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

VERFAHREN ZUR HERSTELLUNG EINER HOMOGENEN MATERIALBAHN AUS NIKOTINFREIEN PFLANZENFASERN

PROCÉDÉ DE PRODUCTION DE FEUILLES HOMOGENES DE FIBRES VÉGÉTALES SANS NICOTINE

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**WO-A1-2016/067226 WO-A1-2019/157576**

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## Description

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

**[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  $\mu\text{m}$  and 220  $\mu\text{m}$  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.

**[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 claim 1.

**[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:

- the solid components of the raw materials are crushed with vegetable fibers until they reach a particle size of about 20 - 220  $\mu\text{m}$ , preferably about 80-180  $\mu\text{m}$ ,
- 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 %,
- 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,
- 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  $\mu\text{m}$ , preferably of about 140-200  $\mu\text{m}$ , is obtained,

- said strip is dried until its liquid content is about 8-15%.

**[0016]** 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:

Figure 1 shows a general schematic view of a plant for the production of homogeneous sheets of vegetable fibers according to the invention,

Figure 2 shows its feeding section in case the sheets of vegetable fibers are obtained from plant leaves,

Figure 3 shows its feeding section in case the sheets of vegetable fibers are obtained from stems and branches of plants,

Figure 4 shows a partial scheme of the plant with two distinct lines of pre-treatment of the leaves and stems and branches of plants,

Figure 5 shows its section of grinding, mixing and storage,

Figure 6 shows a schematic view of one of its cylinders refiner,

Figure 7 shows in plan its stratification section in a particular embodiment.

Figure 8 schematically shows its hot air dryer, and

Figure 9 schematically shows its hot air dryer in a different embodiment.

**[0017]** 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.

**[0018]** More particularly, the plant for carrying out the method according to the invention comprises:

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

- a drying section of the laminated web.

**[0019]** 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).

**[0020]** 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.

**[0021]** 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.

**[0022]** 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.

**[0023]** 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.

**[0024]** 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.

**[0025]** 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  $\mu\text{m}$ , preferably about 80-180  $\mu\text{m}$ .

**[0026]** 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.

**[0027]** 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.

**[0028]** Preferably, the pin mill 12 is arranged for carrying out cryogenic grinding, that is, milling in the presence of liquid nitrogen.

**[0029]** 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.

**[0030]** 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  $-175^{\circ}\text{C}$  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  $10^{\circ}\text{C}$ , 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.

**[0031]** In summary, the positive factors of cryogenic milling are:

- higher yields,
- better quality of the final product without breaking or tearing of the molecular structure,
- decrease in energy required,
- better quality of the final product,
- less waste due to overheating and oxidation,
- more homogeneous and finer final product,
- less amount of material to be reprocessed in the milling system.

**[0032]** 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  $\mu\text{m}$ , preferably of about 80-180  $\mu\text{m}$ , from larger sizes, inevitably present.

**[0033]** Conveniently, the fluidized bed sieve 54 therefore has the function of classifying the product and re-introducing the one with fractions greater than 220  $\mu\text{m}$  into the mill 12, after having separated them from those between 20  $\mu\text{m}$  and 220  $\mu\text{m}$ , which through a pneumatic transport 56 are sent to one or more mixing and storage silos 58.

**[0034]** 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.

**[0035]** 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.

**[0036]** 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%.

**[0037]** 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 July 2014, pages 1-16).

**[0038]** 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.

**[0039]** 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.

**[0040]** 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  $\mu\text{m}$  and is preferably in a percentage comprised between 2% and 10% by weight with respect to the crushed tobacco. 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.

**[0041]** 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.

**[0042]** 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.

**[0043]** 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.

**[0044]** 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 dodecanedim and dimethyl tetradecanoate), 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.

**[0045]** 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).

**[0046]** 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.

**[0047]** 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.

**[0048]** 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.

**[0049]** 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.

**[0050]** Preferably, the first rolling unit 90 comprises a lobe feeder 92 to homogenize the mixture formed by the portions 82.

**[0051]** 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.

**[0052]** 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 cylinders 98, which are configured to form a continuous strip of thickness about 1-20 mm, preferably about 1-10 mm.

**[0053]** 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

rolling cylinders 98.

**[0054]** Therefore, the first rolling 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 rolling 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.

**[0055]** 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 rolling unit 90 provided with a lobe feeder 92.

**[0056]** Advantageously, downstream of the first rolling unit 90 and upstream of the rolling 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 rolling unit 90, so as to transform it into a multi-layer belt with a thickness of about 2-20 mm, which is then sent to the inlet of the rolling line 100. 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.

**[0057]** 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 rolling line 100 (fig. 1), while if the conveyor belts of the rolling 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 rolling 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.

**[0058]** 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 rolling line 100 and the formation of a belt laminated with a width substantially equal to the useful width of the rolling line itself.

**[0059]** 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 rolling line 100 is configured to progressively bring the continuous strip to a thickness of 90 - 280  $\mu\text{m}$ , preferably of about 140-200  $\mu\text{m}$ .

**[0060]** 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.

**[0061]** Advantageously, the rolling line 100 is then completed with one or more calibration stations, each formed by a pair of calibrating rolls 112.

**[0062]** 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.

**[0063]** 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.

**[0064]** 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.

**[0065]** 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.

**[0066]** 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 con-

veying 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.

**[0067]** 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.

**[0068]** 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.

**[0069]** The stalks and branches chopped and dosed in the correct quantities are from here transferred through a pneumatic line to the cryogenic mill 12.

**[0070]** 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).

**[0071]** 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  $\mu\text{m}$ , preferably about 80-180  $\mu\text{m}$ . 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.

**[0072]** 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.

**[0073]** Conveniently, the whole is then mixed together to form a mixture 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.

**[0074]** Preferably, the mixture thus obtained is transferred to the forming unit 80, from which the portions 82, preferably loaf-shaped, exit in succession.

**[0075]** 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.

**[0076]** This continuous strip, which comes out of the first rolling unit 90, can be transferred directly to the rolling 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 rolling line 100.

**[0077]** 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.

**[0078]** 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  $\mu\text{m}$ , preferably of about 140-200  $\mu\text{m}$ . 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.

**[0079]** 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%.

**[0080]** 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).

**[0081]** 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.

**[0082]** 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.

**[0083]** 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  $\mu\text{m}$ , preferably of about 140-200  $\mu\text{m}$ . 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 cast as well as the overall dimensions of the plant.

**[0084]** 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  $\mu\text{m}$ .

**[0085]** 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.

**[0086]** The pressure between the cylinders is hydraulically controlled.

**[0087]** 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.

**[0088]** 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.

**[0089]** 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  $\mu\text{m}$ , preferably about 80-180  $\mu\text{m}$ .

**[0090]** The product is then transferred in the manner already described into the mixer 64, in which a product mixture is formed as described above.

