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(54) **Title:** TRIPLE HEAD DRAW SLOT FOR PRODUCING PULP AND SPUNMELT FIBERS CONTAINING WEB

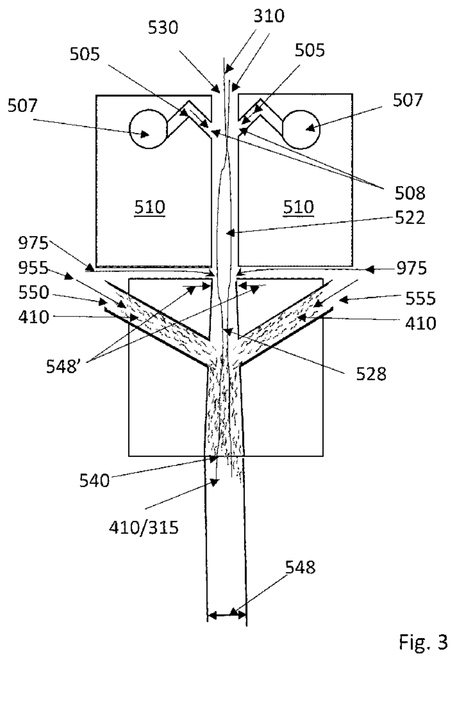

Fig. 3

(57) **Abstract:** The present invention is a novel improved process and apparatus for making polymeric fibers and combining these with cellulosic fibers so as to form a fibrous-containing nonwoven, and in particular fibrous material containing spunmelt nonwoven.

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TRIPLE HEAD DRAW SLOT FOR PRODUCING PULP AND SPUNMELT FIBERS CONTAINING WEB

Field of the invention

The present invention relates to the field of nonwovens forming. In this field, the invention relates to a novel improved process and apparatus for making polymeric filaments and combining these with short fibers so as to form a fiber-containing nonwoven, such as particular pulp-containing nonwoven.

Background

It is well known to manufacture nonwoven materials by combining in-situ formed synthetic fibers or filaments with other fibers, such as preformed staple fibers and/or natural based fibers, in particular cellulosic or pulp fibers.

The in-situ forming of the synthetic or filaments fibers can be achieved by technologies as are often summarized as "spunmelt", i.e. a process where fibers or filaments are spun from molten polymer through a plurality of holes in a die head connected to one or more extruders. The spunmelt process may include meltblown, spunbond and as well as intermediate processes, such as sometimes referred to as "spun-blowing ®" e.g., by Biax Fiberfilm, WI, US.

Spunbond is a process for producing strong fibrous nonwoven webs directly from thermoplastics polymers by attenuating the spun filaments using cold, high speed air while quenching the fibers near the spinneret face. Individual and typically continuous filaments are then laid down randomly on a collection belt and conveyed to a bonder to give the web added strength and integrity. Filament size is usually below 250 µm and the average filament size is in the range of from between about 10 µm to about 50 µm. A high strength of the filaments may be achieved by molecular chain alignment during the attenuation of the crystallized (solidified) filaments. A typical spunbond die has multiple rows of polymer holes and a suitable polymer melt flow rate for such a process is usually below about 500 grams/10 minutes.

The term "meltblown" is typically used for a process for producing very fine fibers having a diameter of less than about 10 µm, where a plurality of molten polymer streams are attenuated using a hot, high speed gas stream once the filaments emerge from the nozzles. The attenuated fibers are then collected on a flat belt or dual drum collector directly or on other layers, often fibrous layers, which were pre-formed or formed in-situ upstream of the meltblowing laydown zone. The typical meltblow die uses two inclined air jets for attenuating the filaments.

A process and apparatus for manufacturing a meltblown nonwoven are well-known and described for example in US3849241 (Butin et al) and in US 4048364 (Harding et al.). Generally, in a meltblow process, the primary air is also adjusted in such way that the meltblown filaments are broken at the outlet of the die head into discontinuous fibers (microfibers or nanofibers) of shorter length. The discontinuous fibers generally have a length exceeding the typical length of staple fibers. More particularly, to date with a standard known meltblow process, discontinuous meltblown fibers having a length between 5 mm and 20 mm can be produced.

More recently, an intermediate technology, such as described in US2015/0322603 and US2015/0322592 or distributed by Biax-Fiberfilm Inc, WI, US, provides strong yet fine fibers.

For forming a nonwoven web from any such in-situ formed fibers or filaments, these are delivered downstream from the die head onto a moving surface, like for example a cylinder or conveyor belt, in order to form a web of unoriented fibers. Preferably, the forming surface is air permeable, and even more preferably suction means are provided for sucking the fibers onto the forming surface. Optionally, the lay-down zone may already comprise other layers, often fibrous layers, which were pre-formed or formed in-situ upstream of the meltblowing laydown zone. This web can then be transported to consolidating means, like for example thermal bonding calendar, a water needling unit, an ultrasonic bonding unit, in order to form a consolidated nonwoven web.

