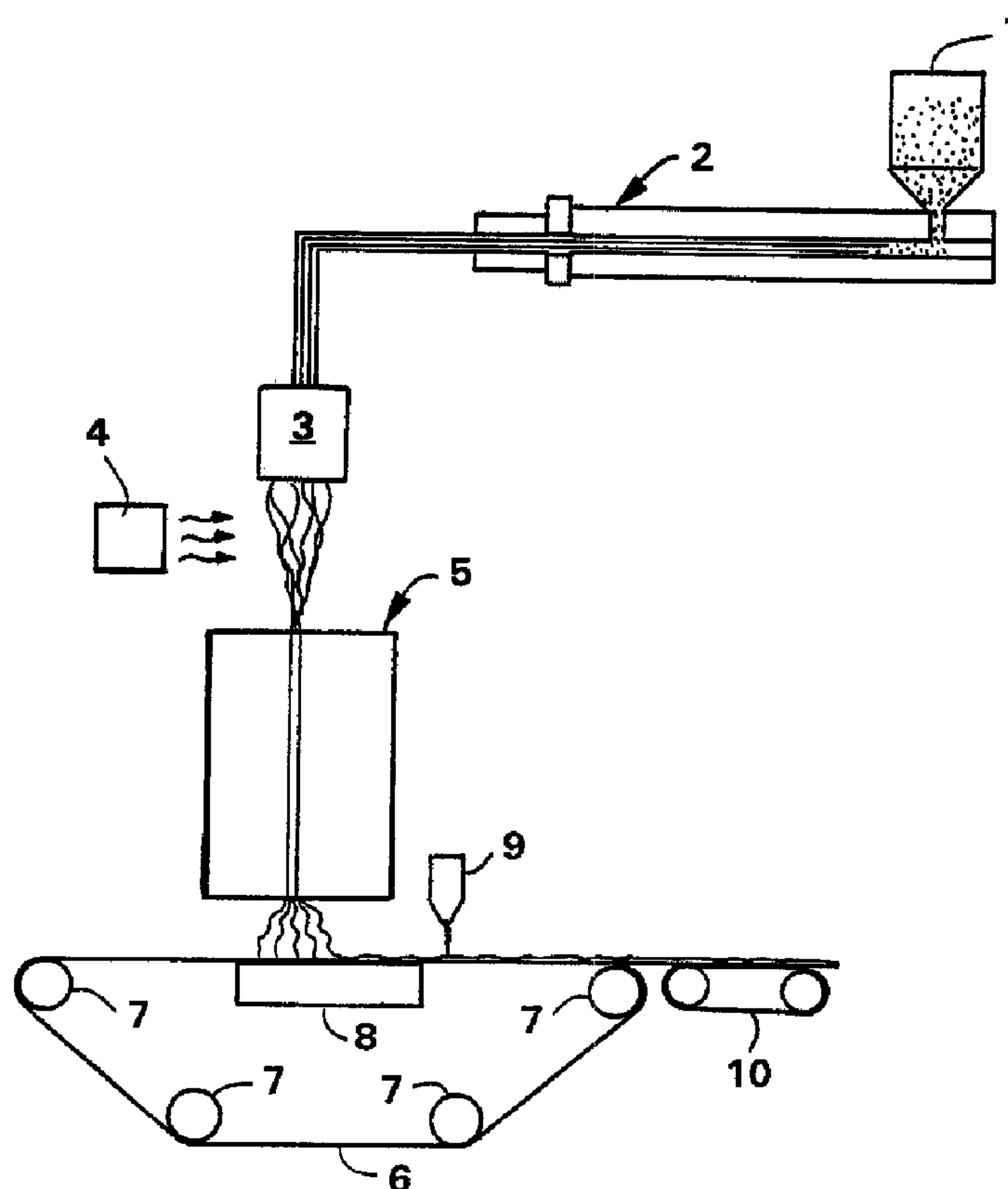




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(57) Abrégé/Abstract:

There is provided a process which comprises the step of subjecting a just produced spunbond web to a high flow rate, heated stream of air across substantially the width of the web to very lightly bond the fibers of the web together. Such bonding should be

(57) **Abrégé(suite)/Abstract(continued):**

the minimum necessary in order to satisfy the needs of further processing yet not detrimentally affect the web. The fibers of the web may be monocomponent or biconstituent and the web should be substantially free of adhesives and not subjected to compaction rolls.

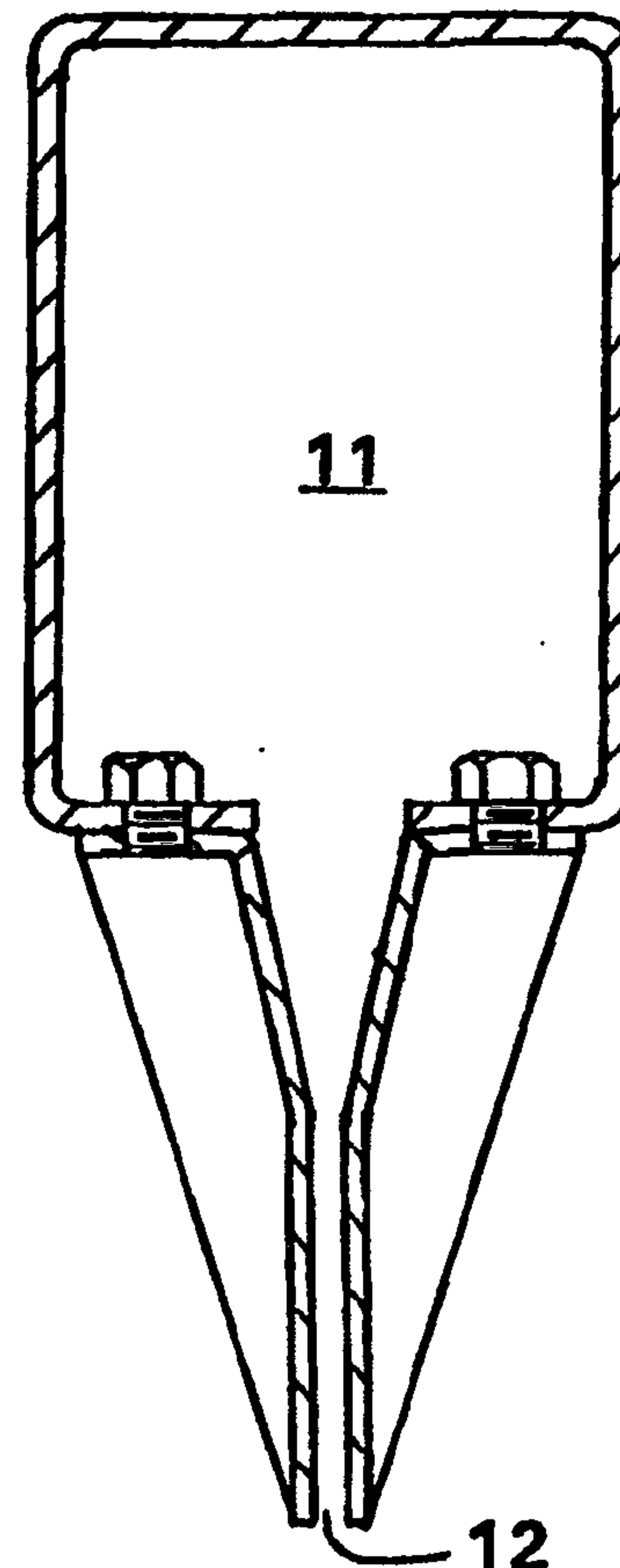
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(21) International Application Number: PCT/US95/16619 (22) International Filing Date: 19 December 1995 (19.12.95) (30) Priority Data: 08/362,328 22 December 1994 (22.12.94) US (71) Applicant: KIMBERLY-CLARK CORPORATION [US/US]; 401 North Lake Street, Neenah, WI 54956 (US). (72) Inventors: ARNOLD, Billy, Dean; Route 2, Box 97-A1, Ramer, TN 38367 (US). MARMON, Samuel, Edward; 4571 Oakhurst Lane, Alpharetta, GA 30201 (US). PIKE, Richard, Daniel; 5544 Fort Fisher Way, Norcross, GA 30092 (US). PRIMM, Stephen, Harding; 1615 Turner Road, Cumming, GA 30131 (US). ROMANO, Lawrence, James, III; 3540 Oak Knoll Drive, Marietta, GA 30068 (US). SASSE, Philip, Anthony; 5020 Morton Ferry Circle, Alpharetta, GA 30202 (US). (74) Agents: ROBINSON, James, B. et al.; Kimberly-Clark Corpo- ration, 401 North Lake Street, Neenah, WI 54956 (US).		(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> (88) Date of publication of the international search report: 6 September 1996 (06.09.96)