**[0091]** 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  $\mu\text{m}$ . 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.

**[0092]** 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.

## Claims

1. Method for producing homogeneous sheets of nicotine-free vegetable fibers wherein:

- the solid components of the raw material containing the nicotine-free vegetable fibers are crushed up to bring them to a particle size of about 20 - 220  $\mu\text{m}$ , preferably of about 80-180  $\mu\text{m}$ ,
- the ground product thus obtained is mixed 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%, preferably about 35 -40%,
- 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,

**characterized by** the fact that:

- said strip which has already been subjected to said first lamination is subjected to a series of further lamination steps, until obtaining a strip having a constant thickness of about 90 - 280  $\mu\text{m}$ , preferably of about 140-200  $\mu\text{m}$ ,
  - said strip is dried until its liquid content at about 8-15%.
2. Method according to claim 1, **characterized in that** the dried continuous strip is subjected to winding or transversal cutting or shredding into threads of pre-defined dimensions.
  3. Method according to one or more of the preceding claims, **characterized in that** the solid components of said raw material are crushed by grinding.
  4. Method according to one or more of the preceding claims, **characterized in that** the solid components of said raw material are crushed with a mill.
  5. Method according to one or more of the preceding claims, **characterized in that** the solid components of said raw material are crushed with a cryogenic pin mill (12).
  6. Method according to one or more of the preceding claims, **characterized in that** powdered cellulose is also mixed with the other substances that form the mixture.
  7. Method according to the preceding claim, **characterized in that** powdered cellulose consisting of an organic fiber obtained from natural cellulose is used.
  8. Method according to claim 6 or 7, **characterized in that** said mixture is formed with powdered cellulose having a particle size between 50 and 100  $\mu\text{m}$ .
  9. Method according to one or more of the preceding claims, **characterized in that** said mixture is formed with powdered cellulose in a percentage comprised between 2% and 10% of the weight of the raw material.
  10. Method according to one or more of the preceding claims, **characterized in that** before forming said mixture with the crushed components of said raw material, said crushed components are mixed with powdered cellulose.
  11. Method according to one or more of the preceding claims **characterized in that** the mixture formed by crushed product, possible powdered cellulose,
- to a roughing step by passing through at least one pair of grooved cylinders (84) and/or
  - to a refining step by passing through at least one pair of refining cylinders (124,124') until it reaches a particle size not exceeding 20  $\mu\text{m}$ .
12. Method according to one or more of the preceding claims, **characterized in that** said mixture is subjected to a step of homogenization and forming before subjecting it to said first rolling step.
  13. Method according to one or more of the preceding claims **characterized in that** said at least one binding agent 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, in particular ammonium alginate and sodium alginate.
  14. Method according to the preceding claim **characterized in that** 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.
  15. Method according to one or more of the preceding claims **characterized in that** said mixture is subjected to a homogenization and shaping step for its transformation into a sequence of portions (82) to be then subjected to said first rolling step.
  16. Method according to one or more of the preceding claims, **characterized by** the fact that it carries out said first rolling the mixture with a unit (90) comprising a lobe feeders (92) and at least one pair of rolling cylinders (98).
  17. Method according to one or more of the preceding claims **characterized in that** said first lamination comprises a homogenization step which is carried out before obtaining said continuous strip having a thickness of about 1-20 mm, preferably about 1-10 mm.
  18. Method according to one or more of the preceding claims **characterized in that** said mixture is subjected in sequence first to a forming step for its transformation into a sequence of portions (82) and subsequently to a step of homogenizing said portions (82) before obtaining from these said continuous strip having a thickness of about 1-20 mm,

preferably about 1-10 mm.

19. Method according to one or more of the preceding claims, **characterized in that** said mixture is homogenized mainly or exclusively by means of a lobe feeder (92) positioned at the inlet of at least one pair of rolling cylinders (98). 5
20. Method according to one or more of the preceding claims, **characterized in that** at the outlet of said first lamination a single-layer tape with a thickness of about 1-10 mm is obtained. 10
21. Method according to one or more of the preceding claims **characterized in that**, 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. 15
22. Method according to the preceding claim **characterized in that**, in said series of further rolling steps, the mixture is allowed to rest between one rolling station and the next. 20
23. Method according to one or more of the preceding claims, **characterized by** the fact that the lamination is carried out with pairs of cylinders (108) at least partially heated. 25
24. Method according to one or more of the preceding claims **characterized in that** said laminated strip is dried by passing through a recirculating air dryer (114). 30
25. Method according to one or more of the preceding claims, **characterized in that** vegetable fibers of at least one of the following vegetable substances are used: potato, hemp, tea, chamomile, mint, sage, rosemary and eucalyptus. 35
26. Method according to one or more of the preceding claims, **characterized by** the fact that said first lamination is carried out in a unit of first lamination (90) 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 rolling cylinders (98), which are configured to form a continuous strip with a thickness of about 1-20 mm, preferably about 1-10 mm. 40
27. Method according to the preceding claim **characterized in that** said homogenization module comprises a lobe feeder (92). 45

## Patentansprüche

1. Verfahren zur Herstellung homogener Materialbahnen aus nikotinfreien Pflanzenfasern, wobei:
- die festen Bestandteile des Rohmaterials, die die nikotinfreien Pflanzenfasern enthalten, zerkleinert werden, um sie auf eine Teilchengröße von ungefähr 20 bis 220  $\mu\text{m}$ , vorzugsweise ungefähr 80 bis 180  $\mu\text{m}$ , zu bringen;
  - das so gewonnene gemahlene Produkt mit Wasser, mindestens einem Bindemittel und mindestens einem Material, um ein Aerosol zu bilden, gemischt wird, bis ein Gemisch mit einem Flüssigkeitsgehalt von ungefähr 30 bis 50 %, vorzugsweise ungefähr 35 bis 40 %, gewonnen wird;
  - dieses Gemisch einer ersten Schichtbildung unterzogen wird, um einen durchgehenden Streifen mit einer Dicke von ungefähr 1 bis 20 mm, vorzugsweise ungefähr 1 bis 10 mm, zu gewinnen,
- dadurch gekennzeichnet, dass**
- der Streifen, der bereits der ersten Schichtbildung unterzogen wurde, einer Reihe von weiteren Schichtbildungsschritten unterzogen wird, bis ein Streifen entsteht, der eine konstante Dicke von ungefähr 90 bis 280  $\mu\text{m}$ , vorzugsweise 140 bis 200  $\mu\text{m}$ , aufweist;
  - der Streifen getrocknet wird, bis sein Flüssigkeitsgehalt ungefähr 8 bis 15 % beträgt.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** der durchgehende getrocknete Streifen dem Aufwickeln oder Querschneiden oder Vorzerkleinern in Stränge mit vorgegebenen Abmessungen unterzogen wird. 35
3. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die festen Bestandteile des Rohmaterials durch Mahlen zerkleinert werden. 40
4. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die festen Bestandteile des Rohmaterials mit einer Mühle zerkleinert werden. 45
5. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die festen Bestandteile des Rohmaterials mit einer Stiftmühle für Kryogenvermahlung (12) zerkleinert werden. 50
6. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet,**