For making a laminate having high absorbency properties, it is known to combine in-situ formed synthetic fibers with fibrous material having high absorbency capacity, such as for example short wood-pulp fibers. Coform is typically referred to as a technique generally made by a process in which conventional meltblown fibers are comingled with staple and/or pulp fibers to produce absorbent materials, see e.g. US4931355 and in US4939016 (Radwanski et al), but also U.S. Pat. No. 4,100,324 issued to Anderson et al; U.S. Pat. No. 4,923,454 issued to Seymour et al.; and U.S. Pat. No. 8,017,534 issued to Harvey et al., as well as U.S. Publication No. 2009/0233049 to Jackson et al. The fibrous material, e.g. wood pulp, is fed directly into the polymer streams immediately downstream from the outlet of the meltblow die head, typically in a mixing box. The meltblown fibers are mainly used to hold the short pulp fibers together. Since the conventional meltblown fibers are weak, non-woven manufacturers use often more than about 25% thermoplastic fibers to add integrity to the finished web. Because the thermoplastic fibers are more expensive than the pulp fibers, the higher the amount of thermoplastic fibers in the web, the higher is the cost of the web.

In WO2012/020053 (Boscolo - hereinafter referred to as “WO’053”) an apparatus and a process is described for making a nonwoven web comprising pulp and spunmelt fibers, wherein the polymeric filaments formed in a die head are fed to a drawing or stretching unit, wherein the continuous filaments are further stretched by additional air flow. At the entry of the filaments into the drawing unit, short fibers, such as cellulosic fibers can be added to the air stream, such that a combined web with spunmelt and short, e.g. cellulosic, fibers can be assembled below the drawing head on a collecting belt. However, in this set-up, the tendency for the short fibers to accumulate around the entry into the drawing unit may deteriorate quality or require a more frequent cleaning procedure.

Summary

In a first aspect, the present invention relates to a method for forming a fiber containing web, which comprises spunmelt fibers, and fibrous material, preferably cellulosic pulp material. The method comprises the steps of

(i) providing

- supply unit for polymeric material;
- supply unit of fibrous material;
- a filament forming unit comprising a melt-extruder for the polymeric material and a die head;
- a fibrous material delivery unit
- a drawing unit comprising
  - a filament infeed;
  - at least one, preferably two fibrous material infeed(s);
  - a drawing channel; and
  - a drawing channel outlet;
- a collection unit;
- means for creating air flows at predetermined flow rates for air with predetermined temperatures;

(ii) forming filaments of polymeric material in the filament forming unit;

(iii) transferring the formed filaments to the a filament entry slot of the drawing unit, thereby quenching and drawing the filaments by a first air flow,

the process being characterized in that it further comprises the steps of

(iv) suspending the fibrous material in an additional air flow and transferring the fibrous material in the additional air flow to the fibrous material infeed(s) of the drawing unit

whereby the fibrous material infeed(s) is/are separate from the filament infeed;

(v) feeding the filaments and the fibrous material into the drawing channel;

(vi) creating an air flow in the drawing channel thereby

mixing the fibrous material and the filaments and

(vii) collecting the mixed spunmelt filaments and the fibrous material on a collection unit, thereby forming the fiber containing web.

Optionally, one or more of the conditions selected from the group consisting of the following, are satisfied:

a) the polymeric material for forming the filaments is an olefinic polymeric material, more preferably of the polypropylene type, and most preferably exhibiting a MFI of between 15 and 70 g/10 min, when determined according to ASTM 1237-(4) (230°C/2.16kg);

b) the fibrous material is cellulosic pulp material;

c) the fibrous material comprises particulate material, preferably superabsorbent polymer particles;

d) the spunmelt fibers exhibit a diameter of between 10 µm and 40 µm;

e) the spunmelt fibers exhibit a length of more than 20 mm, preferably more than 40 mm, but less than 250 mm, preferably less than 150 mm;

f) the additional air flow is at a temperature of between 32° C and 35°C, when being added to the fibrous material;

g) the additional air flow is at a relative humidity of less than 85%, when being added to the fibrous material;

h) the additional air flow is provided at a ratio of from 10 Nm^3 to 50 Nm^3, preferably of 20 Nm^3 to 30 Nm^3, most preferably about 25 Nm^3 of air relative to 1 kg of fibrous material, on an hourly basis and per meter length of drawing unit;

j) the creation of an airflow in the drawing channel of the drawing unit in step (vi) creates a Venturi effect of pulling further air through the filament infeed;

In another aspect, the present invention is an apparatus for making a fiber-containing web. The apparatus comprises

- means for providing meltable polymeric material;
- a filament forming unit comprising
    - a melt-extruder for the polymeric material and
    - a filament forming unit;
- means for creating air flow;
- means for providing and delivering fibrous material;
- a drawing unit positioned below the filament forming unit, adapted to receive the filaments and the fibrous material.

