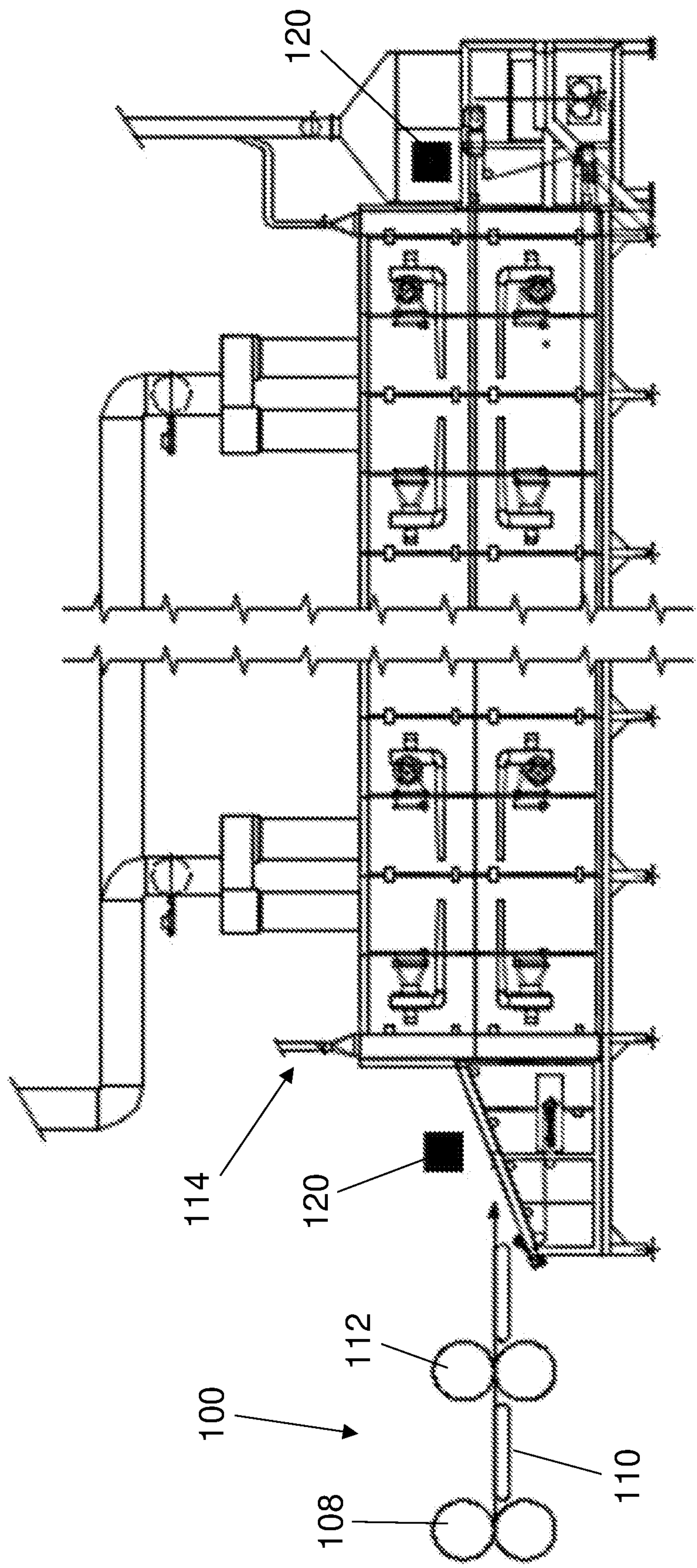


FIG. 7

FIG. 8



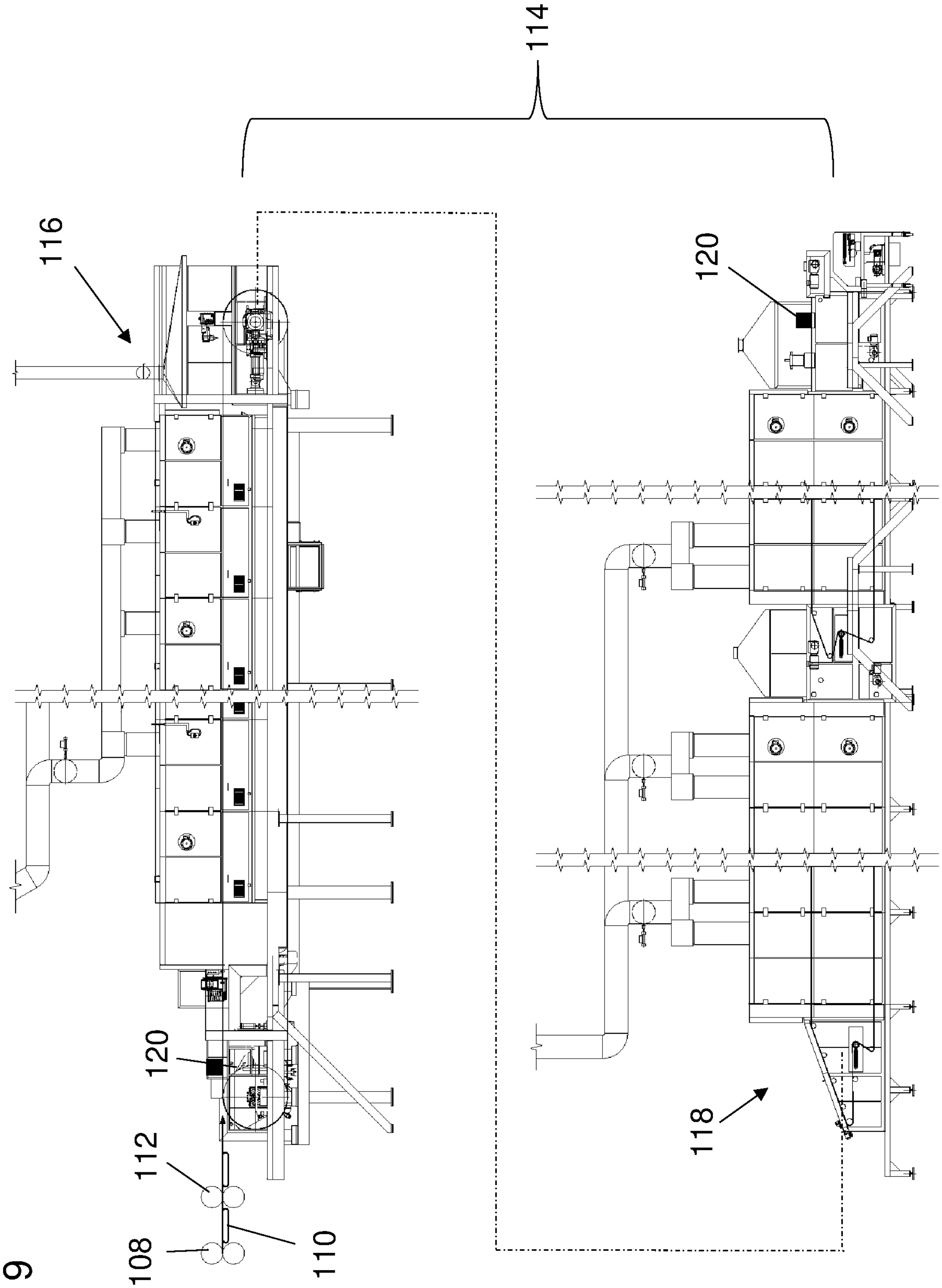


FIG. 9

METHOD OF PRODUCING HOMOGENEOUS SHEETS OF NICOTINE-FREE VEGETABLE FIBERS

FIELD OF THE INVENTION

[0001] The present invention relates to a method of producing homogeneous sheets of nicotine-free vegetable fibers.

BACKGROUND

[0002] Methods for producing reconstituted tobacco sheets are known, both conventional and unconventional, the latter also referred to as HNB (Heat Not Burn). In general, reconstituted tobacco is obtained with the use of tobacco by-products and processing scraps (ribs, small pieces of leaves, powder, etc.) which, properly ground up to be practically reduced to powder and mixed with water, glycerin binders and other liquid additives, allow to obtain an extremely fluid mixture (slurry) having a liquid content of about 70% by weight, which is then poured in the form of a veil on a steel strip and with this transferred to a drying. Here the evaporation of the liquid fraction of the mixture takes place, so that the solid residue forms a sort of continuous strip of tobacco having approximately the same width as the steel strip. Subsequently, the dried mixture strip is separated from the steel strip and is cut into pieces of various sizes according to the request. These pieces are then transformed into thin filaments which, suitably mixed, are fed to a traditional cigarette packing machine.

[0003] Depending on the raw materials used and, in particular, depending on whether shredded tobacco by-products up to a particle size between 20 μm and 220 μm are used, or whether crushed tobacco leaves with dimensions between 5 and 10 mm are used, the reconstituted tobacco is distinguished into conventional or unconventional.

[0004] WO 2016/050469, WO 2016/050470, WO 2016/050471, WO 2016/050472 describe known techniques for the production of reconstituted tobacco, which however require large plants and involve high energy consumption to carry the slurry, which when it is product is rather fluid, to the consistency of a sheet of tobacco. It is sufficient to point out that a drying oven can reach up to 100 m in length.

[0005] Another drawback of the known techniques for the production of reconstituted tobacco with the use of by-products consists in the fact that the formation of the sheet starting from the slurry film is rather irregular, since the starting products are not homogeneous and their distribution on the steel is not uniform; it follows that the reconstituted tobacco sheet does not allow it to be reeled or cut regularly.