- dass** auch pulverisierte Cellulose mit den anderen Stoffen, die das Gemisch bilden, gemischt wird.
7. Verfahren nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** pulverisierte Cellulose, bestehend aus einer aus natürlicher Cellulose gewonnenen organischen Faser, genutzt wird. 5
8. Verfahren nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** das mit pulverisierter Cellulose gebildete Gemisch eine Teilchengröße zwischen 50 und 100 µm aufweist. 10
9. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gemisch mit pulverisierter Cellulose in einem Anteil zwischen 2 % und 10 % des Rohmaterialgewichts gebildet wird. 15
10. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die zerkleinerten Bestandteile mit pulverisierter Cellulose gemischt werden, bevor das Gemisch mit den zerkleinerten Rohmaterialbestandteilen gebildet wird. 20 25
11. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das durch zerkleinerte Produkt, etwaige pulverisierte Cellulose, Wasser, mindestens ein Bindemittel und mindestens ein Material zum Bilden eines Aerosols gebildete Gemisch Folgendem unterzogen wird: 30
- einem Vorbereitungsschritt mittels des Durchgangs durch mindestens ein Paar genuteter Zylinder (84) und/oder
  - einem Aufbereitungsschritt mittels des Durchgangs durch mindestens ein Paar Aufbereitungszyylinder (124, 124'), bis es eine Teilchengröße erreicht, die 20 µm nicht überschreitet. 35 40
12. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gemisch einem Homogenisierungs- und Formgebungsschritt unterzogen wird, bevor es dem ersten Walzschritt unterzogen wird. 45
13. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das mindestens eine Bindemittel mindestens entweder Hydroxypropylcellulose und/oder Hydroxypropylmethylcellulose und/oder Hydroxyethylcellulose und/oder mikrokristalline Cellulose und/oder Methylcellulose und/oder Carboxymethylcellulose (CMC) und/oder Maisstärke und/oder Kartoffelstärke und/oder Guarkernmehl und/oder Johannisbrotkernmehl und/oder Pektin und Alginate, insbesondere Ammoniumalginat und Natriumalginat, einschließt. 50
14. Verfahren nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** das Gemisch einer Homogenisierungs- und Gestaltungsphase unterzogen wird, um in einen durchgehenden Streifen mit einer im Wesentlichen konstanten Breite zwischen 100 und 2000 mm und einer Dicke zwischen 1 und 10 mm umgewandelt und dann dem ersten Schichtbildungsschritt unterzogen zu werden. 55
15. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gemisch einem Homogenisierungs- und Formgebungsschritt unterzogen wird, um es in eine Abfolge von Abschnitten (82) umzuwandeln, die dann dem ersten Walzschritt unterzogen werden.
16. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das erste Walzen des Gemischs mit einer Einheit (90) durchgeführt wird, die einen Ringextruder (92) und mindestens ein Paar Walzzyylinder (98) umfasst.
17. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die erste Schichtbildung einen Homogenisierungsschritt umfasst, der ausgeführt wird, bevor der durchgehende Streifen mit einer Dicke von ungefähr 1 bis 20 mm, vorzugsweise ungefähr 1 bis 10 mm, gewonnen wird.
18. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gemisch nacheinander zuerst einem Formungsschritt für seine Umwandlung in eine Abfolge von Abschnitten (82) und dann einem Homogenisierungsschritt der Abschnitte (82) unterzogen wird, bevor aus diesen der durchgehende Streifen mit einer Dicke von ungefähr 1 bis 20 mm, vorzugsweise ungefähr 1 bis 10 mm, gewonnen wird.
19. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gemisch hauptsächlich oder ausschließlich mittels eines Ringextruders (92), der am Einlass von mindestens einem Paar von Walzzyindern (98) positioniert ist, homogenisiert wird.
20. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** am Auslass der ersten Schichtbildung ein Band mit einer einzelnen Schicht mit einer Dicke von ungefähr 1 bis 10 mm gewonnen wird.
21. Verfahren nach einem oder mehreren der vorher-

- gehenden Ansprüche, **dadurch gekennzeichnet, dass** der Streifen, der bereits der ersten Schichtbildung unterzogen wurde, bevor er der Reihe weiterer Schichtbildungsschritte unterzogen wird, einer Stratifizierung unterzogen wird, bis ein mehrschichtiger Streifen mit einer Dicke von ungefähr 2 bis 20 mm gewonnen wird. 5
22. Verfahren nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** dem Gemisch in der Reihe weiterer Walzschritte erlaubt wird, zwischen einer Walzstation und der nächsten zu ruhen. 10
23. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Schichtbildung mit Paaren von Zylindern (108) durchgeführt wird, die zumindest teilweise erwärmt sind. 15
24. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der geschichtete Streifen mittels des Durchgangs durch einen Umluftrockner (114) getrocknet wird. 20
25. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Pflanzenfaser von mindestens einer der nachfolgenden Pflanzenstoffe genutzt werden: Kartoffeln, Hanf, Tee, Kamille, Minze, Salbei, Rosmarin und Eukalyptus. 30
26. Verfahren nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die erste Schichtbildung in einer Einheit zur ersten Schichtbildung (90) durchgeführt wird, die ein Modul zur Homogenisierung des Gemischs umfasst, das unmittelbar vorgelagert in Bezug auf ein Vorwalzmodul befindlich ist, das durch mindestens ein Paar von Walzzylindern (98) definiert ist, die ausgelegt sind, um einen durchgehenden Streifen mit einer Dicke von ungefähr 1 bis 20 mm, vorzugsweise 1 bis 10 mm, zu bilden. 40
27. Verfahren nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** das Homogenisierungsmodul einen Ringextruder (92) umfasst. 45
- Revendications** 50
1. Procédé de production de feuilles homogènes de fibres végétales sans nicotine, dans lequel :
- les composants solides de la matière première contenant les fibres végétales sans nicotine sont concassés pour les amener à une taille de particule d'environ 20 - 220  $\mu\text{m}$ , de préférence d'environ 80 - 180  $\mu\text{m}$ ,
  - le produit moulu ainsi obtenu est mélangé à de l'eau, à au moins un agent liant et à au moins une matière pour former un aérosol, jusqu'à l'obtention d'un mélange ayant une teneur en liquide d'environ 30-50 %, de préférence d'environ 35-40 %,
    - ledit mélange est soumis à un premier laminage pour obtenir une bande continue d'une épaisseur d'environ 1-20 mm, de préférence d'environ 1-10 mm,
- caractérisé en ce que :**
- ladite bande qui a déjà été soumise audit premier laminage est soumise à une série d'étapes de laminage supplémentaires, jusqu'à l'obtention d'une bande ayant une épaisseur constante d'environ 90 - 280  $\mu\text{m}$ , de préférence d'environ 140 - 200  $\mu\text{m}$ ,
  - ladite bande est séchée jusqu'à ce que sa teneur en liquide soit d'environ 8-15 %.
2. Procédé selon la revendication 1, **caractérisé en ce que** la bande continue séchée est soumise à un enroulement ou à une coupe transversale ou à un déchiquetage en fils de dimensions prédéfinies.
3. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** les composants solides de ladite matière première sont concassés par broyage.
4. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** les composants solides de ladite matière première sont concassés à l'aide d'un broyeur.
5. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** les composants solides de la matière première sont concassés à l'aide d'un broyeur cryogénique à broches (12).
6. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** la cellulose en poudre est aussi mélangée aux autres substances qui forment le mélange.
7. Procédé selon la revendication précédente, **caractérisé en ce que** la cellulose en poudre, constituée d'une fibre organique obtenue à partir de cellulose naturelle, est utilisée.
8. Procédé selon la revendication 6 ou 7, **caractérisé en ce que** ledit mélange est formé avec de la cellulose en poudre dont la taille des particules est comprise entre 50 et 100  $\mu\text{m}$ .

9. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit mélange est formé avec de la cellulose en poudre dans un pourcentage compris entre 2 et 10 % du poids de la matière première.
10. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**avant de former ledit mélange avec les composants concassés de ladite matière première, lesdits composants concassés sont mélangés à de la cellulose en poudre.
11. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** le mélange formé par le produit concassé, éventuellement la cellulose en poudre, l'eau, au moins un agent liant et au moins une matière pour former un aérosol est soumis :
- à une étape de dégrossissage en passant à travers au moins une paire de cylindres rainurés (84) et/ou
  - à une étape de raffinage en passant à travers au moins une paire de cylindres de raffinage (124,124') jusqu'à ce qu'il atteigne une taille de particule n'excédant pas 20 µm.
12. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit mélange est soumis à une étape d'homogénéisation et de formage avant de le soumettre à ladite première étape de roulement.
13. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit au moins un agent liant inclut au moins l'un des composants suivants : hydroxypropylcellulose, hydroxypropylméthylcellulose, hydroxyéthylcellulose, cellulose microcristalline, méthylcellulose, carboxyméthylcellulose (CMC), amidon de maïs, fécule de pomme de terre, gomme de guar, gomme de caroube, pectine et alginates, en particulier alginate d'ammonium et alginate de sodium.
14. Procédé selon la revendication précédente, **caractérisé en ce que** ledit mélange est soumis à une phase d'homogénéisation et de mise en forme pour sa transformation en une bande continue, de largeur sensiblement constante comprise entre 100 et 2 000 mm et d'épaisseur comprise entre 1 et 10 mm, pour être ensuite soumise à ladite première étape de laminage.
15. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit mélange est soumis à une étape d'homogénéisation et de mise en forme pour sa transformation en une séquence de parties (82) à soumettre ensuite à ladite première étape de roulement.
16. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il réalise ledit premier roulement du mélange avec une unité (90) comprenant des alimentateurs à lobes (92) et au moins une paire de cylindres de roulement (98).
17. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit premier laminage comprend une étape d'homogénéisation qui est effectuée avant l'obtention de ladite bande continue ayant une épaisseur d'environ 1-20 mm, de préférence d'environ 1-10 mm.
18. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit mélange est soumis successivement d'abord à une étape de formage pour sa transformation en une séquence de parties (82) et ensuite à une étape d'homogénéisation desdites parties (82) avant d'obtenir à partir de celles-ci ladite bande continue ayant une épaisseur d'environ 1-20 mm, de préférence d'environ 1-10 mm.
19. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit mélange est homogénéisé principalement ou exclusivement au moyen d'un alimentateur à lobes (92) positionné à l'entrée d'au moins une paire de cylindres de roulement (98).
20. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**à la sortie du premier laminage, une bandelette monocouche d'une épaisseur d'environ 1 à 10 mm est obtenue.
21. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que**, avant de soumettre ladite bande, déjà soumise audit premier laminage, à ladite série d'autres étapes supplémentaires de laminage, celle-ci est soumise à une stratification jusqu'à l'obtention d'une bande multicouche d'une épaisseur d'environ 2-20 mm.
22. Procédé selon la revendication précédente, **caractérisé en ce que**, dans ladite série d'étapes de roulement supplémentaires, le mélange est laissé au repos entre un poste de roulement et le suivant.
23. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** le laminage est effectué avec des paires de cylindres (108) au moins partiellement chauffés.
24. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ladite bande laminée est séchée en passant à travers un séchoir à

recirculation d'air (114).

25. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** des fibres végétales d'au moins une des substances végétales suivantes sont utilisées : pomme de terre, chanvre, thé, camomille, menthe, sauge, romarin et eucalyptus. 5
26. Procédé selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit premier laminage est effectué dans une unité de premier laminage (90) comprenant un module d'homogénéisation du mélange, situé immédiatement en amont par rapport à un module de pré-roulement, qui est défini par au moins une paire de cylindres de roulement (98), qui sont configurés pour former une bande continue d'une épaisseur d'environ 1-20 mm, de préférence d'environ 1- 10 mm. 10  
15  
20
27. Procédé selon la revendication précédente, **caractérisé en ce que** ledit module d'homogénéisation comprend un alimentateur à lobes (92). 25