(54) Title: METHOD FOR PRODUCING A NONWOVEN WEB**(57) Abstract**

There is provided a process which comprises the step of subjecting a just produced spunbond web to a high flow rate, heated stream of air across substantially the width of the web to very lightly bond the fibers of the web together. Such bonding should be the minimum necessary in order to satisfy the needs of further processing yet not detrimentally affect the web. The fibers of the web may be monocomponent or biconstituent and the web should be substantially free of adhesives and not subjected to compaction rolls.



METHOD FOR PRODUCING A NONWOVEN WEB

TECHNICAL FIELD

This invention relates to the field of nonwoven fabrics or webs
5 and their manufacture. More particularly, it relates to such
nonwoven fabrics which are comprised of at least one layer of
spunbond fibers or filaments. Such fibers are commonly
comprised of a thermoplastic polymer such as polyolefins, e.g.
polypropylene, polyamides, polyesters and polyethers.

10 BACKGROUND ART

Uses for such webs are in such applications as diapers,
feminine hygiene products and barrier products such as medical
gowns and surgical drapes.

15 In the process of production of a nonwoven spunbond web it is
standard practice to increase the integrity of the web by some
method for further processing. Increasing the web's integrity
is necessary in order to maintain its form during post
formation processing. Generally, compaction is used
20 immediately after the formation of the web.

Compaction is accomplished by "compaction rolls" which squeeze
the web in order to increase its self-adherence and thereby its
integrity. Compaction rolls perform this function well but
25 have a number of drawbacks. One such drawback is that
compaction rolls do indeed compact the web, causing a decrease
in bulk or loft in the fabric which may be undesirable for the
use desired. A second and more serious drawback to compaction
rolls is that the fabric will sometimes wrap around one or both
30 of the rolls, causing a shutdown of the fabric production line
for cleaning of the rolls, with the accompanying obvious loss
in production during the down time. A third drawback to
compaction rolls is that if a slight imperfection is produced
in formation of the web, such as a drop of polymer being formed
35 into the web, the compaction roll can force the drop into the

foraminous belt, onto which most webs are formed, causing an imperfection in the belt and ruining it.

DESCRIPTION OF THE INVENTION

5 Accordingly, it is an object of an aspect of the present invention to provide a method of providing a nonwoven web with enough integrity for further processing without the use of compaction rolls or adhesives, and which is suitable for use in continuous industrial production operation.

10 According to a first broad aspect of the present invention, a method is provided for producing a nonwoven web comprising the steps of forming a nonwoven web, and passing that web through a hot air knife having at least one slot to bond the
15 fibers of the web lightly, in order to provide sufficient integrity to said web for further processing.

According to a second broad aspect of this invention, a method is provided for providing integrity to a spunbond web
20 comprising the steps of forming a spunbond web from a fiber which is selected from the group consisting of monocomponent fibers and biconstituent fibers, and passing said web through a hot air knife having at least one slot to bond the fibers of said web lightly in order to provide sufficient
25 integrity to the web for further processing. The method is carried out with a hot air knife which operates at a temperature of between about 93°C and 290°C, with a focused stream of air and an air flow of between about 305 to 3050 meters per minute. The web is substantially-free of
30 adhesives before said passing step. The said web is not subjected to compaction rollers prior to said hot air knife.

2a

The web is subjected to the hot air knife for less than one tenth of a second.

- 5 Thus, according to aspects of the present invention, a method is provided which includes the step of subjecting a just-produced spunbond web to a high flow rate, heated stream of air across substantially the width of the web in order to very lightly bond the fibers of the web together.
- 10 Such bonding should be the minimum necessary in order to satisfy the needs of further processing, but yet not detrimentally impacting the properties of the finished web. The fibers of the web may be monocomponent or biconstituent and the web should be substantially-free of adhesives and
- 15 not subjected to compaction rolls.

It has surprisingly been discovered that a properly controlled HAK, operating under the conditions presented herein, can serve to bond a monocomponent or biconstituent

20 fiber spunbond web lightly without detrimentally

affecting web properties and may even improve the web properties, thereby obviating the need for compaction rolls.

DESCRIPTION OF THE FIGURES

5

In the accompanying drawings:

Figure 1 is a schematic illustration of an apparatus which may be utilized to perform the method and to produce the nonwoven
10 web of the present invention.

Figure 2 is a cross-sectional view of a device which may be used in the practice of this invention.

