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(54) **METHOD AND APPARATUS FOR THE PRODUCTION OF ARTIFICIAL FIBERS**

VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG VON KÜNSTLICHEN FASERN

PROCEDE ET DISPOSITIF DE PRODUCTION DE FIBRES ARTIFICIELLES

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Description

Field Of The Invention

[0001] This invention relates generally to the production of man-made fibers, and particularly, to the field of production of man-made fibers using melt-blown, and coform techniques.

Background Of The Invention

[0002] The production of man-made fibers has long used melt-blown, coform and spunbond techniques to produce fibers for use in forming non-woven webs of material. Figures 1a through 3b illustrate prior art machines which manufacture non-woven webs from melt-blown and spunbond techniques. Additionally, prior art coform techniques are discussed in greater detail hereinafter.

[0003] Figures 1a-1c illustrate a typical approach for producing melt-blown fibers. Referring to Figure 1a, a hopper 10 contains pellets of resin. Extruder 12 melts the resin pellets by a conventional heating arrangement to form a molten extrudable composition which is extruded through a melt-blowing die 14 by the action of a turning extruder screw (not shown) located within the extruder 12. As shown in Figure 1c, the extrudable composition is fed to the orifice 18 through extrusion slot 28. The die 14 and the gas supply fed therethrough are heated by a conventional arrangement (not shown).

[0004] Figure 1b illustrates the die 14 in greater detail. The tip 16 of die 14 contains a plurality of melt-blowing die orifices 18 which are arranged in a linear array across the face 16. Referring now to Figure 1c, inlets 20 and 21 feed heated gas to the plenum chambers 22 and 23. The gas then exits respectively through the passages 24 and 25 to converge and form a gas stream which captures and attenuates the polymer or resin threads extruded from orifice 18 to form a gas borne stream of fibers 26 as is seen in Figure 1a.

[0005] The melt-blowing die 14 includes a die member 36 having a base portion 38 and a protruding central portion 39 within which an extrusion slot 28 extends in fluid communication with the plurality of orifices 18, the outer ends of which terminate at the die tip. The gas borne stream of fibers 26 is projected onto a collecting device which in the embodiment illustrated in Figure la includes a foraminous endless belt 30 carried on rollers 31 and which may be fitted with one or more stationary vacuum chambers (not shown) located beneath the collecting surface on which a non-woven web 34 of fibers is formed. The collected entangled fibers form a coherent web 34, a segment of which is shown in plan view in Figure 2. The web 34 may be removed from the belt 30 by a pair of pinch rollers 33 (shown in Fig. la) which press the entangled fibers together. The prior art melt-blowing apparatus of Figs. 1a-1c may optionally include pattern-embossing means as by patterned calender nip or ultrasonic embossing equipment (not shown) and web 34 may thereafter be taken up on a storage roll or passed to subsequent manufacturing steps. Other embossing means may be utilized such as the pressure nip between a calender and an anvil roll, or the embossing step may be omitted altogether.

[0006] Figure 3a illustrates a prior art apparatus 44 for producing spunbond fibers. The spunbond apparatus typically contains a fiber draw unit 46 positioned above an endless belt 78 which is supported on rollers 76. Figure 3b illustrates the fiber draw unit in greater detail. Fiber draw unit 46 includes upper air regions 48 and 50 and a longitudinal air chamber which contains an upper portion 52, a mid-portion 54, and a lower portion or tail pipe 56. The fiber draw unit also includes a first air plenum 58 and an air inlet 60 leading from the first air plenum 58 to mid-portion 54 of the fiber draw unit. Additionally, a second air plenum 62 also communicates with mid-portion 54 of the fiber draw unit via air inlet 64. The spunbond apparatus 44 also includes standard equipment for melting an extruding resin through dies to create fibers 68. Typically, this equipment feeds resin fed from a supply to a hopper extruder, through a filter, and finally through a die to create the fibers 68.

[0007] High velocity air is admitted into the fiber draw unit through plenums 58 and 62 via inlets 72 and 74, respectively. The addition of air to the fiber draw unit through inlet 60 and 64 aspirates air through inlets 50 and 48. The air and fibers then exit through tail pipe 56 into exit area 70. Generally, air admitted into the fiber draw unit through inlets 50 and 48 draws fibers 68 as they pass through the fiber draw unit. The drawn fibers are then laid down on endless belt 78 to form a non-woven web 80 as is seen in Figure 3a. Rollers 82 may then remove the non-woven web from the endless belt 78 and further press the entangled fibers together to assist in forming the web. The web 80 is then bonded, such as by embossing by calender and anvil, ultrasonic embossing, or other known technique, to form the finished material.

[0008] It is well known in the art to vary a number of processing parameters in both melt-blown and spunbond fiber forming processes to obtain fibers of desired properties in order to form fabrics with desired characteristics. However, the majority of prior art techniques for varying fiber characteristics required more time consuming changes in machinery or process, such as changing dies or changing the resins. Therefore, those techniques required that the production line be halted while the necessary changes were made, which resulted in inefficiency when a new material was to be run.

[0009] The prior art has previously taught that various effects can be obtained by the manipulation of air flow near the fiber exit in melt-blown and spunbond fiber producing equipment. For example, Shambaugh, U.S. Patent No. 5,405,559, teaches that the air flow provided in the melt-blown process can be alternately turned on and off on both sides of the die, thus reducing the energy required to produce melt-blown fiber. However, this teaching of Shambaugh has several drawbacks. Under some conditions, the complete shutting off of the air on either side will tend to blow the liquefied resin onto the air plates on the other side of the die, thereby clogging the machinery for typical production airflow rates (especially with high MFR polymers or other polymers normally used in non-woven web production). Further, such techniques would likely result in the deposition of resin globs or "shot", on the production web since the resin would be affected only minimally during the transition from airflow on one side of the die to the other. Finally, while the Shambaugh reference teaches switching air on and off for the purposes of reducing fiber size for a given flow, its main emphasis is that such switching saves energy by reducing the overall airflow requirements in the melt-blown process. Moreover, the low frequencies taught by Shambaugh would result in poor formation on a high speed machine. Fibers produced as given in the examples are coarser, e.g. larger diameters than typically found in non-woven commercial production. Finally, Shambaugh teaches no applicability of selective alteration of airflow characteristics for varying fiber parameters in a spunbond fiber production environment.

[0010] SU 1015013 discloses a method according to the preamble of claim 1.

Summary of The Invention

[0011] The invention provides a process and apparatus for the production of fibers in accordance with method claim 1 and apparatus claim 32.

[0012] Generally, the present invention relates to an apparatus for forming artificial fibers with a meltblowing or coforming process from a liquefied resin and for forming a non-woven web. The apparatus includes means for generating a substantially continuous airstream for entraining fibers along a primary axis, at least a first extrusion die located next to the airstream for extruding the liquefied resin, and perturbation means for selectively perturbing the air stream by varying the air pressure on either side or both sides of the primary axis.

[0013] The apparatus may also include a substrate disposed below the first die, substrate translation means for moving the substrate relative to the die, wherein the entrained fibers are deposited on the substrate to form a non-woven web.

[0014] The apparatus may include a first supply of air connected to first and second air plenum chambers located on opposite sides of the axis, wherein plenum chambers outlets provide a substantially continuous air stream for fiber attenuation. The perturbation means may include a valve for selectively varying the airflow rate to the first and second plenums, thereby providing airflow perturbation to the entrained fibers. Additionally, airstream perturbation may be achieved by superimposing a perturbed secondary air supply on the first air supply within the plenum chambers. Alternatively, the perturbation means may include first and second pressure transducers adjacent or attached to the first and second plenum chambers, and means for selective activation of the first and second pressure transducers for selectively varying the pressure in the first and second plenum chambers. Generally, the perturbation means varies a steady state pressure in the first and second plenum chambers at a perturbation frequency of approximately less than 1000 Hertz, and varies an average plenum pressure in the first and second plenum chamber up to about 100% of the total average plenum pressure in the absence of activation of the perturbation means.

[0015] The apparatus may also include a fiber draw unit disposed below the first die and adapted to channel the primary air flow therethrough. The fiber draw unit may include a fiber inlet at a top portion thereof for receiving fluid flow and fibers entrained therein, an outlet for dispensing the air entrained fibers onto the substrate. The apparatus may also include a multiple die arrangement for extruding several types of resin simultaneously, as well as means for adding other fibers or particulates (coform).

[0016] The apparatus may also include first and second secondary perturbing air supplies disposed on opposite sides of said axis and near the die or fiber draw unit for alternatingly perturbing the substantially continuous flow of air.

Brief Description of the Drawings

[0017]

Figures 1a-1c illustrate schematic representations of a prior art apparatus for producing melt-blown fibers.

Figure 2 is a surface representation of a non-woven web made in accordance with prior art methods.

Figures 3a and 3b illustrate schematic representations of a prior art apparatus for producing spunbond fibers.

Figure 4 is a photograph of a surface of a non-woven web manufactured without airstream perturbation.

Figure 5 is a photograph of a surface of a non-woven web manufactured in accordance with the present invention.

Figures 6a-6d illustrate schematic representations of apparati for producing melt-blown fibers according to the present invention.

Figures 7a-7e illustrate schematic representations of three-way valve embodiments which may be utilized in accordance with the present invention.

Figures 8a and 8d illustrate plenum pressure as a function of time for a prior art apparatus for producing melt-blown fibers.

Figures 8b-8c illustrate plenum pressure as a function of time for an apparatus for producing melt-blown fibers in accordance with the present invention.

Figure 9 illustrates fiber diameter distribution for melt-blown fibers manufactured in accordance with the prior art.

Figure 10 illustrates fiber diameter distribution for melt-blown fibers manufactured in accordance with the present invention.

Figure 11 illustrates Frazier porosity as a function of perturbation frequency for a melt-blown non-woven web manufactured in accordance with the present invention.

Figure 12 illustrates hydrohead as a function of perturbation frequency for a melt-blown non-woven web manufactured in accordance with the present invention.

Figure 13 is a photograph of the surface of a non-woven web manufactured in the absence of airstream perturbation.

Figure 14 is a photograph of the surface of a non-woven web manufactured in accordance with the present invention.

Figure 15 illustrates peak load as a function of perturbation frequency of a non-woven web of spunbond fibers.

Figure 16 is a schematic representation of a coform apparatus configured in accordance with the present invention.

Figures 17a-17d and 19 illustrate various apparatus configurations for manufacturing a non-woven web of spunbond fibers which is described for a better understanding of the present invention.

Figures 18a-18f, 20a and 20b, and 21a-21d illustrate various configurations of secondary jets for use with the present invention.

Figures 22 and 23 are X-Ray Diffraction Scans of a prior art meltblown fiber and a fiber made in accordance with the present invention.

Figure 24 is a DSC (Differential Scanning Calorimetry) comparing the calorimetric characteristics of a prior art meltblown fiber and a fiber made in accordance with the present invention.

Detailed Description of The Preferred Embodiments

[0018] The following techniques are applicable to the melt-blown, spunbond and coform fiber forming processes. For the sake of clarity, the general principles of the invention will be discussed with reference to these techniques. Following the general description of the techniques, the specific application of these techniques in the melt-blown, spunbond, and coform fields will be described. For ease in following the discussion, sub-headings are provided below; however, these sub-heading are for the sake of clarity and should not be considered as limiting the scope of the invention as defined in the claims. As used herein, the term "perturbation" means a small to moderate change from the steady flow of fluid, or the like, for example up to 50% of the steady flow, and not having a discontinuous flow to one side. Furthermore, as used herein, the term fluid shall mean any liquid or gaseous medium; however, in general the preferred fluid is a gas and more particularly air. Additionally, as used herein the term resin refers to any type of liquid or material which may be liquefied to form fibers or non-woven webs, including without limitation, polymers, copolymers, thermoplastic resins, waxes and emulsions.

General Description of the Air Flow Perturbation Process

[0019] As was described previously, the production of fibers having various characteristics has been known in the prior art. However, the preferred embodiments of the present invention provide for a much greater range of variation in fiber characteristics and provide for a greater range of control for forming various non-woven web materials from such fibers, these techniques allow one to "tune in" the characteristics of the non-woven web formed thereby with little or no interruption of the production process. The basic technique involves perturbing the air used to draw the fiber from the die. Preferably, the airflow in which the fiber travels is alternately perturbed on opposite sides of an axis parallel to the direction of travel of the fiber. Thus, the airstream carrying the forming fiber is perturbed, resulting in perturbation of the fiber during formation. Airstream perturbation according to the methods and apparati of the present invention may be implemented in melt-blown and spunbond manufacturing, but is not limited to those processes.

[0020] In general, the airflow may be perturbed in a variety of ways; however, regardless of the method used to perturb the airflow, the perturbations have two basic characteristics, frequency and amplitude. The perturbation frequency may be defined as the number of pulses provided per unit time to either side. As is common the frequency will be described in Hertz (number of cycles per second) throughout the specification. The amplitude may also be described by the percentage increase or difference in air pressure ($\Delta P/P$) X 100 in the perturbed stream as compared to the steady state. Additionally, the perturbation amplitude may be described as the percentage increase or difference in the air flow rate during perturbation as compared to the steady state. Thus, the primary variables which may be controlled by the new fiber forming techniques are perturbation frequency and perturbation amplitude. The techniques described below easily control these variables. A final variable which may be changed is the phase of the perturbation. For the most part, a 180° phase differential in perturbation is described below (that is, a portion of the airflow on one side of an axis parallel to the direction of flow is perturbed and then the other side is alternately perturbed); however, the phase differential could be adjusted between 0° to 180° to achieve any desired result. Tests have been conducted with the perturbation being symmetric (in phase) and with varying phase relationships. This variation allows for still more control over the fibers made thereby and the resulting web or material.

[0021] The perturbation of the air stream and fibers during formation has several positive effects on the fiber formed thereby. First, the particular characteristics of the fiber such as strength and crimp may be adjusted by variation of the perturbation. Thus, in non-woven web materials, increased bulk and tensile strength may be obtained by selecting the proper perturbation frequency and amplitude. Increased crimp in the fiber contributes to increased bulk in the non-woven web, since crimped fibers tend to take up more space. Additionally, preliminary investigation of the characteristics of meltblown fibers made in accordance with the present invention, as compared to those made with prior art techniques, appear to indicate that fibers made in accordance with the present invention exhibit different crystalline and heat transfer characteristics. It is believed that such differences are due to heat transfer effects (including quenching) which result from the movement of fibers in a turbulent airflow. It is further believed that such differences contribute to the enhanced characteristics of fibers and non-woven materials made in accordance with the techniques of the present invention. Additionally, the perturbation of the airflow also results in improved deposition of the fibers on the forming substrate, which enhances the strength and other properties of the web formed thereby.

[0022] Furthermore, since the variables of frequency and amplitude of the perturbation are easily controlled, fibers of different characteristics may be made by changing the frequency and/or amplitude. Thus, it is possible to change the character of the non-woven web being formed during processing (or "on the fly"). By this type of adjustment, a single machine may manufacture non-woven web fabrics having different characteristics required by different product specification while eliminating or reducing the need for major hardware or process changes, as is discussed above. Additionally, the present invention does not preclude the use of conventional process control techniques to adjust the fiber characteristics.

[0023] Referring now to Figures 4 and 5, magnified photographs of melt-blown webs made in accordance with prior art techniques (Fig. 4) and according to the present invention (Fig. 5) may be compared. As is seen in Figure 4, the individual fibers of the web are relatively linear. However, as is seen in Figure 5, the fibers in the web made in accordance with the perturbation techniques of the present invention are much more crimped and are not predominantly aligned in the same direction. Thus, as will be seen in the results described below, webs made in accordance with the present invention tend to exhibit greater bulk for a given weight and frequently have greater machine and cross direction strengths (the machine direction is the direction of movement, relative to the forming die, of the substrate on which the web is formed; the cross direction is perpendicular to the machine direction). It is believed that the increase crimp will provide many more points of contact for the fibers of the web which will enhance web strength. As a note, at first glance it would appear that many more and larger voids are present in the web of Figure 5 as compared to that of Figure 4; however, in fact, the web of Figure 5 does not contain more or larger voids than that of Figure 4. Since the SEM photographs of these Figures present views of the top surface of the material, the increased bulk of the web of Figure 5 is not seen in the photograph and the bulk manifests in a manner to make it appear that there are a greater number of larger voids. Conversely, since the web of Figure 4 has less bulk, a greater number of fibers of that web are located in the plane of the photograph, giving the appearance of fewer and small voids. As is seen below, the barrier properties of webs made in accordance with the present invention can be selected to be superior to those made in accordance with the prior art, thus demonstrating that the appearance of voids in the photograph of Figure 5 is misleading.

Melt-Blown Applications

[0024] Figures 6a through 6d illustrate various embodiments of the present invention which utilize alternating air pulses to perturb air flow in the vicinity of the exit of a melt-blown die 59. Each melt-blown embodiment of the present invention includes diametrically opposed plenum/manifolds 22 and 23 and air passages 24 and 25 which lead to a tip of the melt die 59 to create a stream of fibers in a jet stream 26. The function of the present invention is to maintain a steady flow and to superimpose an alternating pressure perturbation on that steady flow near the tip of melt die 59 by alternatingly increasing or reducing the pressure of the manifolds 22 and 23. This technique assures controlled modifications in the gas borne stream of fibers 26 and therefore facilitates regularity of pressure fluctuations in the gas borne stream of fibers. Additionally, the relatively high steady state air flow with respect to perturbation air flow amplitude also serves to prevent the airborne stream of fibers from becoming tangled on air plates 40 and 42. The jet structure air entrainment rate (and therefore quenching rate) and fiber entanglement are thus modified favorably.