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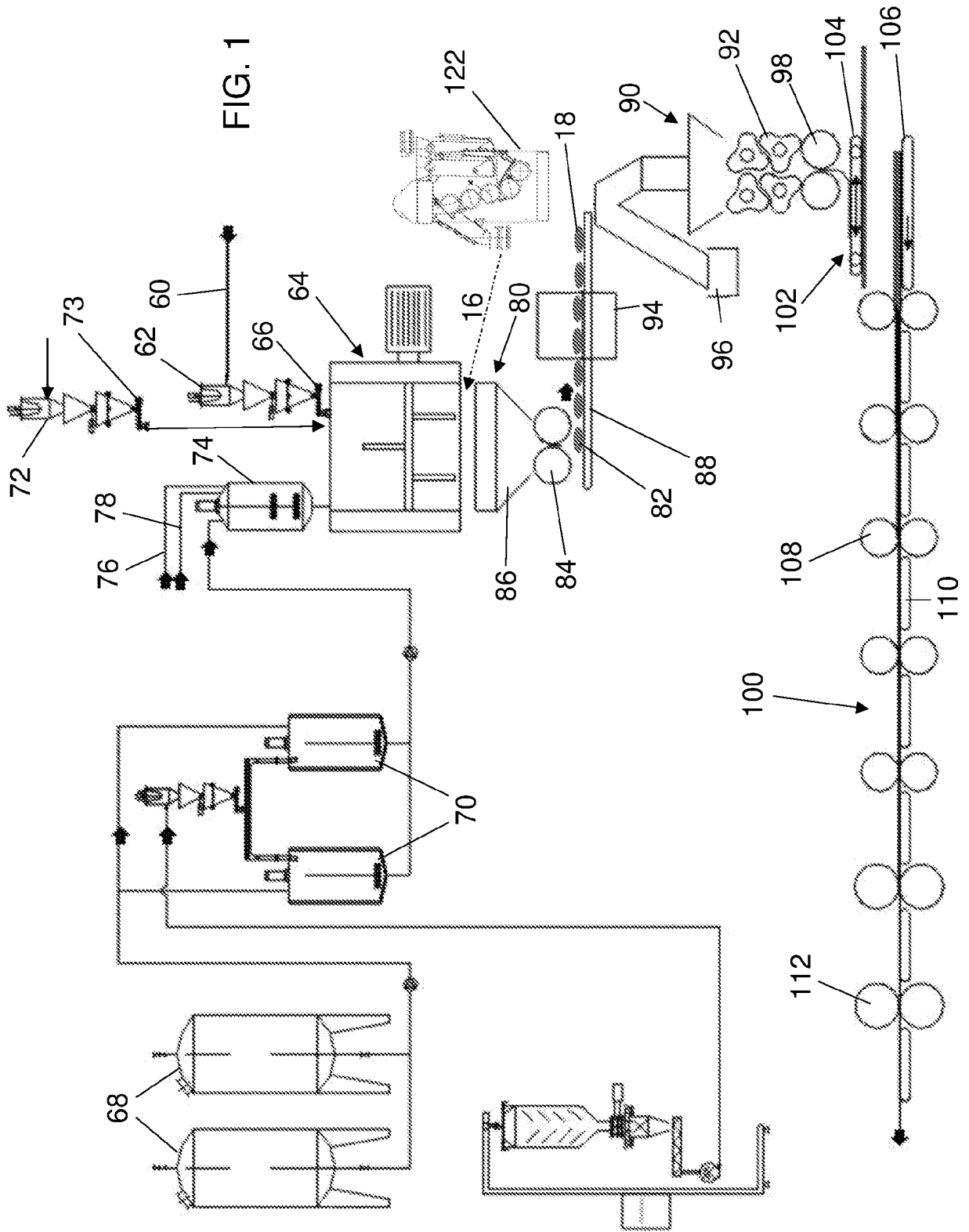
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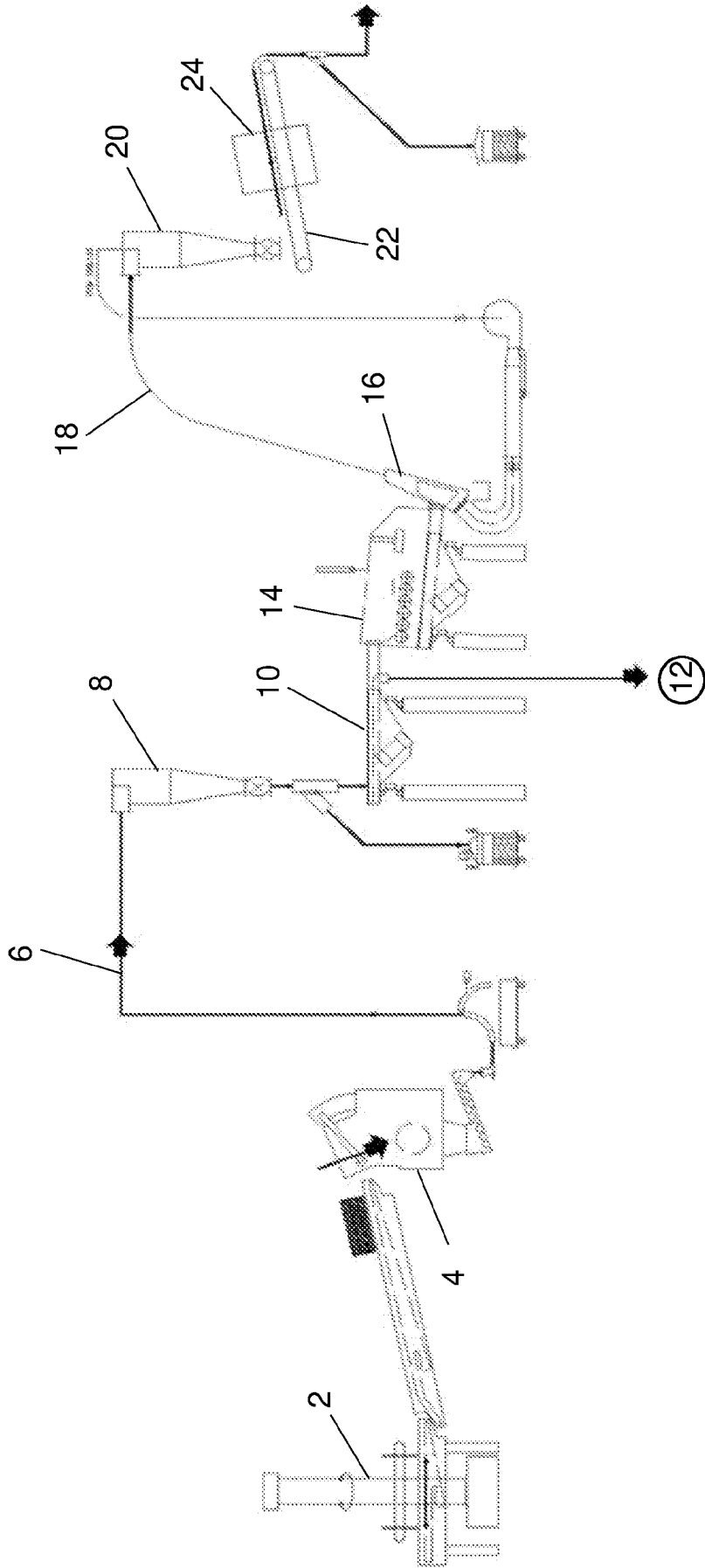