15 Figures 3 and 4 are scanning electron micrographs of two webs made in accordance with the invention.

As used herein the term "nonwoven fabric or web" means a web having a structure of individual fibers or threads which are
20 interlaid, but not in an identifiable manner as in a knitted fabric. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes. The basis weight of nonwoven fabrics is usually expressed in ounces
25 of material per square yard (osy) or grams per square meter (gsm) and the fiber diameters are usually expressed in μm . (Note that to convert from osy to gsm, multiply osy by 33.91).

As used herein the term "microfibers" means small diameter
30 fibers having an average diameter not greater than about 75 μm , for example, having an average diameter of from about 0.5 μm to about 50 μm , or more particularly, microfibers may have an average diameter of from about 0.5 μm to about 40 μm . Another frequently used expression of fiber diameter is denier, which
35 is defined as grams per 9000 meters of a fiber. For example,

the diameter of a polypropylene fiber given in μm may be converted to denier by squaring, and multiplying the result by 0.00629, thus, a 15 μm polypropylene fiber has a denier of about 1.42 ($15^2 \times 0.00629 = 1.415$).

5

As used herein the term "spunbonded fibers" refers to small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinnerette with the diameter
10 of the extruded filaments then being rapidly reduced as by the process shown, for example, in U.S. Patent no. 4,340,563 to Appel et al., and U.S. Patent no. 3,692,618 to Dorschner et al., U.S. Patent no. 3,802,817 to Matsuki et al., U.S. Patent nos. 3,338,992 and 3,341,394 to Kinney, U.S. Patent nos.
15 3,502,538 to Levy, U.S. Patent no. 3,502,763 to Hartman, and U.S. Patent no. 3,542,615 to Dobo et al. Spunbond fibers are generally continuous and have diameters larger than 7 μm , more particularly, between about 10 and 30 μm . Spunbond fibers are generally not tacky when they are deposited onto the collecting
20 surface.

As used herein the term "meltblown fibers" means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten
25 threads or filaments into converging high velocity gas (e.g. air) streams which attenuate the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a
30 collecting surface to form a web of randomly disbursed meltblown fibers. Meltblown fibers are generally tacky when they are deposited on the collecting surface. Such a process is disclosed, for example, in U.S. Patent no. 3,849,241 to Butin. Meltblown fibers are microfibers which may be

continuous or discontinuous and are generally smaller than 10 μm in diameter.

As used herein the term "polymer" generally includes but is not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible molecular geometrical configurations of the material. These configurations include, but are not limited to isotactic, syndiotactic and random symmetries.

As used herein, the term "machine direction" or "MD" means the length of a fabric in the direction in which it is produced. The term "cross machine direction" or "CD" means the width of fabric, i.e. a direction generally perpendicular to the MD.

As used herein the term "monocomponent" fibers refers to fibers formed from one polymer only. This is not meant to exclude fibers formed from one polymer to which small amounts of additives have been added for coloration, anti-static properties, lubrication, hydrophilicity, etc. These additives, e.g. titanium dioxide for coloration, are generally present in an amount less than 5 weight percent and more typically about 2 weight percent.

As used herein the term "bicomponent fibers" refers to fibers which have been formed from at least two polymers extruded from separate extruders but spun together to form one fiber. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the bicomponent fibers which extend continuously along the length of the bicomponent fibers. The configuration of such a bicomponent fiber may be, for example, a sheath/core arrangement wherein one polymer is surrounded by another or may be a side by side

arrangement or an "islands-in-the-sea" arrangement. Bicomponent fibers are taught in U.S. Patent 5,108,820 to Kaneko et al., U.S. Patent 5,336,552 to Strack et al., and European Patent 0586924. If two polymers are used they may be
5 present in ratios of 75/25, 50/50, 25/75 or any other desired ratios.

As used herein the term "biconstituent fibers" refers to fibers which have been formed from at least two polymers extruded from
10 the same extruder as a blend. The term "blend" is defined below. Biconstituent fibers do not have the various polymer components arranged in relatively constantly positioned distinct zones across the cross-sectional area of the fiber and the various polymers are usually not continuous along the
15 entire length of the fiber, instead usually forming fibrils which start and end at random. Biconstituent fibers are sometimes also referred to as multiconstituent fibers. Fibers of this general type are discussed in, for example, U.S. Patent 5,108,827 to Gessner. Bicomponent and biconstituent fibers are
20 also discussed in the textbook Polymer Blends and Composites by John A. Manson and Leslie H. Sperling, copyright 1976 by Plenum Press, a division of Plenum Publishing Corporation of New York, ISBN 0-306-30831-2, at pages 273 through 277.

25 As used herein the term "blend" means a mixture of two or more polymers while the term "alloy" means a sub-class of blends wherein the components are immiscible but have been compatibilized. "Miscibility" and "immiscibility" are defined as blends having negative and positive values, respectively,
30 for the free energy of mixing. Further, "compatibilization" is defined as the process of modifying the interfacial properties of an immiscible polymer blend in order to make an alloy.

As used herein, through air bonding or "TAB" means a process of
35 bonding a nonwoven bicomponent fiber web which is wound at

least partially around a perforated roller which is enclosed in a hood. Air which is sufficiently hot to melt one of the polymers of which the fibers of the web are made is forced from the hood, through the web and into the perforated roller. The
5 air velocity is between 30.48 m and 152.4 m per minute (100 and 500 feet per minute) and the dwell time may be as long as 6 seconds. The melting and resolidification of the polymer provides the bonding. Through air bonding has restricted variability and is generally regarded a second step bonding
10 process. Since TAB requires the melting of at least one component to accomplish bonding, it is restricted to bicomponent fiber webs.

As used herein, the term "medical product" means surgical gowns
15 and drapes, face masks, head coverings, shoe coverings wound dressings, bandages, sterilization wraps, wipers and the like.

As used herein, the term "personal care product" means diapers, training pants, absorbent underpants, adult incontinence
20 products, and feminine hygiene products.

As used herein, the term "protective cover" means a cover for vehicles such as cars, trucks, boats, airplanes, motorcycles, bicycles, golf carts, etc., covers for equipment often left
25 outdoors like grills, yard and garden equipment (mowers, rototillers, etc.) and lawn furniture, as well as floor coverings, table cloths and picnic area covers.

As used herein, the term "outdoor fabric" means a fabric which
30 is primarily, though not exclusively, used outdoors. Outdoor fabric includes fabric used in protective covers, camper/trailer fabric, tarpaulins, awnings, canopies, tents, agricultural fabrics and outdoor apparel such as head coverings, industrial work wear and coveralls, pants, shirts,
35 jackets, gloves, socks, shoe coverings, and the like.

