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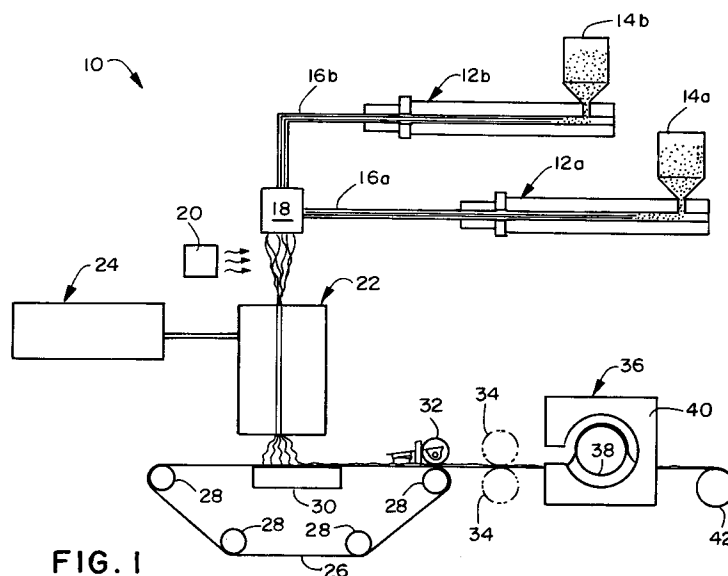
(11) Publication number:

**0 685 579 A2**

(12)

**EUROPEAN PATENT APPLICATION**(21) Application number: **95107486.3**(51) Int. Cl.<sup>6</sup>: **D01F 8/06, D04H 1/54,  
D04H 3/16**(22) Date of filing: **16.05.95**(30) Priority: **03.06.94 US 253876**(43) Date of publication of application:  
**06.12.95 Bulletin 95/49**(84) Designated Contracting States:  
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**D-80538 München (DE)**(54) **Highly crimpable conjugate fibers and nonwoven webs made therefrom.**

(57) The present invention provides conjugate fibers having an ethylene polymer component and a propylene polymer component, which are highly crimpable even at fine deniers. Also provided are nonwoven fabrics made from the fibers. The propylene polymer component of the conjugate fiber contains a propylene polymer having a melt flow rate equal to or higher than about 45 g/ 10 min. at 230 °C.

**FIG. 1****EP 0 685 579 A2**

## BACKGROUND OF THE INVENTION

The present invention is related to conjugate fibers containing a high melt flow rate propylene polymer and to nonwoven webs produced therefrom.

Conjugate fibers having two or more of component polymers that are designed to benefit from combinations of desired chemical and/or physical properties of the component polymers are well known in the art. Methods for making conjugate fibers and fabrics made therefrom are disclosed, for example, in U.S. Patents 3,423,266 to Davies et al., Reissue 30,955 to Stanistreet and European Patent Application 0 586 924.

In addition to providing combined desirable properties of component polymers, conjugate fibers can be thermally crimped, especially when the fibers are produced from component polymers that are different in crystallization, shrinkage and/or solidification properties, to improve tactile properties, including "cloth-like" texture, bulk and fullness, of nonwoven webs or fabrics made from the fibers. For example, European Patent Application 0 586 924 discloses thermally crimped conjugate fibers that are dimensionally stable.

Although processes for thermally crimping conjugate fibers are known in the art, it is also known that the process of thermally imparting crimps becomes highly onerous as the thickness of fibers gets smaller. Consequently, small denier fibers tend to form flat or dense nonwoven webs. Although thermally crimped fine-denier conjugate fibers can be produced by significantly reducing the throughput, i.e., the amount of polymer processed through a spinneret, or by increasing the processing temperature of the polymer components, neither of the alternatives is commercially desirable. Reducing the throughput rate decreases the production rate of the fibers and increasing the polymer processing temperature creates processing difficulties, e.g., thermal degradation of the polymers, and heightens the quenching requirement of the spun fibers.