[0025] Figures 7a through 7d illustrate a few examples of valves that alternatingly augment the pressure in plenum chambers 22 and 23 shown in Figs. 6a-6d. Referring to Figure 7a, perturbation valve 86 is essentially comprised of a bifurcation of main air line 84 into inlet air lines 20 and 21. In the immediate vicinity of the bifurcation, a pliant flapper 98 alternatingly traverses the full or partial width of the bifurcation. This provides a means for alternatingly restricting air flow to one of air inlet lines 20 and 21 thereby superimposing a fluctuation in air pressure in manifolds 22 and 23.

Alternatively, an activator may mechanically oscillate the flapper across the bifurcation to produce the appropriate fluctuation in air pressure in plenums 22 and 23. Flapper valve 98 may traverse the bifurcation of mainline 84 in an alternating manner simply by the turbulence of air in mainline 84 using the natural frequency of the flapper. Oscillation frequency of valve 86 as disclosed in Figure 7a may be varied mechanically by an activator which reciprocates the flapper, or by simply adjusting the length of the flapper 98 to change its natural frequency.

[0026] Figure 7b illustrates a second embodiment of the perturbation valve 86. This embodiment may include a motor 100 which rotates a shaft 102. The shaft 102 may be fixed to a rotation plate 109 which has a plurality of apertures 108 disposed thereon. Behind rotation plate 109 is a stationary plate 104 containing a plurality of apertures 106. Both disks may be mounted so that flow is realized through fixed disk openings only when apertures from the rotation plate 109 are aligned with apertures in the stationary plate 104. The apertures on each plate may be arranged such that a steady flow may be periodically augmented when apertures on each plate are aligned. The frequency of the augmented flow may be controlled through a speed control of motor 100.

[0027] Figure 7c illustrates yet another embodiment of perturbation valve 84. In this embodiment a motor 100 is rotatingly coupled to a shaft 112 which supports a butterfly valve 110 having essentially a slightly smaller cross-section than main air line 84. Turbulence created downstream from rotating butterfly 110 may then provide an alternatingly augmented air pressure in air inlet lines 20 and 21 and also in air plenums 22 and 23 to achieve the flow conditions in accordance with the present invention.

[0028] Figure 7d represents yet another embodiment of a perturbation valve 86 in accordance with the present invention. There, a motor 100 is coupled to a shaft 112 and butterflies 110 and 114 within inlet air lines 20 and 21 respectively. As is seen from Figure 7d, butterflies 110 and 114 are mounted on shaft 112 approximately 90° to each other. Additionally, each of the butterflies 110 and 114 may include apertures 111 so as to provide a constant air flow to each of the plenums while alternatingly augmenting pressure in each of the plenums 22 and 23 when the appropriate butterfly is in an open position.

[0029] Figure 7e represents still another embodiment of the perturbation valve 86. In this embodiment an actuator 124 is coupled to a shaft 122 which in turn is mounted to a spool 123. Spool 123 includes channels 118 and 120 which communicate with air inlet lines 20 and 21 respectively, depending on the longitudinal position of the spool 123. Each of the channels 118 and 120 is fluidly connected to main channel 116 which is fluidly connected to main air line 84. In this embodiment, perturbation valve 86 may achieve alternatingly augmented air pressures in each of the plenums by reciprocation of rod 122 from actuator 124. Additionally, channels 118 and 120 may simultaneously be connected to main air line 84 while activator 124 reciprocates spool 123 to vary an amount of overlap, and thus air flow restriction, between channels 118 and 120 with lines 20 and 21, respectively, to achieve alternating augmented pressures in the plenum chambers 22 and 23, respectively. Actuator 124 may include any known means for achieving such reciprocation. This may include but is not limited to pneumatic, hydraulic or solenoid means.

[0030] Figures 8a-8d illustrate, respectively, plenum air pressures in both the prior art melt-blown apparatus and in the melt-blown apparatus according to the present invention. As is seen in Figure 8a, a prior art air pressure in the plenum chambers is essentially constant over time whereas in Figures 8b and 8c the air pressure in the plenum chambers is essentially augmented in an oscillatory manner. As an example, the point at which the mean pressure intersects the ordinate can be about 7 psig. Fig. 8d illustrates a prior art air pressure in the vicinity of a prior art extrusion die where air is turned on and off. In this case, the mean pressure meets the ordinate at about 0.5 psig, for example. The on/off control of prior art air flow as illustrated in Fig. 8d is conducive to die clogging due to the intermittent flow, as explained above. Additionally, the prior art on/off air flow control illustrated in Fig. 8d (implemented by Shambaugh) utilizes a lower average pressure, a lower frequency and less pressure amplitude than the present invention. Although the airflow characteristic illustrated in Fig. 8a is not conducive to die clogging, no control may be implemented over fiber crimping or web characteristics, since the flow is virtually constant with respect to time.

[0031] Perturbation valve 86 may be placed in a multitude of arrangements to achieve the alternatingly augmented flow in plenum chambers 22 and 23 of the melt-blown apparatus according to the present invention. For example, Figure 6b shows another embodiment according to the present invention. In this embodiment, main air line 84 bifurcates constant air flow to inlet air lines 20 and 21 while bleeding an appropriate flow of air to perturbation valve 86 via bleeder valve 90. Therefore, in this embodiment plenum chambers 23 and 22 each include two inlets. The first inlet introduces essentially constant flow from air inlet lines 20 and 21. The second inlet of each plenum chamber introduces the alternating flow to the chamber, thereby superimposing oscillatory flow on the constant flow from lines 20 and 21. The amount of air bled from bleeder valve 88 will control the amplitude of the pressure augmentation for precise adjustment of fiber characterization, as explained in greater detail below, while perturbation valve 86 controls frequency.

[0032] Figure 6c represents yet another embodiment of the present invention. In this embodiment, main air line 84 bifurcates into air lines 21 and 22 to supply air pressure to plenum chambers 22 and 23. Additionally, an auxiliary air line 92 bifurcates at perturbation valve 86. The perturbation valve 86 then superimposes an alternatingly augmented air pressure onto plenum chambers 22 and 23 to achieve the oscillatory flow conditions in accordance with the present invention. Here, pressure on the air line 92 controls the amplitude of air pressure perturbation, while perturbation valve

86 controls perturbation frequency, as explained above.

[0033] Figure 6d represents yet another embodiment of the present invention. In this embodiment, main air line 84 bifurcates into inlet air lines 20 and 21 which lead to plenum chambers 22 and 23 respectively. The alternatingly augmented pressure in plenum chambers 22 and 23 may be provided by transducers 94 and 96 respectively. Transducers 94 and 96 are actuated by means of an electrical signal. For example, the transducers may actually be large speakers which receive an electrical signal to pulsate 180° out of phase in order to provide the alternating augmented pressures in plenum chambers 22 and 23. However, any type of appropriate transducer may create an augmented air flow by using any means of actuation. This may include but is not limited to electromagnetic means, hydraulic means, pneumatic means or mechanical means.

[0034] As was discussed previously, all of the described embodiments allow for the precise control of the perturbation frequency and amplitude, preferably without interrupting the operation of the fiber forming machinery. As will be described below, this ability to precisely control the perturbation parameters allows for relatively precise control of the characteristics of the fibers and web formed thereby. Typically, there are a wide variety of fiber parameters and while a particular set of parameters may be desired for making one type of non-woven material, such as filter material, a different set of fiber parameters may be desired for making a different type of material, such as for disposable garments.

[0035] For example, in filter applications, the material is preferably made of small diameter fibers. However, larger diameter fibers may be desired for other materials. Furthermore, many end products consist of layers of material having a variety of characteristics. For example, disposable diapers generally consist of a wicking layer designed to move moisture away from contact with the skin of an infant and to keep such moisture away. A middle, absorbent layer is used to retain the moisture. Finally, an outer, barrier layer is desired to prevent the absorbed moisture from seeping out of the diaper. The fiber characteristics for each layer of the diaper are different in order to achieve the specific functions of each type of material. With the present techniques, various portions of the web can be formed by varying the perturbation parameters with respect to time so that each layer of the diaper is formed sequentially in one non-woven web. Then the single web may be folded to provide the layered finished material.

[0036] Sorbent structures for oil are described, for example, in U.S. Patent No. 5,364,680 to Cotton which is incorporated herein in its entirety by reference. For oil sorbent applications it is desired to have a microfiber web that is oleophilic and characterized by a bulk in terms of density of no more than about 0.1g/cc, preferably no more than about 0.06g/cc. In general, lower densities are preferred but densities below 0.01g/cc are difficult to handle. Such webs have the ability to soak up and retain oil in an amount of at least about 10 times the web weight, preferably at least about 20 times the web weight. For certain applications it may be desired to provide a treatment with one or more compositions to increase wettability by aqueous liquids. Such treatments are well known and described, for example, in coassigned U.S. Patent No. 5,057,361 which is incorporated herein in its entirety. Prior attempts to produce such webs by meltblowing techniques, while resulting in useful fine fiber materials, have lacked the desirable bulk and absorbency due to the manner in which the air streams applied the still tacky fibers to the forming surface.

[0037] Thus, with precise control of the fiber and material characteristics by control of the perturbation characteristics, a great degree of flexibility is possible in the formation of non-woven webs. This control, in turn, allows for greater efficiency and the ability to design a greater range of materials which may be produced with little interruption of the production process.

[0038] One shortcoming of prior art melt-blown equipment is the relative inability to precisely control the diameter of fibers produced thereby. The formation of materials with particular characteristics often requires precise control over the diameter of the fibers used to form the non-woven web. With the perturbation technique of the present invention, it is possible to provide for much less variation in fiber diameter than was previously possible with prior art techniques.

[0039] Figures 9 and 10 illustrate fiber diameter distribution for samples taken from prior art melt-blown techniques and the melt-blown fiber producing technique according to the melt-blown apparatus embodiment of Figure 6c. Figure 9 shows a diameter distribution in accordance with the prior art. Figure 10 represents a fiber diameter distribution chart for melt-blown fibers made in accordance with the inventive technique. The fiber distribution in Figure 10 illustrates a fiber diameter sample which has a distribution that is centered on a peak between about 1 and 2 microns. Here, the narrow band of fiber distribution achieved by the perturbation method and apparatus illustrates the great extent to which fiber diameter may be controlled by only varying perturbation frequency or amplitude.

[0040] Figure 11 represents the Frazier porosity of a non-woven melt-blown web made in accordance with the present invention as a function of perturbation frequency in the plenum chambers 22 and 23. The Frazier Porosity is a standard measure in the non-woven web art of the rate of airflow per square foot through the material and is thus a measure of the permeability of the material (units are cubic feet per square foot per minute). For all samples the procedure used to determine Frazier air permeability was conducted in accordance with the specifications of method 5450, Federal Test Methods Stand No. 191 A, except that the specimen sizes were 8 inches by 8 inches rather than 7 inches by 7 inches. The larger size made it possible to ensure that all sides of the specimen extended well beyond the retaining ring and facilitated clamping of the specimen securely and evenly across the orifice.

[0041] As is illustrated in Figure 11, the Frazier porosity generally falls first to a minimum and then increases with perturbation frequency from a steady state to approximately 500 hertz. Thus, one can observe that to make a material with a desired Frazier porosity with the present invention, it is only necessary to vary the oscillation frequency (and/or the amplitude). With prior art techniques, changes in porosity often required changes to the die or starting materials or the duplication of machinery. Thus, with the present techniques, it is possible to easily change the porosity of a material once a run is completed; it is only necessary to adjust the perturbation frequency (or amplitude), which can easily be done with simple controls and without stopping production. Therefore, the melt-blowing apparati according to the present invention may quickly and easily manufacture filtering materials of varying porosity by simply changing perturbation frequency.

[0042] Figure 12 illustrates a plot of hydrohead as a function of perturbation frequency. The Hydrohead Test is a measure of the liquid barrier properties of a fabric. The hydrohead test determines the height of water (in centimeters) which the fabric will support before a predetermined amount of liquid passes through. A fabric with a higher hydrohead reading indicates it has a greater barrier to liquid penetration than a fabric with a lower hydrohead. The hydrohead test is performed according to Federal Test Standard No. 191A, Method 5514. Generally, hydrohead first increases and then decreases with increasing perturbation frequency in a frequency range of approximately 75 hertz to 525 hertz. Since perturbation frequency directly affects hydrohead, an appropriate adjustment of the perturbation valve 86 provides the type of barrier to liquid required by a particular application. Perturbation frequency may be used to vary hydrohead to suit the particular use for the material.

Examples

[0043] The following examples provide a basis for demonstrating the advantages of the present invention over the prior art in the production of melt-blown, coform and spunbond webs and materials. These examples are provided solely for the purpose of illustrating how the methods of the present invention may be implemented and should not be interpreted as limiting the scope of the invention as set forth in the claims.

Example 1

Process Condition

[0044]

Die Tip Geometry:	Recessed Die Width = 20" Gap = 0.090" 30 hpi
Primary Airflow:	Heated (≈608°F in heater) 488 scfm Pressure P_T = 6.6 psig
Auxiliary Airflow:	Unheated (ambient air temp.) 60 scfm Inlet Pressure = 20 psig
Polymer: Copolymer of butylene and propylene	polypropylene* - 79% polybutylene - 20% blue pigment - 01%

*800 MFR polypropylene coated with peroxide - final MFR ≈ 1500

Polymer Throughput:	0.5 GHM
Melt Temperature:	470°F
Perturbation Frequency:	0 Hz, 156 Hz, 462 Hz

(continued)

Basis Weight:	0.54 oz/yd^2
Forming Height:	10"

Test Results

Barrier

[0045]

Table 1-1

Perturbation Frequency	0 Hz	156 Hz	462 Hz
Frazier Porosity (cfm/ft^2)	45.18	35.70	65.89
Hydrohead (cm)	86.40	103	74.60

[0046] In this example, the melt-blown process was configured as described above and corresponds to the embodiment shown in FIG. 6c, in which the primary airflow is supplemented with an auxiliary airflow. In the example, the unit hpi characterizes the number of holes per inch present in the die. P_T is defined as the total pressure measured in a stagnant area of the primary manifold. GHM is defined as the flow rate in grams per hole per minute; thus, the GHM unit defines the amount, by weight, of polymer flowing through each hole of the melt-blown die per minute. As discussed above, Frazier Porosity is a measure of the permeability of the material (units are cubic feet per minute per square foot). The hydrohead, measured as the height of a column of water supported by the web prior to permeation of the water into the web, measures the liquid barrier qualities of the web.

[0047] The above configuration and results provide a baseline comparison of a typical melt-blown production run with no air perturbation (a frequency of perturbation of 0 Hz) with runs conducted with perturbation frequencies of 156 and 462 Hz. As can be seen from Table 1-1, in general, the barrier characteristics of materials made using perturbed airflows improve with increasing perturbation frequency. Thus, by merely varying the perturbation frequency, a relatively easy process, materials or webs with desired barrier characteristics may be made without major changes to the process conditions. This ability to adjust barrier properties was not previously possible in the prior art without substantial changes to the process conditions which required significant time and effort. As can be seen there is an initial decrease in Frazier Porosity (which represents an decrease in the permeability of the web or material to air) at the 156 Hz perturbation frequency. Similarly, at the 156 Hz frequency, there is an increase in the supported hydrohead. Thus, at the 156 Hz frequency, the web material produced is a more effective barrier. At the 462 Hz perturbation frequency, the Frazier Porosity has increased and the Hydrohead has decreased from both the 0 Hz (prior art) and 156 Hz production runs. Thus, at the higher perturbation frequency, the web material is a less effective barrier, but is more suitable for use as an absorbent or wicking material.

[0048] The change in barrier properties with respect to change in perturbation frequency is also demonstrated in Figures 11 and 12 (for different process conditions from those of Example 1). As Figure 11 shows, there is an initial drop in Frazier Porosity as the process is changed from no perturbation to a perturbation frequency between 1 and 200 Hz. As the perturbation frequency is increased above about 200 Hz, the Frazier Porosity increases, until the original 0 Hz Frazier Porosity is exceeded between about 300 to 400 Hz. Above 400 Hz, the Frazier Porosity increases relatively steeply with increasing perturbation frequency. Similarly, referring to Figure 12, supported hydrohead initially increases between about 1 to 200 Hz perturbation frequency. Then the hydrohead steadily decreases with increasing perturbation frequency until the supported hydrohead at between about 400 to 500 Hz is less than that at the 0 Hz (steady flow) frequency. Thus, as these Figures demonstrate, with no variation in the basic process conditions such as polymer type, flow conditions, die geometry, aside from a simple change in the frequency of perturbation of the airflow, a wide variety of different web materials can be made having desired barrier properties. For example, by merely setting the perturbation frequency in the 100 to 200 Hz range, with all of the other process conditions remaining unchanged, a more effective barrier material can be made. Then, if less effective barrier material was desired, the only process change necessary would be an increase in the perturbation frequency, which could be accomplished with a simple control and without necessitating the interruption of the production line. In prior art techniques, alteration of the production run barrier properties may require substantial changes in the process conditions, thereby requiring a production line shut-down to make the changes. In actuality, such changes are not typically made on a given machine; multiple machines typically produce a single type of web material (or an extremely narrow range of materials) having desired properties.