AT LEAST ONE MODE FOR CARRYING OUT THE INVENTION

TEST METHODS

5

Cup Crush: The drapeability of a nonwoven fabric may be measured according to the "cup crush" test. The cup crush test evaluates fabric stiffness by measuring the peak load required for a 4.5 cm diameter hemispherically shaped foot to deform a
10 23 cm by 23 cm piece of fabric into an approximately 6.5 cm diameter by 6.5 cm tall inverted cylinder while the cup shaped fabric is surrounded by an approximately 6.5 cm diameter cylinder to maintain a uniform deformation of the cup shaped fabric. The foot and the cylinder are aligned to avoid contact
15 between the cup walls and the foot which could affect the peak load. The peak load is measured while the foot is descending at a rate of about 38.1 cm per minute (0.25 inches per second). A lower cup crush value indicates a softer web. A suitable device for measuring cup crush is a model FTD-G-500 load cell
20 (500 gram range) available from the Schaevitz Company, Pennsauken, NJ. Cup crush is measured in grams.

Tensile: The tensile strength of a fabric may be measured according to the ASTM test D-1682-64. This test measures the
25 strength in kg (pounds) and elongation in percent of a fabric.

Spunbonded fibers are small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a
30 spinnerette with the diameter of the extruded filaments then being rapidly reduced. Spunbond fibers are generally continuous and have diameters larger than 7 μm , more particularly, between about 10 and 30 μm . The fibers are usually deposited on a moving foraminous belt or forming wire where they form a web.

Spunbond fabrics are generally lightly bonded in some manner immediately as they are produced in order to give them sufficient structural integrity to withstand the rigors of further processing into a finished product. This light, first
5 step bonding may be accomplished through the use of an adhesive applied to the fibers as a liquid or powder which may be heat activated, or more commonly, by compaction rolls.

The fabric then generally moves on to a more substantial second
10 step bonding procedure where it may be bonded with other nonwoven layers which may be spunbond, meltblown or bonded carded webs, films, woven fabrics, foams, etc. The second step bonding can be accomplished in a number of ways such as
15 hydroentanglement, needling, ultrasonic bonding, through air bonding, adhesive bonding and thermal point bonding or calendering.

Compaction rolls are widely used for the light, first step bonding and have a number of drawbacks which were outlined
20 above. For example, shutdowns caused by the wrapping of the nonwoven web are quite costly. These "compaction wraps" require dismantling and cleaning of the compaction rolls which take a substantial amount of time and effort. This is
25 expensive not only from the point of view of lost or discarded material but from the loss of production, assuming one is operating at full capacity. Compaction rolls also can force a drop of polymer from a formation imperfection into the foraminous belt or forming wire onto which most spunbond webs are formed. This "grinding in" of the polymer drop can ruin a
30 belt for further use, requiring its replacement. Since forming wires are quite long and of specialized materials, replacement costs can run as high as \$50,000, as of this writing, in addition to the lost production while changing the belt.

The novel method of providing integrity to a nonwoven web which is the subject of this invention avoids the use of compaction rolls and adhesives. This invention functions through the use of a "hot air knife" or HAK. A hot air knife is a device which focuses a stream of heated air at a very high flow rate, generally from about 305 to 3050 meters per minute (1000 to about 10000 feet per minute (fpm)), directed at the nonwoven web immediately after its formation.

10 The HAK air is heated to a temperature insufficient to melt the polymer in the fiber but sufficient to soften it slightly. This temperature is generally between about 93 and 290°C (200 and 550°F) for the thermoplastic polymers commonly used in spunbonding.

15

The HAK's focused stream of air is arranged and directed by at least one slot of about 3 to 25.4 mm (1/8 to 1 inches) in width, particularly about 9.4 mm (3/8 inch), serving as the exit for the heated air towards the web, with the slot running in a substantially cross machine direction over substantially the entire width of the web. In other embodiments, there may be a plurality of slots arranged next to each other or separated by a slight gap. The at least one slot is preferably, though not essentially, continuous, and may be comprised of, for example, closely spaced holes.

25

The HAK has a plenum to distribute and contain the heated air prior to its exiting the slot. The plenum pressure of the HAK is preferably between about 0.2 kPa and 3 kPa (1.0 and 12.0 inches of water, 2 to 22 mmHg), and the HAK is positioned between about 6 mm and 254 mm (0.25 and 10 inches) and more preferably 19 to 76.2 mm (0.75 to 3.0 inches) above the forming wire. In a particular embodiment, the HAK's plenum size, as shown in Figure 2, is at least twice the cross sectional area for CD flow relative to the total exit slot area.

35

Since the foraminous wire onto which the polymer is formed generally moves at a high rate of speed, the time of exposure of any particular part of the web to the air discharged from the hot air knife is less a tenth of a second and generally about a hundredth of a second in contrast with the through air bonding process which has a much larger dwell time. The HAK process has a great range of variability and controllability of at least the air temperature, air velocity and distance from the HAK plenum to the web.

As mentioned above, the spunbond process uses thermoplastic polymers which may be any known to those skilled in the art. Such polymers include polyolefins, polyesters, polyetherester, polyurethanes and polyamides, and mixtures thereof, more particularly polyolefins such as polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers and butene copolymers. Polypropylenes that have been found useful include, for example, polypropylene available from the Himont Corporation of Wilmington, Delaware, under the trade designation PF-304, polypropylene available from the Exxon Chemical Company of Baytown, Texas under the trade designation Exxon 3445 and polypropylene available from the Shell Chemical Company of Houston, Texas under the trade designation DX 5A09.

Though the instant invention may use air temperatures above the melting point of the polymer, the surface of the polymer does not reach its melting point by controlling the air flow rate and maintaining the web's exposure within the specified time range.

Referring to the drawings, particularly to Figure 1, there is schematically illustrated at 20 an exemplary process for providing integrity to a spunbond web without the use of adhesives or compaction rolls.

Polymer is added to the hopper 1 from which it is fed into the extruder 2. The extruder 2 heats the polymer and melts it and forces it into the spinnerette 3. The spinnerette 3 has
5 openings arranged in one or more rows. The spinnerette 3 openings form a downwardly extending curtain of filaments when the polymer is extruded. Air from a quench blower 4 quenches the filaments extending from the spinnerette 3. A fiber draw unit 5 is positioned below the spinnerette 3 and receives the
10 quenched filaments.

Illustrative fiber draw units are shown in U.S. Patents no. 3,802,817, 3,692,618 and 3,423,266. The fiber draw unit draws the filaments or fibers by aspirating air entering from the
15 sides of the passage and flowing downwardly through the passage.