It is highly desirable to provide a method of producing highly crimpable conjugate fibers that can be processed to have high levels of crimps even at fine deniers and that does not require complicated and/or onerous manufacturing steps, and it is also highly desirable to provide nonwoven webs made from such fibers.

## SUMMARY OF THE INVENTION

The present invention provides a highly crimpable conjugate fiber having an ethylene polymer component and a propylene polymer component. The propylene polymer component of the conjugate fiber contains a propylene polymer having a melt flow rate equal to or higher than about 45 g/ 10 min. at 230 °C. The conjugate fibers may be continuous spunbond filaments or staple fibers. Additionally provided is a nonwoven web fabricated from the conjugate fibers.

The present conjugate fibers are highly crimpable even at fine deniers, providing a soft, high loft nonwoven web. As such, the nonwoven webs produced from the conjugate fibers are highly useful as various parts for disposable articles, including diapers, sanitary napkins, incontinence products, wipes, cover materials, garment materials and the like, and filters.

The term "conjugate fibers" refers to fibers containing at least two polymeric components which are arranged to occupy distinct sections for substantially the entire length of the fibers. The conjugate fibers are formed by simultaneously extruding at least two molten polymeric component compositions as a plurality of unitary multicomponent filaments or fibers from a plurality of capillaries of a spinneret. The term "spunbond fiber web" refers to a nonwoven fiber web of small diameter filaments or fibers that are formed by extruding or melt-spinning molten thermoplastic polymers as filaments or fibers from a plurality of capillaries of a spinneret. The extruded filaments are partially cooled and then rapidly drawn by an eductive or other well-known drawing mechanism. The drawn filaments are deposited or laid onto a forming surface in a random, isotropic manner to form a loosely entangled fiber web, and then the laid fiber web is subjected to a bonding process to impart physical integrity and dimensional stability. Bonding processes suitable for spunbond fiber webs are well known in the art, which include calender bonding, ultrasonic bonding, hydroentangling, needlepunching and through air bonding processes. The production of spunbond webs is disclosed, for example, in U.S. Patents 4,340,563 to Appel et al.; 3,692,618 to Dorschner et al and European Patent Application 0 586 924 to Kimberly-Clark Corp. European Patent Application 0 586 924, which is herein incorporated by reference in its entirety, discloses a particularly suitable spunbond fiber web forming process for the present invention. Typically, spunbond filaments or fibers have an average diameter in excess of 10  $\mu\text{m}$  and up to about 55  $\mu\text{m}$  or higher, although finer spunbond fibers can be produced. The term "bonded carded staple fiber web" refers to a nonwoven web that is formed from staple fibers. Staple fibers are conventionally produced with a melt-spinning process, in which continuous fibers or filaments are

produced and then cut to a staple length, often in the range of from about 1 inch to about 8 inches. The continuous fiber-forming steps of the process are typically similar to the melt-spinning steps of a conventional spunbond fiber web-forming process. The staple fibers are subsequently carded and bonded to form a nonwoven web.

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## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a suitable process for producing the conjugate fiber and the nonwoven web of the invention.

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## DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a nonwoven fiber web of spunbond conjugate fibers or staple conjugate fibers that are highly crimpable even at fine deniers. The fiber web provides improved textural properties, including softness and bulk, as well as improved physical properties, such as web uniformity and coverage. The conjugate fibers of the present invention contain an ethylene polymer component and a propylene polymer component, although the conjugate fibers may contain additional polymer components that are selected from a wide variety of fiber-forming polymers. Desirably, the conjugate fibers contain from about 20 wt% to about 80 wt% of an ethylene polymer and from about 80 wt% to about 20 wt% of a propylene polymer, based on the total weight of the fibers.