Example 2

Process Conditions

[0049]

Die Tip Geometry:	Recessed Die Width = 20" Gap = 0.090" 30 hpi
Primary Airflow:	Heated (≈608°F in heater) 317 scfm Pressure P_T = 2.6 psig
Auxiliary Airflow:	Unheated (ambient air temp.) 80 scfm Inlet Pressure = 20 psig
Polymer:	High MFR PP*

*e.g. 800 MFR polypropylene coated with peroxide - final MFR ≈ 1500

Polymer Throughput:	0.5 GHM
Melt Temperature:	470°F
Perturbation Frequency:	0 Hz (control), 70 Hz
Basis Weight:	5 oz/yd^2
Forming Height:	10"

Test Results

[0050] In this example the bulk of the web made using a 70 Hz perturbation frequency was compared to a control web (0 Hz perturbation frequency).

Control -	0.072" (thickness)
70 Hz -	0.103"

[0051] Thus, it can be seen that using a modest 70 Hz perturbation frequency results in a 43% increase in bulk over the prior art. Increased bulk is often desired in the final web or material because the increased bulk often provides for better feel and absorbency.

[0052] Furthermore, with respect to desired texture or appearance, the use of the perturbation techniques of the present invention allows for custom texture or appearance control. Referring to the photographs of Figures 13 and 14, Figure 13 represents the appearance of the web produced with the 0 Hz perturbation frequency while the web of Figure 14 represents that produced using the 70 Hz perturbation frequency. As can be seen from the Figures, the web of Figure 14 has a leather like appearance and texture which is not present in the web of Figure 13. Thus, to the extent such appearance and texture is desired, the techniques of the present invention allow for added control and variety in production of various types of webs having such characteristics.

Examples 2A - 2I

Process Conditions

[0053]

Die Tip Geometry:	Die Width 100 in		
	30 hpi		
Primary Airflow:	1500-	1800 scfm	(general range)
	2A	1800 scfm	
	2B	1750 scfm	
	2C	1750 scfm	(per bank)
	2D	1750 scfm	(per bank)
	2E	1800 scfm	
	2F	1800 scfm	
	2G	1600 scfm	
	2H	1500 scfm	
	21	1750 scfm	
Primary Air Temp:	575°F -	625°F	(general range)
	2A	625°F	
	2B	600°F	
	2C	600°F	(per bank)
	2D	600°F	(per bank)
	2E	625°F	
	2F	575°F	
	2G	575°F	
	2H	575°F	
	21	600°F	

Perturbation Frequency:	75 Hz - 200 Hz
Polymer:	PF-015 - polypropylene
Throughput:	4.8PIH
Melt Temperature:	600°F

[0054] This series of examples illustrates the high bulk and oil capacity results obtainable with meltblown webs in accordance with the present invention. Using an arrangement as shown in Figure 6B, meltblown webs were produced using the processing conditions shown. These materials were tested for bulk and oil capacity, and in addition, the roll samples were tested for oil absorption rate.

Oil Absorption Tests

[0055] Oil absorption test results were obtained using a test procedure based on ASTM D 1117-5.3. Four square inch samples of fabric were wieghed and submerged in a pan containing oil to be tested (white mineral oil, +30 Saybolt color, NF grade, 80-90 S.U. viscosity in the case of roll samples and 10W40 motor oil in the case of hand samples) for two minutes. The samples were then hung to dry (20 minutes in the case of roll samples and 1 minute in the case of hand samples). The samples were weighed again, and the difference calculated as the oil capacity.

[0056] The variation in results for bulk and oil capacity between the rolled samples and hand samples results from compression in the rolled configuration. In both cases the improvement of the invention is apparent. Since the control was not perturbed, it was compressed as formed and was relatively unaffected by being formed into a roll.

Oil Rate Tests

[0057] Oil rate results were obtained in accordance with TAPPI Standard Method T 432 su-72 with the following changes:

To measure oil absorbency rate, 0.1 ml of white mineral oil is used as the test liquid.

Three separate drops are timed on each specimen, rather than just one drop.

Five specimens are tested from each sample rather than ten, i.e. a total of 15 drops is timed for each sample instead of ten drops.

Oilsorb Data

[0058]

Table 2-1 - roll samples

Example	Perturbation Conditions	Bulk inches	Density gm/cm^3	Oil Capacity g/g	oil Rate sec
2A Control 1 Bank	0Hz	0.1294	0.057	11.91 (18.21*)	1.847
2B 1 Bank	200Hz	0.1678	0.047	12.84	1.673
2C 2 Bank	200Hz/150Hz	0.1537	0.050	11.25	1.805
2D Control 2 Bank	0Hz	0.0987	0.075	9.79	2.200
*Test method for hand samples - Table 2-2					

Example 3

Process Conditions

[0059]

Die Tip Geometry:	Recessed Gap = 0.090" 30 hpi
Primary Airflow:	Heated (≈608°F in heater) 426 scfm Pressure P_T = 5 psig
Auxiliary Airflow:	Unheated (ambient air temp.) 80 scfm Inlet Pressure = 20 psig
Polymer:	High MFR PP*, 1% Blue pigment
*e.g. 800 MFR polypropylene coated with peroxide - final MFR ≈ 1500	

Polymer Throughput:	0.6 GHM
Melt Temperature:	480°F
Perturbation Frequency:	0 Hz (control), 192 Hz, 436 Hz
Basis Weight :	0.54 oz/yd^2
Forming Height:	10"

Test Results

[0060]

Softness -	Cup Crush -	0 Hz - 1352
		192 Hz - 721

[0061] Cup Crush is a measure of softness whereby the web is draped over the top of an open cylinder of known diameter, a rod of a diameter slightly less than the inner diameter of the cup cylinder is used to crush the web or material into the open cylinder while the force required to crush the material into the cup is measured. The cup crush test was used to evaluate fabric stiffness by measuring the peak load required for a 4.5 cm diameter hemispherically-shaped foot to crush a 22.9 cm by 22.9 cm piece of fabric shaped into an approximately 6.5 cm diameter by 6.5 centimeter tall inverted cup while the cup shaped fabric was surrounded by an approximately 6.5 cm centimeter diameter cylinder to maintain a uniform deformation of the cup shaped fabric. The foot and cup were aligned to avoid contact between the cup walls and the foot which could affect the peak load. The peak load was measured while the foot was descending at a rate of about 0.64 cm/s utilizing a Model 3108-128 10 load cell available from the MTS Systems Corporation of Cary, North Carolina. A total of seven to ten repetitions were performed for each material and then averaged to give the reported values.

[0062] The lower cup crush number achieved by the material made using the 192 Hz perturbation frequency indicates that the material made thereby is softer. Subjective softness tests such as by hand or feel also confirm that the material made by using the 192 Hz perturbation frequency is softer than that made using the prior art techniques.

Strength

[0063]

Table 3-1

Perturbation Frequency	0 Hz	192 Hz	436 Hz
MD Peak Load (lbs)	1.989	2.624	2.581
MD Elongation (in)	0.145	0.119	0.087
CD Peak Load (lbs)	1.597	1.322	1.743
CD Elongation (in)	0.202	0.212	0.135

[0064] As can be seen from Table 3-1, the machine direction strength increases for runs in which the perturbation frequency is greater than 0 Hz. In the production runs of Example 3, the direction of perturbation was generally parallel to the machine direction (MD). Applicants believe that the increased strength in MD is due to more controlled and regular overlap in the lay-down of the web on the substrate as the fibers oscillate as a result of the perturbation. A similar result is demonstrated in Figure 15 which is a graph showing the variation of Peak Load in MD and CD as a function of perturbation frequency. As is seen in the Figure 15, strength in the MD increases as the perturbation frequency increases. Typically, CD strength remains relatively constant (with slight variations) regardless of perturbation frequency. It is applicants' belief that increases in CD strength can be achieved by varying the angle of the perturbation relative to the MD. Thus, by having the perturbation occur at some angle between parallel to MD and perpendicular to MD, CD strength can be improved as well as MD strength.

Barrier

[0065]

Table 3-2

Perturbation Frequency	0 Hz	192 Hz
Frazier Porosity (cfm/ft^2)	31.5	22.3
Hydrohead (cm of H_2O)	90.8	121.6
Equiv. Pore Diameter (μm)	13.2	10.8

[0066] As Table 3-2 demonstrates, and as was demonstrated in Example 1, at relatively low perturbation frequencies (between about 100 to 200 Hz) the barrier properties of a web produced thereby increase. This result is explained by the measured Equivalent Circular Pore Diameter in the 0 Hz case and the 192 Hz case. As is shown in Table 3-2, the pore size for web material produced using a 192 Hz perturbation frequency is 2.4 microns less than that for a material produced with no perturbation. Thus, since the pores in the material are smaller, the permeability of the material is less and the barrier properties are greater.

Example 4

Process Conditions

[0067]

Die Tip Geometry:	Recessed Die Width = 20" Gap = 0.090" 30 hpi
Primary Airflow:	Heated (≈608°F in heater) 422 scfm Pressure P_T = 5 psig
Auxiliary Airflow:	Unheated (ambient air temp.) 40 scfm Inlet Pressure = 15 psig
Polymer:	Copolymer of butylene and propylene polypropylene* - 79% polybutylene - 20% blue pigment - 01%

*800 MFR polypropylene coated with peroxide - final MFR ≈ 1500

Polymer Throughput:	0.6 GHM
Melt Temperature:	471°F
Perturbation Frequency:	0 - 463 Hz
Basis Weight:	0.8 oz/yd^2
Forming Height:	12"

Test Results

Barrier

[0068]

Table 4-1

Perturbation Frequency	0 Hz	305 Hz	463 Hz
Frazier Porosity ((cfm/ft^2)	46.27	26.85	59.34

[0069] Once again, it can be seen that the porosity of the web material initially decreases when the airflow is perturbed. However, as the perturbation frequency increases, the porosity also increases. The results in Example 4 agree with the other barrier property results from the other examples and with the results reported in Figures 11 and 12.

[0070] Although the above referenced examples utilize a polypropylene or mixture of high melt flow polypropylene and polybutylene resins for non-woven web production, a multitude of thermoplastic resins and elastomers may be utilized to create melt-blown non-woven webs in accordance with the present invention. Since it is the structure of the web of the present invention which is largely responsible for the improvements obtained, the raw materials used may be selected from a wide variety. For example, and without limiting the generality of the foregoing, thermoplastic polymers such as polyolefins including polyethylene, polypropylene as well as polystyrene may be used. Additionally, polyesters may be used including polyethylene, terepthalate and polyamides including nylons. While the web is not necessarily elastic, it is not intended to exclude elastic compositions. Compatible blends of any of the foregoing may also be used. In addition, additives such as processing aids, wetting agents, nucleating agents, compatibilizers, wax, fillers, and the like may be incorporated in amounts consistent with the fiber forming process used to achieve desired results. Other fiber or filament forming materials will suggest themselves to those of ordinary skill in the art. It is only essential that the composition be capable of spinning into filaments or fibers of some form that can be deposited on a forming surface. Since many of these polymers are hydrophobic, if a wettable surface is desired, known compatible surfactants may be added to the polymer as is well-known to those skilled in the art. Such surfactants include, by way of example and not limitation, anionic and nonionic surfactants such as sodium diakylsulfosuccinate (Aerosol OT available from American Cyanamid or Triton X-100 available from Rohm & Haas). The amount of surfactant additive will depend on the desired end use as will also be apparent to those skilled in this art. Other additives such as pigments, fillers, stabilizers, compatibilizers and the like may also be incorporated. Further discussion of the use of such additives may be had by reference to, for example, U.S. Patent Nos. 4,374,888 issued on Bornslaeger on February 22, 1983, and 4,070,218 issued to Weber on January 24, 1978

[0071] Additionally, a multitude of die configurations and die cross-sections may be utilized to create melt-blown non-woven webs in accordance with the present invention. For example orifice diameters of 20 to 50 holes per inch (hpi) are preferred, however, virtually any appropriate orifice diameter may be utilized. Additionally, star-shaped, elliptical, circular, square, triangular, or virtually, any other geometrical shape for the cross-section of an orifice may be utilized for melt-blown non-woven webs.

Coform Applications

[0072] Applicant hereby incorporates by reference U.S. Patent No. 4,818,464, issued to Lau on April 4, 1989 which discloses coform methods of polymer processing by combining separate polymer melt streams into a single polymer melt stream for extrusion through orifices in forming non-woven webs. Additionally, applicant hereby incorporates by reference U.S. Patent No. 4,818,464, issued to Lau on April 4, 1989 which discloses the introduction of super absorbent material as well as pulp, cellulose, or staple fibers through a centralized chute in an extrusion die for combination with resin fibers in a non-woven web. Referring now to Figure 16, a description of the coform process is provided. In essence, a coform die 170 is basically a combination of two melt-blown die heads 173, 175. Air flows 176 and 178 are provided around die 172 and air flows 180 and 182 are provided around die 174. A chute 184 is provided through which pulp, staple fibers, or other material may be added to vary the characteristics of the resulting web. Since any of the above described techniques to vary the airflow around a melt-blown die may be used in the coform technique, specific descriptions of all of the valving techniques will not be repeated. However, it will be apparent to one skilled in the art, that to vary the four air flows present in the coform die, the equipments used to control the perturbation of the air flows will have to be doubled.

[0073] In the coform technique, there are a variety of possible perturbation combinations. The most basic is to perturb each side of a given die 172 or 174 just as described above with respect to the melt-blown techniques (basically, air flows 176 and 178 alternating with each other and the same for airflows 180 and 182). However, it is also possible to perturb the air flows around die 172 relative to those around die 174. Thus, air flows 176 and 182 could be perturbed in phase with each other, but out of phase with air flows 178 and 180 to achieve a desired characteristic in the fibers or web. To achieve a different effect it may be desirable for air flows 176 and 180 to be perturbed in phase with each other, but out of phase with air flows 178 and 182. It should be readily apparent that with four air flows, many perturbation combinations are possible, all of which are within the scope of the present invention. For example, a centralized chute may be located between the two centralized air flow for introducing pulp or cellulose fibers and particulates. Such a centralized location facilitates integration of the pulp into the non-woven web and results in consistent pulp distribution in the web.

Example 5

[0074] As described above with reference to Figure 16, coform materials are essentially made in the same manner as melt-blown materials with the addition of a second die. Thus, there are two airflows around each die, for a total of four air flows, which may be perturbed as described above. Additionally, there is typically a gap between the two dies through which pulp or other material may be added to the fibers produced and incorporated into the web being formed.

The following example utilizes such a coform-form head, but otherwise, with respect to the airflow perturbation, conforms to the previous description of the melt-blown process.

Process Conditions

[0075]

Die Tip Geometry:	Recessed Gap = 0.070" Die Width = 20"
Primary Air Flow:	350 scfm per bank (20" bank)
Primary Air Temperature:	510°F
Auxiliary Air Flow:	40 scfm per MB bank
Polymer:	PF-015 (polypropylene)
Polymer Ratio:	65/35
Basis Weight:	75 gsm (2.2 osy)

Test Results

[0076]

Table 5-1

Perturbation Frequency	0 Hz	67 Hz	208 Hz	320 Hz
MD Peak Load	1.578	1.501	1.67	2.355
MD Elongation (%)	23.86	22.48	24.21	20.23
CD Peak Load	0.729	0.723	0.759	0.727
CD Elongation (%)	49.75	52.46	58.08	71.23
Cup Crush (gm/mm)	2518	2485	2434	2281

[0077] From table 5-1, it can be seen that the results generally agree with those shown in the melt-blown examples. Generally, with increasing perturbation frequency, aligned along the MD, MD strength increased while CD strength remains about the same. Similarly, the softness, measured as cup crush, generally increases as the perturbation frequency increases (a lower cup crush value indicates increased softness). Thus, this example shows that the techniques previously described can be applied to coform-forming technology to achieve the process and material control by simple adjustment of the perturbation frequency in the same manner as they were applied to the melt-blown process.

Spunbond Applications

[0078] Figures 17a through 17d represent various embodiments described for a better understanding of the invention which utilize alternatingly augmented air pressure in plenum chambers 58 and 62 of a standard fiber draw unit, as illustrated in Figure 3b. In a manner similar to that of the valving arrangements for the melt-blown unit, the fiber draw unit may receive alternatingly augmented air pressure into plenum chambers 62 and 58 via lines 72 and 74, respectively, through the bifurcation of main air lines 66 via perturbation valve 86. Alternatively, as is illustrated in Figure 17b, main air line 66 may be bifurcated by valve 86 into supply lines 130 and 128 with a third bleeder portion supplying perturbation valve 86. While lines 128 and 130 receive air from bleeder valve 88 at a relatively constant pressure, perturbation valve 86 receives bleed air from bleeder valve 88 and perturbs that air to create an oscillatory pressure which is then superimposed onto supply lines 128 and 130 to create alternatingly augmented pressure in lines 74 and 72 for supply to plenum chambers 58 and 62, respectively. In Figure 17c, main supply line 66 bifurcates into lines 128 and 130. This embodiment utilizes an auxiliary air supply 92 which is perturbed by valve 86 superimposed onto the constant air pressure of lines 128 and 130 to create an alternatingly augmented air flow supply in lines 72 and 74 so as to supply air plenum chambers 62 and 58 of the fiber draw unit, respectively. Finally, Figure 17d represents still another embodiment for a better understanding of the present invention which utilizes a perturbation valve 86 which provides an alternatingly perturbing air flow prior to the bifurcation of the main air supply line.

