



(19) **United States**

(12) **Patent Application Publication**
Andersen

(10) **Pub. No.: US 2003/0070262 A1**

(43) **Pub. Date:** **Apr. 17, 2003**

(54) **DRY PRODUCTION OF A NON-WOVEN FIBRE WEB**

(52) U.S. Cl. 19/296; 19/304

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(57) **ABSTRACT**

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(21) Appl. No.: **10/294,621**

(22) Filed: **Nov. 15, 2002**

Related U.S. Application Data

(63) Continuation of application No. PCT/DK01/00381,
filed on May 31, 2001.

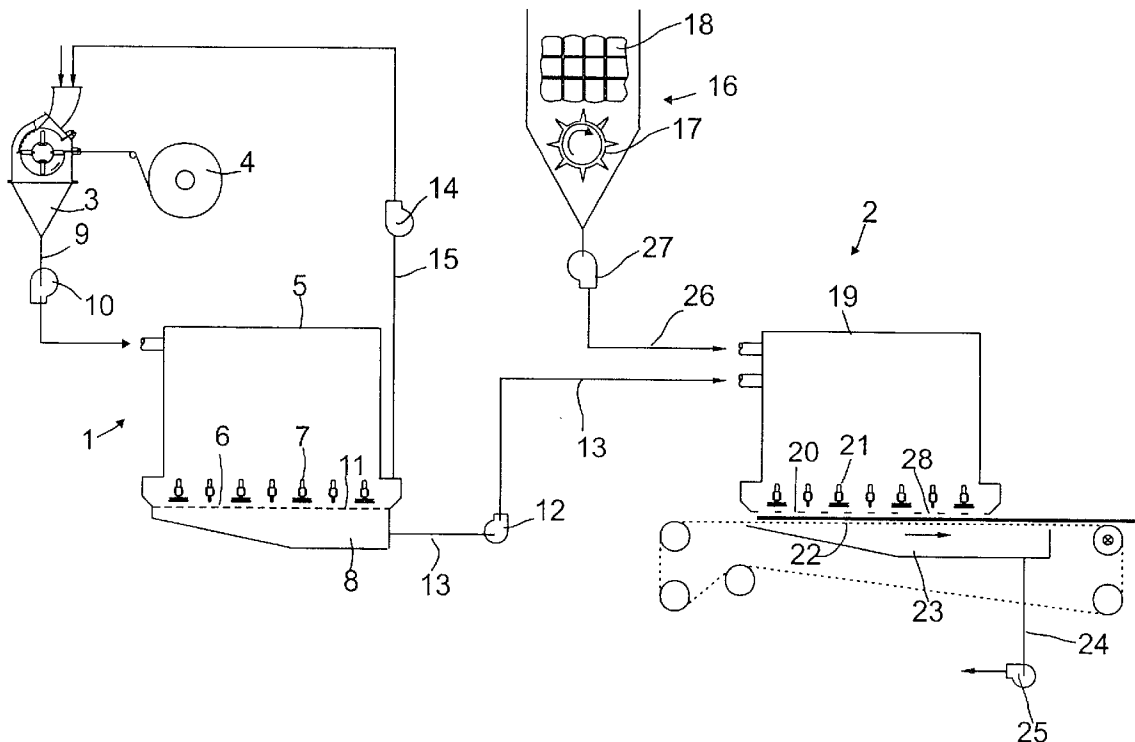
(30) **Foreign Application Priority Data**

May 31, 2000 (DK) PA 2000 00857

Publication Classification

(51) **Int. Cl.⁷** **D01G 25/00**

A plant that includes two air-lay stations placed one after the other serving for the dry production of a non-woven fiber web. Each station includes a fiber feed duct for feeding fibers to the station from a fiber source, an air-lay forming head connected to the fiber feed duct and at least partly defined by a perforated screen, and a suction box for successively sucking fibers in the forming head through the screen. A separate fiber source is part of each station. The first station furthermore has a fiber collector placed under the screen of its forming head whereas the second station has a forming wire placed under the screen of its forming head. The two stations are connected to at least one conveyor for conveying fibers from the fiber collector of the first station to the forming head of the second station. By means of the plant, a cotton fiber web on the basis of Cotton Linters Pulp and thermobinding fibers can be produced which, considering its quality, are price competitive with corresponding fiber webs based on cellulose pulp. This cotton fiber web has a homogenous, nit-free structure which is desirable for use in various products.