Suitable propylene polymers for the present invention are homopolymers and copolymers of propylene, which include isotactic polypropylene, syndiotactic polypropylene and propylene copolymers containing minor amounts of one or more of other monomers that are known to be suitable for forming propylene copolymers, e.g., ethylene, butylene, methylacrylate-co-sodium allyl sulphonate, and styrene-co-styrene sulphonamide. Also suitable are blends of these polymers. Additionally suitable propylene polymers are the above-mentioned propylene polymers blended with a minor amount of ethylene alkyl acrylate, e.g., ethylene ethyl acrylate; polybutylene; and/or ethylene-vinyl acetate. Of these suitable propylene polymers, more desirable are isotactic polypropylene and propylene copolymers containing up to about 10 wt% of ethylene. In accordance with the present invention, suitable propylene polymers have a melt flow rate higher than conventional fiber-forming polypropylenes. The melt flow rate of a suitable propylene polymer is equal to or higher than about 45 g/ 10 min. at 230 °C, as measured in accordance with ASTM D-1238; and desirably, the melt flow rate is between about 50 and about 200 g/ 10 min at 230 °C; more desirably, between about 55 and about 175 g/ 10 min at 230 °C and most desirably, the melt flow rate is between about 60 and about 150 g/ 10 min at 230 °C. If the melt flow rate of the propylene polymer is lower than the specified range, it is difficult to produce highly crimped conjugate fibers of fine deniers, e.g., 2.5 denier or less, with a conventional fiber-forming process at commercial speed, and if the melt flow rate is higher than the specified more desired range, the physical incompatibility of the component polymer melts may cause fiber-spinning difficulties and produce malformed fibers or fail the fiber-spinning process altogether. To a limited extent, the difficulties in spinning a propylene polymer having a melt flow rate higher than the specified range can be alleviated by employing an ethylene polymer having a comparably high melt flow rate. Surprisingly, the present conjugate fibers containing a high melt flow rate propylene polymer can be thermally processed to contain high levels of crimps even at fine deniers and thus can be fabricated into lofty fabrics of fine denier fibers. For example, the conjugate fibers can be processed to provide a fiber web having a bulk of at least about 20 mils per ounce per square yard, as measured under a 0.025 psi load, even when the size of the fibers is reduced to about 2.5 denier or less, desirably to about 2 denier or less, and more desirably to about 1.5 denier.

Ethylene polymers suitable for the present invention are fiber-forming homopolymers of ethylene and copolymers of ethylene and one or more of comonomers, such as, butene, hexene, 4-methyl-1 pentene and octene, ethylene-vinyl acetate and ethylene alkyl acrylate, e.g., ethylene ethyl acrylate, as well as blends thereof. The suitable ethylene polymers may be blended to contain a minor amount of ethylene alkyl acrylate, e.g., ethylene ethyl acrylate; polybutylene; and/or ethylene-vinyl acetate. More desirable ethylene polymers include high density polyethylene, linear low density polyethylene, medium density polyethylene, low density polyethylene and blends thereof; and most desirable ethylene polymers are high density polyethylene and linear low density polyethylene.

Fiber-forming polymers suitable for the additional polymer components of the present conjugate fibers include polyolefins, polyesters, polyamides, acetals, acrylic polymers, polyvinyl chloride, vinyl acetate-based polymer and the like, as well as blends thereof. Useful polyolefins include polyethylenes, e.g., high density polyethylene, medium density polyethylene, low density polyethylene and linear low density