FIG. 2

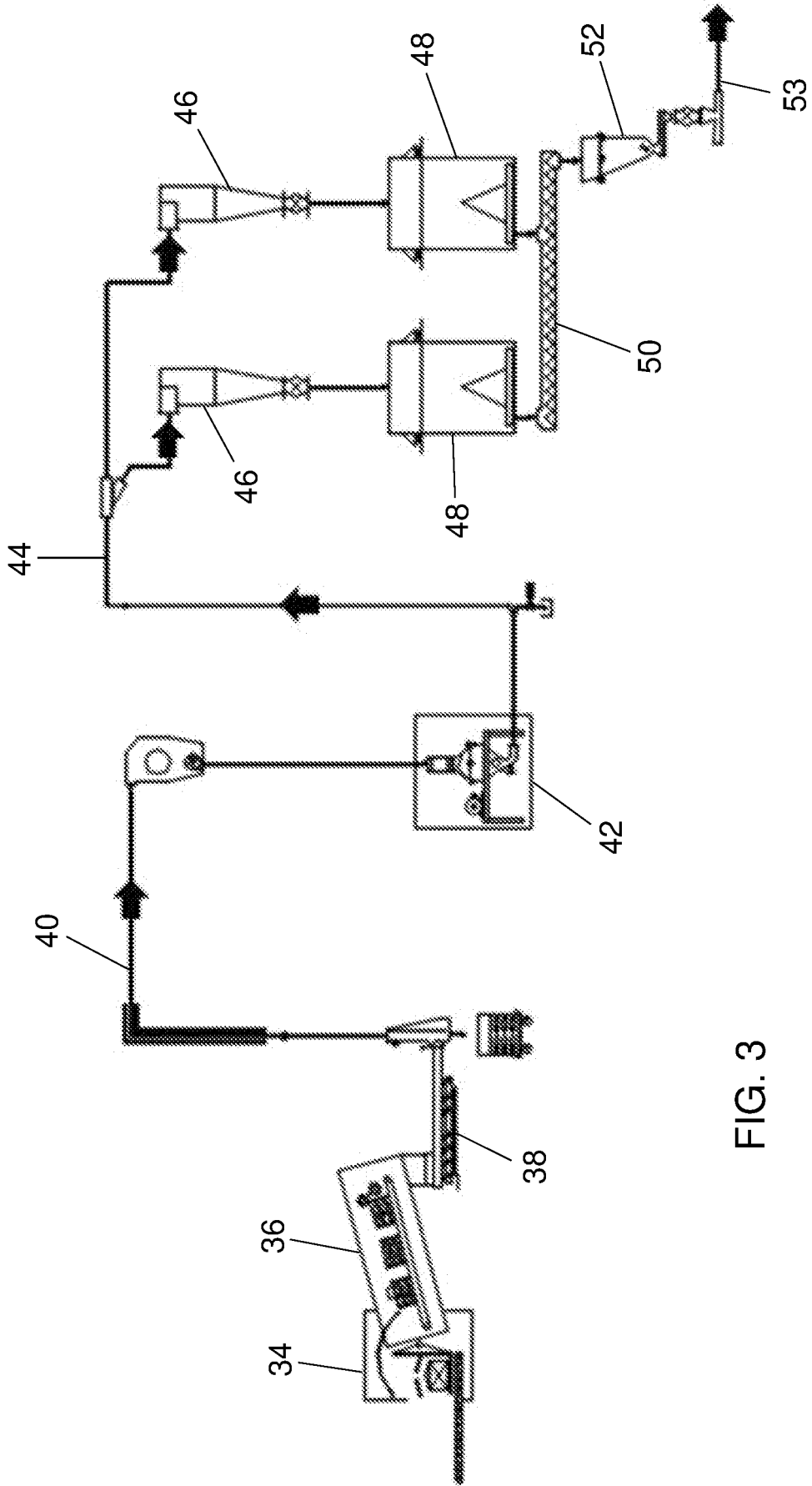


FIG. 3

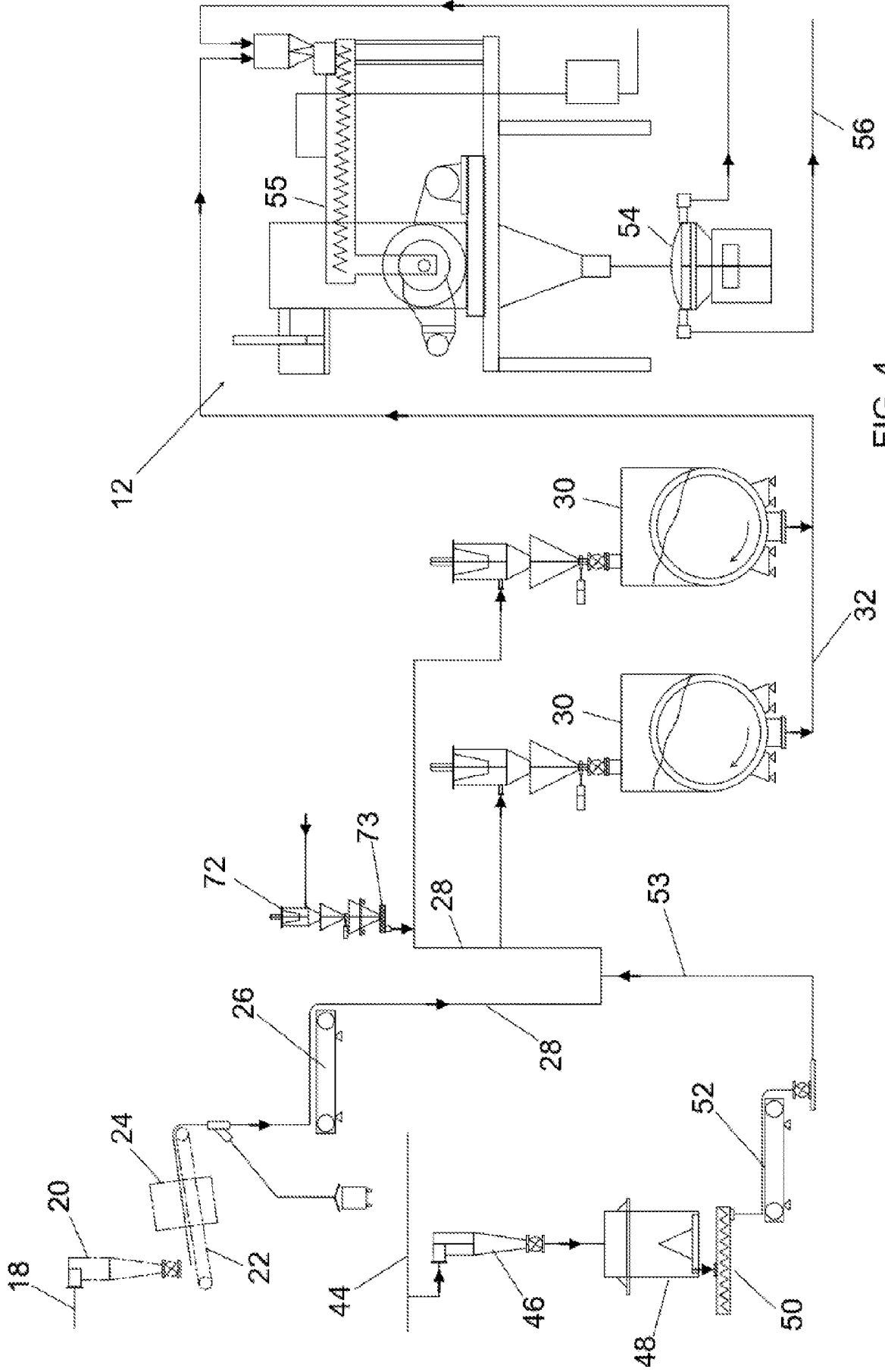


FIG. 4

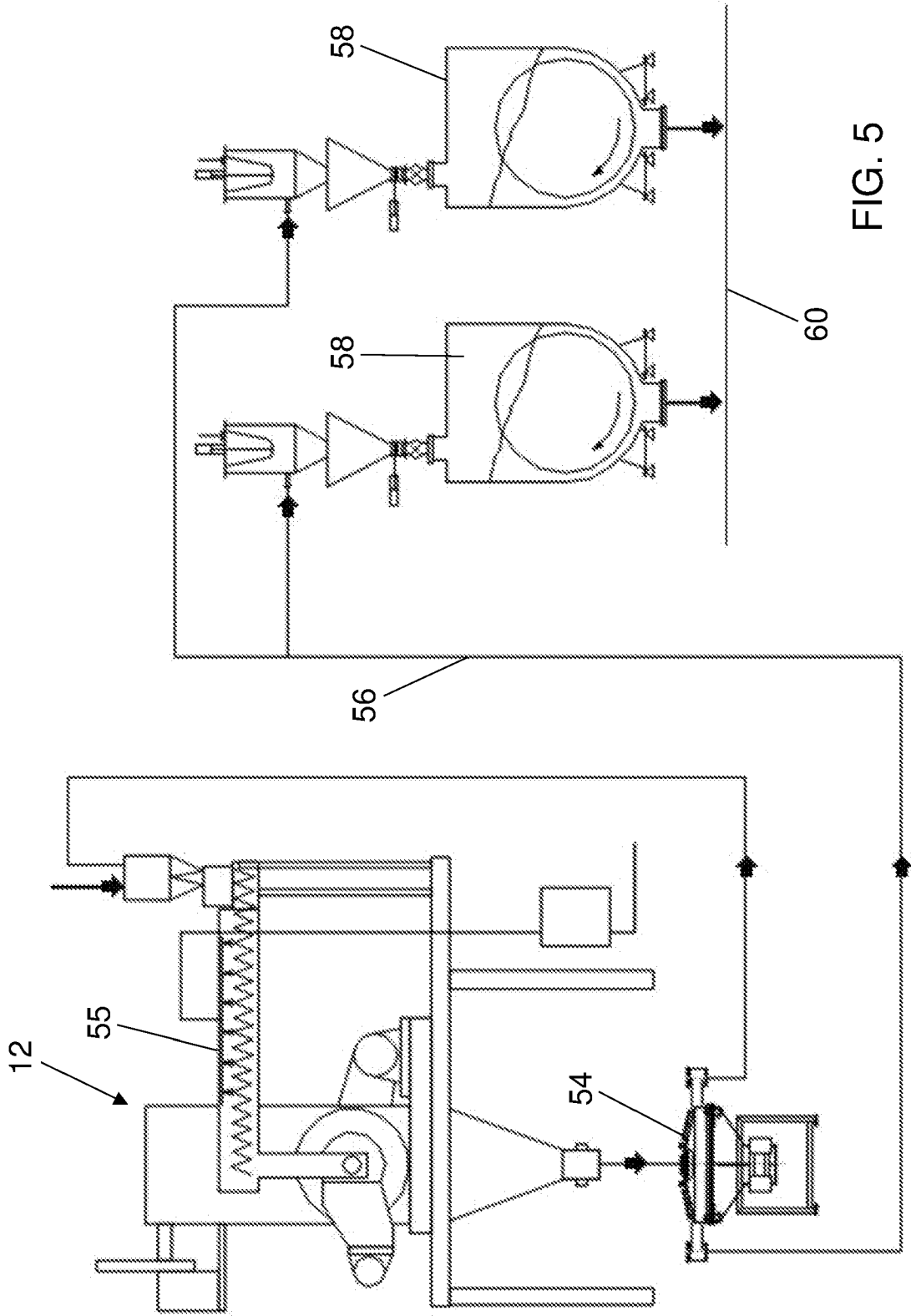