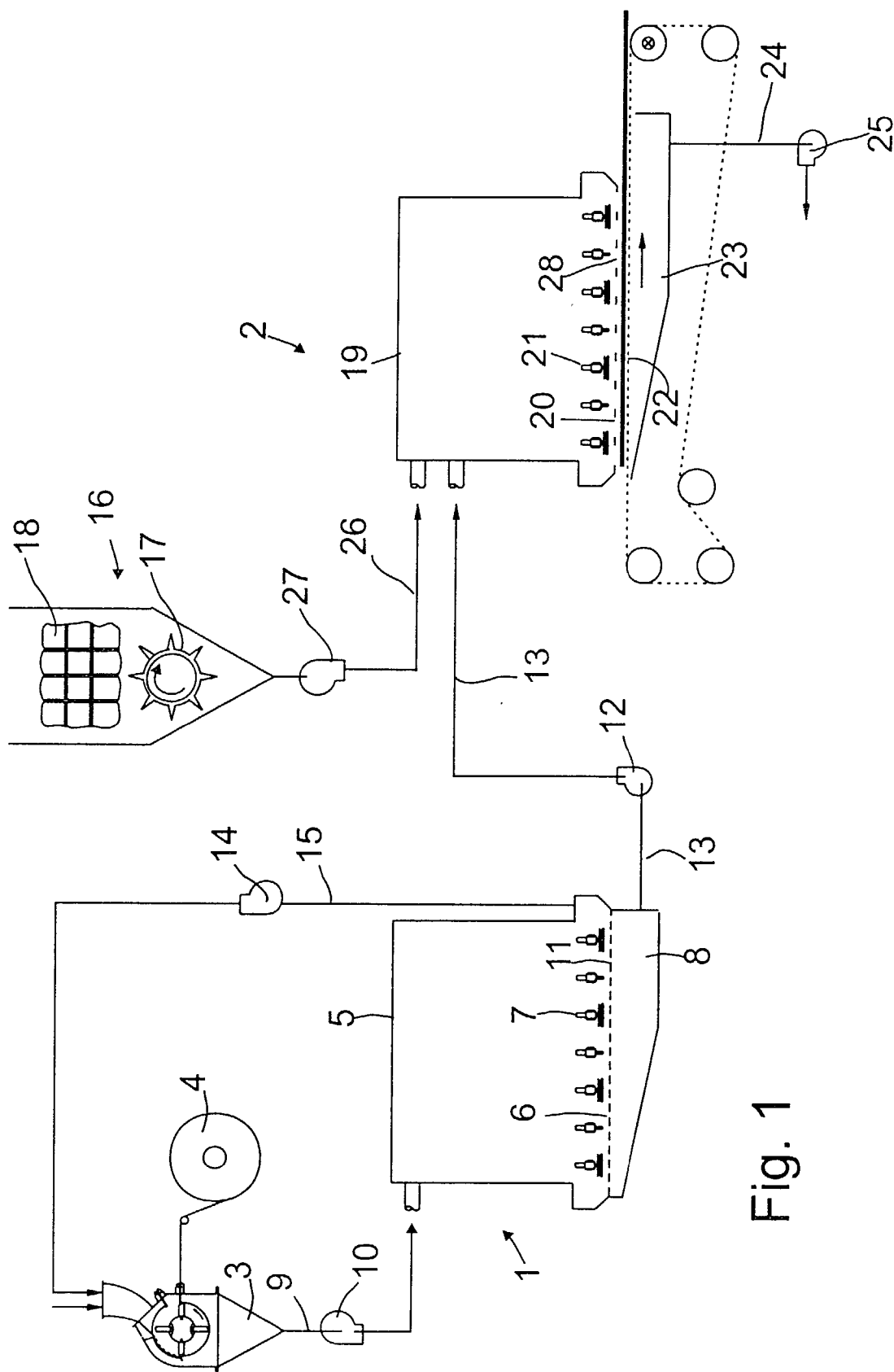
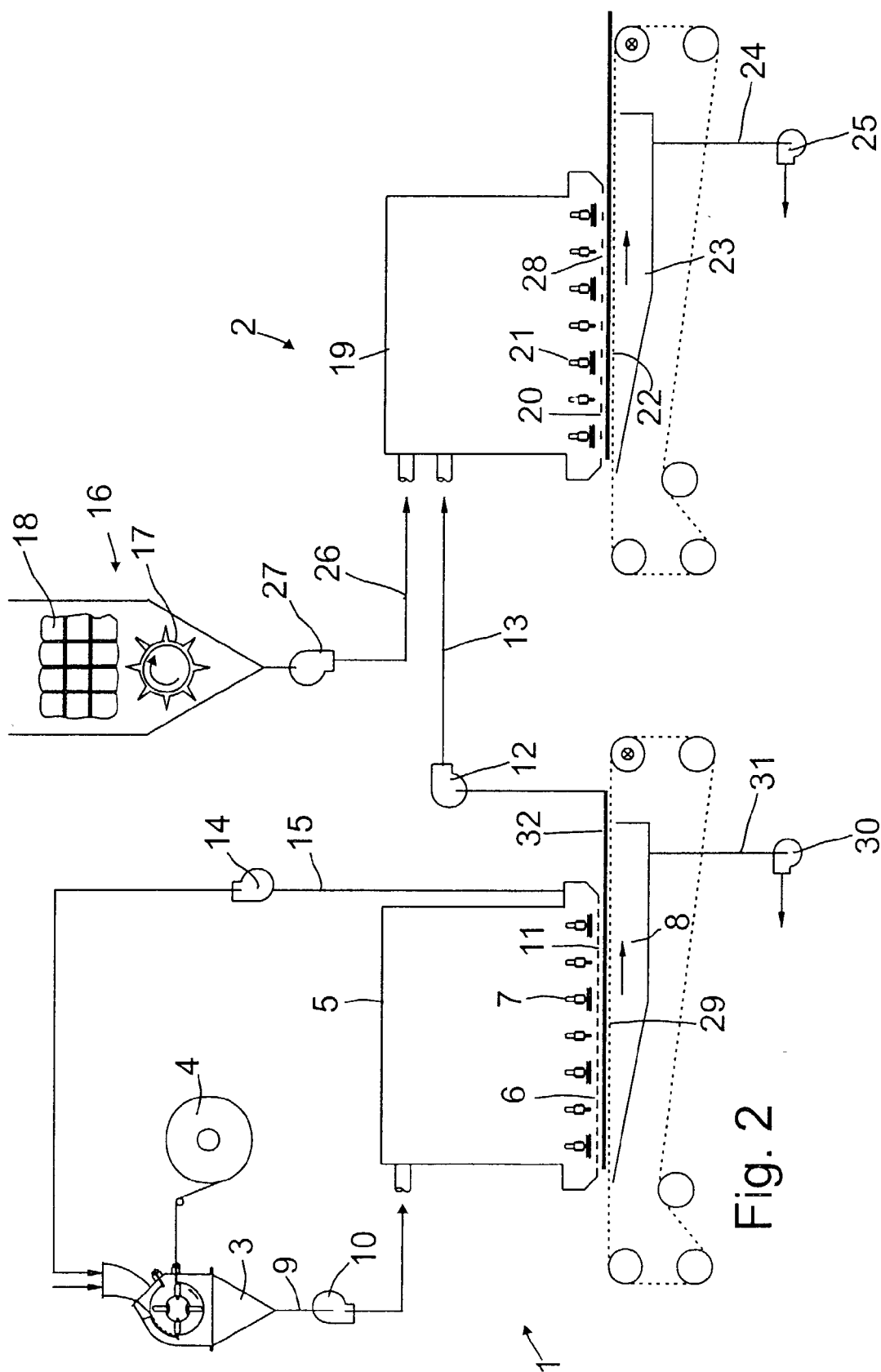