polyethylene; polypropylenes, e.g., isotactic polypropylene and syndiotactic polypropylene; polybutylenes, e.g., poly(1-butene) and poly(2-butene); polypentenenes, e.g., poly(2-pentene), and poly(4-methyl-1-pentene); and blends thereof. Useful vinyl acetate-based polymers include polyvinyl acetate; ethylene-vinyl acetate; saponified polyvinyl acetate, i.e., polyvinyl alcohol; ethylene-vinyl alcohol and blends thereof. Useful polyamides include nylon 6, nylon 6/6, nylon 10, nylon 4/6, nylon 10/10, nylon 12, hydrophilic polyamide copolymers such as caprolactam and alkylene oxide, e.g., ethylene oxide, copolymers and hexamethylene adipamide and alkylene oxide copolymers, and blends thereof. Useful polyesters include polyethylene terephthalate, polybutylene terephthalate, and blends thereof. Acrylic polymers suitable for the present invention include ethylene acrylic acid, ethylene methacrylic acid, ethylene methyl methacrylate and the like as well as blends thereof. In addition, the fiber composition may further contain minor amounts of compatibilizing agents, colorants, pigments, optical brighteners, ultraviolet light stabilizers, antistatic agents, lubricants, abrasion resistance enhancing agents, crimp inducing agents, nucleating agents, fillers and other processing aids.

Suitable conjugate fibers for the present invention may have a side-by-side or sheath-core configuration. When a sheath-core configuration is utilized, an eccentric sheath-core configuration, i.e., non-concentrically aligned sheath and core, is more desirable since eccentric sheath-core fibers are more amenable to thermal crimping processes. Suitable conjugate fibers can be produced with any known staple or continuous conjugate fiber forming process, for example, disclosed in U.S. Patents 3,423,266 to Davies et al., Reissue 30,955 to Stanistreet, 4,189,338 to Ejima et al. and European Patent Application 0 586 924. As is known in the art, crimps in conjugate fibers can be imparted before, during or after the fibers are deposited or laid to form a nonwoven web. However, it is highly desirable to crimp the conjugate fibers before they are formed into a nonwoven web since the crimping process inherently causes shrinkage and dimensional changes. It is to be noted that although the present invention is illustrated with thermal crimping processes, any known mechanical crimping process can also be utilized.

Turning to Figure 1, the drawing illustrates a highly suitable process 10 for producing a highly suitable nonwoven conjugate fiber web, more specifically a bicomponent fiber web. A pair of extruders 12a and 12b separately extrude two polymeric compositions, which compositions are separately fed into a first hopper 14a and a second hopper 14b, to simultaneously supply molten polymeric compositions to a spinneret 18 through conduits 16a and 16b. Suitable spinnerets for extruding conjugate fibers are well known in the art. Briefly, the spinneret 18 has a housing which contains a spin pack, and the spin pack contains a plurality of plates and dies. The plates have a pattern of openings arranged to create flow paths for directing the two polymers to the dies that have one or more rows of openings, which are designed in accordance with the desired configuration of the resulting conjugate fibers.

A curtain of fibers is produced from the rows of the die openings and is partially quenched by a quench air blower 20 before being fed into a fiber draw unit, or an aspirator, 22. The quenching process not only partially quenches the fibers but also develops a latent helical crimp in the fibers. Suitable fiber draw units or aspirators for use in melt spinning polymers are well known in the art, and particularly suitable fiber draw units for the present invention include linear fiber aspirators of the type disclosed in European Patent Application 0 586 924, published March 16, 1994, which is incorporated by reference. Briefly, the fiber draw unit 22 includes an elongate vertical passage through which the filaments are drawn by heated aspirating air entering from the side of the passage from a temperature adjustable heater 24. The hot aspirating air draws the filaments and ambient air through the fiber draw unit 22. The temperature of the air supplied from the heater 24 is sufficient that, after some cooling due to mixing with cooler ambient air aspirated with the filaments, the air heats the filaments to a temperature required to activate the latent crimp. The temperature of the air from the heater can be varied to achieve different levels of crimp. In general, a higher air temperature produces a higher number of crimps.

The process line 10 further includes an endless foraminous forming surface 26 which is positioned below the fiber draw unit 22. The continuous fibers from the outlet of the draw unit are deposited onto the forming surface 26 in a random fashion to produce a continuous web of uniform density and thickness. The fiber depositing process can be assisted by a vacuum unit 30 placed below the forming surface 26. Optionally, the resulting web can be subjected to a light compacting pressure with a roller 32 to consolidate the web to impart additional physical integrity to the web before being subjected to a bonding process.