FIG. 5

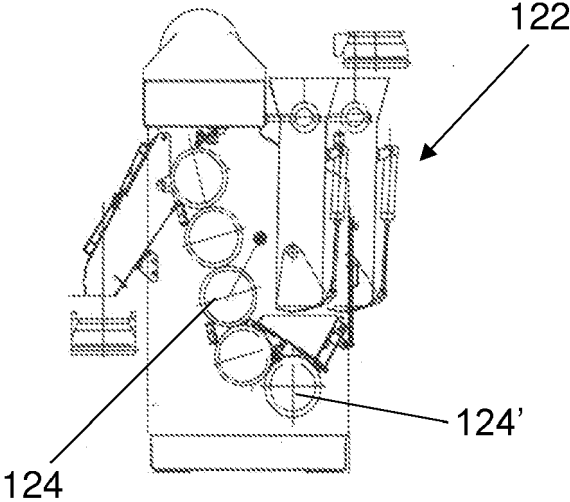


FIG. 6

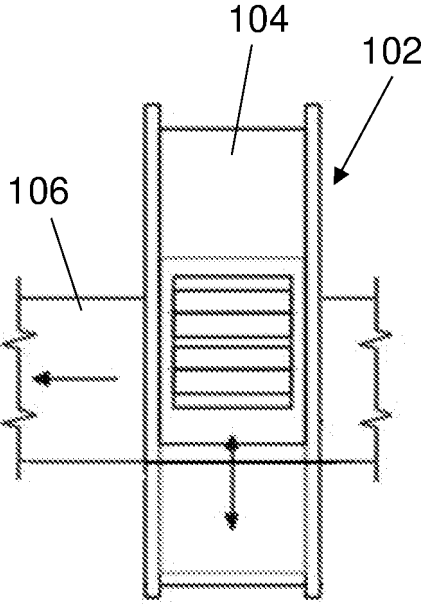
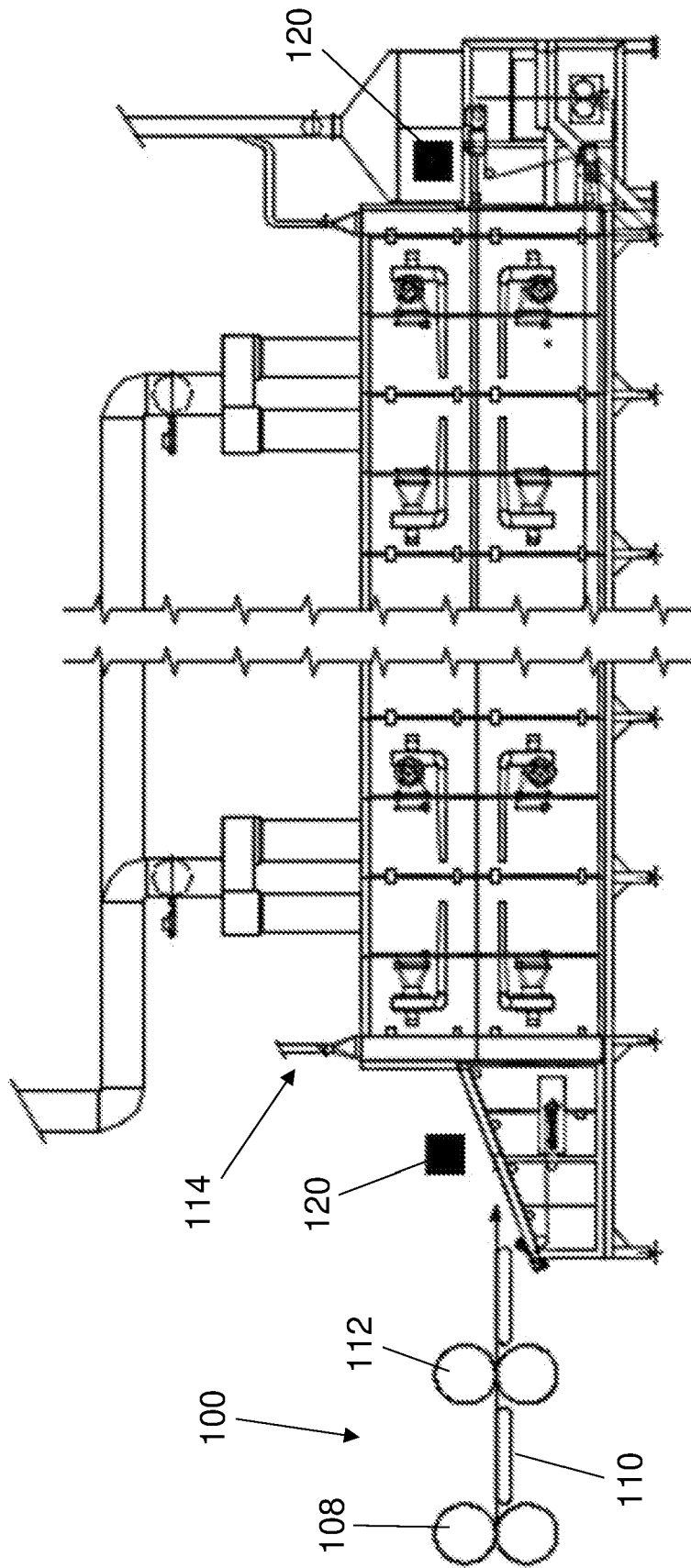