[0079] Figures 18a through 18f illustrate various locations for secondary perturbation jets which may be used with a standard prior art fiber draw unit such as the one illustrated in Figure 3b to create the proper flow conditions for increasing desirable properties of fibers made in accordance with the present invention. For example, Figure 18a illustrates the tail pipe 56 of a fiber draw unit which utilizes secondary perturbation jets 132 and 134. As described above, these secondary perturbation jets impose alternating augmented flow in a direction which is perpendicular to the main air flow through the tail pipe 56 of the present invention. This orthogonal relationship between primary and secondary air flow increases both the degree and order of turbulence of the air flow in the vicinity of the tail pipe 56.

[0080] As illustrated in Figure 18b, tail pipe 56 may also include alternatingly, or otherwise activated, co-flowing jets 136 and 138 create turbulent flow in accordance with the present invention near the tail pipe of the fiber draw unit. Figure 18c illustrates secondary perturbing jets 142 and 140 disposed near a top portion of the fiber draw unit upstream of plenum chamber inlets 60 and 64. Figure 18d represents yet another embodiment of the present invention that utilizes alternatingly augmented flow through Coanda nozzles 144 and 146 at an exit of tail pipe 56 to create turbulent air flow in the vicinity of tail pipe 56. Additionally, Figure 18e illustrates Coanda-like nozzles 190 and 192 disposed at mid portion 54 of the fiber draw unit. Finally, Figure 18f illustrates jets at inlet portions 48 and 50 of the fiber draw unit. Each of those jets illustrated in Figures 18a through 18f may alternatingly perturb air flow through the fiber draw unit in addition to any perturbation which may be implemented upstream of the jets. Additionally, each of the jets illustrated in Figures 18a-18f may also be implemented without additional perturbation means upstream therefrom.

[0081] Figure 19 represents yet another embodiment for a better understanding of the present invention. The alternatingly augmented pressure in plenum chambers 147 and 150 may be provided by transducers 148 and 152 via inlets 150 and 154, respectively. Transducers 148 and 152 are preferably actuated by means of an electrical signal. For example, the transducers may actually be large speakers which receive an electrical signal to activate 0° to 180° out of phase in order to provide the alternating augmented pressures in plenum chambers 147 and 150. However, any type of appropriate transducer may create an augmented air flow by using any means of actuation. This may include but is not limited to electromagnetic means, hydraulic means, pneumatic means or mechanical means.

[0082] Figures 20a and 20b illustrate yet another embodiment of the present invention wherein hot and cold jets are alternatingly used to increase fiber crimp. Referring to Figure 20a, fiber draw unit 69 includes secondary perturbation jets 156 and 158. Oscillatory jet 156 supplies hot air whereas oscillatory air jet 158 supplies cold air. Alternatively, Figure 20b illustrates perturbation air jets 164, 166, which alternatingly supply hot air to the primary air flow and fiber bundle exiting from the tail pipe of the fiber draw unit. Both Figures 20a and 20b illustrate the fiber bundle deflection upon application of secondary perturbation. This secondary perturbation creates fiber bundle deflection and heating or cooling effects which lead to added crimp of the fibers being distributed within a web on an endless belt. The temperature varied perturbation provides for additional parameters which may be varied and controlled during production. The jets may be symmetrically or asymmetrically oriented to achieve desired fiber characteristics, namely fiber crimp. As with perturbation frequency and amplitude, the temperature of the air may be controlled without interruption of the production process, although this control is more complex. Thus, materials having different properties can be made without requiring the line to be substantially delayed and without the need for additional equipment. This technique may be applied to processes utilizing the homopolymer fibers as well as to multi-component fibers and materials.

[0083] Figures 21(a) through 21(d) represent yet another embodiment of the present invention, wherein a standard fiber draw unit includes secondary perturbation jets at an exit of the tail pipe thereof wherein at least one bank of perturbation jets is rotated with respect to the machine direction to create a crimp or fiber movement in a cross direction with respect to travel of the belt within the fiber draw unit apparatus to increase tensile strength in the cross direction of the non-woven web. For example, as shown in Figure 21(a), jet bank 162 is disposed at an angle with respect to the machine direction while jet bank 160 is essentially parallel to the machine direction. Figure 21(b) illustrates jet banks 202 and 200 which are both disposed at an angle with respect to the machine direction but oppose one another. Furthermore, Figure 21(c) illustrates yet another configuration for jet orientation. There, jet banks 202 and 204 are each rotated with respect to the machine direction and face in the same direction. Finally, Figure 21(d) illustrates opposing jet banks 208 and 210.

[0084] Finally, Figure 15 illustrates the peak load of a non-woven web sample as a function of perturbation frequency of secondary perturbation jets for the embodiment utilized in Example 6. As is illustrated in the chart, machine direction strength of the non-woven web increases with increasing perturbation frequency. In the process run used to generate the data for Figure 15, the direction of perturbation was parallel to the machine direction, as illustrated in Figure 21(d). Furthermore, by varying the direction of the perturbation jets or airstreams relative to the machine direction, it is possible to increase cross-direction strength.

[0085] The following examples show the production of fibers and non-woven webs in the spunbond process. The processes and apparati are described using terms and units well known in the prior art. The initial example describes fibers and a web formed using prior art techniques to provide a basis for comparison for fibers and webs formed using the techniques of the present invention.

Example 6

[0086] The following examples show the application of perturbing airflows to the spunbond process. In this particular example, the perturbing airflows were applied to the air stream carrying the fibers at the exit of the fiber draw unit (FDU), which corresponds to the embodiment shown in Figure 21(d). However, as was previously described, the process is equally applicable to perturbing the airflow in the FDU itself, or by application of auxiliary air, or bleeding airflow, at the manifolds prior to the FDU.

Process Conditions

[0087]

FDU Draw Pressure:	4 psi
	Draw unit width = 14"
Polymer Throughput:	0.5 GHM
Polymer:	3445 Polypropylene*
Melt Temperature:	430 °F
Auxiliary Flow:	40 scfm
Basis Weight:	0.5 osy (17 gsm)
*Exxon brand 3445 polymer, peroxide coated	

Test Results

[0088]

Table 6-1

Perturbation Frequency (Hz)	0	67	227	338	463
MD Peak Load (lb)	0.921	1.687	1.844	2.108	2.452
CD Peak Load (lb)	0.824	0.645	0.462	0.586	0.521
MD Elongation (%)	23.85	52.79	18.03	11.08	23.05
CD Elongation (%)	60.84	46.5	42.31	38.76	57.10
Total Tensile $(MD^2+CD^2)^{1/2}$	1.24	1.81	1.90	2.19	2.51

[0089] As can be seen from the Table, the use of perturbing airflows in the spunbond process provides substantially increased MD strength (in this example, the perturbing airflows were aligned with the machine direction). As was the case with the melt-blown process with perturbed airflows, the CD strength remained relatively constant after a slight decrease. As the total tensile strength calculation indicates, however, the overall strength of the web is increased by the application of the perturbing airflows. Once again, as was demonstrated with the use of perturbation of airflow in the melt-blown process, the use of airflow perturbation provides for a range of selectable characteristics in the final web material, merely by adjusting the perturbation frequency. Typically, to prepare spunbond web materials with varying properties, the processing equipment must be completely shut down and the process conditions changed, such as by changing the die or other substantial change to the equipment. Though the present invention does not preclude those processes, with the present process, such changes to the web material may be accomplished on the fly by merely changing the perturbation frequency while the other process conditions remain constant. This feature of the present invention allows for much greater flexibility and efficiency in the operation of spunbond equipment.

Example 7

[0090] In this example, the spunbond process was adapted, using the techniques disclosed herein to provide for perturbing airflows disposed at the exit of the FDU. For the purposes of this example, the perturbing airflows were not disposed immediately opposite each other, as was the case in Example 6, but rather one bank of auxiliary air nozzles was directed parallel to the machine direction, while the other was directed at an angle with respect to the cross direction to provide a slight cross direction trajectory (as shown schematically in Fig. 21(a)).

Process Conditions

[0091]

Fiber Draw Pressure:	9 psi
Polymer Throughput:	0.75 GHM
Basis Weight:	1.0 oz/yd^2
Polymer:	3445 Polypropylene*

*Exxon brand 3445 polymer, peroxide coated

Melt Temperature:	450°F
Auxiliary Air Flow:	75 scfm

Test Results

[0092]

Table 7-1

Perturbation Frequency (Hz)	0	115	195	338	500
MD Peak Load (lb)	12.00	19.96	21.00	21.13	20.00
MD Elongation (%)	34.75	37.36	38.36	39.77	37.48
CD Peak Load (lb)	8.965	11.30	10.53	10.34	12.69
CD Elongation (%)	40.10	49.78	52.84	43.18	47.94

[0093] Once again, it can be seen that by simply varying the perturbation frequency of the airflow, a variety of changes can be effectuated in the final non-woven web. Thus, to the extent that a material having different characteristics is desired, varying the perturbation frequency of the perturbing airflow can result in substantial changes in the final non-woven material. This change represents a substantial departure from prior art spunbond techniques in which other process conditions, which are much more difficult to achieve, must be varied to vary the characteristics of the final material.

[0094] As is seen from the above Examples 1-5 of meltblown, and coform non-wovens made in accordance with the present invention and Examples 6 and 7 of spunbond non-wovens, the techniques of the present invention allow for the formation of a non-woven webs of various characteristics with relatively simple adjustments to process controls. While some of the differences can be attributed to the lay-down of the fibers on the forming surface, preliminary investigation indicates that the present inventive techniques also result in fundamental changes to the fibers formed thereby. Referring now to Figures 22 and 23, there are shown X-Ray diffraction scans of a meltblown fiber made according to prior art techniques (Figure 22) and a meltblown fiber made in accordance with the present invention (Figure 23) both otherwise under identical processing conditions and polymer type. As can be seen from comparison of Figures 22 and 23, the X-Ray scan of the meltblown fiber made with the inventive techniques has two peaks, while that of the prior art meltblown fiber has several peaks. It is believed that the differences observed in Figure 23 result from the presence of smaller crystallites in the fiber, which possibly result from better quenching of the fiber during formation. In summary, these X-Ray diffraction scans indicate that the fibers made in accordance with the present technique are more amorphous than prior art fibers and may have a broader bonding window than fibers made in accordance with prior art techniques.

[0095] Additional evidence of the believed characteristic differences between fiber made in accordance with the present invention and those made in accordance with the prior art are shown in Figure 24. Figure 24 is a graph showing the results of a Differential Scanning Calorimetry (DSC) test conducted on a prior art meltblown fiber (indicated by the dashed line on the graph) and with a fiber made in accordance with the present techniques (the solid line). The test basically observes the absorbance or emission of heat from the sample while the sample is heated. As can be seen from Figure 24, the DSC scan of the prior art fiber is significantly different from that of the present fiber. A comparison of DSC scans shows two main features in the present fiber that do not appear in the prior art fiber: (1) heat is given off from 80-110°C (apparent exotherm) and (2) a double melting peak. It is believed that these DSC results confirm that the present formation techniques produce fibers having significant differences from fibers produced with prior art techniques. Once again, it is believed that these differences relate to crystalline structure and quenching of the fiber during formation.

[0096] While preferred embodiments of the present invention have been described in the foregoing detailed description, the invention is capable of numerous modifications, substitutions, additions and deletions from the embodiments described above without departing from the scope of the following claims. For example, the teachings of the present application could be applied to the atomizing of liquids into a mist (or entraining a liquid in a fluid flow such as air). An apparatus for entraining such liquids is very similar, in cross section, to the melt-blown apparatus shown in Figures 6A-6D. In this embodiment, the apparatus simply would not have the typical melt-blown width of several inches to several feet. Additionally, the components of an atomizer would typically be several orders of magnitude smaller. In any event, the perturbation techniques in an atomizing embodiment provide for narrow droplet size distribution and more even distribution of the small liquid droplets in the entraining air flow. This embodiment could be employed in many applications such as creating fuel/air mixtures for engines, improved paint sprayers, improved pesticide applicators, or in any application in which a liquid is entrained in an airflow and an even distribution of the liquid and narrow particle size distribution in the airflow is desired.

Claims

1. A method for forming artificial fibers from a liquefied resin comprising the steps of:

generating a continuous fluid stream along a primary axis;
extruding the liquefied resin through a first die located adjacent to the fluid stream;
injecting said liquefied resin into said fluid stream to form fibers; and
selectively perturbing the flow of fluid in the fluid stream by perturbation means for varying the fluid pressure on either side of the primary axis

characterized in that
the artificial fibers are formed in a melt-blowing or coforming process.

2. The method of claim 1 comprising the further steps of:

providing a substrate disposed below said first die;
translating said substrate relative to said first die, the direction of movement of said substrate defining a machine direction;
orientating said first die perpendicular to said machine direction in a cross-direction; and
depositing the fibers on said substrate to form a non-woven web.

3. The method of claim 1 comprising the further steps of :

providing a first supply of fluid having a flow rate;
providing first and second fluid plenum chambers adjacent said first die;
directing at least a portion of said first supply of fluid to inlets of first and second fluid plenum chambers; and
directing fluid from each of said first and second plenum chambers to a location adjacent said first die to form said substantially continuous fluid stream.

4. The method of claim 3 comprising the further steps of:

providing a primary fluid conduit connected between said first supply of fluid and said perturbation means;
connecting a first plenum conduit between said perturbation means and said first plenum chamber inlet;
connecting a second plenum conduit between said perturbation means and said second plenum chamber inlet; and
dividing said first supply of fluid between said first and second plenum conduits; and
selectively varying the pressure of fluid flowing in each of said first and second plenum conduits.

5. The method of claim 3 further comprising the further steps of:

providing a second supply of fluid having a flow rate;
providing a second inlet located in each of said first and second plenum chambers;
directing fluid flow from said perturbation means to said second inlets in said first and second plenum chambers; and
selectively varying the fluid flow rate provided from said second fluid source to achieve selective variation of the fluid flow rate providing said pressure variation on either side of said primary axis.

6. The method of claim 5 comprising the further step of:

adjustably bleeding fluid flow from said first supply of fluid to provide said second supply of fluid.

7. The method of claim 3 comprising the further steps of:

providing first and second pressure transducers in said first and second plenum chambers, respectively; and
selectively activating said first and second pressure transducers for selectively varying the pressure in said first and second plenum chambers.

8. The method of claim 3 comprising the further step of:

varying a steady state pressure in each said first and second plenum chambers at a perturbation frequency of approximately less than 1000 Hertz.

9. The method of claim 3 comprising the further step of:

varying an average plenum pressure in said first and second plenum chambers by less than about 100% of the total average plenum pressure in the absence of activation of said perturbation means.

10. The method of claim 3 comprising the further step of:

directing fluid flow from at least one of said plenum chambers in a non-parallel direction with respect to the machine direction.

11. The method of claim 5 comprising the further step of:

providing first and second secondary perturbing jets on opposite sides of said axis and near die for alternatingly perturbing said substantially continuous flow of fluid.

12. The method of claim 11 comprising the further step of:

directing fluid flow from at least one of said first and second secondary jets in a substantially perpendicular orientation to said primary axis.

13. The method of claim 11 comprising the further step of:

directing fluid flow from at least one of said first and second secondary jets in an orientation defining an acute angle with respect to the primary axis.

14. The method of claim 11 comprising the further step of:

directing fluid flow from at least one said secondary jets in a non-parallel direction with respect to the machine direction.

15. The method of claim 11 comprising the further steps of:

providing hot fluid from said first secondary jet; and
providing fluid at an approximately ambient temperature from said second secondary jet.

16. The method of claim 1 comprising the further steps of:

extruding a second liquified resin through a second die positioned adjacent said first die;
positioning said second die adjacent to the fluid stream for injecting said liquified resin in the fluid stream to form fibers.

17. The method of claim 16 comprising the further step of:

introducing pulp fibers into said continuous fluid stream through a chute located between said first and second dies.

18. The method of claim 16 comprising the further steps of:

providing a substrate below said first die;
translating said substrate relative to said first die, the direction of movement of said substrate defining a machine direction;
orientating said first die perpendicular to said machine direction in a cross-direction; and
depositing the fibers on said substrate to form a non-woven web.

19. The method of claim 1 comprising the further step of:

channeling the primary fluid flow and fibers through a fiber draw unit located below said first die.

20. The method of claim 19 comprising the further step of:

supplying a first fluid flow having a flow rate;
providing first and second fluid plenum chambers on opposite sides of said axis;
directing at least a portion of said supply of fluid to each of said first and second longitudinal fluid plenum chambers; and
directing fluid from each of said first and second plenum chambers to said fiber draw unit to form said substantially continuous fluid stream into said fiber draw unit.

21. The method of claim 20 comprising the further steps of:

dividing said first supply of fluid between said first and second plenum chamber inlets; and
selectively varying the pressure of fluid flowing into each of said first and second plenum inlets.