An endless, generally foraminous forming surface 6 receives the continuous spunbond fibers from the fiber draw unit 5. The
20 forming surface 6 is a belt which travels around guide rollers 7. A vacuum 8 positioned below the forming surface 6 draws the fibers against the forming surface 6. Immediately after formation, hot air is directed through the fibers from a hot air knife (HAK) 9. The HAK 9 gives the web sufficient
25 integrity to be passed off of the forming surface 6 and onto belt 10 for further processing.

Figure 2 shows the cross-sectional view of an exemplary hot air knife. The area of the plenum 1 is at least twice the cross
30 sectional area for CD flow relative to the total slot air exit area 2.

Figures 3 and 4 show scanning electron micrograph (SEM) pictures of webs which have been treated by the HAK. The web
35 of Figure 4 has been treated at slightly more severe conditions

than that of Figure 3. Note that there is little bonding between the filaments in Figure 3 and a bit more in Figure 4. Figure 3 is at a magnification of 119X and Figure 4 is at a magnification of 104X. Webs subjected to compaction rolls
5 alone do not have these characteristic bonds.

The fabric used in the process of this invention may be a single layer embodiment or a multilayer laminate of spunbond and other fibers but not necessarily limited to spunbond. Such
10 fabrics usually have a basis weight of from about 5 to about 407 gsm (0.15 to 12 osy). Such a multilayer laminate may be an embodiment wherein some of the layers are spunbond and some meltblown such as a spunbond/meltblown/spunbond (SMS) laminate as disclosed in U.S. Patent no. 4,041,203 to Brock et al. and
15 U.S. Patent no. 5,169,706 to Collier, et al. or as a spunbond/spunbond laminate. Note that there may be more than one meltblown layer present in the laminate.

An SMS laminate may be made by sequentially depositing onto a
20 moving conveyor belt or forming wire first a spunbond fabric layer, then at least one meltblown fabric layer and last another spunbond layer, treating the web with the HAK after the deposition of each spunbond layer. Treating meltblown layers with the HAK is not thought necessary since meltblown fibers
25 are usually tacky when they are deposited and so therefore naturally adhere to the collection surface but such treating with the HAK is not excluded, which in the case of an SMS laminate is a spunbond layer. Alternatively, the fabric layers may be made individually, collected in rolls, and combined in a
30 separate bonding step, with each spunbond layer having been subjected to the HAK as it was produced.

The more substantial secondary bonding step is generally accomplished by the methods previously mentioned. One such
35 method is calendering and various patterns for calender rolls

have been developed. One example is the expanded Hansen Pennings pattern with about a 15% bond area with about 100 bonds/6.45 cm² (100 bonds/square inch) as taught in U.S. Patent 3,855,046 to Hansen and Pennings. Another common pattern is a diamond pattern with repeating and slightly offset diamonds.

The fabric of this invention may also be laminated with films, glass fibers, staple fibers, paper, and other commonly used materials known to those skilled in the art.

10

CONTROL 1

Nonwoven spunbond webs were made generally according to Figure 1 in which the layer was deposited onto a moving forming wire. Five samples were made with an average 42 gsm (1.24 osy) basis weight. The polymer used to produce the layer was Exxon 3445 polypropylene to which was added 2 weight percent of titanium dioxide (TiO₂) to provide a white color to the web. The TiO₂ used was designated SCC4837 and is available from the Standridge Color Corporation of Social Circle, Georgia. The web was processed through compaction rolls after formation and a hot air knife was not used.

15
20

CONTROL 2

25

Nonwoven spunbond webs were made generally according to Figure 1 in which the layer was deposited onto a moving forming wire, except that the web was processed through compaction rolls after formation and a hot air knife was not used. Five samples were made with an average 20 gsm (0.6 osy) basis weight. The polymer and additive were the same as in Control 1.

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CONTROL 3

Nonwoven spunbond webs were made generally according to Figure 1 in which the layer was deposited onto a moving forming wire, except that the web was processed through compaction rolls after formation and a hot air knife was not used. Five samples were made with an average 17 gsm (0.5 osy) basis weight. The polymer and additive were the same as in Control 1.

10 EXAMPLE 1

Nonwoven spunbond webs were made generally according to Figure 1 in which the layer was deposited onto a moving forming wire. Five samples were made with an average 42 gsm (1.25 osy) basis weight. The polymer used to produce the layer was Exxon 3445 polypropylene to which was added 2 weight percent of titanium dioxide (TiO_2) to provide a white color to the web. The TiO_2 used was designated SCC4837 and is available from the Standridge Color Corporation of Social Circle, Georgia. The web was not processed through compaction rolls after formation but instead was treated by a hot air knife. The HAK was positioned 2.54 cm (1 inch) above the web and the HAK slot was 0.635 cm (one quarter of an inch) wide. The HAK had a plenum pressure of 1.7 kPa (7 inches of water, 13 mmHg) and a temperature of 160°C (320°F). The exposure time of the web to the air of the HAK was less than a tenth of a second.

EXAMPLE 2

Nonwoven spunbond webs were made generally according to Figure 1 in which the layer was deposited onto a moving forming wire. Five samples were made with an average 20 gsm (0.6 osy) basis weight. The polymer and additive were the same as in Example 1. The web was not processed through compaction rolls after formation but instead was treated by a hot air knife. The HAK

was positioned 2.54 cm (1 inch) above the web and the HAK slot was 0.635 cm (one quarter of an inch) wide. The HAK had a plenum pressure of 1.7 kPa (7 inches of water, 13 mmHg) and a temperature of 160°C (320°F). The exposure time of the web to the air of the HAK was less than a tenth of a second.

EXAMPLE 3

Nonwoven spunbond webs were made generally according to Figure 1 in which the layer was deposited onto a moving forming wire. Five samples were made with an average 17 gsm (0.5 osy) basis weight. The polymer and additive were the same as in Control 1. The web was not processed through compaction rolls after formation but instead was treated by a hot air knife. The HAK was positioned 2.54 cm (1 inch) above the web and the HAK slot was 0.635 cm (one quarter of an inch) wide. The HAK had a plenum pressure of 1.7 kPa (7 inches of water, 13 mmHg) and a temperature of 166°C (330°F). The exposure time of the web to the air of the HAK was less than a tenth of a second.

The average results of the testing of the five webs of each Control and Example are shown in Table 1. Line speed is given in m per minute (feet per minute), plenum pressure in kPa (inches of water) and temperature in °C (°F).