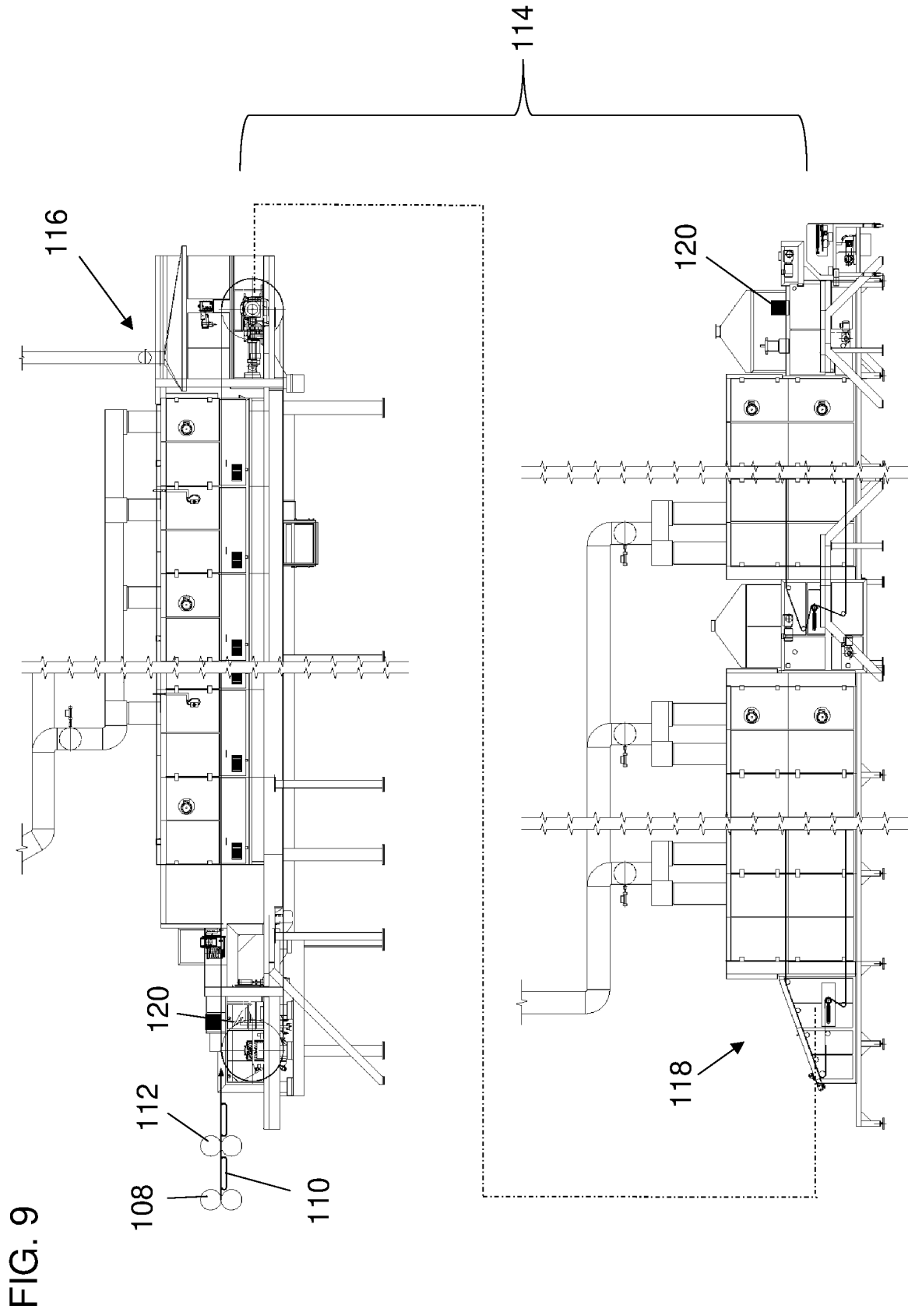


FIG. 7

FIG. 8





**REFERENCES CITED IN THE DESCRIPTION**

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