22. The method of claim 20 comprising the further steps of:

providing a second supply of fluid having a flow rate;
connecting said second supply of fluid to said perturbation means;
directing fluid flow from said perturbation means to said first and second plenum chambers; and
selectively varying the fluid flow rate from said second supply of fluid for providing said pressure variation on either side of said primary axis.

23. The method of claim 22 comprising the further step of:

adjustably bleeding fluid flow from said first supply of fluid to provide said second supply of fluid.

24. The method of claim 20 comprising the further steps of:

providing first and second pressure transducers adjacent to said first and second plenum chambers to form said perturbation means; and
selective activating of said first and second pressure transducers for selectively varying the pressure in said first and second plenum chambers.

25. The method of claim 20 comprising the further step of:

providing first and second secondary pulsing jets on opposite sides of said axis and near said fiber draw unit for alternatingly perturbing said substantially continuous flow of fluid.

26. The method of claim 25 comprising the further step of:

positioning said first and second secondary jets between said fiber draw unit inlet and outlet.

27. The method of claim 25 comprising the further step of:

directing fluid flow from at least one of said first and second secondary jets in a substantially horizontal orientation.

28. The method of claim 25 comprising the further step of:

directing fluid flow from at least one of said first and second secondary jets in a downward orientation.

29. The method of claim 25 comprising the further step of:

directing fluid flow from at least one said secondary jets in a non-parallel direction with respect to the machine direction.

30. The method of claim 25 comprising the further steps of:

providing hot fluid from said first secondary jet; and
providing fluid at an approximately ambient temperature from said second secondary jet.

31. The method of claim 20 comprising the further step of:

varying a steady state pressure in each said first and second plenum chambers at a perturbation frequency of approximately less than 1000 Hertz.

32. An apparatus for forming artificial fibers with a melt-blowing or coforming process from a liquefied resin comprising:

means for generating a substantially continuous fluid stream along a primary axis;
a first extrusion die for extruding the liquefied resin, said die located adjacent to the fluid stream for injecting said liquefied resin in the fluid stream to form fibers; and
perturbation means for selectively perturbing the flow of fluid in fluid stream by varying the fluid pressure on either side of the primary axis.

33. The apparatus of claim 32 further comprising:

a substrate disposed below said first die;
substrate translation means for moving said substrate relative to said first die, the direction of movement of said substrate defining a machine direction;
said first die oriented perpendicular to said machine direction in a cross-direction; and
wherein the fibers are deposited on said substrate to form a non-woven web.

34. The apparatus of claim 33 wherein said means for generating a substantially continuous fluid stream further comprises:

a first supply of fluid having a flow rate;
first and second longitudinal fluid plenum chambers located on opposite sides of said axis, each said plenum chamber including at least a first inlet and an outlet;
first and second plenum conduits for directing at least a portion of said supply of fluid to the inlet of each of said first and second longitudinal fluid plenum chambers; and
first and second exit conduits extending from the outlet of each of said first and second plenum chambers to a location adjacent said die, on opposite sides of said primary axis, and directing fluid from each of said first and second plenum chambers to a location adjacent said first die to form said substantially continuous fluid stream.

35. The apparatus of claim 34 further comprising:

a primary fluid conduit connected between said first supply of fluid and said perturbation means;
said first plenum conduit connected between said perturbation means and said inlet on said first plenum;
said second plenum conduit connected between said perturbation means and said inlet on said second plenum; and
wherein said perturbation means divides said first supply of fluid between said first and second plenum conduits and selectively varies the pressure of fluid flowing in each of said first and second plenum conduits.

36. The apparatus of claim 34 further comprising:

a second supply of fluid having a flow rate;
an auxiliary conduit connected between said second supply of fluid and said perturbation means;
a second inlet located in each of said first and second plenum chambers;
at least a first secondary conduit fluidly coupled between said perturbation means and said second inlet in said first plenum chamber, directing fluid flow from said perturbation means to said second inlet in said first plenum chamber;
at least a second secondary conduit fluidly coupled between said perturbation means and said second inlet in said second plenum chamber, directing fluid flow from said perturbation means to said second inlet in said second plenum chamber; and
said perturbation means further comprising a perturbation valve means for selectively varying the fluid flow rate provided from said auxiliary conduit to said first and second secondary conduits, said selective variation of the fluid flow rate providing said pressure variation on either side of said primary axis.

37. The apparatus of claim 36 further comprising:

a three way valve comprising;

an inlet connected to and receiving said first supply of fluid;
first and second outlets directing fluid flow into said first and second plenum conduits; and
a third outlet for adjustably bleeding fluid flow from said first supply of fluid to said auxiliary conduit to provide said second supply of fluid.

38. The apparatus of claim 36 wherein said perturbation means includes a perturbation valve comprising:

an inlet for receiving fluid flow from said auxiliary conduit; and
first and second outlets for delivering selectively varied fluid flow to said first and second secondary conduits.

39. The apparatus of claim 34 wherein said perturbation means further comprises a perturbation valve further comprising:

an inlet for receiving fluid flow from said second fluid source; and
first and second outlets for delivering selectively varied fluid flow to said first and second plenum conduits.

40. The apparatus of claim 34 wherein said perturbation means, further comprises:

first and second pressure transducers adjacent to said first and second plenum chambers; and
means for selective activation of said first and second pressure transducers for selectively varying the pressure in said first and second plenum chambers.

41. The apparatus of claim 34 said perturbation means varies a steady state pressure in each said first and second plenum chambers at a perturbation frequency of approximately less than 1000 Hertz.

42. The apparatus of claim 34 wherein said perturbation means varies an average plenum pressure in said first and second plenum chamber less than about 50% of the total average plenum pressure in the absence of activation of said perturbation means.

43. The apparatus of claim 33 further comprising:

means for directing fluid flow from at least one of exit conduits in a non-parallel direction with respect to the machine direction.

44. The apparatus of claim 36 further comprising:

a first and second secondary pulsing jets disposed on opposite sides of said axis and near die for alternatingly perturbing said substantially continuous flow of fluid.

45. The apparatus of claim 44 further comprising:

means for positioning said first and second secondary jets between said fiber draw unit inlet and outlet.

46. The apparatus of claim 44 further comprising:

means for directing fluid flow from at least one of said first and second secondary jets in a substantially horizontal orientation.

47. The apparatus of claim 44 further comprising:

means for directing fluid flow from at least one of said first and second secondary jets in a downward orientation.

48. The apparatus of claim 44 further comprising:

means for directing fluid flow from at least one said secondary jets in a non-parallel direction with respect to the machine direction.

49. The apparatus of claim 44 further comprising:

means for providing hot fluid from said first secondary jet; and
means for providing fluid at an approximately ambient temperature from said second secondary jet.

50. The apparatus of claim 32 further comprising:

means for extruding a second liquefied resin through a second die positioned adjacent said first die, said second die located adjacent to the fluid stream for injecting said liquefied resin in said fluid stream to form fibers.

51. The apparatus of claim 50 further comprising:

means for directing fluid flow between said first and second dies; and
means for directing fluid flow near peripheral portions of said first and second dies.

52. The apparatus of claim 51 further comprising:

a chute disposed between said first and second dies for introducing pulp fibers into said continuous fluid stream.

53. The apparatus of claim 32 further comprising:

a fiber draw unit disposed below said first die and adapted to channel the primary fluid flow therethrough, said fiber draw unit including,
an fiber inlet at a top portion thereof for receiving fluid flow and fibers, and
an outlet for dispensing the fibers.

54. The apparatus of claim 53 further comprising:

a substrate disposed below said first die;
substrate translation means for moving said substrate relative to said first die, the direction of movement of said substrate defining a machine direction;
said first die oriented perpendicular to said machine direction in a cross-direction; and
wherein the fibers are deposited on said substrate to form a non-woven web.

55. The apparatus of claim 53 wherein said means for generating a substantially continuous fluid stream further comprises:

a first supply of fluid having a flow rate;
first and second longitudinal fluid plenum chambers located on opposite sides of said axis, each said plenum chamber including at least a first inlet and an outlet;
first and second plenum conduits for directing at least a portion of said supply of fluid to the inlet of each of said first and second longitudinal fluid plenum chambers; and

first and second exit conduits extending from the outlet of each of said first and second plenum chambers to said fiber draw unit, on opposite sides of said primary axis, for directing fluid from each of said first and second plenum chambers to said fiber draw unit to form said substantially continuous fluid stream into said fiber draw unit.

56. The apparatus of claim 55 further comprising:

a primary fluid conduit connected between said first supply of fluid and said perturbation means;
said first plenum conduit connected between said perturbation means and said inlet on said first plenum;
said second plenum conduit connected between said perturbation means and said inlet on said second plenum; and
wherein said perturbation means divides said first supply of fluid between said first and second plenum conduits and selectively varies the pressure of fluid flowing in each of said first and second plenum conduits.

57. The apparatus of claim 55 further comprising:

a second supply of fluid having a flow rate;
an auxiliary conduit connected between said second supply of fluid and said perturbation means;
a second inlet located in each of said first and second plenum chambers;
at least a first secondary conduit fluidly coupled between said perturbation means and said second inlet in said first plenum chamber, directing fluid flow from said perturbation means to said second inlet in said first plenum chamber;
at least a second secondary conduit fluidly coupled between said perturbation means and said second inlet in said second plenum chamber, directing fluid flow from said perturbation means to said second inlet in said second plenum chamber; and
said perturbation means further comprising a perturbation valve means for selectively varying the fluid flow rate provided from said auxiliary conduit to said first and second secondary conduits, said selective variation of the fluid flow rate providing said pressure variation on either side of said primary axis.

58. The apparatus of claim 57 further comprising:

a three way valve comprising;

an inlet connected to and receiving said first supply of fluid;
first and second outlets directing fluid flow into said first and second plenum conduits; and
a third outlet for adjustably bleeding fluid flow from said first supply of fluid to said auxiliary conduit to provide said second supply of fluid.

59. The apparatus of claim 55 wherein said perturbation means includes a perturbation valve comprising:

an inlet for receiving fluid flow from said auxiliary conduit; and
first and second outlets for delivering selectively varied fluid flow to said first and second secondary conduits.

60. The apparatus of claim 55 wherein said perturbation means further comprises a perturbation valve further comprising:

an inlet for receiving fluid flow from said second fluid source; and
first and second outlets for delivering selectively varied fluid flow to said first and second plenum conduits.

61. The apparatus of claim 55 wherein said perturbation means further comprises:

first and second pressure transducers adjacent to said first and second plenum chambers; and
means for selective activation of said first and second pressure transducers for selectively varying the pressure in said first and second plenum chambers.

62. The apparatus of claim 53 further comprising:

a first and second secondary pulsing jets disposed on opposite sides of said axis and near said fiber draw unit for alternatingly perturbing said substantially continuous flow of fluid.

63. The apparatus of claim 62 further comprising:

means for positioning said first and second secondary jets between said fiber draw unit inlet and outlet.

64. The apparatus of claim 62 further comprising:

means for directing fluid flow from at least one of said first and second secondary jets in a substantially horizontal orientation.

65. The apparatus of claim 62 further comprising:

means for directing fluid flow from at least one of said first and second secondary jets in a downward orientation.

66. The apparatus of claim 62 further comprising:

means for directing fluid flow from at least one said secondary jets in a non-parallel direction with respect to the machine direction.

67. The apparatus of claim 62 further comprising:

means for providing hot fluid from said first secondary jet; and
means for providing fluid at an approximately ambient temperature from said second secondary jet.

68. The apparatus of claim 53 said perturbation means varies a steady state pressure in each said first and second plenum chambers at a perturbation frequency of approximately less than 1000 Hertz.

69. The apparatus of claim 32 wherein said fluid is a gas.

70. The apparatus of claim 32 wherein said fluid is air.

Patentansprüche

1. Ein Verfahren zum Herstellen von künstlichen Fasern aus einem flüssigen Harz, umfassend die Schritte:

Erzeugen eines kontinuierlichen Fluidstroms entlang einer primären Achse; Extrudieren des flüssigen Harzes durch eine erste Form, die benachbart zu dem Fluidstrom angeordnet ist;
Einspritzen des besagten flüssigen Harzes in den besagten Fluidstrom, um Fasern auszubilden; und
Stören des Flusses des Fluids in dem Fluidstrom in einer selektiven Art und Weise durch Störungsmittel zum Variieren des Fluiddrucks an jeder Seite der primären Achse, **dadurch gekennzeichnet, dass** die künstlichen Fasern in einem Verfahren des Schmelzblasens oder einem Verfahren des Coformens hergestellt sind.

2. Das Verfahren nach Anspruch 1, enthaltend die weiteren Schritte:

Bereitstellen eines Substrats, das unterhalb der besagten ersten Form angeordnet ist; Versetzen des besagten Substrats im Verhältnis zu der besagten ersten Form, wobei die Richtung der Bewegung des besagten Substrats eine Maschinenrichtung definiert;
Ausrichten der besagten ersten Form senkrecht zu der besagten Maschinenrichtung in einer Querrichtung; und
Ablegen der Fasern auf dem besagten Substrat, um eine Vliesstoffbahn auszubilden.

3. Das Verfahren nach Anspruch 1, umfassend die weiteren Schritte von:

Bereitstellen eines ersten Zulaufs eines Fluids mit einer Flussrate;
Bereitstellen von ersten und zweiten Fluidsammelkammern, benachbart zu der besagten ersten Form;
Führen von zumindest einem Abschnitt des besagten ersten Zulaufs eines Fluids in die Einlässe der ersten und zweiten Fluidsammelkammern; und
Führen eines Fluids von jeder der besagten ersten und zweiten Sammelkammern zu einer Position benachbart zu der besagten ersten Form zum Ausbilden des besagten, im Wesentlichen kontinuierlichen Fluidstroms.

4. Das Verfahren gemäß Anspruch 3, umfassend die weiteren Schritte:

Bereitstellen einer primären Fluidleitung, die zwischen dem besagten ersten Zulauf eines Fluids und dem besagten Störungsmittel angeschlossen ist;
Anschließen einer ersten Sammelleitung zwischen dem besagten Störungsmittel und dem Einlass der besagten ersten Sammelkammer;
Anschließen einer zweiten Sammelleitung zwischen dem besagten Störungsmittel und dem Einlass der besagten zweiten Sammelkammer; und
Aufteilen des besagten ersten Zulaufs eines Fluids zwischen den besagten ersten und zweiten Sammelleitungen; und
Variieren des Drucks des in jeder der besagten ersten und zweiten Sammelleitungen fließenden Fluidsin einer selektiven Art und Weise.

5. Das Verfahren nach Anspruch 3, femer umfassend die weiteren Schritte:

Bereitstellen eines zweiten Zulaufs eines Fluids mit einer Flussrate; Bereitstellen eines zweiten Einlasses, der in jeder der besagten ersten und zweiten Sammelkammem angeordnet ist;
Führen des Fluidflusses von dem besagten Störungsmittel zu den besagten zweiten Einlässen in den besagten ersten und zweiten Sammelkammern und
Variieren der Flussrate des Fluids, die von der besagten zweiten Fluidquelle bereitgestellt wird, in einer selektiven Art und Weise, um eine selektive Variation der Flussrate des Fluids zu erzielen, wobei die besagte Druckvariation auf jeder Seite der besagten primären Achse bereitgestellt wird.

6. Das Verfahren nach Anspruch 5, umfassend die weiteren Schritte:

Abzapfen eines Fluidflusses von dem besagten ersten Zulauf eines Fluids in einer einstellbaren Art und Weise, um den besagten zweiten Zulauf eines Fluids bereitzustellen.

7. Das Verfahren nach Anspruch 3, umfassend die weiteren Schritte:

Bereitstellen von ersten und zweiten Druckwandlern in den besagten ersten bzw. zweiten Sammelkammern; und
Aktivieren der besagten ersten und zweiten Druckwandler in einer selektiven Art und
Weise, um den Druck in besagten ersten und zweiten Sammelkammern in einer selektiven Art und Weise zu variieren.

8. Das Verfahren gemäß Anspruch 3, umfassend den weiteren Schritt von:

Variieren eines Drucks eines stationären Zustands in jeder der besagten ersten und zweiten Sammelkammern mit einer Frequenz der Störung von näherungsweise weniger als 1000 Hertz.

9. Das Verfahren gemäß Anspruch 3, umfassend den weiteren Schritt von:

Variieren eines durchschnittlichen Sammeldrucks in den besagten ersten und zweiten Sammelkammern um weniger als ungefähr 100 % des gesamten durchschnittlichen Sammeldrucks in der Abwesenheit der Aktivierung des besagten Störungsmittels.

10. Das Verfahren gemäß Anspruch 3, umfassend den weiteren Schritt von:

Führen eines Fluidflusses von zumindest einer der besagten Sammelkammern in einer nicht parallelen Richtung mit Bezug auf die Maschinenrichtung.

11. Das Verfahren gemäß Anspruch 5, umfassend den weiteren Schritt von:

Bereitstellen von ersten und zweiten sekundären störenden Düsenstrahlen auf gegenüberliegenden Seiten der besagten Achse und in der Nähe der Form, um den besagten und im Wesentlichen kontinuierlichen Fluss des Fluids in einer alternierenden Art und Weise zu stören.

12. Das Verfahren gemäß Anspruch 11, umfassend den weiteren Schritt von:

Lenken des Flusses des Fluids von zumindest einer der besagten ersten und zweiten sekundären Düsenstrahlen in einer im Wesentlichen senkrechten Ausrichtung zu der besagten primären Achse.