The drawing unit comprises

- a filament entry slot opening adapted to receive the filaments;
- an exit slot downwardly opposite of the filament entry slot;
- a drawing channel positioned there between.

Further, the apparatus comprises a means for collecting filaments, thereby forming the fiber containing web.

The drawing unit further comprises at least one, preferably two fibrous material infeed(s) separate from the filament entry slot, adapted to deliver the fibrous material suspended in an air flow to the drawing channel. The drawing channel is adapted to mixing of the spunmelt filaments and the fibrous material.

Further, the width of the air flow infeed at the point of connection to the drawing channel may be less than about 0.8 mm, preferably less than about 0.65 mm, more preferably less than 0.4 mm. The exit slot of the drawing channel may exhibit an exit gap width of less than about 15 mm, preferably less than about 12 mm, more preferably less than about 8 mm, most preferably less than about 5 mm. The ratio of the exit gap width to said width of the air flow infeed at the point of connection to said drawing channel may be less than about 20, preferably less than about 18.5, more preferably less than about 15.5, most preferably less than about 10.

In another aspect, the present invention provides a method for the reduction of energy consumption of an apparatus for forming a fiber containing web comprising the steps on concurrently reducing the width of the air flow infeed at the point of connection to the drawing channel and the width of the exit gap width.

Brief description of the figures

Fig. 1 depicts schematically the general set-up for an apparatus suitable for the present invention.

Fig. 2 depicts schematically a drawing unit according to the prior art.

Fig. 3 depicts schematically a drawing unit according to a preferred execution of the present invention.

Same numerals refer to same or equivalent elements or features.

Detailed description

With reference to Fig. 1, a suitable apparatus 10 for the present invention as well as a sketch for the operation of this equipment according to the second aspect of the present invention is described. From at least a first supply unit 100 a first polymeric material 110 can be provided, optionally further supply units 120 may be provided for being used for further polymeric materials 130.

The selection of the polymeric material is not particularly critical for the present invention, and can be any melt spinnable polymer(s) than can be extruded through a die head, such as polyolefin (in particular homo or copolymer of polypropylene or polyethylene), homo or copolymer of polyester, or homo or copolymer of polyamide or any blend thereof. It also can be advantageously any biodegradable thermoplastic polymer, like for example homo or copolymer of polylactic acid (PLA), or any biodegradable blend comprising a homo or copolymer of PLA. Mostly the polymer will be non-elastic, but elastomeric or elastic compounds can also be used.

In a preferred execution, the polymeric material may exhibit a melt flow index according ASTM D1238 (230°C / 2.16 kg) of between 15 and 70 g / 10 min, e.g. polypropylene (co-)polymers or mixtures or blends thereof.

The first and optionally further polymeric material(s) 110, 130 is/are fed into a filament forming unit comprising a melt-extruder 200 for melting and homogenizing the polymeric material(s) and supplied to a die head 300 whereby the pressure is increased by a spinning pump 290.

The die head may be a conventional spunmelting die head, e.g. of the meltblowing or spunblowing type or of an intermediate type. For explaining the principles of the present invention, reference is made to the description of WO'053.

The die head comprises several spinning orifices through which the molten polymeric material is pressed such that a curtain of molten essentially continuous filaments 310 is created and may have a width (extending out of the plane of drawing in the figures) of more than about 1.6 m, often more than 3.2 m or even more than 4.2 m. The die head may be executed as a single or multi-row orifice die-head.

The filaments may exhibit various cross-sectional shapes, such as circular, bilobal, multilobal, star-like, etc., and bi- or multi-lobal fibers may be preferred for many applications, allowing better mixing and bonding with the fibrous material. Within the present context, the term "filament" refers to an essentially continuous filament, whilst "fiber" or "fibrous material" refers to fibers of a relatively short fiber length, such as resulting from breaking up filaments.

There may also an even further compound or mixture of compounds 150 as may be delivered from a different polymer supply system 140, melt-extruder 240 and spinning pump 294 to the die head, where it may be co-extruded to form bi- or even multi-component fibers, whereby the components may be arranged side-by-side, or concentric, or eccentric, with side-by-side being preferred in case of creating crimped filaments.

Optionally, at the outlet of the die head 300 the filament may be drawn and attenuated by a first hot air flow 935 from a first air supply unit 930 at a temperature which is substantially equal or slightly higher then than the melt temperature of the polymer.

Cooling air 945 from a secondary air supply 940 may be drawn just after the outlet to provide quenching of the polymeric spunmelt filaments 310. The temperature of the quenching air may be about room temperature, but also may be as low as 5°C.

As a skilled person will readily realize, for an execution in the context of a spunbonding filament forming process, the filaments are more strongly attenuated upon solidification of the filaments.