The nonwoven web is then bonded, for example, by a through air bonding process. Generally described, a through air bonder 36 includes a perforated roller 38, which receives the web, and a hood 40 surrounding the perforated roller. Heated air, which is sufficiently high enough to melt the lower melting component polymer the conjugate fiber, is supplied to the web through the perforated roller 38 and withdrawn by the hood 40. The heated air melts the lower melting polymer and the melted polymer forms interfiber bonds throughout the web, especially at the points where the fibers cross over. Through air

bonding processes are particularly suitable for producing a lofty, uniformly bonded spunbond web since these processes uniformly effect interfiber bonds and do not utilize intermittently placed compacting pressures to effect interfiber bonds. Alternatively, the unbonded nonwoven web can be bonded with a calender bonder. A calender bonder is typically is an assembly of two or more of abuttingly placed heated rolls that apply a combination of heat and pressure to melt fuse the fibers of a thermoplastic nonwoven web, thereby effecting bonded regions or points in the web. The bonding rolls may be smooth to provide uniformly bonded nonwoven webs or contain a pattern of raised bond points to provide point bonded webs.

The soft, high loft nonwoven web of the present invention are highly useful as disposable medical fabrics, e.g., surgical gowns, surgical drapes and sterile wrap; cover materials, e.g., automobile and boat covers; protective garments, e.g., coveralls, uniforms and aprons; and various parts for disposable and personal care articles, e.g. diapers, training pants, sanitary napkins, incontinence products, wipes and the like. In addition, the present lofty nonwoven web that contains fine denier fibers and has a higher bulk and improved uniformity over conventional conjugate spunbond fiber webs is highly useful for filtration applications in that the web provides uniformly distributed finer interfiber pores without sacrificing the loft of the web.

The following examples are provided for illustration purposes and the invention is not limited thereto.

### Examples:

#### Examples 1-2 (Ex1-Ex2)

Point bonded spunbond fiber webs of round side-by-side conjugate fibers containing 50 wt% linear low density polyethylene and 50 wt% polypropylene were produced using the process illustrated in Figure 1. The bicomponent spinning die had a 0.6 mm spinhole diameter, a 6:1 L/D ratio and a 50 holes/inch spinhole density. Linear low density polyethylene (LLDPE), Aspun 6811A, which is available from Dow Chemical, was blended with 2 wt% of a TiO<sub>2</sub> concentrate containing 50 wt% of TiO<sub>2</sub> and 50 wt% of polypropylene, and the mixture was fed into a first single screw extruder. The LLDPE composition was extruded to have a melt temperature of about 430 °F as the extrudate exits the extruder. Polypropylene, X11029-20-1, which has a melt flow rate (MFR) of about 65 g/ 10 min. at 230 °C and is available from Himont, was blended with 2 wt% of the above-described TiO<sub>2</sub> concentrate, and the mixture was fed into a second single screw extruder. The melt temperature of the polypropylene composition was kept at 430 °F for Example 1 and 465 °F for Example 2. The LLDPE and polypropylene extrudates were fed into the spinning die which was kept at about 430 °F, and the spinhole throughput rate was kept at 0.7 gram/hole/minute for Example 1 and 0.5 gram/hole/minute for Example 2. The bicomponent fibers exiting the spinning die were quenched by a flow of air having a flow rate of 45 SCFM/inch spinneret width and a temperature of 65 °F. The quenching air was applied about 5 inches below the spinneret. The quenched fibers were drawn and crimped in the aspirating unit using a flow of air heated to about 350 °F and supplied to have a flow rate of 50.9 ft<sup>3</sup>/min/inch width. Then, the drawn, crimped fibers were deposited onto a foraminous forming surface with the assist of a vacuum flow to form an unbonded fiber web. The unbonded fiber web was bonded by passing the web through the nip formed by two abuttingly placed bonding rolls, a smooth anvil roll and a patterned embossing roll. The raised bond points of the embossing roll covered about 15% of the total surface area and there were about 310 regularly spaced bond points per square inch. Both of the rolls were heated to about 250 °F and the pressure applied on the webs was about 100 lbs/linear inch of width. The bonded nonwoven webs, which had an average weight of about 1.0 ounce per square yard (osy), were tested for their bulk and average fiber size. The crimp level of the fibers forming the nonwoven webs was indirectly measured by comparing the bulk of the webs since the bulk is directly correlated to the crimp level of the fibers, and the bulk is measured in mils under a 0.025 psi load. The results are shown in Table 1.