13. Das Verfahren gemäß Anspruch 11, umfassend den weiteren Schritt von:

Lenken des Flusses des Fluids von zumindest einer der besagten ersten und zweiten sekundären Düsenstrahlen in einer Ausrichtung, die einen spitzen Winkel mit Bezug auf die primäre Achse definiert.

14. Das Verfahren gemäß Anspruch 11, umfassend den weiteren Schritt von:

Lenken des Flusses des Fluids von zumindest einer der besagten sekundären Düsenstrahlen in einer nicht parallelen Richtung mit Bezug auf die Maschinenrichtung.

15. Das Verfahren gemäß Anspruch 11, umfassend die weiteren Schritte von:

Bereitstellen eines heißen Fluids von dem besagten ersten sekundären Düsenstrahl; und Bereitstellen eines Fluids mit näherungsweise Umgebungstemperatur von dem besagten zweiten sekundären Düsenstrahl.

16. Das Verfahren gemäß Anspruch 1, umfassend die weiteren Schritte von:

Extrudieren eines zweiten flüssigen Harzes durch eine zweite Form, die benachbart zu der besagten ersten Form positioniert ist;
Positionieren der besagten zweiten Form benachbart zu dem Fluidstrom zum Einspritzen des besagten flüssigen Harzes in den Fluidstrom, um Fasern zu formen.

17. Das Verfahren nach Anspruch 16, umfassend den weiteren Schritt von:

Einleiten von Zellstofffasern in den besagten kontinuierlichen Fluidstrom durch einen Schacht, der zwischen den besagten ersten und zweiten Formen angeordnet ist.

18. Das Verfahren nach Anspruch 16, umfassend die weiteren Schritte von:

Bereitstellen eines Substrats unter der besagten ersten Form;
Versetzen des besagten Substrats im Verhältnis zu der besagten ersten Form, wobei die Richtung der Bewegung des besagten Substrats eine Maschinenrichtung definiert;
Ausrichten der besagten ersten Form senkrecht zu der besagten Maschinenrichtung in einer Querrichtung; und
Ablegen der Fasern auf dem besagten Substrat, um eine Vliesstoffbahn auszubilden.

19. Das Verfahren nach Anspruch 1, umfassend den weiteren Schritt von:

Kanalisieren des primären Flusses des Fluids und der Fasern durch eine Faserzieh - Einheit, die unter der besagten ersten Form angeordnet ist.

20. Das Verfahren nach Anspruch 19, umfassend den weiteren Schritt von:

Bereitstellen eines ersten Flusses eines Fluids mit einer Flussrate ;
Bereitstellen von ersten und zweiten Fluidsammelkammern auf gegenüberliegenden Seiten der besagten Achse;
Führen zumindest eines Abschnitts des besagten Zulaufs eines Fluids zu jeder der besagten ersten und zweiten länglichen Fluidsammelkammern; und
Führen des Fluids von jeder der besagten ersten und zweiten Sammelkammern zu der besagten Faserzieh - Einheit, um den besagten, im Wesentlichen kontinuierlichen Fluidstrom innerhalb der besagten Faserzieh - Einheit auszubilden.

21. Das Verfahren gemäß Anspruch 20, umfassend die weiteren Schritte von:

Aufteilen des besagten ersten Zulaufs eines Fluids zwischen den Einlässen der besagten ersten und zweiten Sammelkammern; und

Variieren des Drucks des in jeden der Einlässe der besagten ersten und zweiten Sammelkammern fließenden Drucks in einer selektiven Art und Weise.

22. Das Verfahren nach Anspruch 20, umfassend die weiteren Schritte von:

Bereitstellen eines zweiten Zulaufs eines Fluids mit einer Flussrate;
Anschließen des besagten zweiten Zulaufs eines Fluids an das besagte Störungsmittel;
Führen des Flusses des Fluids von dem besagten Störungsmittel zu den besagten ersten und zweite Sammelkammern; und
Variieren der Flussrate des Fluids von dem besagten zweiten Zulauf eines Fluids in einer selektiven Art und Weise, um die besagte Druckvariation auf jeder Seite der besagten primären Achse bereitzustellen.

23. Das Verfahren nach Anspruch 22, umfassend die weiteren Schritte von:

Abzapfen eines Flusses eines Fluids von dem besagten ersten Zulauf eines Fluids in einer einstellbaren Art und Weise, um den besagten zweiten Zulauf eines Fluids bereitzustellen.

24. Das Verfahren nach Anspruch 20, umfassend die weiteren Schritte von:

Bereitstellen von ersten und zweiten Druckwandlern, benachbart zu den besagten ersten und zweiten Sammelkammern, um das besagte Störungsmittel auszubilden; und
Aktivieren der besagten ersten und zweiten Druckwandler in einer selektiven Art und Weise, um den Druck in den besagten ersten und zweiten Sammelkammern in einer selektiven Art und Weise zu variieren.

25. Das Verfahren nach Anspruch 20, umfassend den weiteren Schritt von:

Bereitstellen von ersten und zweiten sekundären pulsierenden Düsenstrahlen auf gegenüberliegenden Seiten der besagten Achse und in der Nähe der besagten Faserzieh- Einheit, um den besagten und im Wesentlichen kontinuierlichen Fluss des Fluids in einer alternierenden Art und Weise zu stören.

26. Das Verfahren nach Anspruch 25, umfassend den weiteren Schritt von:

Positionieren der besagten ersten und zweiten sekundären Düsenstrahlen zwischen dem Einlass und dem Auslass der besagten Faserzieh - Einheit.

27. Das Verfahren nach Anspruch 25, umfassend den weiteren Schritt von:

Lenken des Flusses eines Fluids von zumindest einem der besagten ersten und zweiten sekundären Düsenstrahlen in einer im Wesentlichen horizontalen Ausrichtung.

28. Das Verfahren nach Anspruch 25, umfassend den weiteren Schritt von:

Lenken des Flusses eines Fluids von zumindest einem der besagten ersten und zweiten sekundären Düsenstrahlen in einer abwärts gerichteten Ausrichtung.

29. Das Verfahren nach Anspruch 25, umfassend den weiteren Schritt von:

Lenken des Flusses eines Fluids von zumindest einem der besagten sekundären Düsenstrahlen in einer nichtparallelen Ausrichtung mit Bezug auf die Maschinenrichtung.

30. Das Verfahren nach Anspruch 25, umfassend die weiteren Schritte von:

Bereitstellen eines heißen Fluids von dem besagten ersten sekundären Düsenstrahl; und Bereitstellen eines Fluids mit näherungsweise Umgebungstemperatur von dem besagten zweiten sekundären Düsenstrahl.

31. Das Verfahren nach Anspruch 20, umfassend den weiteren Schritt von:

Variieren eines Drucks eines stationären Zustands in jeder der besagten ersten und zweiten Sammelkammern mit einer Frequenz der Störung von näherungsweise weniger als 1000 Hertz.

32. Eine Vorrichtung zum Herstellen von künstlichen Fasern aus einem flüssigen Harz mit einem Verfahren des Schmelzblasens oder mit einem Verfahren des Coformens, umfassend:

Mittel zum Erzeugen eines im Wesentlichen kontinuierlichen Fluidstroms entlang einer primären Achse;
eine erste Extrusionsform zum Extrudieren des flüssigen Harzes, wobei die besagte Form benachbart zu dem Fluidstrom angeordnet ist, um das besagte flüssige Harz in den Fluidstrom einzuspritzen, um Fasern zu formen; und
Störungsmittel, um den Fluss des Fluids in dem Fluidstrom in einer selektiven Art und Weise zu stören, um den Fluiddruck auf jeder Seite der primären Achse zu variieren.

33. Die Vorrichtung nach Anspruch 32, ferner umfassend:

ein Substrat, das unter der besagten ersten Form angeordnet ist;
Versetzungsmittel für das Substrat, um das besagte Substrat im Verhältnis zu der besagten ersten Form zu bewegen, wobei die Richtung der Bewegung des besagten Substrats eine Maschinenrichtung definiert;
wobei die besagte erste Form senkrecht zu der besagten Maschinenrichtung in einer Querrichtung ausgerichtet ist; und
wobei die Fasern auf dem besagten Substrat abgelegt werden, um eine Vliesstoffbahn auszubilden.

34. Die Vorrichtung nach Anspruch 33, wobei das besagte Mittel zum Erzeugen eines im Wesentlichen kontinuierlichen Fluidstroms ferner umfasst:

einen ersten Zulauf eines Fluids mit einer Flussrate;
erste und zweite längliche Fluidsammelkammern, die auf gegenüberliegenden Seiten der besagten Achse angeordnet sind, wobei jede der besagten Sammelkammern zumindest einen ersten Einlass und einen Auslass umfasst;
erste und zweite Sammelleitungen, um zumindest einen Teil des besagten Zulaufs eines Fluids zu dem Einlass von jeder der besagten ersten und zweiten länglichen Fluidsammelkammern zu lenken; und
erste und zweite Ausgangsleitungen, die sich von dem Auslass von jeder der besagten ersten und zweiten Sammelkammern bis zu einer Stelle benachbart zu der besagten Form auf gegenüberliegenden Seiten der besagten primären Achse erstrecken, und Lenken eines Fluids von jeder der besagten ersten und zweiten Sammelkammern zu einer Stelle benachbart zu der besagten ersten Form, um den besagten, im Wesentlichen kontinuierlichen Fluidstrom auszubilden.

35. Die Vorrichtung nach Anspruch 34, ferner umfassend:

eine primäre Fluidleitung, die zwischen dem besagten ersten Zulauf eines Fluids und dem besagten Störungsmittel angeschlossen ist; wobei die besagte erste Sammelleitung zwischen dem besagten Störungsmittel und dem besagten Einlass an der besagten ersten Sammelkammer angeschlossen ist; wobei die besagte zweite Sammelleitung zwischen dem besagten Störungsmittel und dem besagten Einlass an der besagten zweiten Sammelkammer angeschlossen ist; und

wobei das besagte Störungsmittel den besagten ersten Zulauf eines Fluids zwischen den besagten ersten und zweiten Sammelleitungen teilt und den Druck des in jede der besagten ersten und zweiten Sammelleitungen fließenden Fluids in einer selektiven Art und Weise variiert.

36. Die Vorrichtung nach Anspruch 34, ferner umfassend:

einen zweiten Zulauf eines Fluids mit einer Flussrate;
eine Hilfsleitung, die zwischen dem besagten zweiten Zulauf eines Fluids und dem besagten Störungsmittel angeschlossen ist;
einen zweiten Einlass, der in jeder der besagten ersten und zweiten Sammelkammem angeordnet ist; zumindest eine erste sekundäre Leitung, die in einer fluidleitenden Art und Weise zwischen dem besagten Störungsmittel und dem besagten zweiten Einlass der besagten ersten Sammelkammer gekoppelt ist, um einen Fluidfluss von dem besagten Störungsmittel zu dem besagten zweiten Einlass der besagten ersten Sammelkammer zu lenken;
zumindest eine zweite sekundäre Leitung, die in einer fluidleitenden Art und Weise zwischen dem besagten

Störungsmittel und dem besagten zweiten Einlass der besagten zweiten Sammelkammer gekoppelt ist, um einen Fluidfluss von dem besagten Störungsmittel zu dem besagten zweiten Einlass der besagten zweiten Sammelkammer zu lenken; und

wobei das besagte Störungsmittel ferner ein Störungsventilmittel umfasst, um die von der besagten Hilfsleitung an die besagten ersten und zweiten sekundären Leitungen bereitgestellte Flussrate des Fluids in einer selektiven Art und Weise zu variieren,
wobei die selektive Variation der Flussrate des Fluids die besagte Druckvariation an jeder Seite der besagten primären Achse bereitstellt.

37. Die Vorrichtung nach Anspruch 36, ferner umfassend:

ein Dreiwegeventil, umfassend;
einen Einlass, der an den besagten ersten Zulauf eines Fluids angeschlossen und ist und diesen aufnimmt;
erste und zweite Auslässe, die den Fluss des Fluids in die besagten ersten und zweiten Sammelleitungen lenken ; und
einen dritten Auslass, um einen Fluidfluss von dem besagten ersten Zulauf eines Fluids zu der besagten Hilfsleitung in einer einstellbaren Art und Weise abzuzapfen, um den besagten zweiten Zulauf eines Fluids bereitzustellen.

38. Die Vorrichtung nach Anspruch 36, wobei das besagte Störungsmittel ein Störungsventil umfasst, enthaltend:

einen Einlass zum Aufnehmen eines Fluidflusses von der besagten Behelfsleitung; und
erste und zweite Auslässe zum Ausgeben eines in einer selektiven Art und Weise variierten Fluidflusses an die besagten ersten und zweiten sekundären Leitungen.

39. Die Vorrichtung nach Anspruch 34, wobei das besagte Störungsmittel ferner ein Störungsventil enthält, ferner umfassend:

einen Einlass zum Aufnehmen eines Fluidflusses aus der besagten zweiten Fluidquelle ; und
erste und zweite Auslässe zum Ausgeben eines in einer selektiven Art und Weise variierten Fluidflusses an die besagten ersten und zweiten Sammelleitungen.

40. Die Vorrichtung nach Anspruch 34, wobei das besagte Störungsmittel ferner umfasst:

erste und zweite Druckwandler, benachbart zu den besagten ersten und zweiten Sammelkammern; und
Mittel zur selektiven Aktivierung der besagten ersten und zweiten Druckwandler, um den Druck in den besagten ersten und zweiten Sammelkammern in einer selektiven Art und Weise zu variieren.

41. Die Vorrichtung nach Anspruch 34, wobei das besagte Störungsmittel einen Druck in einem stationären Zustand in jeder der besagten ersten und zweiten Sammelkammem mit einer Frequenz der Störung von näherungsweise weniger als 1000 Hertz variiert.

42. Die Vorrichtung nach Anspruch 34, wobei das besagte Störungsmittel einen durchschnittlichen Sammeldruck in den besagten ersten und zweiten Sammelkammern weniger als ungefähr 50 % des gesamten durchschnittlichen Sammeldrucks in der Abwesenheit der Aktivierung des besagten Störungsmittels variiert.

43. Die Vorrichtung nach Anspruch 33, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einer der Ausgangsleitungen in einer nicht parallelen Richtung mit Bezug auf die Maschinenrichtung.

44. Die Vorrichtung nach Anspruch 36, ferner umfassend:

erste und zweite sekundäre pulsierende Düsenstrahlen, die auf gegenüberliegenden Seite der besagten Achse und in der Nähe der Form angeordnet sind, um den besagten, im Wesentlichen kontinuierlichen Fluss des Fluids in einer alternierenden Art und Weise zu stören.

45. Die Vorrichtung nach Anspruch 44, ferner umfassend:

Mittel zum Positionieren der besagten ersten und zweiten sekundären Düsenstrahlen zwischen dem Einlass und dem Auslass der besagten Faserzieh - Einheit.

46. Die Vorrichtung nach Anspruch 44, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einem der besagten ersten und zweiten sekundären Düsenstrahlen in einer im Wesentlichen horizontalen Ausrichtung.

47. Die Vorrichtung nach Anspruch 44, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einem der besagten ersten und zweiten sekundären Düsenstrahlen abwärts gerichteten Ausrichtung.

48. Die Vorrichtung nach Anspruch 44, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einem der besagten sekundären Düsenstrahlen in einer nicht parallelen Ausrichtung mit Bezug auf die Maschinenrichtung.

49. Die Vorrichtung nach Anspruch 44, ferner umfassend:

Mittel zum Bereitstellen eines heißen Fluidsaus dem besagten ersten sekundären Düsenstrahl; und
Mittel zum Bereitstellen eines Fluids mit näherungsweise einer Umgebungstemperatur von dem besagten zweiten sekundären Düsenstrahl.

50. Die Vorrichtung nach Anspruch 32, ferner umfassend:

Mittel zum Extrudieren eines zweiten flüssigen Harzes durch eine zweite Form, die benachbart zu der besagten ersten Form positioniert ist, wobei die besagte zweite Form benachbart zu dem Fluidstrom angeordnet ist, um das besagte flüssige Harz in den besagten Fluidstrom einzuspritzen, um Fasern zu formen.

51. Die Vorrichtung nach Anspruch 50, ferner umfassend: Mittel zum Lenken eines Fluidflusses zwischen den besagten ersten und zweiten Formen; und
Mittel zum Lenken des Fluidflusses in die Nähe von umfangsseitigen Abschnitten der ersten und zweiten Formen.

52. Die Vorrichtung nach Anspruch 51, ferner umfassend:

einen Schacht, der zwischen den besagten ersten und zweiten Formen angeordnet ist, um Zellstofffasem in den besagten kontinuierlichen Fluidstrom einzuleiten.

53. Die Vorrichtung nach Anspruch 32, ferner umfassend:

eine Faserzieh - Einheit, die unter der besagten ersten Form angeordnet ist und die dazu eingerichtet ist, den primären Fluidstrom dort durch zu kanalisieren, wobei die besagte Faserzieh - Einheit umfasst,
einen Fasereinlass an einem oberseitigen Abschnitt davon zum Aufnehmen eines Fluidflusses und Fasern, und einen Auslass zum Ausgeben der Fasern.