[0006] WO2019/157576 describes a method for the preparation of strips of reconstituted vegetable material in which, between a pre-lamination phase and the final lamination phase, a remixing of the pre-laminated sheet is provided inside a mixer in order to obtain a homogeneous mass from then submit to the final lamination.

[0007] WO2016/067226 describes a method a process for preparing reconstituted tobacco comprising: a first drying unit, a grinding unit, a mixing unit for the solid components (i.e. tobacco powder with solid powder of natural binders), a mixing unit for the liquid components (i.e. liquid/nanogel with propylene glycol and glycerin), a unit for mixing the solid mixed components with the liquid mixed components, from one to three lamination units to obtain a 0.15 film—0.3 mm, and a dryer to reduce the moisture content of the film.

[0008] The purpose of the invention is to use the known technique for producing sheets and strips of reconstituted tobacco in sectors in which it has not yet been used and at the same time to modify it in order to eliminate the drawbacks that it already highlights in the specific tobacco sector and would highlight even more in these new sectors of use. In particular, the invention aims to produce homogeneous sheets and strips of nicotine-free vegetable fibers, in particular potato, hemp, tea, chamomile, mint, sage, rosemary, eucalyptus and others.

[0009] Another object of the invention is to produce homogeneous sheets of vegetable fibers with plants of much smaller dimensions than those of the known plants for the production of reconstituted tobacco.

[0010] Another object of the invention is to produce homogeneous sheets of vegetable fibers with limited energy consumption.

[0011] Another object of the invention is to produce homogeneous sheets of vegetable fibers using apparatuses that are partly already available on the market, even if never used in this specific technical sector.

[0012] Another object of the invention is to produce homogeneous sheets of vegetable fibers with characteristics suitable for satisfying different market demands.

[0013] Another object of the invention is to produce homogeneous sheets of vegetable fibers by operating at low temperatures and therefore preserving all the aromas of the raw materials used.

SUMMARY

[0014] According to the invention, all these objects and others that will result from the following description are jointly or separately achieved with a method of producing homogeneous sheets of nicotine-free vegetable fibers according to the appended claims.