#### Control 1-2 (C1-C2)

The procedure outlined for Examples 1 and 2 was repeated to produce Control 1-2, respectively, except Exxon PP3445 polypropylene was used. The polypropylene has a melt flow rate of about 35 g/ min. at 230 °C and is a conventional fiber grade polypropylene. The results are shown in Table 1.

Table 1

| Example | Polypropylene MFR (g/min) | Throughput Rate (g/hole/min) | Fiber Size (denier) | Bulk (mil) |
|---------|---------------------------|------------------------------|---------------------|------------|
| Ex1     | 65                        | 0.7                          | 2.5                 | 20.3       |
| Ex2     | 65                        | 0.5                          | 1.8                 | 14.5       |
| C1      | 35                        | 0.7                          | 2.8                 | 11.8       |
| C2      | 35                        | 0.5                          | 1.8                 | 11.0       |

The results demonstrate that the conjugate fibers containing a high melt flow polypropylene provide bulkier nonwoven fabrics, and thus the fibers contain a higher level of crimps than the conjugate fibers produced from a conventional spunbond fiber-forming fiber grade polypropylene. It is also to be noted that C1 and C2 exhibited similar bulk values even though the difference in the size of the fibers was highly significant, demonstrating the difficulty in thermally crimping fine denier fibers.

#### Example 3-7 (Ex3-Ex7)

Unbonded nonwoven webs of side-by-side conjugate fibers were produced in accordance with the procedure outline in Example 1 using two different grades of polypropylene as indicated in Table 2, except the polymer throughput rate was kept at 0.7 g/hole/minute and the melt temperature of the two component polymer compositions was maintained at 430 °F. In addition, the size of the fibers was controlled by changing the flow rate of heated air supplied to the aspirating unit as indicated in Table 2. Both 100 melt flow rate and 65 melt flow rate polypropylene resins were obtained from Shell Chemical.

The unbonded nonwoven webs were then bonded by passing the webs through a through-air bonder. The bonder exposed the nonwoven webs to a flow of heated air having a temperature of about 270 °F and a flow rate of about 200 feet/min. The average weight, fiber size and bulk of the bonded webs were measured, and the bulk was normalized to 1 osy. The results are shown in Table 2.

#### Control 3-5 (C3-C5)

Example 3 was repeated except the polypropylene employed was the 35 melt flow rate polypropylene disclosed in Control 1. The results are shown in Table 2.

Table 2

| Example | PP MFR (g/min) | Flow Rate of Heated Air (ft <sup>3</sup> /min/inch width) | Fiber Size (denier) | Web Weight (osy) | Bulk (mil/osy) |
|---------|----------------|-----------------------------------------------------------|---------------------|------------------|----------------|
| Ex3     | 100            | 37.3                                                      | 2.0                 | 2.03             | 36.5           |
| Ex4     | 65             | 37.3                                                      | 2.5                 | 1.85             | 37.2           |
| Ex5     | 100            | 42.9                                                      | 1.9                 | 1.89             | 37.4           |
| Ex6     | 100            | 48.6                                                      | 1.8                 | 1.94             | 23.7           |
| Ex7     | 65             | 48.6                                                      | 1.9                 | 2.18             | 23.6           |
| C3      | 35             | 37.3                                                      | 2.5                 | 1.95             | 19.5           |
| C4      | 35             | 42.9                                                      | 2.2                 | 2.03             | 14.5           |
| C5      | 35             | 44.5                                                      | 2.0                 | 2.12             | 14.3           |

The results clearly demonstrate that utilizing a high melt flow propylene polymer significantly improves the bulk of the conjugate fiber webs. For example, although the fibers of Example 4 and Control 3 had the same fiber size, the bulk of Example 4 was about 91% loftier than that of Control 3.