Fig. 1



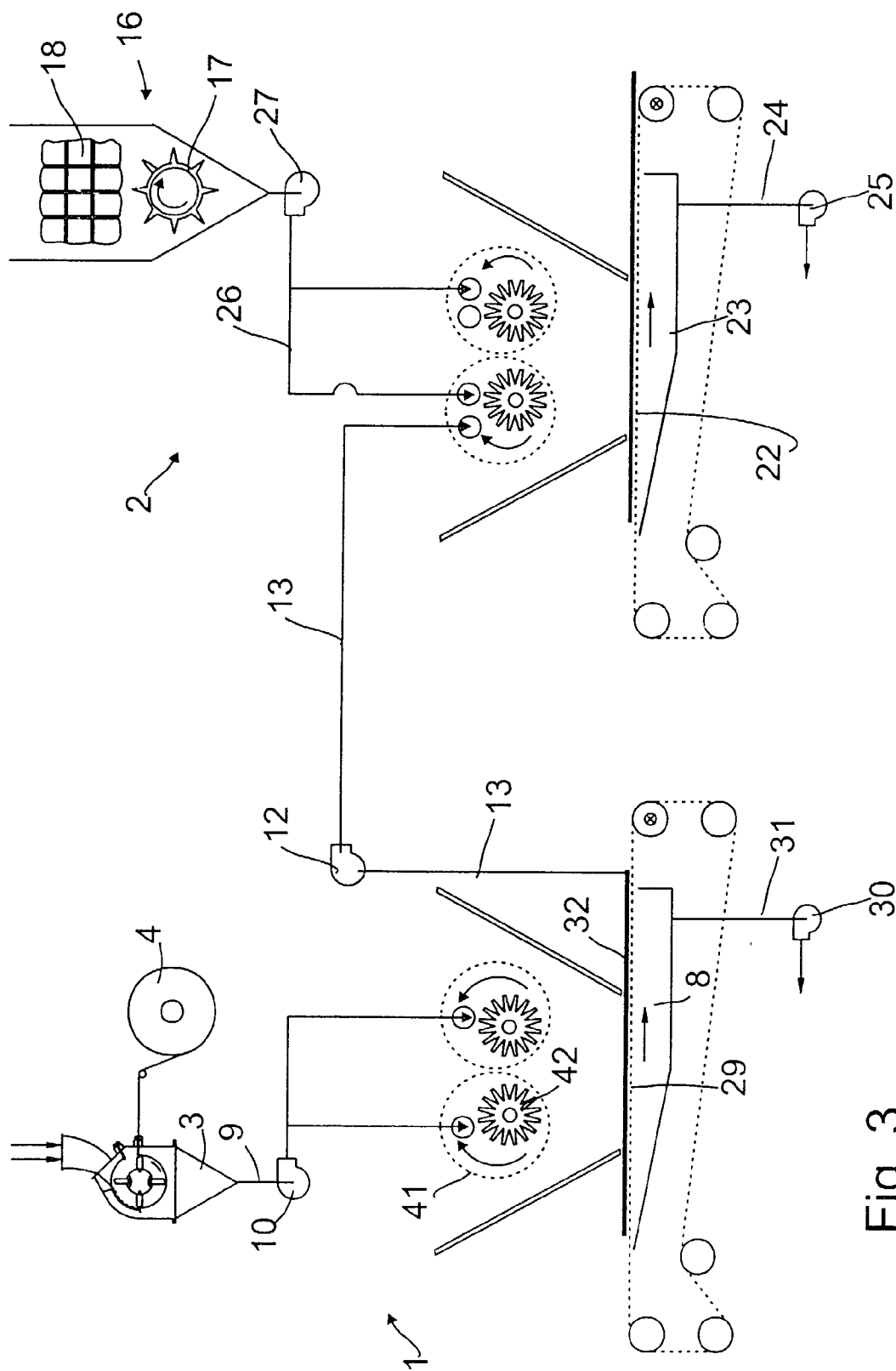


Fig. 3

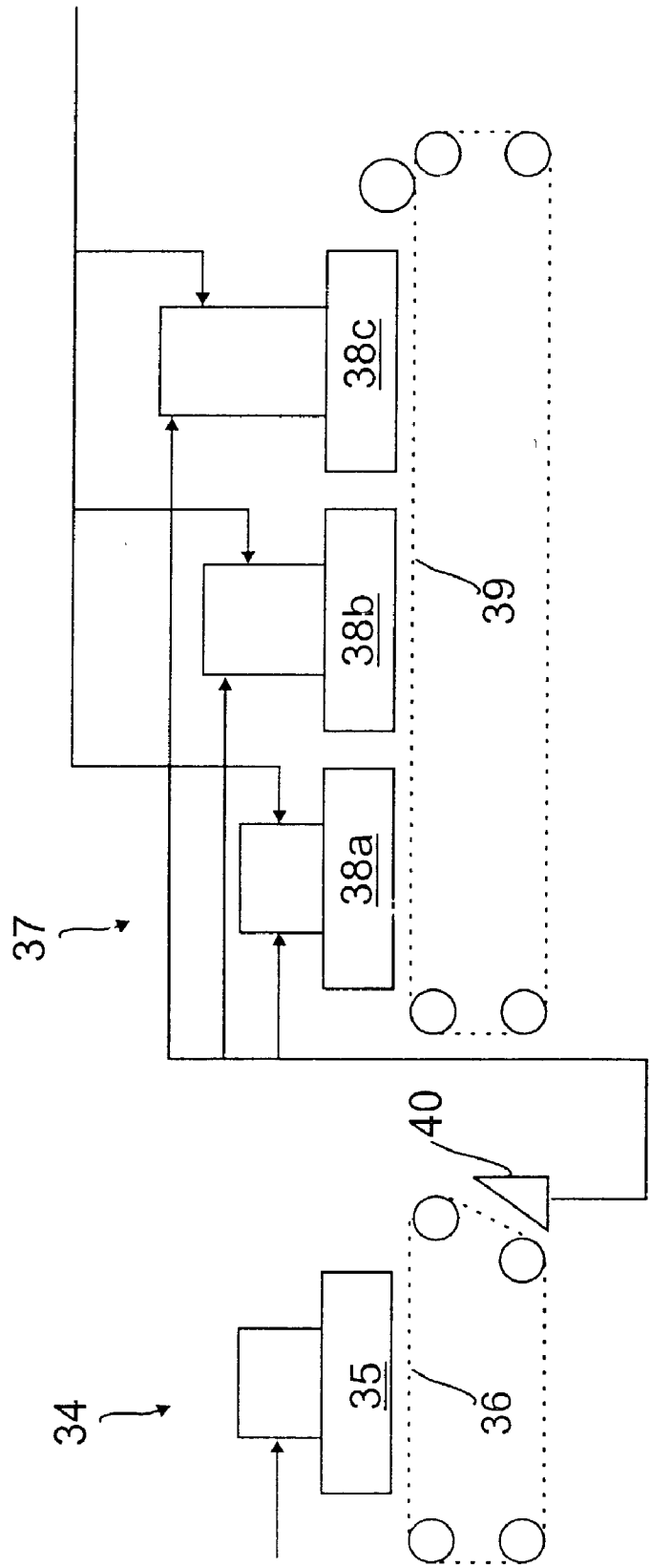


Fig. 4

DRY PRODUCTION OF A NON-WOVEN FIBRE WEB

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of the US national stage designation of International application PCT/DK01/00381 filed May 31, 2001, the content of which is expressly incorporated herein by reference thereto.

BACKGROUND ART

[0002] The invention relates to a method for the dry production of a non-woven fiber web of at least relatively short and relatively long fibers. The invention also relates to a plant for the dry production of a non-woven fiber web by means of two air-lay stations placed one after the other and each comprising at least one fiber feed duct to feed fibers to the station from a fiber source, at least one air-lay forming head connected to the fiber feed duct and at least partly defined by a perforated screen, and a suction box for successively sucking fibers in the forming head through the screen.

[0003] The invention moreover relates to a non-woven fiber web produced by means of the method and the plant for dryly producing a non-woven fiber web.

[0004] Finally, the invention relates to the use of Cotton Linters Pulp (CLP), which is a relatively inexpensive by-product derived from the seed coats of the cotton plant, for the dry production of a relatively inexpensive non-woven air laid cotton fiber web.

[0005] The air-lay technique is known generally from GB Patent No. 1,499,687 which describes a plant for the dry production of a non-woven fiber web. This plant has an air-lay forming head in form of a box which is defined by a perforated base at the bottom. Above the base are rows of rotating wings which distribute the fibers during operation into flows across the perforated base. Below this base is placed an air-permeable forming wire which is running endlessly during operation for accommodating fibers which are drawn through the openings of the perforated base by the negative pressure in a suction box placed under the forming wire.

[0006] This plant is well suited for producing a non-woven fiber web of like fibers or at least of fibers on the whole having the same configuration. If the fiber web is to be made of fibers having substantially different lengths, the plant can however not function optimally, and the fiber web produced cannot obtain a completely satisfactory quality.