[0015] In particular, the method according to the invention for producing homogeneous sheets of nicotine-free vegetable fibers is characterized by the fact that it includes the carrying out, in sequence, of the following steps:

- **[0016]** the solid components of the raw materials are crushed with vegetable fibers until they reach a particle size of about 20-220 μm, preferably about 80-180 μm,
- **[0017]** the crushed product thus obtained is mixed with water, optionally powdered cellulose, at least one binding agent and at least one material to form an aerosol, until a mixture is obtained with a liquid content of about 30-50%, preferably about 35-40%,
- **[0018]** said mixture is subjected to a first lamination to obtain a continuous strip with a thickness of about 1-20 mm, preferably about 1-10 mm,
- **[0019]** - said strip, already subjected to said first lamination, is subjected to a series of further lamination steps, until a strip having a significantly constant thickness of about 90-280 μm, preferably of about 140-200 μm, is obtained,
- **[0020]** said strip is dried until its liquid content is about 8-15%.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The present invention is further clarified hereinafter in some of its preferred embodiments reported for purely illustrative and non-limiting purposes with reference to the attached drawings, in which:

[0022] FIG. **1** shows a general schematic view of a plant for the production of homogeneous sheets of vegetable fibers according to the invention,

[0023] FIG. **2** shows its feeding section in case the sheets of vegetable fibers are obtained from plant leaves,

[0024] FIG. **3** shows its feeding section in case the sheets of vegetable fibers are obtained from stems and branches of plants,

[0025] FIG. **4** shows a partial scheme of the plant with two distinct lines of pre-treatment of the leaves and stems and branches of plants,

[0026] FIG. **5** shows its section of grinding, mixing and storage,

[0027] FIG. **6** shows a schematic view of one of its cylinders refiner,

[0028] FIG. **7** shows in plan its stratification section in a particular embodiment.

[0029] FIG. **8** schematically shows its hot air dryer, and

[0030] FIG. **9** schematically shows its hot air dryer in a different embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] As can be seen from the figures, the method according to the invention to produce homogeneous sheets of nicotine-free vegetable fibers uses a plant comprising several sections aimed at operating on the input raw materials up to transforming them into a continuous belt of vegetable fibers to be sent to subsequent processing or packaging. The raw materials used can consist for example of potato, hemp, tea, chamomile, mint, sage, rosemary, eucalyptus and others.

[0032] More particularly, the plant for carrying out the method according to the invention comprises:

- **[0033]** a pre-treatment section of the starting solid products (leaves, stems and branches of the plants) for their preparation for subsequent grinding treatments,
- **[0034]** a grinding and storage section awaiting subsequent mixing with suitable treatment liquids,
- **[0035]** a mixing section of solid and liquid materials to obtain a homogeneous mixture with a rather dense consistency,
- **[0036]** a section for converting the mixture, and in particular of a plurality of portions of said mixture, into a continuous belt,
- **[0037]** a rolling line of the continuous strip for its reduction to the desired final thickness,
- **[0038]** a drying section of the laminated web.

[0039] Conveniently, the preparation and pretreatment section of the solid starting products can comprise a pretreatment section of the plant leaves used for the preparation of the vegetable fiber sheets (FIG. **2**, **4**) and/or a preparation and pretreatment section of the stems and branches of plants (FIG. **3**, **4**).

[0040] In the case of preparation and pre-treatment of plant leaves (FIG. **2**, **4**), the relative section includes a feeding station with a bench **2** for unpacking the bales of vegetable leaves, which generally contain them, and the transfer of these to a grinder **4**.

[0041] Conveniently, the output of this grinder **4** is connected, through a pneumatic conveying line **6**, to a cyclone **8**, in which the transport air is separated from the solid product, which is transferred to a sieve vibrator **10** for the separation of the fine parts from the remaining parts of the product. The outlet of the fine parts is directly connected to a mill **12**, preferably of the cryogenic type, while the outlet of the remaining parts of the product feeds a traditional twine lever machine **14**, which eliminates any twine previously not removed from the bales of leaves of vegetables.

[0042] The output of the twine lever machine **14** feeds a classification chamber **16** for the separation of any heavy foreign bodies from the vegetable leaves, which through a pneumatic conveying line **18**, a cyclone **20**, a belt conveyor **22**, equipped with a metal detector **24** for the removal of any metal bodies, a weighing system **26** (master scale), and a pneumatic conveying line **28**, are transferred to storage and mixing silos **30**, from which they can then be transported through another pneumatic transport **32**, to the cryogenic mill **12**. These silos **30** are sized in such a way as to contain the quantities of product necessary to form the batches according to the particular recipes to be prepared.

[0043] On the other hand, in the case in which the preparation and pre-treatment section is provided to operate on the stems and branches of plants to be used to prepare the sheets of vegetable fibers (FIG. **3**, **4**), it comprises a tilter **34** for containers containing stems and branches of plants, a feeder **36** of these to a vibrating conveyor **38**, for the separation from them of any heavy bodies, and a pneumatic conveying line **40** for their transfer to a hammer mill or to a shredder **42**, where they are shredded.

[0044] The hammer mill or shredder **42** has the outlet in turn connected, by means of a pneumatic conveying line **44** equipped with cyclone filters **46**, to one or more storage silos **48**.

[0045] The output of the storage silos **48** is in turn connected, by means of a screw conveyor **50**, to a weighing system **52** (slave scale), which doses the chopped stems and branches in the percentage required by the particular recipe to be prepared, which can then be started, through a line of pneumatic transport **53**, to the storage and mixing silos **30**, from which they can then be transported, through the pneumatic transport line **32**, to the cryogenic mill **12**, which grinds the various products received up to bring them to an average particle size of about 20-220 μm, preferably about 80-180 μm.

[0046] There are various types of mills that can be used, although it is more advantageous to use a cryogenic pin mill, which allows the product to be kept at low process temperatures and therefore to retain the aromas of the raw materials used.