As generally described in the referenced WO'053, but in the present invention applicable to any meltspun filaments, a drawing unit is positioned below the die head, optionally at an adjustable distance thereto. The filaments are fed into the drawing unit 500, where they are combined with fibrous material 410 as may be provided from a fiber supply 400 and – depending on the application of an additional air flow – may be further drawn and broken into shorter fibers. In case of the spunbonding process option, the filaments 315 will remain essentially endless, but well mixed with and intermingling the fibrous material.

The terms "fibrous material" used therein encompasses any material comprising short length fibers and/or comprising particles. The average length of the fibers of the fibrous material 410 will generally, though not necessarily, not exceed the average length of the meltblown fibers 315 created in the drawing unit 500 (see below), if present.

In a particularly preferred execution, the fibrous material can advantageously comprise "pulp". The term "pulp" as used herein refers to absorbent material made of or containing fibers from natural sources such as woody and non-woody plants. Woody plants (i.e. for wood-pulp) include, for example, deciduous and coniferous trees. Non-woody plants include, for example, cotton, flax, esparto grass, milkweed, straw, jute hemp, and bagasse. Typically, the average length of the pulp fibers is not more than 5 mm. The fibrous material can also comprise or essentially consist of staple fibers (natural and/or synthetic), and for example cotton fibers. Such fibrous material typically exhibits a length of not less than 20 mm, often more than 40 mm, though typically not more than 250 mm, often less than 150 mm.

The fibrous material can be made solely of pulp, or can also be made of a dry mixture of pulp with other materials (fibers and/or particles). In particular the fibrous material can comprise or essentially consist of fibers or particles of superabsorbent polymer (SAP) material.

The mixture of spunmelt fiber or filament 315 and fibrous material 410 is further downwardly fed towards a lay-down unit, such as an air-permeable belt 600 optionally supported by a suction box 610.

In case of the spunbonding process, the spunmelt fibers may exhibit a diameter of between 10 µm and 400 µm. In case of the meltblowing process, fibers often exhibit a diameter of between 1 µm and 5 µm, though diameters of more than 4 µm or even less than 1 µm may be preferred for particular applications, and an average length of between 5 mm and 20 mm.

It should be noted that within the context of the present description, the term “downward” and related expressions refer to a general alignment with the direction of gravity. Whilst the general arrangement of the various units does not have to be as indicated in the figures, the orientation from the die head to the drawing unit to the lay-down belt typically follows the downward direction 15 so as to allow better control of the flow of the filaments and fibers.

Typically, the fibers or filaments lay down on the belt or on a pre-formed or upstream in-situ formed web, preferably a fibrous web, in an arbitrary arrangement and the formed batt of fibers can be fed towards a consolidation unit 700 where the nonwoven web 710 can be compacted or bonded, and may be transferred to further material treatment or handling processes.

It should be noted that the apparatus 10 as described in the above may be part of a greater apparatus arrangement, optionally with several of such apparatuses or other web supplying units before or after the presently described apparatus, to create layered nonwoven structures, such as described in WO'053 or in copending patent application WO2017/085089.

In this context, the terms "before" or "after" as well as "upstream" or "downstream" refer to the process direction given by the movement direction of the lay-down unit (i.e. along the general process direction 650, in Fig. 1 to the right hand side). Each of the apparatuses may have its own web consolidating unit 700, or several may have a single consolidation unit.

Other web supplying units may be other in-situ web-forming units such as spin-bonding units, or fiber-lay-down units such as air-laying units, optionally with carding units, or unwinding units for preformed webs.

The webs may be fibrous webs, but also films, optionally also in-situ formed films or coatings may suitably applied depending on the desired application.

Generally, the equipment and process as described in the context of Fig. 1 are known in the art. In particular express reference is made to the WO'053 disclosure for specifics as to the various units and process steps, apart from the design and operation of the drawing unit 500.

In Fig. 2, the drawing unit 500 according to WO'053 is schematically and simplified depicted.

The continuous filament 310 is fed to the filament infeed 530 of the drawing unit body 510. In the slot-shaped drawing channel 520, and aided by supplemental air 505 from supplemental air infeed 507 from a supplemental air supply (not shown in Fig. 2), the filament 315 is further drawn and attenuated, leaving the drawing unit at the drawing channel outlet 540. Fibrous material, e.g. cellulosic fibers 410 is provided and fed also via the filament infeed 530 into the drawing channel 520, where they are mixed with the meltblown fibers to also leave through the drawing channel outlet 540 towards the lay-down unit.

Such a set-up provides a material with good properties, and also allows good operating conditions. However, over extended operation, fibers accumulate in the drawing unit body next to the filament infeed 530, in Fig. 2 depicted by small "heaps" 425 unless cleaned and removed at an appropriate frequency. These accumulations may from time to time move through the drawing channel and then deteriorate processing conditions as well as properties and quality of the resulting web. These accumulations may be reduced, but still not avoided, by providing ridges (not shown), e.g. with a triangular cross-section next to and parallel to the filament infeed 530.