[0007] These disadvantages can be assigned to the fact that it is not possible to dimension the openings of the base so that they are suited for both relatively short and relatively long fibers. It is therefore necessary to choose openings having a size which is between the optimum sizes for each of the two types of fibers. The openings will then easily be too large for the short fibers and too small for the long ones.

[0008] GB Patent application No. 2,031,970 describes an air-lay plant having several forming heads of the above-mentioned type placed in a row one after another above a joint forming wire. By means of this arrangement, the plant is able to operate with both short and long fibers with good

results. Fibers of one specific length are then distributed from a forming head having base openings which are suited for exactly this fiber length. Layered fiber webs can be produced by means of this technique as it also is desired in some cases. The known plant is however not suited for producing homogeneous fiber webs of fibers of different lengths.

[0009] Attempts have been made to resolve the last-mentioned problem by placing the forming heads on top of each other instead of in a row one after the other. Such a plant is described in published PCT application WO 96/10663. In this application, the plant has three forming heads. The uppermost one is supplied with Super Absorbent Powder (SAP) and has a base with openings that exactly fit the size of the SAP. The middle forming head is supplied with short cellulose fibers and has a base that exactly fits the size of these short fibers, while the lowest forming head is supplied with long thermobinding fibers and has a base that exactly fits the size of these long fibers.

[0010] The base of the upper forming head forms an upper delimitation to the middle forming head, and the base of this head forms an upper delimitation to the lowest forming head. The openings in the base of the lowest forming head are so large that the SAP and the cellulose fibers can pass through the openings simultaneously with the thermobinding fibers, and the openings in the base of the middle forming head are so large that the SAP can pass through these openings simultaneously with the cellulose fibers.

[0011] Below the base of the lowest forming head is an air-permeable forming wire which is running endlessly during operation, and below this a suction box which is common to all three forming heads. When the plant is running, the SAP is driven via the openings in the base of the upper forming head down into the middle forming head, the SAP and the cellulose fibers are driven via the openings in the base of the middle forming head down into the lowest forming head, and the SAP, the short cellulose fibers and the long thermobinding fibers are driven via the openings in the base of the lowest forming head down in a layer onto the forming wire.

[0012] The SAP and the short cellulose fibers are first mixed in the middle forming head and then the long thermobinding fibers in the lowest forming head. By means of this mixing, a homogenous fiber web should be obtainable. However, it is difficult to control the different air flows of the process such that the resulting fiber web obtains an acceptable homogeneity. This is among other things due to the fact that the air flows inevitably will interfere with each other. Thus, air is simultaneously blown in on both sides of the base of both the upper and the middle forming head, and the negative pressure from the suction box furthermore has to propagate to the base of the middle forming head via the openings in the base of the lowest forming head and to the base of the upper forming head via the openings in the middle forming head. At the same time, the SAP, the short cellulose fibers and the long thermobinding fibers are moving in the opposite direction through the openings of the respective bases, with those openings thereby randomly blocked to the flow of the air to a greater or smaller extent.

[0013] When the forming heads are placed on top of each other instead of in a row after each other, the plant will furthermore be disproportionately high. Therefore, the plant

known from the published PCT application WO 96/10663 can rarely find room in existing buildings, and new buildings for the plant will normally look quite out of place in an otherwise harmonious group of buildings. Furthermore, the great height means that it is difficult to inspect the plant and control the process in this plant.

[0014] Today, dry-produced fiber webs are used extensively for many different purposes, of which napkins, toilet paper, diapers, sanitary napkins and absorbent products for people suffering from incontinence can be mentioned.

[0015] In order to be able to keep the prices of these products at a commercially acceptable level, a large part of the fibers that form part of the air-laid fiber product are normally inexpensive cellulose fibers which can be mixed with e.g., thermobinding fibers depending on the application purpose just as the products also can contain SAP to increase the ability of the products to absorb liquids. However, for some purposes, products are desired that are substantially softer than the products that are based on cellulose fibers. Such a very soft, non-woven fiber product can be produced by utilizing cotton fibers instead of cellulose fibers. Due to the high price of the cotton fibers, however, the resulting products will be too expensive for practical applications.

[0016] The production of cotton leaves a by-product called Cotton Linters Pulp (CLP) which consists of short residual fibers from the seed coats of the cotton plants. This by-product is far less expensive than common cotton fibers. It is therefore possible to use it for producing a very soft, non-woven cotton fiber web which, considering its quality, would be able to compete on price with fiber webs based on cellulose fibers. However, CLP consists of fibers that are very fine, very short and also have a large content of unopen fibers or nit. The above known plants and methods can therefore not be used with a satisfactory result to produce a nit-free, homogenous, non-woven fiber web of CLP-fibers and thermobinding fibers. Thus, there is a need for improved products of this type, and these are provided by the present invention.

SUMMARY OF THE INVENTION

[0017] The present invention provides a method and a plant for the dry production of a non-woven fiber web of at least relatively short and relatively long fibers, by means of which a homogenous, nit-free, non-woven fiber web can advantageously be produced on the basis of CLP-fibers and thermobinding fibers.

[0018] The invention also provides a non-woven fiber web that has a homogenous and substantially nit-free structure and which is produced by the method and plant.

[0019] The invention further provides CLP as base material for the dry production of a non-woven cotton fiber web which can be used to make a wide variety of absorbent materials.