[0047] The pin mill is traditional in itself and comprises within a closed structure a fixed disc and a rotating disc or two counter-rotating discs, provided with facing and partially interpenetrating pins. Being a traditional apparatus in itself, it has been globally indicated with **12** in FIGS. **4** and **5** but is not shown in its internal construction characteristics or in its operating modes.

[0048] Preferably, the pin mill **12** is arranged for carrying out cryogenic grinding, that is, milling in the presence of liquid nitrogen.

[0049] As stated, in a plant for the production of sheets of vegetable fibers a cryogenic pin mill **12** is somewhat more advantageous than a traditional mill, essentially due to the different ways in which the products to be ground are treated. In fact, milling at room temperature can lead to poor quality products while milling in the presence of liquid nitrogen allows the physical properties and the chemical and organoleptic characteristics of the products to be preserved.

[0050] The amount of liquid nitrogen used in cryogenic milling processes is a key part to consider when investigating the pros and cons of the process, and can vary depending on the materials being processed. Liquid nitrogen at a temperature of −175° C. is injected onto the product inside the chamber of a screw conveyor **55** which feeds the mill **12** and its residence time in contact with the nitrogen is approximately 2 to 5 sec., which is also the transit time of the product inside the screw **55**. The temperature of the product leaving the mill **12** is advantageously lower than 10° C., so that the nitrogen vapors, which are released almost instantly at the contact with the raw material to be cooled, run through the entire feeding system of the mill in countercurrent, carrying out the desired pre-cooling effect. The flow of liquid nitrogen in the pre-cooling system and in the mill is controlled by thermocouples, which make the cryomilling process fully automatic.

[0051] In summary, the positive factors of cryogenic milling are:

[0052] higher yields,

[0053] better quality of the final product without breaking or tearing of the molecular structure,

[0054] decrease in energy required,

[0055] better quality of the final product,

[0056] less waste due to overheating and oxidation,

[0057] more homogeneous and finer final product,

[0058] less amount of material to be reprocessed in the milling system.

[0059] Conveniently, the outlet of the cryogenic pin mill **12** is connected to a fluid bed sieve **54**, which has the function of separating the ground product, which comes out of the mill itself and generally has an average particle size of about 20-220 μm, preferably of about 80-180 μm, from larger sizes, inevitably present.

[0060] Conveniently, the fluidized bed sieve **54** therefore has the function of classifying the product and reintroducing the one with fractions greater than 220 μm into the mill **12**, after having separated them from those between 20 μm and 220 μm, which through a pneumatic transport **56** are sent to one or more mixing and storage silos **58**.

[0061] Advantageously, the outlet of the mixing and storage silos **58** is connected, by means of a pneumatic transport line **60**, with a cyclone filter **62**, which has the function of breaking down the dusty air and more specifically of separating the dust, which is then recovered and reintroduced into the cycle, from the air, which can then be expelled.

[0062] Conveniently, the outlet of the cyclone filter **62** feeds, through a continuous dosing system **66**, preferably with a screw, a mixer **64**, which can be of various types, for example of the horizontal tilting type or vertical spiral type.

[0063] The mixer **64** is fed with metered quantities of chopped raw material, water, at least one binding agent and at least one material to form an aerosol, and is configured to obtain a mixture with a liquid content of about 30-50%, preferably about 35-40%.

[0064] In particular, the values of liquid or humidity, indicated in the present description, are intended to be determined according to the measuring system on a wet basis. In particular, the humidity values are defined as the percentage of water contained in the total mass of the corresponding product and, in other words, as the percentage ratio between the quantity of water and the total mass of the assembly. Conveniently, these values are obtained using the traditional methods provided in the literature to measure the amount of water in a product, such as those presented in "Tobacco Moisture, Water and Oven Volatiles—A status report of common moisture methods used within the tobacco industry" by Nils Rose ET AL. in "Analytical and bioanalytical chemistry" (1 Jul. 2014, pages 1-16).

[0065] Preferably, at least one duct for inlet water, a material for the formation of aerosols (for example glycerin) and at least one binding agent (binder) is connected to the mixer **64**. Conveniently, one or more inlet ducts can be provided for other additives required by the particular recipe to be prepared.

[0066] More particularly, the plant comprises one or more storage tanks **68** for aerosol formation material and one or more pre-mixers **70**, into which said material for aerosol formation can be introduced and, preferably, a plurality of additives dosed in the right proportions to form the liquid to be introduced into the mixer **64**.

[0067] In order to increase the resistance of the sheet of finished product and at the same time increase the density of the product itself, it is preferable that it is introduced into the mixer **64**, together with the other components of the mixture, also powdered cellulose. Conveniently, the cellulose powder used is made up of an organic fiber obtained from natural cellulose, and not a compound derived from cellulose. The powdered cellulose thus added preferably has a particle size comprised between 50 and 100 μm and is preferably in a percentage comprised between 2% and 10% by weight with respect to the crushed tobacco.

[0068] The added powdered cellulose is predominantly or exclusively of natural origin. In particular, the powdered cellulose thus added is not synthetic and is not obtained by chemical treatments.

[0069] Conveniently, the powdered cellulose thus added does not have a binding function but the function of lowering the specific weight of the finished product and of reducing the solid components of tobacco, thus reducing the costs of the finished product, since cellulose has a cost much lower than tobacco. Furthermore, the addition of cellulose makes the finished product less brittle by increasing the tensile strength, and therefore it is more easily workable, and this is particularly useful in the case in which a pleated sheet of finished product is to be obtained.

[0070] This powdered cellulose, which before its use is contained in bags or big-bags, can be directly introduced into the mixer **64** (FIG. **1**) and in this case, after being poured into a traditional hopper, it is fed to a cyclone filter **72**, which through a continuous dosing system **73**, preferably of the screw type, introduces it in a metered quantity into the mixer **64**.