54. Die Vorrichtung nach Anspruch 53, ferner umfassend:

ein Substrat, das unter der besagten ersten Form angeordnet ist;
ein Versetzungsmittel für das Substrat, um das besagte Substrat im Verhältnis zu der besagten ersten Form zu bewegen, wobei die Richtung der Bewegung des besagten Substrats eine Maschinenrichtung definiert;

wobei die besagte erste Form senkrecht zu der besagten Maschinenrichtung in einer Querrichtung ausgerichtet ist; und
wobei die Fasern auf dem besagten Substrat abgelegt werden, um eine Vliesstoffbahn auszubilden.

55. Die Vorrichtung nach Anspruch 53, wobei das besagte Mittel zum Erzeugen eines im Wesentlichen kontinuierlichen Fluidstroms ferner umfasst:

einen ersten Zulauf eines Fluids mit einer Flussrate;
erste und zweite längliche Fluidsammelkammern, die auf gegenüberliegenden Seiten der besagten Achse angeordnet sind, wobei jede der besagten Sammelkammern zumindest einen ersten Einlass und einen Auslass umfasst;
erste und zweite Sammelleitungen zum Lenken zumindest eines Teils des besagten Zulaufs eines Fluids zum Einlass von jeder der besagten ersten und zweiten länglichen Fluidsammelkammern; und
erste und zweite Ausgangsleitungen, die sich von dem Auslass jeder der besagten ersten und zweiten Fluidsammelkammern zu der besagten Faserzieh - Einheit auf gegenüberliegenden Seiten der besagten primären Achse erstrecken, um ein Fluid von jeder der besagten ersten und zweiten Sammelkammern zu der besagten Faserzieh - Einheit zu lenken, um den besagten, im Wesentlichen kontinuierlichen Fluidstrom in die besagte Faserzieh - Einheit auszubilden.

56. Die Vorrichtung nach Anspruch 55, ferner umfassend:

eine primäre Fluidleitung, die zwischen dem besagten ersten Zulauf eines Fluids und dem besagten Störungsmittel angeschlossen ist; wobei die besagte erste Sammelleitung zwischen dem besagten Störungsmittel und dem besagten Einlass der besagten ersten Sammelkammer angeschlossen ist;

wobei die besagte zweite Sammelleitung zwischen dem besagten Störungsmittel und dem besagten Einlass an der besagten zweiten Sammelkammer angeschlossen ist; und
wobei das besagte Störungsmittel den besagten ersten Zulauf eines Fluids zwischen den besagten ersten und zweiten Sammelleitungen aufteilt und den Druck des in jede der besagten ersten und zweiten Sammelleitungen fließenden Fluids in einer selektiven Art und Weise variiert.

57. Die Vorrichtung nach Anspruch 55, ferner umfassend:

einen zweiten Zulauf eines Fluids mit einer Flussrate;
eine Hilfsleitung, die zwischen dem besagten zweiten Zulauf eines Fluids und dem besagten Störungsmittel angeschlossen ist; einen zweiten Einlass, der in jeder der besagten ersten und zweiten Sammelkammern angeordnet ist;
zumindest eine erste sekundäre Leitung, die in einer fluidleitenden Art und Weise zwischen dem besagten Störungsmittel und dem besagten zweiten Einlass der besagten ersten Sammelkammer gekoppelt ist, um einen Fluidstrom von dem besagten Störungsmittel zu dem besagten zweiten Einlass der besagten ersten Sammelkammer zu lenken;
zumindest eine zweite sekundäre Leitung, die in einer fluidleitenden Art und Weise zwischen dem besagten Störungsmittel und dem besagten zweiten Einlass der besagten zweiten Sammelkammer gekoppelt ist, um einen Fluidstrom von dem besagten Störungsmittel zu dem besagten zweiten Einlass der besagten zweiten Sammelkammer zu lenken; und

wobei das besagte Störungsmittel ferner ein Störungsventilmittel umfasst, um die von der besagten Hilfsleitung an die besagten ersten und zweiten sekundären Leitungen bereitgestellte Flussrate des Fluids in einer selektiven Art und Weise zu variieren,
wobei die selektive Variation der Flussrate des Fluids die besagte Druckvariation auf jeder Seite der besagten primären Achsen bewerkstelligt.

58. Die Vorrichtung nach Anspruch 57, ferner umfassend:

ein Dreiwegeventil, umfassend
einen Einlass, der an den besagten ersten Zulauf eines Fluids angeschlossen ist und diesen aufnimmt;
erste und zweite Auslässe, die einen Fluidfluss in die besagten ersten und zweiten Sammelleitungen lenken; und
einen dritten Auslass, um einen Fluidfluss von dem besagten ersten Zulauf eines Fluids zur besagten Hilfsleitung in einer einstellbaren Art und Weise abzuzapfen, um den besagten zweiten Zulauf eines Fluids zu bewerkstelligen.

59. Die Vorrichtung nach Anspruch 55, wobei das besagte Störungsmittel ein Störungsventil umfasst, enthaltend:

einen Einlass zum Aufnehmen eines Fluidflusses aus der besagten Hilfsleitung; und
erste und zweite Auslässe zum Ausgeben eines in einer selektiven Art und Weise variierten Fluidflusses an die besagten ersten und zweiten sekundären Leitungen.

60. Die Vorrichtung nach Anspruch 55, wobei das besagte Störungsmittel ferner ein Störungsventil enthält, das ferner umfasst:

einen Einlass zum Aufnehmen eines Fluidflusses aus der besagten zweiten Fluidquelle; und
erste und zweite Auslässe zum Ausgeben eines in einer selektiven Art und Weise variierten Fluidflusses an die besagten ersten und zweiten Sammelleitungen.

61. Die Vorrichtung nach Anspruch 55, wobei das besagte Störungsmittel ferner umfasst:

erste und zweite Druckwandler, benachbart zu den besagten ersten und zweiten Sammelkammern; und
Mittel zum selektiven Aktivieren der besagten ersten und zweiten Druckwandler, um den Druck in den besagten ersten und zweiten Sammelkammern in einer selektiven Art und Weise zu variieren.

62. Die Vorrichtung nach Anspruch 53, ferner umfassend:

erste und zweite sekundäre pulsierende Düsenstrahlen, die auf gegenüberliegenden Seiten der besagten Achse und in der Nähe der besagten Faserzieh - Einheit angeordnet sind, um den besagten, im Wesentlichen kontinuierlichen Fluidstrom in einer alternierenden Art und Weise zu stören.

63. Die Vorrichtung nach Anspruch 62, ferner umfassend:

Mittel zum Positionieren der besagten ersten und zweiten sekundären Düsenstrahlen zwischen dem Einlass und dem Auslass der besagten Faserzieh - Einheit.

64. Die Vorrichtung nach Anspruch 62, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einem der besagten ersten und zweiten sekundären Düsenstrahlen in einer im Wesentlichen horizontalen Ausrichtung.

65. Die Vorrichtung nach Anspruch 62, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einem der besagten ersten und zweiten sekundären Düsenstrahlen in einer abwärts gerichteten Ausrichtung.

66. Die Vorrichtung nach Anspruch 62, ferner umfassend:

Mittel zum Lenken eines Fluidflusses von zumindest einem der besagten sekundären Düsenstrahlen in einer nicht-parallelen Ausrichtung mit Bezug auf die Maschinenrichtung.

67. Die Vorrichtung nach Anspruch 62, ferner umfassend:

Mittel zum Bereitstellen eines heißen Fluids von dem besagten ersten sekundären Düsenstrahl; und
Mittel zum Bereitstellen eines Fluids mit näherungsweise einer Umgebungstemperatur von dem besagten zweiten sekundären Düsenstrahl.

68. Die Vorrichtung nach Anspruch 53, wobei das besagte Störungsmittel einen Druck eines stationären Zustands in jeder der besagten ersten und zweiten Sammelkammer mit einer Frequenz der Störung von näherungsweise weniger als 1000 Herz variiert.

69. Die Vorrichtung nach Anspruch 32, wobei das besagte Fluid ein Gas ist.

70. Die Vorrichtung nach Anspruch 32, wobei das besagte Fluid Luft ist.

Revendications

1. Procédé de formation de fibres artificielles à partir d'une résine liquéfiée, comprenant les étapes de :

    génération d'un courant de fluide continu le long d'un axe primaire ;
    extrusion de la résine liquéfiée au travers d'une première filière située adjacente au courant de fluide ;
    injection de ladite résine liquéfiée dans ledit courant de fluide pour former des fibres ; et
    perturbation sélective du flux de fluide dans le courant de fluide par des moyens de perturbation aux fins de faire varier la pression du fluide d'un côté et de l'autre de l'axe primaire,

    caractérisé en ce que
    les fibres artificielles sont formées par un procédé d'extrusion-soufflage ou de coformage.

2. Procédé selon la revendication 1, comprenant les étapes supplémentaires de :

    fourniture d'un substrat disposé au-dessous de ladite première filière ;
    déplacement par translation dudit substrat par rapport à ladite première filière, la direction du mouvement dudit substrat définissant un sens machine ;
    orientation de ladite première filière perpendiculairement audit sens machine, dans un sens travers ; et
    dépôt des fibres sur ledit substrat pour former un voile non-tissé.

3. Procédé selon la revendication 1, comprenant les étapes supplémentaires de :

    fourniture d'une première alimentation en fluide ayant un débit d'écoulement ;
    fourniture d'une première et d'une seconde chambres plénums de fluide adjacentes à ladite première filière ;
    direction d'au moins une portion de ladite première alimentation en fluide vers des entrées des première et secondes chambres plénums de fluide ; et
    direction du fluide provenant de chacune desdites première et seconde chambres plénums vers un emplacement adjacent à ladite première filière pour former ledit courant de fluide substantiellement continu.

4. Procédé selon la revendication 3, comprenant les étapes supplémentaires de :

    fourniture d'un conduit de fluide primaire connecté entre ladite première alimentation en fluide et lesdits moyens de perturbation ;
    connexion d'un premier conduit plénum entre lesdits moyens de perturbation et ladite entrée à ladite première chambre plénum ;
    connexion d'un second conduit plénum entre lesdits moyens de perturbation et ladite entrée à la seconde chambre plénum ; et
    division de ladite première alimentation en fluide entre lesdits premier et seconds conduits plénums ; et
    variation sélective de la pression de fluide s'écoulant dans chacun desdits premier et second conduits plénums.

5. Procédé selon la revendication 3, comprenant en outre les étapes supplémentaires de :

    fourniture d'une seconde alimentation en fluide ayant un débit d'écoulement ;
    fourniture d'une seconde entrée située dans chacune desdites première et seconde chambres plénums ;
    direction du flux de fluide depuis lesdits moyens de perturbation vers lesdites secondes entrées dans lesdites première et seconde chambres plénums ; et
    variation sélective du débit d'écoulement de fluide fourni depuis ladite seconde source de fluide pour obtenir une variation sélective du débit d'écoulement de fluide fournissant ladite variation de pression d'un côté et de l'autre dudit axe primaire.

6. Procédé selon la revendication 5, comprenant l'étape supplémentaire de :

    sous-tirage réglable du flux de fluide depuis ladite première alimentation en fluide pour fournir ladite seconde alimentation en fluide.

7. Procédé selon la revendication 3, comprenant les étapes supplémentaires de :

fourniture d'un premier et d'un second transducteurs de pression, respectivement, dans lesdites première et seconde chambres plénums ; et
activation sélective des premier et second transducteurs de pression pour faire varier sélectivement la pression dans lesdites première et seconde chambres plénums.

8. Procédé selon la revendication 3, comprenant l'étape supplémentaire de :

variation d'une pression de régime permanent dans chacune desdites première et seconde chambres plénums à une fréquence de perturbation inférieure à approximativement 1000 Hertz.

9. Procédé selon la revendication 3, comprenant l'étape supplémentaire de :

variation d'une pression moyenne de plénum dans lesdites première et seconde chambres plénums de moins d'environ 100 % de la pression moyenne de plénum en l'absence d'activation desdits moyens de perturbation.

10. Procédé selon la revendication 3, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'une au moins desdites chambres plénums selon une direction non parallèle au sens machine.

11. Procédé selon la revendication 5, comprenant l'étape supplémentaire de :

fourniture d'un premier et d'un second jets de perturbation secondaires sur les côtés opposés dudit axe et au voisinage de la filière pour perturber alternativement ledit flux de fluide substantiellement continu.

12. Procédé selon la revendication 11, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation substantiellement perpendiculaire audit axe primaire.

13. Procédé selon la revendication 11, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation définissant un angle aigu avec l'axe primaire.

14. Procédé selon la revendication 11, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'un au moins desdits jets secondaires selon une direction non parallèle au sens machine.

15. Procédé selon la revendication 11, comprenant les étapes supplémentaires de :

fourniture de fluide chaud depuis ledit premier jet secondaire ; et
fourniture de fluide approximativement à la température ambiante depuis ledit second jet secondaire.

16. Procédé selon la revendication 1, comprenant les étapes supplémentaires de :

extrusion d'une seconde résine liquéfiée au travers d'une seconde filière positionnée adjacente à ladite première filière ;
positionnement de ladite seconde filière adjacente au courant de fluide pour injecter ladite résine liquéfiée dans le courant de fluide aux fins de former des fibres.

17. Procédé selon la revendication 16, comprenant l'étape supplémentaire de :

introduction de fibres de pâte dans ledit courant de fluide continu via une goulotte située entre lesdites première et seconde filières.

18. Procédé selon la revendication 16, comprenant les étapes supplémentaires de :

fourniture d'un substrat au-dessous de ladite première filière ;
déplacement par translation dudit substrat par rapport à ladite première filière, la direction du mouvement dudit substrat définissant un sens machine ;
orientation de ladite première filière perpendiculairement audit sens machine, selon une sens travers ; et
dépôt des fibres sur ledit substrat pour former un voile non-tissé.

19. Procédé selon la revendication 1, comprenant l'étape supplémentaire de :

canalisation du premier flux de fluide primaire et des fibres au travers d'une unité d'étirage de fibres située au-dessous de ladite première filière.

20. Procédé selon la revendication 19, comprenant l'étape supplémentaire de :

fourniture d'un premier flux de fluide ayant un débit d'écoulement ;
fourniture d'une première et d'une seconde chambres plénums de fluide sur les côtés opposés dudit axe ;
direction d'au moins une portion de ladite alimentation en fluide vers chacune desdites première et seconde chambres plénums longitudinales de fluide ; et
direction du fluide provenant de chacune desdites première et seconde chambres plénums vers ladite unité d'étirage de fibres pour faire passer ledit courant de fluide substantiellement continu dans ladite unité d'étirage de fibres.

21. Procédé selon la revendication 20, comprenant les étapes supplémentaires de :

division de ladite première alimentation en fluide entre lesdites entrées aux première et secondes chambres plénums ; et
variation sélective de la pression de fluide s'écoulant dans chacune desdites entrées aux première et seconde chambres plénums.

22. Procédé selon la revendication 20, comprenant les étapes supplémentaires de :

fourniture d'une seconde alimentation en fluide ayant un débit d'écoulement ;
connexion de ladite seconde alimentation en fluide auxdits moyens de perturbation ;
direction du flux de fluide depuis lesdits moyens de perturbation vers lesdites première et seconde chambres plénums ; et
variation sélective du débit d'écoulement de fluide depuis ladite seconde alimentation en fluide pour fournir ladite variation de pression de chaque côté dudit axe primaire.

23. Procédé selon la revendication 22, comprenant l'étape supplémentaire de :

sous-tirage réglable du flux de fluide depuis ladite première alimentation en fluide pour fournir ladite seconde alimentation en fluide.

24. Procédé selon la revendication 20, comprenant les étapes supplémentaires de :

fourniture d'un premier et d'un second transducteurs de pression adjacents auxdites première et seconde chambres plénums pour former lesdits moyens de perturbation ; et
activation sélective desdits premier et second transducteurs de pression pour faire varier sélectivement la pression dans lesdites première et seconde chambres plénums.

25. Procédé selon la revendication 20, comprenant l'étape supplémentaire de :

fourniture de premier et second jets secondaires impulsionnels sur les côtés opposés dudit axe et au voisinage de ladite unité d'étirage de fibres pour perturber alternativement ledit flux de fluide substantiellement continu.

26. Procédé selon la revendication 25, comprenant l'étape supplémentaire de :

positionnement desdits premier et second jets secondaires entre l'entrée et la sortie de ladite unité d'étirage de fibres.

27. Procédé selon la revendication 25, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation substantiellement horizontale.

28. Procédé selon la revendication 25, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation descendante.

29. Procédé selon la revendication 25, comprenant l'étape supplémentaire de :

direction du flux de fluide depuis l'un au moins desdits jets secondaires selon une direction non parallèle au sens machine.

30. Procédé selon la revendication 25, comprenant les étapes supplémentaires de :

fourniture d'un fluide chaud depuis ledit premier jet secondaire ; et
fourniture de fluide à une température approximativement ambiante depuis ledit second jet secondaire.

31. Procédé selon la revendication 20, comprenant l'étape supplémentaire de :

variation d'une pression de régime permanent dans chacune desdites première et seconde chambres plénums à une fréquence de perturbation inférieure à approximativement 1000 Hertz.