[0020] The novel and unique features of the method according to the invention are based on generating a first air flow with short fibers from a fiber source, passing the first air flow through a first perforated screen having openings of a size that mainly allow open, but not unopen short fibers to pass therethrough, passing the first air flow through an air-permeable first forming wire running endlessly during operation thus forming a non-woven layer of short fibers on

the forming wire, passing the first air flow through an air-permeable first forming wire running endlessly during operation to form a non-woven layer of short fibers thereon, generating a second air flow that contains short fibers from the non-woven fiber layer that is formed on the forming wire, generating a third air flow that contains long fibers from a fiber source of same, passing the second and third air flows through a second perforated screen having openings of a size that allow both short and long fibers to pass therethrough, passing the second and third air flows through an air-permeable second forming wire running endlessly during operation to form a fiber layer on the second forming wire, and preparing a non-woven fiber web from the fiber layer with further treatment.

[0021] By using this method, a non-woven fiber web of short and long fibers obtains a homogenous structure which at the same time is free of nits when the unopen short fibers or nits are extracted from the first perforated screen.

[0022] The novel and unique features of the plant according to the invention are the fact that a separate fiber source belongs to each station, that the first station has a fiber collector placed under the screen of its at least one forming head, that the second station has a forming wire placed under the screen of its at least one forming head, and that the two stations are connected by at least one conveyor for conveying fibers from the fiber collector of the first station to the forming head of the second station.

[0023] When the screen openings of the first station have a size that fit the short fibers which e.g. can be CLP-fibers, and the screen openings of the second station have a size that fit the long fibers which e.g. can be thermobinding fibers, the plant can be utilized for producing a non-woven fiber web having a homogenous structure.

[0024] The first station is then fed short fibers whereas the second station is fed both long fibers and short fibers having passed the screen openings of the first station. The short and long fibers thereby obtain being carefully mixed in the second station and can thereby form a fiber layer having a homogenous structure on the forming wire of the second station.

[0025] By means of the above arrangement, unopen fibers or nits can selectively be extracted from the first station so that the resulting fiber web also becomes at least essentially free of nit.

[0026] The conveyor that can be used for connecting the first and second stations together can be a belt conveyor but can in an advantageous embodiment be a fiber feed duct connecting the fiber collector of the first station to the forming head of the second station. By means of a fan generating an air flow through the fiber feed duct, the fibers are sucked from the fiber collector of the first station up into the fiber feed duct in order to then via this being blown into the forming head of the second station.

[0027] The fiber collector of the first station can be of any expedient kind. In an advantageous embodiment the fiber collector can quite simply be part of the suction box of the first station whereby the extraction from the suction box takes place by means of the fiber feed duct which connects the two stations. In a second advantageous embodiment the fiber collector can be a forming wire which then acts as a

travelling filter for filtering off the short fibers from the air flow through the screen openings of the first station.

[0028] The novel and unique features of the fiber web according to the invention are the fact that it comprises a mixture of thermobinding fibers and CLP-fibers screened of unopen fibers or nit, and that it has a homogenous and nit-free structure. Such a web has an extraordinarily great softness which is wanted for many purposes. Furthermore, fiber webs on cotton basis are good for the skin and non-allergenic.

[0029] The novel and unique features of the invention include the use of CLP as base material to produce a non-woven air-laid cotton fiber web together with thermobinding fibers. Thus, in a method for producing a non-woven fiber web, the invention relates to the improvement which comprises combining CLP together with thermobinding fibers to produce the web.

[0030] A cotton fiber web based on conventional cotton fibers will be too expensive for practical application due to the relatively high price of these fibers. By using CLP as base material instead, an inexpensive product is obtained having the same advantages of the cotton fiber web based on conventional cotton fibers. However, the CLP fibers are relatively short and weak. The strength of the web is therefore obtained by binding the fibers together by means of thermobinding fibers using the method and plant according to the invention.

[0031] An especially good strength is obtained according to the invention when the thermobinding fibers are bicomponent fibers of the kind that each has a core consisting of a rather strong material and that is surrounded by an outer coating having a lower melting point than the core. During the production of the fiber web, the outer coating will melt readily and effectively together with both each other and the short and weak CLP fibers, and especially in nodal points whereby the advantageous properties of the CLP cotton fibers are completely maintained whereas the core of the bicomponent fibers transfers its great strength to the cotton fiber web.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The invention will be explained in greater detail below, describing only exemplary embodiments with reference to the drawing figures, in which

[0033] FIG. 1 is a diagrammatic view of a first embodiment of a plant according to the invention,

[0034] FIG. 2 is a diagrammatic view of a second embodiment of a plant according to the invention,

[0035] FIG. 3 is a diagrammatic view of a third embodiment of a plant according to the invention, and

[0036] FIG. 4 is a diagrammatic view of a fourth embodiment of a plant according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] In the following the invention is described on the assumption that a homogenous and nit-free cotton fiber web of CLP-fibers and thermobinding fibers is to be made.

[0038] CLP has very fine and short fibers and also a large content of unopen fibers or nit. Therefore, it has so far not been possible in practice to use CLP for producing a cotton fiber web of satisfactory quality.

[0039] The fine and short CLP-fibers are bound to the thermobinding fibers in a manner known per se in order to thereby give the fiber web the necessary strength. The resulting cotton fiber web is relatively inexpensive to produce and has a very soft structure. There is thus a considerable market for such a product.