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TABLE I

	Controls	Examples		
	1	2	3	1
5	42 (1.24)	21 (0.62)	17.3 (0.51)	42.4 (1.25)
gsm (OSY)				21 (0.62)
	11.16 (24.6)	5.17 (11.4)	3.9 (8.6)	10.39 (22.9)
MD Tensile kg (pounds)				5.08 (11.2)
	9.34 (20.6)	3.72 (8.2)	3.31 (7.3)	8.53 (18.8)
CD Tensile kg (pounds)				4.17 (9.2)
	162.6	39.8	27.4	172.6
Cup Crush g				43.8
	3062	776	423	3416
Crush Energy gm mm				733
	56.1 (184)	114 (374)	141 (464)	56.1 (184)
Line Speed m/min (ft/min)				114 (374)
	NA	NA	NA	1.7 (7)
Plenum Pres. mmHg (inches of water)				1.7 (7)
	NA	NA	NA	160 (320)
Temperature °C (°F)				160 (320)
				166 (330)

It can be seen from the preceding examples that a hot air knife can accomplish web integrity results comparable if not superior to those of compaction rolls without the tremendous and costly problems which have been experienced with those devices and without negatively impacting key web properties such as strength or drape.

CLAIMS:

1. A method of producing a nonwoven web comprising the steps of:
forming a nonwoven web formed from monocomponent or biconstituent fibers and wherein said nonwoven web is substantially free of adhesives; and
passing the web through a hot air knife wherein said web is subjected to said hot air knife for less than one tenth of a second, said hot air knife having at least one slot and an air flow of between about 305 to 3050 meters per minute to bond the fibers of the web in order to provide integrity to the web for further processing.
2. The method according to claim 1, which comprises selecting said nonwoven web to be a spunbonded web.
3. The method according to claim 1, which comprises selecting said nonwoven web to be a meltblown web.
4. The method according to any one of claims 1 to 3, which comprises operating said hot air knife at a temperature of between about 93 and 290°C.
5. The method according to any one of claims 1 to 4, which is carried out in the absence of subjecting said web to compaction rollers.
6. A method of providing integrity to a spunbond web, comprising the steps of:
forming a spunbond web from a monocomponent fiber or a biconstituent fiber; and
passing said web through a hot air knife having at least one slot to bond the fibers of said web lightly in order to provide sufficient integrity to the web for further processing;
said method comprising:
operating said hot air knife at a temperature of between about 93°C and 290°C, with a focused stream of air and an air flow of between about 305 to 3050 meters per minute; and
selecting said web to be substantially-free of adhesives before said passing step;

avoiding subjecting said web to compaction rollers prior to said hot air knife treatment; and

subjecting said web to said hot air knife treatment for less than one tenth of a second.

7. The method of any one of claims 1 to 6, which comprises:

providing said hot air knife with a plenum having a cross sectional area for cross machine direction flow, and a slot having a total exit area; and

selecting said plenum cross-sectional area to be at least twice the total exit area of said slot.

8. The method according to any one of claims 1 to 7, which comprises selecting said web to comprise microfibers of a polymer, the polymer being a polyolefin, polyamide, polyetherester, polyester or a polyurethane.

9. The method according to claim 8, which comprises selecting said polymer to be a polyolefin.

10. The method according to claim 9, which comprises selecting said polyolefin to be polypropylene.

11. The method according to claim 9, which comprises selecting said polyolefin to be polyethylene.

12. The method according to any one of claims 1 to 11, further comprising the step of depositing, onto said web, at least one spunbond layer to form a laminate.

13. The method according to any one of claims 1 to 11, further comprising the step of depositing, onto said web, at least one meltblown layer to form a laminate.

14. The method according to claim 13, wherein said further step of depositing onto said web of at least one meltblown layer is carried out after passing said web through said hot air knife.

15. The method according to claim 13 or 14, further comprising the steps of depositing onto said web, and onto said at least one meltblown layer, a second meltblown layer adjacent to said at least one meltblown layer to form a laminate, and again passing said laminate through said hot air knife.

16. The method according to claim 13 or 14, further comprising the steps of depositing, onto said web and onto said at least one meltblown layer, a spunbond layer adjacent said at least one meltblown layer to form a laminate, and then again passing said laminate through said hot air knife.

17. The method according to any one of claims 12 to 16, further comprising the step of thermal point bonding said laminate.

18. The use of a web made by the method according to any one of claims 1 to 17, in a product which is a medical product, personal care product or an outdoor fabric.

19. The use according to claim 18, wherein said product is a personal care item and said personal care item is a diaper.

20. The use according to claim 18, wherein said product is a personal care item and said personal care item is training pants.

21. The use according to claim 18, wherein said product is a personal care item and said personal care item is absorbent underpants.

22. The use according to claim 18, wherein said product is a personal care item and said personal care item is adult incontinence products.

23. The use according to claim 18, wherein said product is a personal care item and said personal care item is a feminine hygiene product.

24. The use according to claim 18, wherein said product is a medical product and said medical product is a surgical gown.

25. The use according to claim 18, wherein said product is a medical product and said medical product is a sterilization wrap.

26. The use according to claim 18, wherein said product is an outdoor fabric and said outdoor fabric is a protective cover.