#### Claims

1. A highly crimpable conjugate fiber comprising an ethylene polymer component and a propylene polymer component, said propylene polymer component comprising a propylene polymer having a melt flow rate equal to or higher than about 45 g/ 10 min. at 230 °C, wherein each of said components

occupies a distinct section for substantially the entire length of said fiber.

2. The conjugate fiber of claim 1 wherein said conjugate fiber has a side-by-side configuration.
- 5 3. The conjugate fiber of claim 1 wherein said conjugate fiber has an eccentric sheath-core configuration.
4. The conjugate fiber of claim 1 wherein said propylene polymer is selected from the group consisting of homopolymers and copolymers of propylene and blends thereof.
- 10 5. The conjugate fiber of claim 1 wherein said propylene polymer is selected from the group consisting of isotactic polypropylene and propylene copolymers containing up to about 10 wt% of ethylene.
6. The conjugate fiber of claim 1 wherein said propylene polymer has a melt flow rate between about 50 and about 200 g/ 10 min at 230 ° C.
- 15 7. The conjugate fiber of claim 1 wherein said propylene polymer has a melt flow rate between about 55 and about 175 g/ 10 min at 230 ° C.
8. The conjugate fiber of claim 1 wherein said ethylene polymer is selected from the group consisting of homopolymers and copolymers of ethylene and blends thereof.
- 20 9. The conjugate fiber of claim 1 wherein said ethylene polymer is selected from the group consisting of high density polyethylene and linear low density polyethylene.
- 25 10. The conjugate fiber of claim 1 has a weight-per-unit length equal to or less than about 2.5 denier.
11. The conjugate fiber of claim 1 is a thermally crimped fiber selected from the group consisting of spunbond filaments and staple fibers.
- 30 12. A nonwoven web comprising highly crimpable conjugate fibers, said conjugate fibers comprising an ethylene polymer component and a propylene polymer component, said propylene polymer component comprising a propylene polymer having a melt flow rate equal to or higher than about 45 g/10 min. at 230 ° C, wherein each of said components occupies a distinct section for substantially the entire length of said fiber.
- 35 13. The nonwoven web of claim 12 wherein said conjugate fibers are continuous fibers.
14. The nonwoven web of claim 12 wherein said conjugate fibers are staple fibers.
- 40 15. The nonwoven web of claim 12 wherein said conjugate fibers have a side-by-side configuration.
16. The nonwoven web of claim 12 wherein said conjugate fibers have an eccentric sheath-core configuration.
- 45 17. The nonwoven web of claim 12 wherein said propylene polymer is selected from the group consisting of homopolymers and copolymers of propylene and blends thereof.
18. The nonwoven web of claim 12 wherein said propylene polymer has a melt flow rate between about 50 and about 200 g/ 10 min at 230 ° C.
- 50 19. The nonwoven web of claim 12 wherein said ethylene polymer is selected from the group consisting of homopolymers and copolymers of ethylene and blends thereof.
20. The nonwoven web of claim 12 wherein said conjugate fibers have a weight-per-unit length equal to or less than about 2.5 denier.
- 55 21. The nonwoven web of claim 12 wherein said conjugate fibers are thermally crimped fibers selected from the group consisting of spunbond filaments and staple fibers.

**22.** A disposable article comprising the nonwoven web of claim 12.

**23.** A personal care article comprising the nonwoven web of claim 12.

5 **24.** A disposable medical fabric article comprising the nonwoven web of claim 12.