[0040] The plant according to the invention in FIG. 1 has a first air-lay station 1 for CLP-fibers and a second air-lay station 2 for both thermobinding fibers and CLP-fibers which have been screened of nits in the first station. If the thermobinding fibers are mixed with unscreened CLP-fibers, the result is a fiber web of unsatisfactory quality.

[0041] The main components of the first station 1 is a hammer mill 3 for defibrating CLP from a roller 4, and a first forming head 5 having a first perforated base 6, a first set of rotatable wings 7 placed in rows above the base 6, and a first suction box 8 placed under the base 6.

[0042] When the first station is operating, the forming head 5 is supplied with defibrated fibers from the hammer mill 3 via first feed duct 9 having a first feed fan 10.

[0043] The wings 7 are sweeping the supplied CLP-fibers across the base 8 in continuous flows. During this, the fibers are sucked successively down into the suction box 8 via the openings 11 of the base 8 by a second feed fan 12 which is connected to the suction box via the second feed duct 13.

[0044] The openings 11 of the base 8 are arranged with a size that allows the fine, short CLP-fibers to pass but not the coarser nit.

[0045] A return fan 14 serves for returning the nits to the hammer mill 3 via a return duct 15 where the nits can be open.

[0046] The screened fibers are collected in the suction box which thus simultaneously acts as fiber collector.

[0047] The main components of the second station 2 are a fiber source 16 with a bale breaker 17 for breaking up the thermobinding fibers from a bale of thermobinding fibers 18, and a second forming head 19 having a second perforated base 20, a second set of rotatable wings 21 placed in rows above the base 20, a forming wire 22 placed under the base 20, and a second suction box 23 placed under the forming wire 22 and via a suction duct 24 connected to a fan 25 for creating a negative pressure in the suction box.

[0048] When the second station is operating, the second forming head 19 is supplied with screened CLP-fibers from the first suction box 8 via the second feed duct 13 by means of the second feed fan 12.

[0049] The second forming head 19 is simultaneously supplied with thermobinding fibers from the fiber source 16 via a third feed duct 26 with a third feed fan 27.

[0050] In the second forming head 19, the supplied with CLP-fibers are mixed with the supplied thermobinding fibers. The second set of wings 21 are sweeping the now mixed fibers across the second perforated base 20 in continuous flows. During this, the fibers are sucked successively

down into a layer on the forming wire **22** via the openings **28** of the base by means of the fan **25** which is connected to the suction box **23** via the suction duct **24**.

[0051] The openings **28** of the second base **20** are arranged with a size that allow both CLP-fibers and thermobinding fibers to pass.

[0052] Thereby, a fiber layer of CLP-fibers and thermobinding fibers is made on the forming wire **22**, said fiber layer has a homogenous and nit-free structure. In a known subsequent process (not shown), the fiber layer is finally converted into the desired fiber web which among other things can be dust bonded by means of a layer of latex.

[0053] The plant according to the invention shown in **FIG. 2** corresponds essentially to the one shown in **FIG. 1** and referred to above. Like parts are therefore designated by the same reference numerals.

[0054] In this case, the fiber collector of the first station is however a forming wire **29** acting as a travelling filter for filtering off the CLP-fibers from the air flow through the base openings **11** of the first station **1**.

[0055] The CLP-fibers are sucked successively down onto the forming wire **29** via the openings **11** of the first base by means of a fan **30** which is connected to the suction box **8** via a suction duct **31**. An evenly distributed CLP-fiber layer **32** settling on the forming wire **29** is successively conveyed with this wire towards the inlet openings **33** of the second feed duct **13** and supplied in a continuous flow into the second forming head **19** via the second feed duct **13** by means of the second feed fan **12**.

[0056] This solution has especially the advantage that the feeding of screened CLP-fibers in the second forming head **19** is controlled very accurately, and that the resulting cotton fiber web therefore can obtain a very uniform structure in the longitudinal direction.

[0057] The plant according to the invention shown in **FIG. 3** corresponds essentially to the one shown in **FIG. 2** and referred to above. Like parts are therefore designated by the same reference numerals.

[0058] In this embodiment both stations use a known forming head in form of a drum-shaped screen **41** having horizontal brushes **42** for distributing the fibers over the screen. Each station has two forming heads.

[0059] Moreover, the functioning of the embodiment shown in **FIG. 3** of a plant according to the invention corresponds to the one shown in **FIG. 2** and referred to above and will therefore not be mentioned any further here.

[0060] **FIG. 4** is a very diagrammatic view of a plant according to the invention having a first station **34** with one forming head **35** for CLP-fibers placed above a forming wire **36**, and a second station **37** with three forming heads **38a,b,c** for screened CLP-fibers and other fibers placed above a joint forming wire **39**.

[0061] The two stations are connected to a fiber conveyor **40** for, as indicated by the arrows, conveying screened CLP-fibers from the forming wire **36** of the first station **34** into the forming heads **38a,b,c** of the second station.

[0062] This plant can be used for producing cotton fiber webs having a composition that varies depending upon the supply of fibers to the different forming heads of the second station.

[0063] For example, the plant can be used for producing laminated cotton fiber webs, and cotton fiber webs that also comprises a powder for example SAP, and synthetic fibers such as PET.

[0064] Two different, known forming heads are mentioned above and shown in the drawing that can form part of a plant according to the invention. However, this is only to be taken as an example as the plant within the scope of the invention can function with any other kind of forming head just as two or several different types of forming heads can form part of the same plant.