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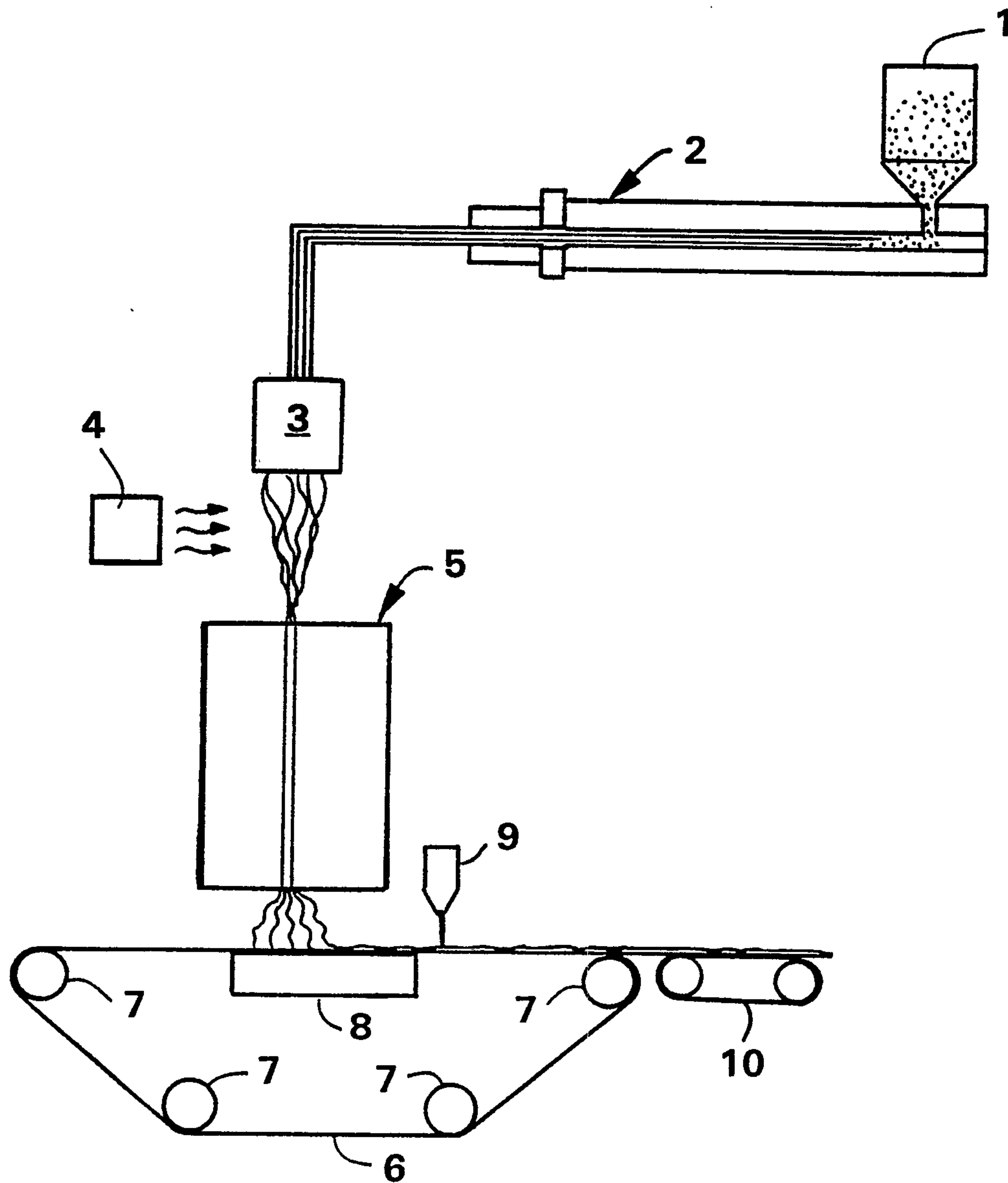


FIG. 1

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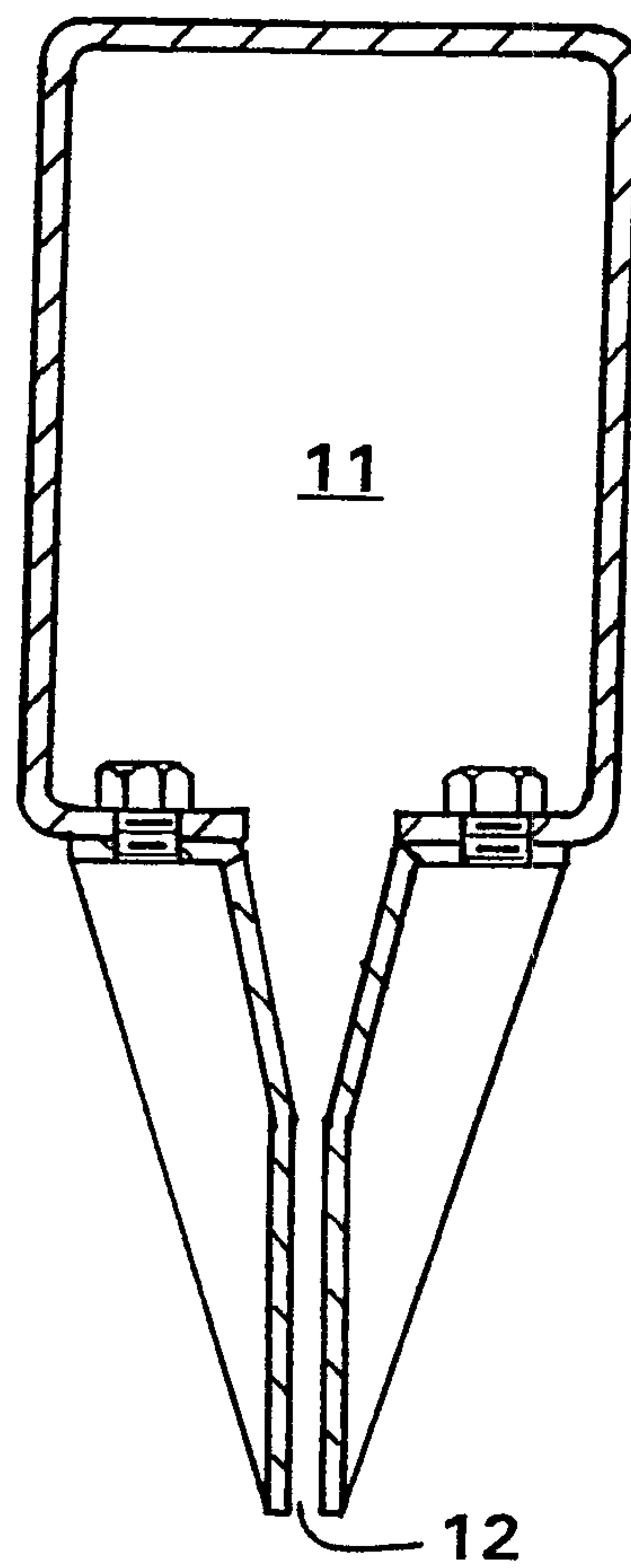