[0071] Alternatively, the powdered cellulose can be introduced, again through a cyclone filter **72** and a continuous dosing system **73**, in the pneumatic conveying line **28** which feeds the mixing and storage silos **30**, from which it is then transferred to the mill **12** (FIG. **4**) through the pneumatic conveying line **32**, together with the other components of the mixture, present in the line itself. From the mill **12** the contents of the mixing and storage silos **30** are then transferred, through the pneumatic conveying line **56** to the silos **58** and from there, through the pneumatic conveying line **60**, the cyclone filter **62** and the metering device **66**, in the mixer **64**.

[0072] Examples of preferred materials for aerosol formation (and in particular for the formation of a visible aerosol) include polyhydric alcohols (e.g. glycerin, propylene glycol, triethylene glycol and tetraethylene glycol), aliphatic esters of acids mono-, di- or polycarboxylics (e.g. methyl stearate, dimethyl dodecanedium and dimethyl tetradecanioate), as well as their mixtures. Suitably, glycerin, propylene glycol, triethylene glycol and tetraethylene glycol can be mixed together to form an aerosol-forming material. The aerosol forming material can also be provided as a portion of the binding agent (e.g., when the binding agent is propylene glycol alginate). Advantageously, suitable combinations of materials for aerosol formation can also be provided.

[0073] Preferably, said at least one binder includes at least one of hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxyethylcellulose, microcrystalline cellulose, methylcellulose, carboxymethylcellulose (CMC), corn starch, potato starch, guar gum, locust bean gum, pectin and alginates (e.g. ammonium alginate and sodium alginate).

[0074] Preferably, the binder and the added powdered cellulose are defined by materials different from each other. Conveniently, the powdered cellulose mainly serves to form a three-dimensional framework with a high thickening effect, a pseudo-plastic behavior and a good capacity to retain liquids, while the binding agent serves exclusively or mainly to bind together the various components to be mixed.

[0075] Advantageously, the outlet of the pre-mixers **70** is connected to an inlet of a hydrator **74**, having other inlets connected to a water supply line **76** and to a compressed air supply line **78**.

[0076] Preferably, the outlet of the mixer **64** feeds a unit **80** for forming the mixture to obtain a plurality of portions **82**, preferably shaped like loaves and separated from each other. Conveniently, the forming unit **80** comprises a pair of forming cylinders **84**, presenting grooves preferably parallel to the axis of the cylinders themselves and intended to pick up the mixture at the inlet and to supply the portions **82** at the outlet. Advantageously, the unit **80** is also configured to carry out a roughing of the mixture and for this purpose, preferably, comprises a hopper **86** provided inside it with a lump breaker and on the bottom of said pair of forming cylinders **84**.

[0077] Advantageously, at the outlet of the forming unit **80** a conveyor belt **88** is provided for transferring the portions **82** to a first rolling unit **90**.

[0078] Preferably, the first rolling unit **90** comprises a lobe feeder **92** to homogenize the mixture formed by the portions **82**.

[0079] Advantageously, a further metal detector **94** can be provided along the transfer path from the forming unit **80** to the lobe feeder **92**, having the function to remove any metal parts, which may still be present in the mixture and could damage subsequent processing units. These metal parts are conveyed along a distinct path before entering the lobe feeder **92** and are collected in a suitable container **96**.

[0080] The lobe feeder **92** comprises a series of lobed feed rollers, between which the portions are made to pass. **82** (which come out of the forming rolls **84** of the forming unit **80**) so as to be mixed together and homogenized before being pushed between a pair of rolling rolls **98**, which are configured to form a continuous strip of thickness about 1-20 mm, preferably about 1-10 mm.

[0081] Conveniently, therefore, the lobe feeder **92** causes homogenization of the product which leaves the forming unit **80** and which could have lumps. Advantageously, moreover, the lobe feeder **92** also advances the product to push it into the inlet between the pair of lamination rolls **98**.

[0082] Therefore, the first lamination unit **90** conveniently comprises a homogenization module, preferably defined by the lobe feeder **92**, which is positioned immediately upstream with respect to a pre-lamination module which is defined by at least one pair of lamination cylinders **98**, which are configured to form a continuous strip with a thickness of approximately 1-20 mm, preferably about 1-10 mm. Advantageously, the strip thus obtained has a greater elasticity.

[0083] Conveniently, in a version not shown of the plant, downstream of the lobe feeder **92** the rolling line **100** can be provided directly. In particular, in this case, the rolling line receives the single-layer continuous strip having a thickness of about 1-20 mm, preferably about 1-10 mm, which comes out of the first lamination unit **90** provided with a lobe feeder **92**.

[0084] Advantageously, downstream of the first lamination unit **90** and upstream of the lamination line **100**, a layering unit **102** can be provided. Preferably, it is configured to arrange on several layers the single-layer continuous strip, having a thickness of about 1-10 mm, which comes out of the first lamination unit **90**, so as to transform it into a multilayer belt with a thickness of about 2-20 mm, which is then sent to the inlet of the rolling line **100**.

[0085] Preferably, said stratification unit **102** consists of an upstream conveyor belt **104**, which it has the function of depositing the product belt on an underlying downstream conveyor belt **106**, preferably belonging to the rolling line **100**, arranging it so that it is layered on said downstream conveyor belt **106**, for example by multiple folding on itself. Preferably, the upstream conveyor belt **104** is raised with respect to the downstream conveyor belt **106** and is equipped with a continuous motion of advancement with respect to its support structure, and at the same time of an alternating motion with its support structure, parallel to the its longitudinal axis.