Henceforth applicants have investigated approaches to alleviate such problems and have come to the solutions as further explained in the context of Fig. 3.

The principle is to separate the infeed of the fibrous material from the filament infeed 530 by directing the fibrous material to at least one, preferably and shown in the figures, two fiber infeeds 550 and 555, from where the fibers are guided through the drawing unit body 510 directly into the drawing channel 520.

As can be seen in Fig. 1, the fibrous material may be suspended in an additional air stream 955 by using an additional air supply unit 950.

As shown in Fig. 3, in the drawing head 500, the additional air stream may create a Venturi effect and may pull further air 965 through the filament infeed into the drawing channel 520.

The drawing channel comprises a first portion 522 and a diffusor portion 528 with a downwardly increasing gap width, and at the transition of the first portion 522 with constant gap width to the diffusor portion 528 additional process air 975 may be sucked in through an air gap.

Depending on the requirements for the resulting web, the filaments may also be broken into meltblown fibres that exhibit a much shorter, predetermined fiber length, respective fiber length distribution.

The width of the air flow infeed at the point of connection to the drawing channel (508) may be less than about 0.8 mm, preferably less than about 0.65 mm, more preferably less than 0.4 mm.

Further, the exit slot of the diffusor portion of the drawing channel may exhibit an exit gap width (548) of less than about 15 mm, preferably less than about 12 mm, more preferably less than about 8 mm, most preferably less than about 5 mm.

Thus, the ratio of said exit gap width (548) to said width of the air flow infeed at the point of connection to said drawing channel (508) is less than about 20, preferably less than about 18.5, more preferably less than about 15.5, most preferably less than about 10.

A further benefit of this execution as compared to the prior art execution as explained in the context of Fig. 2 is a significantly reduced energy reduction for providing the pressurized air, for example when reducing the fiber gap by about 33% and the air gap by about 23%, the required energy may be reduced by about 18%, or when reducing the fiber gap by about 58% and the air gap by about 38%, the energy may be reduced by about 30%.The additional air may preferably exhibit a temperature in the range of 32°C to 35°C and a relative humidity of not more than 85%, in particular for polypropylene based resins.

The additional air and the fibrous material may be added at a ratio of from 10 Nm^3 to 50 Nm^3, preferably of 20 Nm^3 to 30 Nm^3, most preferably about 25 Nm^3 of air relative to 1 kg of fibrous material, both e.g. on an hourly basis and per meter length of drawing unit.

The fibrous-containing spunmelt web of the invention or a laminate comprising at least one fibrous-containing spunmelt web of the invention can be used advantageously for making absorbent products, and more particularly dry wipes, or wet wipes, or diapers, or training pants, or sanitary napkins, or incontinence products, or bed pads.

Claims

1. A method for forming a fiber containing web,

said fiber containing web comprising

spunmelt fibers;

fibrous material, preferably cellulosic pulp material;

said method comprising the steps of

(i) providing

- a supply unit for polymeric material;
- a supply unit of fibrous material;
- a filament forming unit comprising a melt-extruder for said polymeric material and a die head;
- a fibrous material delivery unit;
- a drawing unit comprising a filament infeed; at least one, preferably two fibrous material infeed(s); a drawing channel; and a drawing channel outlet;
- a collection unit;
- means for creating air flows at predetermined flow rates for air with predetermined temperatures; and

(ii) forming filaments of polymeric material in said filament forming unit;

(iii) transferring said formed filaments to said a filament entry slot of said drawing unit, thereby quenching and drawing said filaments by a first air flow,

said process being characterized in that it further comprises the steps of

(iv) suspending said fibrous material in an additional air flow and transferring said fibrous material in said air flow to said fibrous material infeed(s) of said drawing unit whereby said fibrous material infeed(s) is/are separate from said filament infeed;

(v) feeding said filaments and said fibrous material into said drawing channel;

(vi) creating an air flow in said drawing channel thereby mixing said fibrous material and said filaments, and

(vii) collecting said mixed spunmelt fibers and fibrous material on a collection unit, thereby forming said fiber containing web.

2. A method according to claim 1, wherein one or more of the conditions selected from the group consisting of the following, are satisfied:

a) said polymeric material for forming the filaments is an olefinic polymeric material, more preferably of the polypropylene type, and most preferably exhibiting a MFI of between 15 and 70 g/10 min, when determined according to ASTM 1237-(4) (230°C / 2.16 kg);

b) said fibrous material is cellulosic pulp material;

c) said fibrous material comprises particulate material, preferably superabsorbent polymer particles;

d) said spunmelt fibers exhibit a diameter of between 10 µm and 40 µm;

e) said spunmelt fibers exhibit a length of more than 20 mm, preferably more than 40 mm, but less than 250 mm, preferably less than 150 mm;

f) said additional air flow is at a temperature of between 32° C and 35°C, when being added to said fibrous material;

g) said additional air flow is at a relative humidity of less than 85%, when being added to said fibrous material;

h) said additional air flow is provided at a ratio of from 10 Nm^3 to 50 Nm^3, preferably of 20 Nm^3 to 30 Nm^3, most preferably about 25 Nm^3 of air relative to 1 kg of fibrous material, on an hourly basis and per meter length of drawing unit;

j) said creation of an airflow in said drawing channel in step (vi) creates a Venturi effect of pulling further air through said filament infeed;

k) said filaments are broken into meltblown fibers at a predetermined fiber length distribution.