FIG. 2

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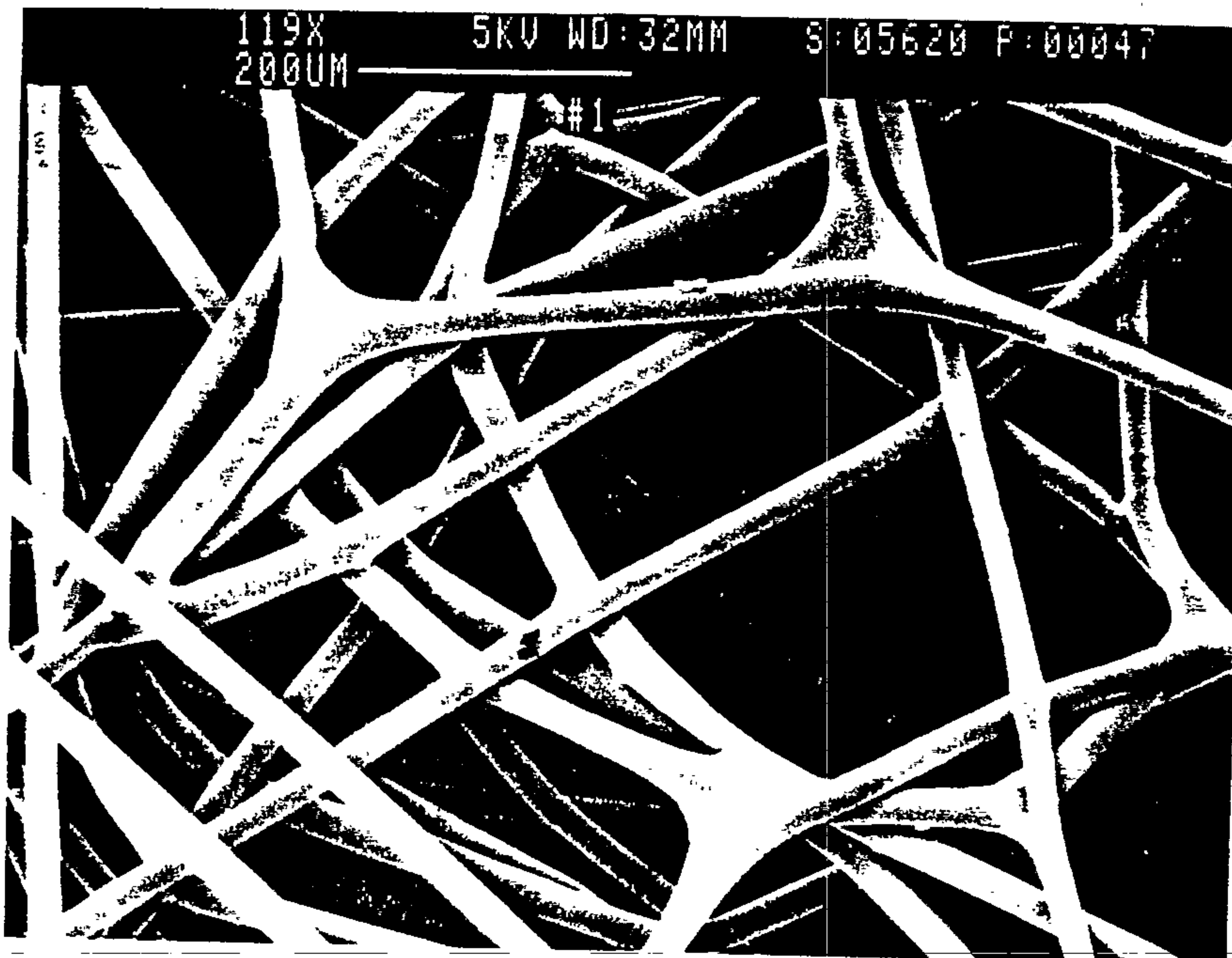


FIG. 3

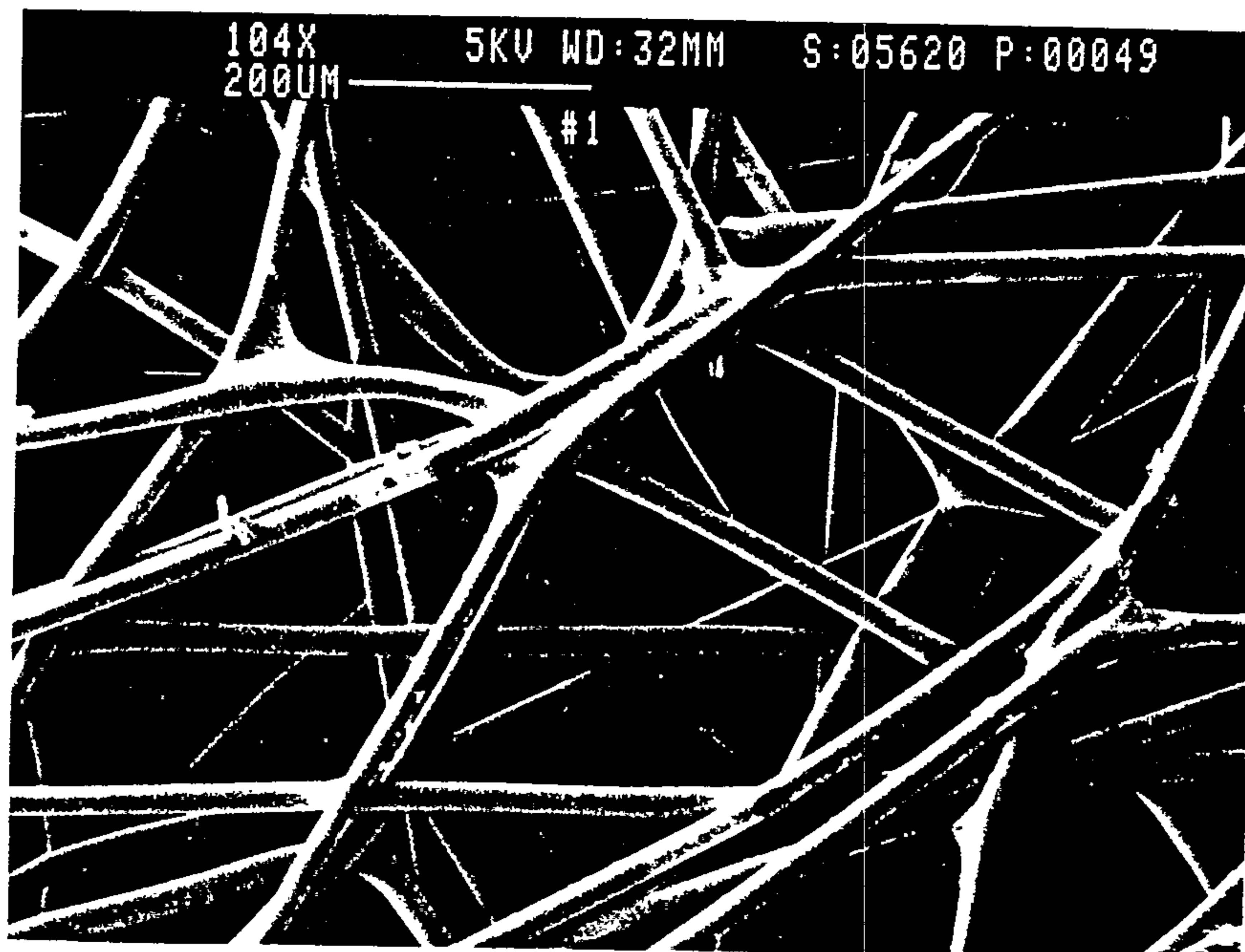


FIG. 4