[0086] Conveniently, the layering unit **102** feeds the subsequent and underlying rolling line **100**, and depending on the type of plant the upstream conveyor belt **104** of the layering unit **102** can be arranged parallel or perpendicular to the downstream conveyor belt **106**, which advantageously is the inlet belt of the rolling line **100**. In particular, if the conveyor belts of the rolling line **100** have a width substantially equal to the width of the product belt that leaves the layering unit **102**, the upstream conveyor belt **104** is arranged parallel to the infeed conveyor belt **106** of the lamination line **100** (FIG. **1**), while if the conveyor belts of the lamination line **100** are wider than the product belt exiting the layering unit **102**, it is preferable that the upstream conveyor belt **104** is arranged orthogonally to the infeed conveyor belt **106** lamination line **100** (FIG. **7**). In this way, the alternating movements of the supporting structure of the upstream conveyor belt **104** of the layering unit **102** can distribute the product belt over the entire useful width of the rolling line **100**.

[0087] In both cases, however, the alternating movement of the support structure of the upstream conveyor belt **104** of the stratification unit **102** causes a stratification of the product belt, which leaves the first rolling unit **90**, on the underlying first conveyor belt **106** of the lamination line **100** and the formation of a belt laminated with a width substantially equal to the useful width of the rolling line itself.

[0088] The rolling line **100** is formed by several rolling stations, each comprising a pair of cylinders **108**, which delimit an increasingly narrow passage between them to progressively reduce the thickness of the strip of product being processed. In particular, the lamination line **100** is configured to progressively bring the continuous strip to a thickness of 90-280 μm, preferably of about 140-200 μm.

[0089] Preferably, between each rolling station and the next there is provided a conveyor belt **110** having a length preferably of about 1.5-2 m, i.e. sufficient to allow the product to rest before it is subjected to the subsequent rolling step.

[0090] Advantageously, the rolling line **100** is then completed with one or more calibration stations, each formed by a pair of calibrating rolls **112**. laminating rolls

[0091] It is advantageously provided that the **108** and possibly also the calibrating rolls **112** can be heated, so as to be able to start the drying phase already during lamination. Conveniently, downstream of the rolling line **100** there is a dryer **114**, preferably with air recirculation (FIG. **8**), to bring the liquid content of said rolled strip to about 8-15%. Advantageously, the dryer **114** can be divided into two units **116**,**118**, placed in series with each other (FIG. **9**). In this case, the upstream unit **116** is provided for carrying out the first drying phase and is equipped inside with a steel belt or net belt conveyor for transporting the product leaving the rolling line **100**; the unit **118** downstream is provided to carry out the second drying phase and the subsequent cooling phase and is internally equipped with a network belt conveyor.

[0092] Furthermore, the dryer **114** is advantageously provided at the inlet and outlet with sensors **120**, preferably infrared rays, which monitor the product along its entire length.

[0093] For the preparation of sheets of vegetable fibers starting from vegetable leaves, the cartons containing said leaves are placed on the undressing bench **2** (FIG. **2**), where the single bales of vegetable leaves are removed from the cartons and sent to the grinder **4**, which reduces the leaves themselves to a substantially uniform size between 5 and 10 mm.

[0094] Conveniently, the grinded product is then transferred along the pneumatic conveying line **6** to the cyclone **8**, which separates it from the air and makes it fall onto the vibrating sieve **10**.

[0095] Here the separation of the finer parts takes place, which are sent directly to the cryogenic mill **12**, from the remaining parts which, after passing through the twine lever machine **14**, are sent to the classification chamber **16** for the separation of any heavy bodies from the shredded leaves, which through the pneumatic conveying line **18**, the cyclone **20**, the conveyor belt **22** equipped with metal detector **24** for the removal of any metal bodies, the weighing system **26** (master scale) and the pneumatic conveying line **28** are transferred to the storage and mixing silos **30**, from which they can then be transported, through the pneumatic conveying line **32**, to the cryogenic mill **12**.

[0096] In the event that sheets of vegetable fibers are to be produced starting from stems and branches of plants, the relative containers are placed on the tipper **34** (FIG. **3**), which feeds them to the vibrating conveyor **38** for the removal of any heavy bodies. The stems and branches are then transferred through the pneumatic line **40** to the hammer mill **42**, which shreds them to reduce them to a size between 5 and 8 mm.

[0097] From here the chopped stems and branches, separated in the cyclones **46** from the transport air, are transferred to the storage silos **48**, from which the different types, coming from different qualities of vegetables, can be picked up and transferred through the screw conveyor **50** to the dispenser **52**, which doses them according to the particular recipe to be prepared.

[0098] The stalks and branches chopped and dosed in the correct quantities are from here transferred through a pneumatic line to the cryogenic mill **12**.

[0099] If the plant is designed to treat both leaves and stems and branches of vegetables, in the pneumatic transport line **28** which feeds the mixing and storage silos **30** also enters the pneumatic conveying line **53** which comes from the storage silos **48** (FIG. **4**).

[0100] Regardless of the type of raw material to be produced, and therefore of the nature of the solid parts of this raw material introduced into the shredding unit, from the fluid bed sieve **54**, fed by the cryogenic mill **12**, a milled product comes out which has an average particle size of about 20-220 μm, preferably about 80-180 μm. It is sent to the mixing and storage silos **58**, from which the products can then be withdrawn according to the needs and transferred to the mixer **64**.

[0101] In addition to the milled raw material, any cellulose and in general, all the solid products coming from the mixing and storage silos **30**, are also introduced water, at least one binding agent and at least one material to form an aerosol. Advantageously, compressed air and other additives can also be introduced.

[0102] Conveniently, the whole is then mixed together to form a slurry having a percentage of liquids (humidity) of about 30-50%, preferably about 35-40%, by weight on a wet basis, i.e., a rather dense consistency.

[0103] Preferably, the mixture thus obtained is transferred to the forming unit **80**, from which the portions **82**, preferably loaf-shaped, exit in succession.

[0104] These portions of mixture **82**, which come out from the forming unit **80** are suitably transferred to the first rolling unit **90** which is configured to homogenize the mixture and to supply at the outlet a continuous strip with a thickness of about 1-20 mm, preferably approximately 1-10 mm.