3. An apparatus for making a fiber-containing web, said apparatus comprising

- means for providing meltable polymeric material;
- a filament forming unit comprising a melt-extruder for said polymeric material and a die head for forming filaments;

  means for creating air flow; and

  means for providing and delivering fibrous material;
- a drawing unit positioned below said filament forming unit, adapted to receive said filaments and said fibrous material, and comprising
  - a filament entry slot opening adapted to receive said filaments:
  - an exit slot downwardly opposite of said filament entry slot;
  - a drawing channel positioned there between;
- a means for collecting fibers thereby forming said fiber containing web;

said apparatus being characterized in that

said drawing unit further comprises at least one, preferably two fibrous material infeed(s) separate from said filament entry slot and adapted to deliver said fibrous material suspended in an air flow to said drawing channel,

and wherein said drawing channel is adapted to mixing of said spunmelt filaments and said fibrous material and optionally create breaking of the filament into meltblown fibers.

4. An apparatus for making a fiber-containing web according to claim 3, wherein further the width of the air flow infeed at the point of connection to said drawing channel is less than about 0.8 mm, preferably less than about 0.65 mm, more preferably less than 0.4 mm.

5. An apparatus for making a fiber-containing web according to claim 3 or 4, wherein said exit slot of said drawing channel exhibits an exit gap width of less than about 15 mm, preferably less than about 12 mm, more preferably less than about 8 mm, most preferably less than about 5 mm.

6. An apparatus for making a fiber-containing web according to claim 5, wherein the ratio of said exit gap width to said width of the air flow infeed at the point of connection to said drawing channel is less than about 20, preferably less than about 18.5, more preferably less than about 15.5, most preferably less than about 10.

7. An apparatus for making a fiber containing web according to any of claims 3 to 6, wherein said drawing channel comprises a first and a diffusor portion and said fibrous material infeed is adapted to deliver said fibrous material to said diffusor portion of said drawing channel,

8. An apparatus for making a fiber containing web according to claim 7, further comprising an air gap adapted to deliver additional process air at the transition region from said first drawing channel portion to said diffusor portion.

9.. A method for the reduction of energy consumption of an apparatus for forming a fiber containing web according to any of claims 4 to 8 said method comprising the steps on concurrently reducing the width of the air flow infeed at the point of connection to said drawing channel and the width of the exit gap width.