**25.** A filter comprising the nonwoven web of claim 12.

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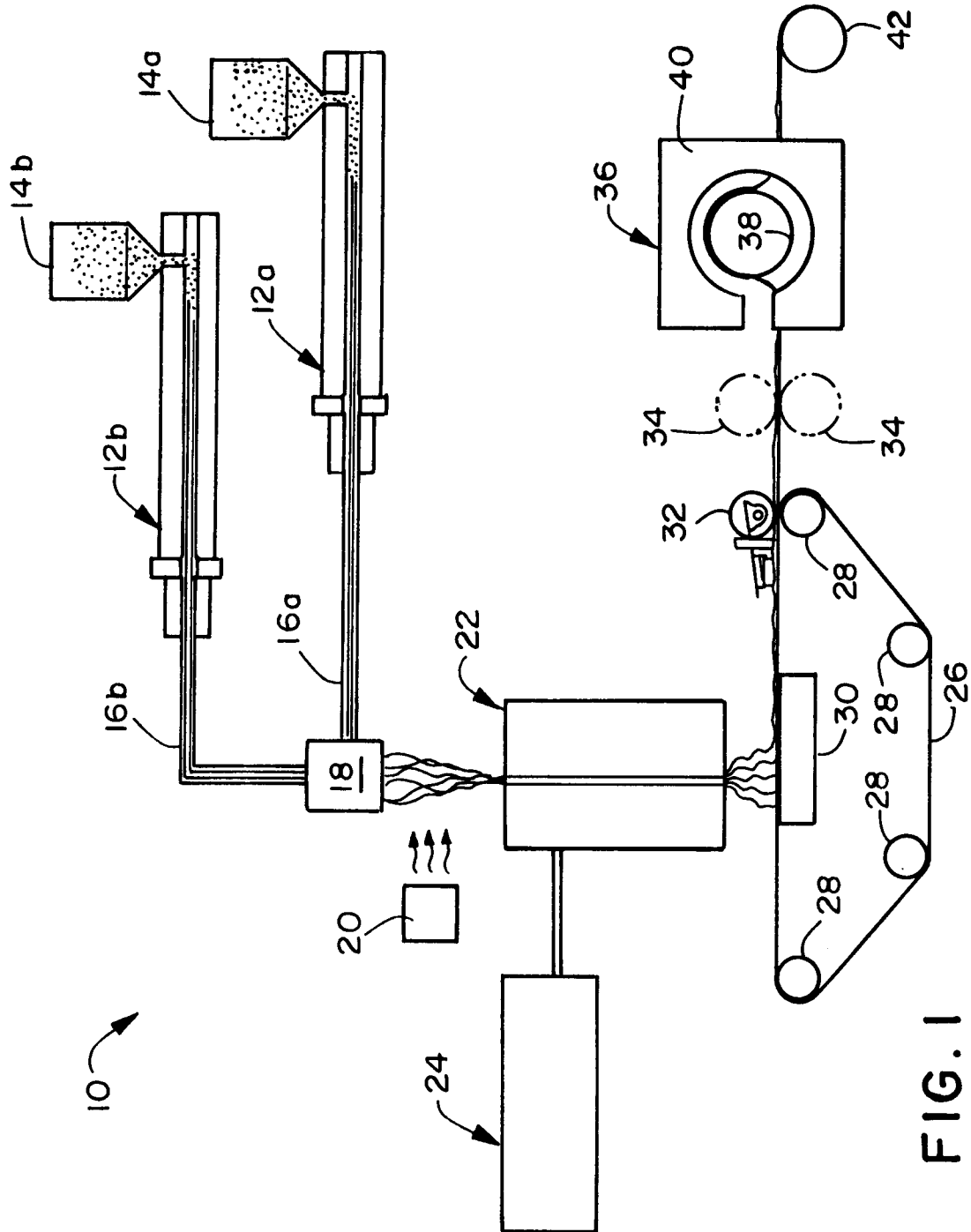


FIG. 1