[0105] This continuous strip, which comes out of the first lamination unit **90**, can be transferred directly to the lamination line **100** or, more advantageously, it can be folded on itself as it passes through the stratification unit **102** to be thus deposited in layered form on the inlet belt of the lamination line **100**.

[0106] Conveniently, as mentioned, the layering is obtained by dropping the continuous belt onto the upstream conveyor belt **104** of the layering unit **102**, which is made to advance with respect to its structure support, which is moved by reciprocating motion, so as to arrange the product belt on several layers on the downstream conveyor belt **106**, that is, at the entrance to the rolling line **100**. Depending on the plant and the direction of the reciprocating movement of the support structure of the conveyor belt **104** of the layering unit **102**, the product belt is arranged on several para layers **11** in line with the longitudinal direction of the rolling line **100** or perpendicular thereto.

[0107] Conveniently, at each passage from one station of the rolling line **100** to the other, the product strip undergoes a thickness reduction, until it reaches the desired thickness in correspondence with the output calibrating cylinders **112**, which has a significantly constant value of about 90.-280 μm, preferably of about 140-200 μm. Advantageously, moreover, at the exit from the rolling line **100** the strip has a liquid content lower than 20% or even 15%, if the laminating cylinders **108** are heated and the removal of the water has already begun during lamination.

[0108] The web of product which leaves the rolling line **100** is then subjected to drying in the dryer **114**, where its liquid content is brought to about 8-15%.

[0109] Conveniently, the dryer **114** is air-recirculated, and compared to the dryers traditionally used in reconstituted tobacco production plants it is somewhat more advantageous both in terms of manufacturing complexity and in terms of overall dimensions and in terms of energy consumption. This is because traditional plants treat a very fluid and not very stable product (slurry), unlike the product treated by the plant just described, which is much denser and much more stable. Consequently, while the plants that treat slurry require traditional irradiation and conduction dryers, the plant just described can advantageously use a recirculating air dryer **114** with a network belt conveyor or a combined system of steel belt conveyors for the first drying phase and net belt conveyors for the second drying phase and the cooling phase. In this way, with the same performance, reduced dimensions are obtained (about 45 m compared to over 100 m of a traditional dryer) and lower energy consumption due to the lower quantity of water to be removed (using about 1000 kg/hour of steam/hour compared to over 5000 kg/hour of steam from a traditional dryer).

[0110] Conveniently, at the outlet of the dryer **114** the product is ready to be wound on a reel or to be cut into sheets or cut into threads of predetermined dimensions, to be used for the intended uses.

[0111] Conveniently, in the method according to the invention, the homogenization of the mixture is carried out mainly or exclusively by means of the lobe feeder **92** and is in any case always and only carried out upstream, preferably immediately upstream of the pre-rolling module, which transforms the homogenized mixture in a continuous strip with a thickness of about 1-20 mm, preferably about 1-10 mm, to be sent to the entrance to the final rolling line **100**.

[0112] In particular, once the homogenized mixture has been transformed in a continuous strip with a thickness of about 1-20 mm, preferably about 1-10 mm, the latter is no longer remixed, but is sent in the form of a strip to the rolling line **100** to be thus brought to the desired thickness, which has a significantly constant value of about 90-280 μm, preferably of about 140-200 μm. Advantageously, the fact that the rolling line **116** receives a strip at the inlet, and not a deformed mixture, allows to guarantee a constant inlet flow, increasing the accuracy of the thickness of the sheet in the subsequent rolling steps and also allows to reduce the number of laminating cylinders **108** of the line itself, thus reducing the cost as well as the overall dimensions of the plant.

[0113] It is advantageously provided that the plant can comprise, as an alternative to the forming unit **80** or in addition and upstream of this, a cylinder refiner **122**, which has the task of bringing the solid components of the mixture to a grain size not exceeding at 20 μm.

[0114] The refiner (FIG. **6**) comprises inside a closed container a plurality of cylinders **124** arranged in sequence in close proximity to each other, so as to delimit corresponding grinding slots. The lower cylinder **124'** is mounted with the axis outside the plane containing the axis of all the other cylinders **124** and functions as a feeder of the mixture, which is taken from the bottom of the container and made to rise upwards in a way to pass between the lower cylinder and the one immediately above and then to follow among all the others. The various pairs of cylinders **124**, between which the mixture passes, rotate at different speeds, in the sense that the upper cylinder rotates at a higher speed than the lower cylinder, with which it cooperates, so as to subject the mixture to stretching during the passage between the cylinders **124** of each pair and to thus reduce the size of the particles of the mixture itself. Indeed, one of the fundamental parameters for the success of the refining process is precisely the different speed of the different cylinders **124**, on which the passage of the whole mass of mixture that has passed through the grinding slot depends.

[0115] The pressure between the cylinders is hydraulically controlled.

[0116] All the cylinders **124** are cooled with cold water which circulates inside each cylinder and in this way contrasts the heat, which develops from the mixture due to the friction due both to the movement of the cylinders and to the rubbing with the product. In this way the temperature of the product mass is reduced until it reaches 25° C.

[0117] Thanks to the refiner **122** just described, the friction action, which is exerted on the mixture by the cylinders **124** of the latter, develops a considerable binding action of the cellulose fibers contained in the raw material and this entails the double advantage of developing the aromatic components of the product and to eliminate the need to introduce more fiber into the mixture to obtain the required binding effect.

[0118] The operation of the plant in this different embodiment provides that the chopped raw material coming from the preparation and pre-treatment stations is fed to the cryogenic pin mill **12** in a proportionally dosed quantity according to the recipe to be obtained, and is brought from this to a particle size of about 20-220 μm, preferably about 80-180 μm.

[0119] The product is then transferred in the manner already described into the mixer **64**, in which a product mixture is formed as described above.