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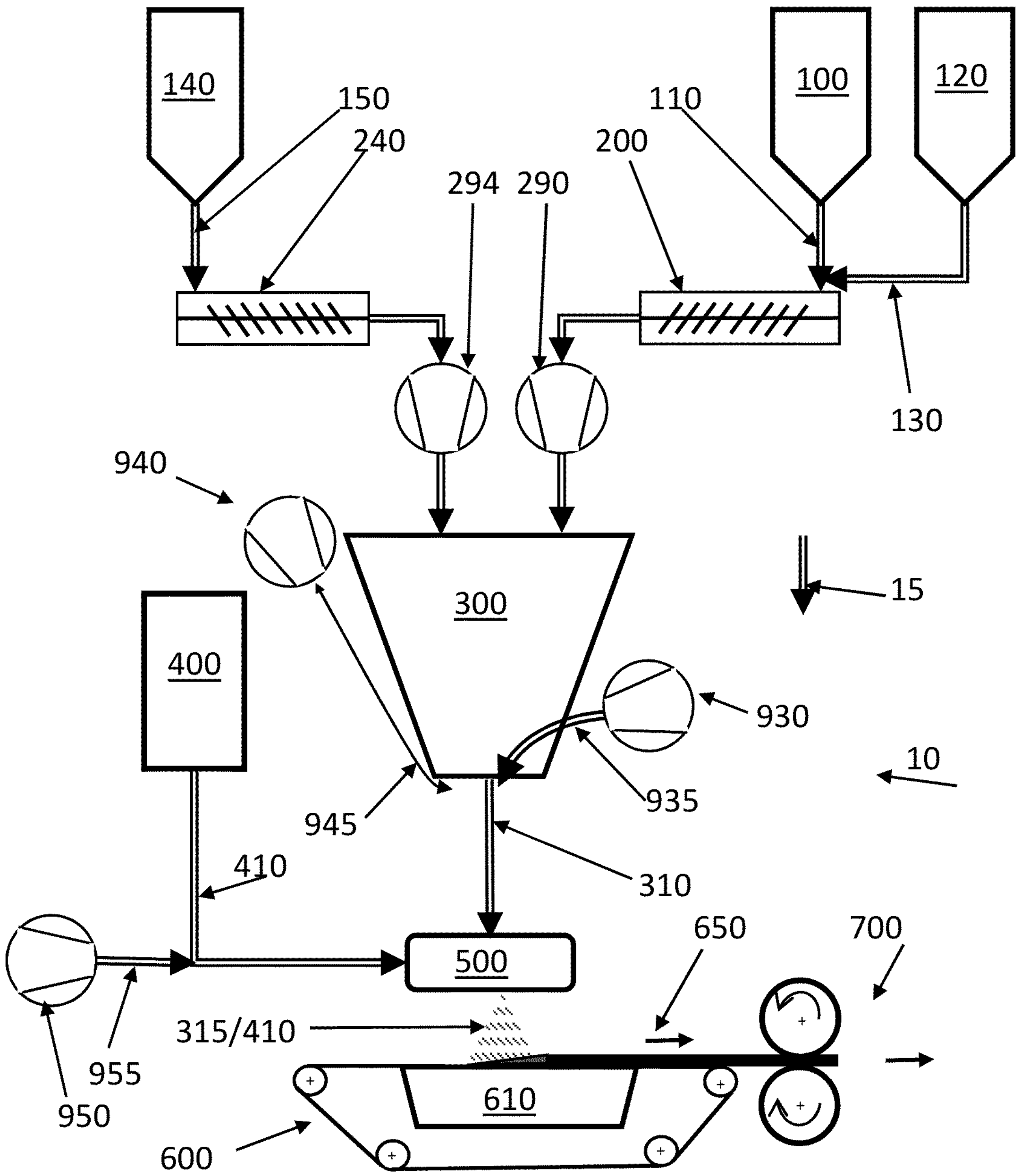
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Fig. 1