[0065] The invention is furthermore described on the assumption that the short fibers forming part of the fiber web according to the inventions are CLP.

[0066] This is also only to be taken as an example as the method and the plant according to the invention advantageously can be used to produce fiber webs having a content of other types of short fibers, for example cellulose fibers.

[0067] The first air-lay station of the plant can furthermore have more than one forming head for short fibers.

[0068] The first station can thus have one forming head for short cellulose fibers and a second for CLP-fibers whereby a homogenous, nit-free, non-woven cotton fiber web can be produced that has an acceptable softness and is relatively inexpensive.

EXAMPLES

[0069] The following non-limiting examples illustrate preferred embodiments of the present invention.

[0070] A web having the advantageously soft properties of the relatively short and weak CLP fibers and the advantageously great strength of the thermobinding fibers can for example be obtained with the following compositions.

Example 1

[0071] A fiber web consisting of 60 weight percentage CLP fibers and 40 weight percentage thermobinding fibers.

Example 2

[0072] A fiber web consisting of 95 weight percentage CLP fibers and 5 weight percentage bicomponent fibers.

Example 3

[0073] A fiber web consisting of a multilayer; for example a three-layer product where the top and base layer consist of 60 weight percentage CLP-fibers and 40 weight percentage bicomponent fibers. The middle layer consists of 95 weight percentage CLP-fibers and 5 weight percentage bicomponent fibers but can just as well comprise SAP, SAF or pulp within the scope of the invention.

What is claimed is:

1. A method for dry production of a non-woven fiber web that includes at least relatively short and relatively long fibers, wherein the method comprises the following process steps:

generating that a first air flow that contains short fibers from a fiber source,

passing the first air flow through a first perforated screen having openings of a size that allow open, but not unopen, short fibers to pass therethrough,

passing the first air flow through an air-permeable first forming wire running endlessly during operation to form a non-woven layer of short fibers thereon,

generating a second air flow that contains short fibers from the non-woven fiber layer that is formed on the forming wire,

generating a third air flow that contains long fibers from a fiber source of same,

passing the second and third air flows through a second perforated screen having openings of a size that allow both short and long fibers to pass therethrough,

passing the second and third air flows through an air-permeable second forming wire running endlessly during operation to form a fiber layer on the second forming wire, and

preparing a non-woven fiber web from the fiber layer from the second forming wire.

2. The method according to claim 1, wherein unopen, short fibers are extracted from the first perforated screen.

3. A plant for dry production of a non-woven fiber web comprising two air-lay stations placed after each other and each comprising at least one fiber feed duct for feeding fibers to the station from a fiber source, at least one air-lay forming head connected with the fiber feed duct and at least partly defined by a perforated screen, a suction box for successively sucking fibers through the screen, a separate fiber source associated with each of the two stations, a fiber collector associated with the first station and placed under the screen of its forming head(s), a forming wire associated with the second station and placed under the screen of its forming head(s), and at least one conveyor associated with the two stations for conveying fibers from the fiber collector of the first station to the forming head of the second station.

4. The plant according to claim 3, wherein the fiber collector of the first station is a forming wire.

5. The plant according to claim 3, wherein the fiber collector of the first station is part of the suction box of the forming head belonging to that station.

6. The plant according to claim 3, wherein the fiber source of the first station consists essentially of relatively short fibers, and that the openings in the screen of its at least one

forming head are of a size that mainly allow open, but not unopen short fibers to pass through; that the fiber source of the second station consists essentially of relatively long fibers, and that the openings in the screen of its at least one forming head are of a size that allow both the relatively short and the relatively long fibers to pass through.

7. The plant according to claim 6, wherein the fiber source of the first station consists essentially of Cotton Linters Pulp, and that the fiber source of the second station consists essentially of thermobinding fibers.

8. The plant according to claim 7, wherein the thermobinding fibers are bicomponent fibers having a core that is surrounded by an outer coating of a material having a lower melting point than that of the core.

9. The plant according to claim 3, wherein the conveyor is a fiber feed duct extending between the fiber collector of the first station and the forming head of the second station.

10. The plant according to claim 3, wherein at least the first station has at least one extraction duct and a conveyor fan for extracting unopen fibers or nits from the screen of the at least one forming head of that station.

11. A non-woven air-laid fiber web comprising a mixture of thermobinding fibers and Cotton Linters Pulp which is mainly screened of unopen fibers.

12. The non-woven air-laid fiber web according to claim 11, wherein the thermobinding fibers are bicomponent fibers having a core consisting essentially of a relatively strong material that is surrounded by an outer coating having a lower melting point than the core.

13. A non-woven air-laid fiber web obtainable by the method of claim 7, such that the web comprises a mixture of thermobinding fibers and Cotton Linters Pulp which is mainly screened of unopen fibers.

14. The non-woven air-laid fiber web according to claim 12, wherein the thermobinding fibers are bicomponent fibers having a core that is surrounded by an outer coating of a material having a lower melting point than that of the core.

15. In a method for producing a non-woven fiber web, the improvement which comprises combining Cotton Linters Pulp together with thermobinding fibers to produce the web.

16. The method of claim 15 wherein the thermobinding fibers are bicomponent fibers having a core that is surrounded by an outer coating of a material having a lower melting point than that of the core.

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