[0120] The mixture thus obtained is then fed to the cylinder refiner **122**, which has the task of bringing the solid components of the mixture to a grain size not exceeding 20 μm. In this way, the friction action exerted on the mixture by the cylinders **124** of the refiner **122** develops a considerable binding action of the cellulose fibers contained in the raw material and in particular in the stems and branches and ribs thereof, and this entails the double advantage to develop, on the one hand, the aromatic components of the product and, on the other hand, to eliminate the need to introduce more fiber into the mixture to obtain the required binding effect.

[0121] FIG. **1** schematically indicates the position of the refiner **122** between the mixer **64** and the forming unit **80**, but the invention also provides that the refiner **122** can be an alternative to the forming unit **80**, and in this case the mixture which it leaves the refiner **122** and is transferred directly to the first rolling unit **90**, for the continuation of the processing cycle according to the methods already described.

1. Method for producing homogeneous sheets of nicotine-free vegetable fibers comprising:
- crushing up solid components of a raw material containing the nicotine-free vegetable fibers to bring them to a particle size of about 20-220 μm,
- mixing the crushed product thus obtained with water, at least one binding agent and at least one material to form an aerosol, until a mixture is obtained with a liquid content of about 30-50%,
- subjecting said mixture to a first lamination to obtain a continuous strip with a thickness of about 1-20 mm,
- subjecting said strip which has already been subjected to said first lamination to a series of further lamination steps, until a strip having a remarkably constant thickness of about 90-280 μm, is obtained, and
- drying said strip to a liquid content of about 8-15%.

2. The method according to claim **1**, wherein the dried continuous strip is subjected to winding or transversal cutting or shredding into threads of predefined dimensions.

3. The method according to claim **1**, wherein the solid components of said raw material are crushed by grinding.

4. The method according to claim **1**, wherein the solid components of said raw material are crushed with a mill.

5. The method according to claim **1**, wherein the solid components of said raw material are crushed with a cryogenic pin mill (**12**).

6. The method according to claim **1**, wherein powdered cellulose is also mixed with the other substances that form the mixture.

7. The method according to claim **6**, wherein
powdered cellulose consisting of an organic fiber obtained from natural cellulose is used.

8. The method according to claim **6**, wherein a slurry is formed with powdered cellulose having a particle size between 50 and 100 μm.

9. The method according to claim **1**, wherein said mixture is formed with powdered cellulose in a percentage comprised between 2% and 10% of the weight of the raw material.

10. The method according to claim **1**, wherein before forming said mixture with the crushed components of said raw material, said crushed components are mixed with powdered cellulose.

11. The method according to claim **10**, wherein the mixture formed by crushed product, possible powdered cellulose, water, at least one binding agent and at least one material for forming an aerosol is subjected to at least one of:
- a roughing step by passing through at least one pair of grooved cylinders (**84**) or
- a refining step by passing through at least one pair of refining cylinders (**124**,**124'**) until it reaches a particle size not exceeding 20 μm.

12. The method according to claim **1**, wherein said mixture is subjected to a step of homogenization and forming before subjecting it to a first rolling step.

13. The method according to claim **12**, wherein said mixture is subjected to a homogenization and shaping phase for its transformation into a continuous strip, with a substantially constant width between 100 and 2000 mm and thickness between 1 and 10 mm, to then be subjected to said first lamination step.

14. The method according to claim **1**, wherein said mixture is subjected to a homogenization and shaping step for its transformation into a sequence of portions (**82**) to be then subjected to a first rolling step.

15. The method according to claim **1**, further comprising carrying out a first rolling of the mixture with a unit (**90**) comprising a lobe feeder (**92**) and at least one pair of rolling cylinders (**98**).

16. The method according to claim **1**, wherein said first lamination comprises a homogenization step which is carried out before obtaining said continuous strip having a thickness of about 1-20 mm.

17. The method according to claim **1**, wherein said mixture is subjected in sequence first to a forming step to transform the mixture into a sequence of portions (**82**) and subsequently to a step of homogenizing said portions (**82**) before obtaining from the portions said continuous strip having a thickness of about 1-20 mm.

18. The method according to claim **1**, wherein said mixture is homogenized mainly or exclusively by means of a lobe feeder (**92**) positioned at an inlet of at least one pair of rolling rolls (**98**).

19. The method according to claim **1**, wherein at the outlet of said first lamination a single-layer tape with a thickness of about 1-10 mm is obtained.

20. The method according to claim **1**, wherein, before subjecting said strip, already subjected to said first lamination, to said series of further lamination steps, it is subjected to stratification until a multilayer strip of thickness is obtained of about 2-20 mm.

21. The method according to claim **20**, wherein, in said series of further rolling steps, the mixture is allowed to rest between one rolling station and the next.

22. The method according to claim **1**, wherein the lamination is carried out with pairs of cylinders (**108**) that are at least partially heated.

23. The method according to claim **1**, wherein said laminated strip is dried by passing through a recirculating air dryer (**114**).

24. The method according to claim **1**, wherein vegetable fibers of at least one of the following vegetable substances are used: potato, hemp, tea, chamomile, mint, sage, rosemary or eucalyptus.

25. The method according to claim **1**, wherein said first lamination is carried out in a unit of first lamination (**90**), which comprises a homogenization module of the mixture, located immediately upstream with respect to a pre-rolling module, which is defined by at least one pair of lamination rolls (**98**), which are configured to form a continuous strip with a thickness of about 1-20 mm.

26. The method according to claim **25**, wherein said homogenization module comprises a lobe feeder (**92**).

27. The method according to claim **1**, wherein said at least one binding agent is selected from the group consisting of: hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxyethylcellulose, microcrystalline cellulose, methylcellulose, carboxymethylcellulose, corn starch, potato starch, guar gum, locust bean gum, pectin, alginates, ammonium alginate and sodium alginates.

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