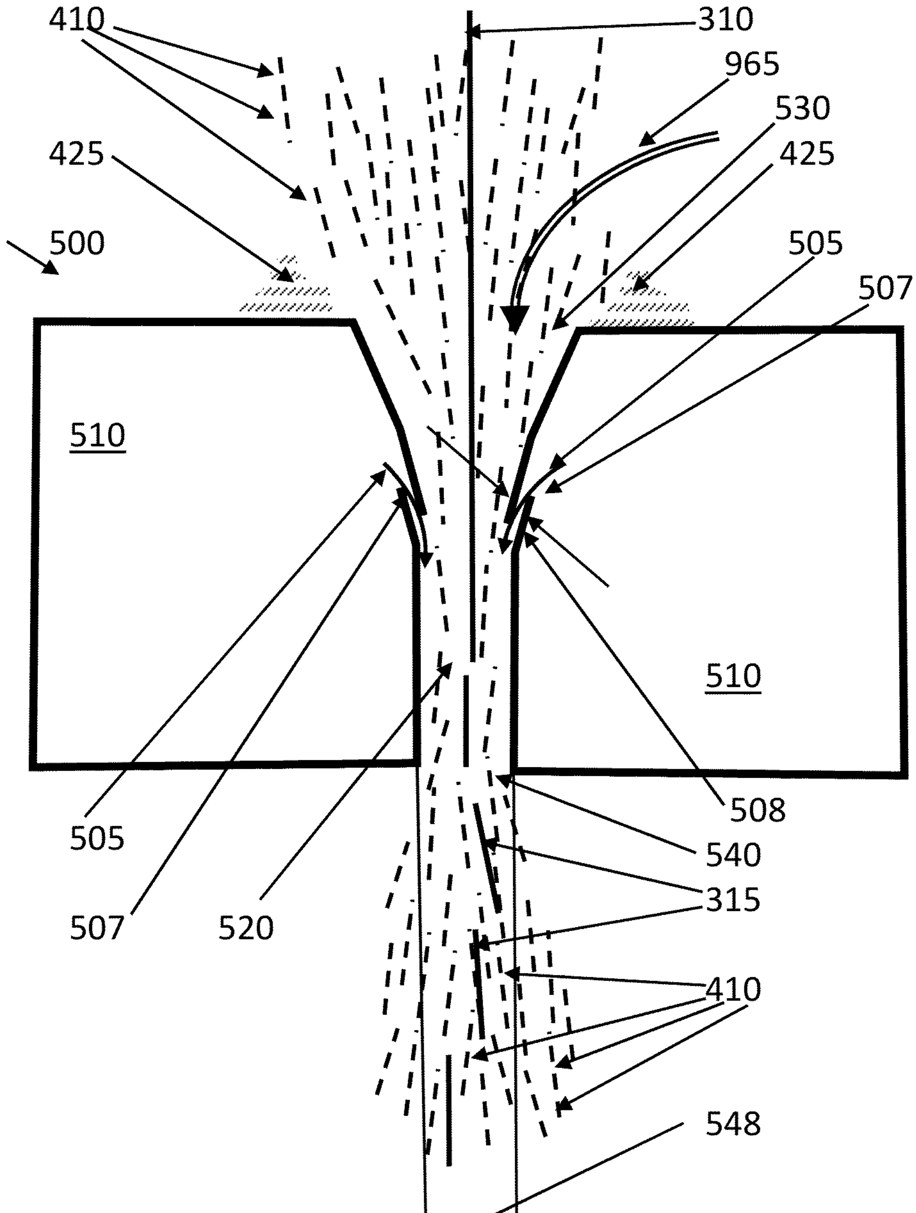

Fig. 2 – Prior Art

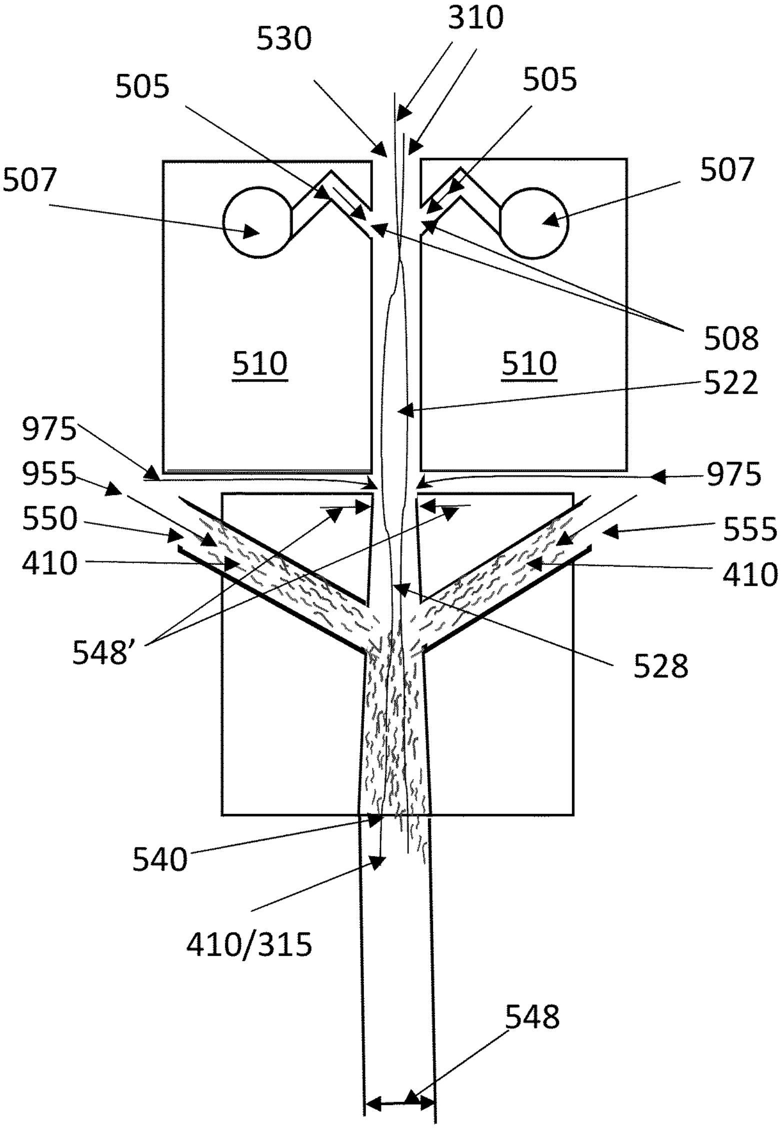
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Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079172

A. CLASSIFICATION OF SUBJECT MATTER
INV. D04H1/425 D04H1/4382 D04H1/56 D04H1/72 D04H1/407
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04H

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/114066 A1 (CLARK DARRYL FRANKLIN [US] ET AL) 19 June 2003 (2003-06-19) paragraphs [0008], [0038], [0041], [0049], [0050]; claims 1,2; figures 1,2 -----	1-9
A	WO 2016/100312 A1 (PROCTER & GAMBLE [US]) 23 June 2016 (2016-06-23) page 23, line 31 - page 24, line 27; figures 6a-e -----	1-9
A	US 4 902 559 A (ESCHWEY HELMUT [DE] ET AL) 20 February 1990 (1990-02-20) column 3, lines 6-60; figure 1 column 6, lines 14-29 -----	1-9
A	WO 2012/020053 A1 (BOSCOLO GALLIANO [IT]) 16 February 2012 (2012-02-16) cited in the application abstract; figure 1 -----	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 2018	26/01/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Elsässer, Ralf

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2017/079172

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