32. Appareil pour former des fibres artificielles au moyen d'un procédé d'extrusion-soufflage ou de coformage, à partir d'une résine liquéfiée, comprenant :

des moyens pour générer un courant de fluide substantiellement continu le long d'un axe primaire ;
une première filière d'extrusion pour extruder la résine liquéfiée, ladite filière étant située adjacente au courant de fluide pour injecter ladite résine liquéfiée dans le courant de fluide pour former des fibres ; et
des moyens de perturbation pour perturber sélectivement le flux de fluide dans le courant de fluide en faisant varier la pression de fluide d'un côté et de l'autre de l'axe primaire.

33. Appareil selon la revendication 32, comprenant en outre :

un substrat disposé au-dessous de ladite première filière ;
des moyens de déplacement en translation du substrat pour déplacer ledit substrat par rapport à ladite première filière, la direction du mouvement dudit substrat définissant un sens machine ;
ladite première filière orientée perpendiculairement audit sens machine, dans un sens travers ; et
appareil dans lequel les fibres sont déposées sur ledit substrat pour former un voile non-tissé.

34. Appareil selon la revendication 33, dans lequel lesdits moyens pour générer un courant de fluide substantiellement continu comprennent en outre :

une première alimentation en fluide ayant un débit d'écoulement ;
des première et seconde chambres plénums de fluide, longitudinales, situées sur les côtés opposés dudit axe, chacune desdites chambres plénums incluant au moins une première entrée et une sortie ;
des premier et second conduits de plénum pour diriger au moins une portion de ladite alimentation en fluide vers l'entrée de chacune desdites première et seconde chambres plénums de fluide, longitudinales ; et
des premier et second conduits de sortie s'étendant depuis la sortie de chacune desdites première et seconde chambres plénums vers un emplacement adjacent à ladite filière, sur les côtés opposés dudit axe primaire, et dirigeant le fluide provenant de chacune desdites première et second chambres plénums vers un emplacement adjacent à ladite première filière pour former ledit courant de fluide substantiellement continu.

35. Appareil selon la revendication 34, comprenant en outre :

un conduit de fluide primaire connecté entre ladite première alimentation en fluide et lesdits moyens de

perturbation ;
ledit premier conduit plénum connecté entre lesdits moyens de perturbation et ladite entrée sur ladite première chambre plénum ;
ledit second conduit plénum connecté entre lesdits moyens de perturbation et ladite entrée sur ladite seconde chambre plénum ; et
appareil dans lequel lesdits moyens de perturbation répartissent ladite première alimentation en fluide entre lesdits premier et second conduits plénums et font sélectivement varier la pression de fluide s'écoulant dans chacun des premier et second conduits plénums.

36. Appareil selon la revendication 34, comprenant en outre :

une seconde alimentation en fluide ayant un débit d'écoulement ;
un conduit auxiliaire connecté entre ladite seconde alimentation en fluide et lesdits moyens de perturbation ;
une seconde entrée située dans chacune desdites première et seconde chambres plénums ;
au moins un premier conduit secondaire couplé hydrauliquement entre lesdits moyens de perturbation et ladite seconde entrée dans ladite première chambre plénum, dirigeant le flux de fluide depuis lesdits moyens de perturbation vers ladite seconde entrée dans ladite première chambre plénum ;
au moins un second conduit secondaire couplé hydrauliquement entre lesdits moyens de perturbation et ladite seconde entrée dans ladite seconde chambre plénum, dirigeant le flux de fluide depuis lesdits moyens de perturbation vers ladite seconde entrée dans ladite seconde chambre plénum ; et
lesdits moyens de perturbation comprenant en outre des moyens formant soupape de perturbation pour faire varier sélectivement le débit d'écoulement du fluide fourni depuis ledit conduit auxiliaire vers lesdits premier et second conduits secondaires, ladite variation sélective de débit d'écoulement de fluide fournissant ladite variation de pression d'un côté et de l'autre dudit axe primaire.

37. Appareil selon la revendication 36, comprenant en outre :

une soupape à trois voies comprenant :

- une entrée connectée à et recevant ladite première alimentation en fluide ;
- des première et seconde sorties dirigeant le flux de fluide dans lesdits premier et second conduits plénums ; et
- une troisième sortie pour soutirer, de manière réglable, du flux de fluide depuis ladite première alimentation en fluide vers ledit conduit auxiliaire pour fournir ladite seconde alimentation en fluide.

38. Appareil selon la revendication 36, dans lequel lesdits moyens de perturbation comprennent une soupape de perturbation comprenant :

- une entrée pour recevoir le flux de fluide depuis ledit conduit auxiliaire ; et
- des première et seconde sorties pour distribuer sélectivement des flux de fluide variés auxdits premier et second conduits secondaires.

39. Appareil selon la revendication 34, dans lequel lesdits moyens de perturbation comprennent en outre une soupape de perturbation, comprenant en outre :

- une entrée pour recevoir le flux de fluide depuis ladite seconde source de fluide ; et
- des première et seconde sorties pour distribuer sélectivement le flux de fluide varié vers lesdits premier et second conduits plénums.

40. Appareil selon la revendication 34, dans lequel lesdits moyens de perturbation comprennent en outre :

- des premier et second transducteurs de pression adjacents auxdites première et seconde chambres plénums ; et
- des moyens pour activer sélectivement lesdits premier et second transducteurs de pression pour faire varier sélectivement la pression dans lesdites première et seconde chambres plénums.

41. Appareil selon la revendication 34, dans lequel lesdits moyens de perturbation font varier une pression de régime permanent dans chacune desdites première et seconde chambres plénums à une fréquence de perturbation inférieure à approximativement 1000 Hertz.

42. Appareil selon la revendication 34, dans lequel lesdits moyens de perturbation font varier une pression de plénum moyenne dans lesdites première et seconde chambres plénums inférieure à environ 50 % de la pression totale moyenne de plénum en l'absence de l'activation desdits moyens de perturbation.

43. Appareil selon la revendication 33, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins des conduits de sortie selon une direction non parallèle au sens machine.

44. Appareil selon la revendication 36, comprenant en outre :

un premier et un second jets secondaires impulsionnels disposés sur les côtés opposés dudit axe et au voisinage de la filière pour perturber alternativement ledit flux de fluide substantiellement continu.

45. Appareil selon la revendication 44, comprenant en outre :

des moyens pour positionner lesdits premier et second jets secondaires entre l'entrée et la sortie de ladite unité d'étirage de fibres.

46. Appareil selon la revendication 44, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation substantiellement horizontale.

47. Appareil selon la revendication 44, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation descendante.

48. Appareil selon la revendication 44, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins desdits jets secondaires selon une direction non parallèle au sens machine.

49. Appareil selon la revendication 44, comprenant en outre :

• des moyens pour fournir du fluide chaud depuis ledit premier jet secondaire ; et
• des moyens pour fournir du fluide à une température approximativement ambiante depuis ledit second jet secondaire.

50. Appareil selon la revendication 32, comprenant en outre :

des moyens pour extruder une seconde résine liquéfiée au travers d'une seconde filière positionnée adjacente à ladite première filière, ladite seconde filière étant située adjacente au courant de fluide pour injecter ladite résine liquéfiée dans ledit courant de fluide aux fins de former des fibres.

51. Appareil selon la revendication 50, comprenant en outre :

. des moyens pour diriger un flux de fluide entre lesdites première et seconde filières ; et

• des moyens pour diriger le flux de fluide au voisinage de portions périphériques desdites première et seconde filières.

52. Appareil selon la revendication 51, comprenant en outre :

une goulotte disposée entre lesdites première et seconde filière pour introduire des fibres de pâte dans ledit courant de fluide continu.

53. Appareil selon la revendication 32, comprenant en outre :

une unité d'étirage de fibres disposée au-dessous de ladite première filière et adaptée à y canaliser le flux de fluide primaire, ladite unité d'étirage de fibres incluant :

- une entrée de fibres au niveau d'une portion supérieure de celle-ci pour recevoir le flux de fluide et les fibres, et
- une sortie pour distribuer les fibres.

54. Appareil selon la revendication 53, comprenant en outre :

un substrat disposé au-dessous de ladite première filière ;
des moyens de déplacement en translation du substrat pour déplacer ledit substrat par rapport à ladite première filière, la direction du mouvement dudit substrat définissant un sens machine ;
ladite première filière orientée perpendiculairement audit sens machine, dans un sens travers ; et
appareil dans lequel les fibres sont déposées sur ledit substrat pour former un voile non-tissé.

55. Appareil selon la revendication 53, dans lequel lesdits moyens pour générer un courant de fluide substantiellement continu, comprennent en outre :

une première alimentation en fluide ayant un débit d'écoulement ;
des première et seconde chambres plénums de fluide, longitudinales, situées sur les côtés opposés dudit axe, chacune desdits chambres plénums incluant au moins une première entrée et une sortie ;
des premier et second conduits plénums pour diriger au moins une portion de ladite alimentation en fluide vers l'entrée de chacune desdites première et seconde chambres plénums de fluide, longitudinales ; et
des premier et second conduits de sortie s'étendant depuis la sortie de chacune desdites première et seconde chambres plénums vers ladite unité d'étirage de fibres, sur les côtés opposés dudit axe primaire, pour diriger le fluide provenant de chacune desdites première et seconde chambres plénums vers ladite unité d'étirage de fibres pour faire passer ledit courant de fluide substantiellement continu dans ladite unité d'étirage de fibres.

56. Appareil selon la revendication 55, comprenant en outre :

un conduit de fluide primaire connecté entre ladite première alimentation en fluide et lesdits moyens de perturbation ;
ledit premier conduit plénum connecté entre lesdits moyens de perturbation et ladite entrée sur ladite première chambre plénum ;
ledit second conduit plénum connecté entre lesdits moyens de perturbation et ladite entrée sur ladite seconde chambre plénum ; et
appareil dans lequel lesdits moyens de perturbation répartissent ladite première alimentation en fluide entre lesdits premier et second conduits plénums et fait sélectivement varier la pression de fluide s'écoulant dans chacun desdits premier et second conduits plénums.

57. Appareil selon la revendication 55, comprenant en outre :

une seconde alimentation en fluide ayant un débit d'écoulement ;
un conduit auxiliaire connecté entre ladite seconde alimentation en fluide et lesdits moyens de perturbation ;
une seconde entrée située dans chacun desdites première et seconde chambres plénums ;
au moins un premier conduit secondaire couplé hydrauliquement entre lesdits moyens de perturbation et ladite seconde entrée dans ladite première chambre plénum, dirigeant le flux de fluide depuis lesdits moyens de perturbation vers ladite seconde entrée dans ladite première chambre plénum ;
au moins un second conduit secondaire couplé hydrauliquement entre lesdits moyens de perturbation et ladite seconde entrée dans ladite seconde chambre plénum, dirigeant le flux de fluide depuis lesdits moyens de perturbation vers ladite seconde entrée dans ladite seconde chambre plénum ; et
lesdits moyens de perturbation comprenant en outre un moyen formant soupape de perturbation pour faire sélectivement varier le débit d'écoulement du fluide fourni depuis ledit conduit auxiliaire vers lesdits premier et second conduits secondaires, ladite variation sélective du débit d'écoulement de fluide fournissant ladite varia-

tion de pression d'un côté et de l'autre dudit axe primaire.

58. Appareil selon la revendication 57, comprenant en outre :

une soupape à trois voies comprenant :

- une entrée connectée à, et recevant, ladite première alimentation en fluide ;
- des première et seconde sorties dirigeant le flux de fluide vers lesdits premier et second conduits plénums ; et
- une troisième sortie pour soutirer, de manière réglable, le flux de fluide depuis ladite première alimentation en fluide vers ledit conduit auxiliaire pour fournir ladite seconde alimentation en fluide.

59. Appareil selon la revendication 55, dans lequel lesdits moyens de perturbation incluent une soupape de perturbation comprenant :

- une entrée pour recevoir le flux de fluide depuis ledit conduit auxiliaire ; et
- des première et seconde sorties pour distribuer sélectivement des flux de fluide variés audit premier et second conduits secondaires.

60. Appareil selon la revendication 55, dans lequel lesdits moyens de perturbation comprennent en outre une soupape de perturbation comprenant en outre :

- une entrée pour recevoir le flux de fluide depuis ladite seconde source de fluide ; et
- des première et seconde sorties pour distribuer sélectivement des flux de fluide variés auxdits premier et second conduits plénums.

61. Appareil selon la revendication 55, dans lequel lesdits moyens de perturbation comprennent en outre :

des premier et second transducteurs de pression adjacents auxdites première et seconde chambres plénums ; et des moyens pour activer sélectivement lesdits premier et second transducteurs de pression pour faire varier sélectivement la pression dans lesdites première et seconde chambres plénums.

62. Appareil selon la revendication 53, comprenant en outre :

un premier et un second jets secondaires impulsionnels disposés sur les côtés opposés dudit axe et au voisinage de ladite unité d'étirage de fibres pour perturber alternativement ledit flux de fluide substantiellement continu.

63. Appareil selon la revendication 62, comprenant en outre :

des moyens pour positionner lesdits premier et second jets secondaires entre l'entrée et la sortie de ladite unité d'étirage de fibres.

64. Appareil selon la revendication 62, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation substantiellement horizontale.

65. Appareil selon la revendication 62, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins desdits premier et second jets secondaires selon une orientation descendante.

66. Appareil selon la revendication 62, comprenant en outre :

des moyens pour diriger le flux de fluide depuis l'un au moins desdits jets secondaires selon une direction non parallèle au sens machine.

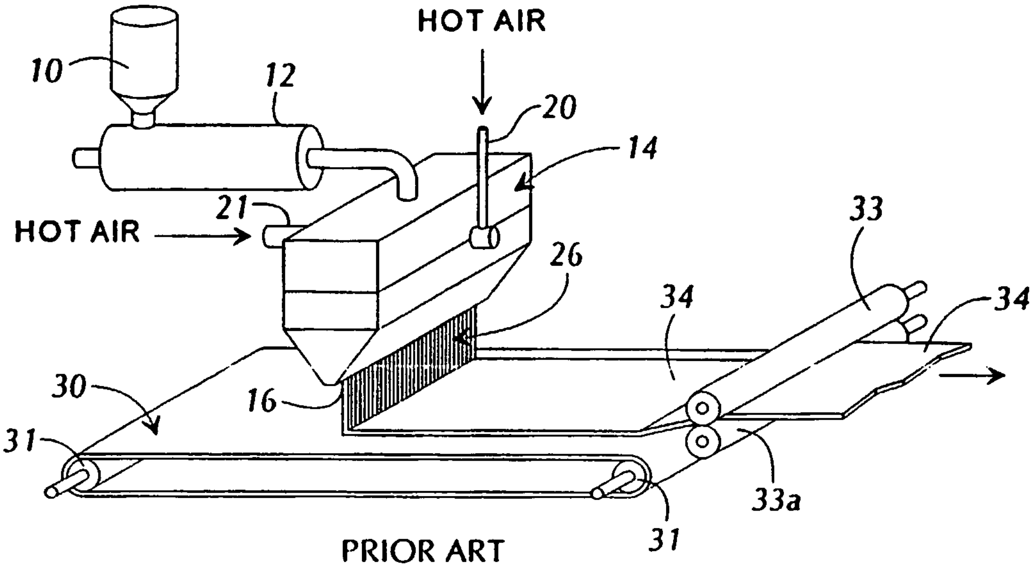
67. Appareil selon la revendication 62, comprenant en outre :

des moyens pour fournir du fluide chaud depuis ledit premier jet secondaire ; et
des moyens pour fournir du fluide à une température approximativement ambiante depuis ledit second jet secondaire.

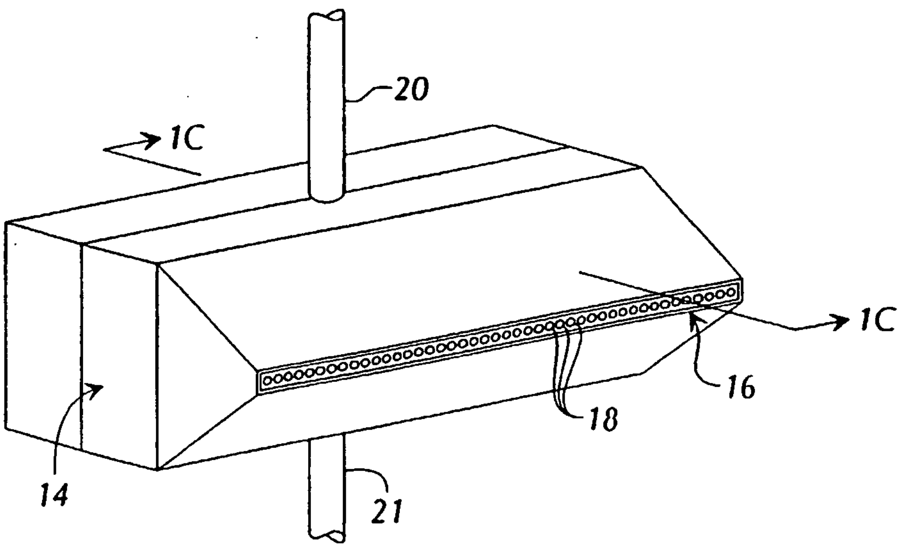
68. Appareil selon la revendication 53, dans lequel lesdits moyens de perturbation font varier une pression de régime permanent dans chacune desdites première et seconde chambres plénums à une fréquence de perturbation inférieure à approximativement 1000 Hertz.

69. Appareil selon la revendication 32, dans lequel ledit fluide est un gaz.

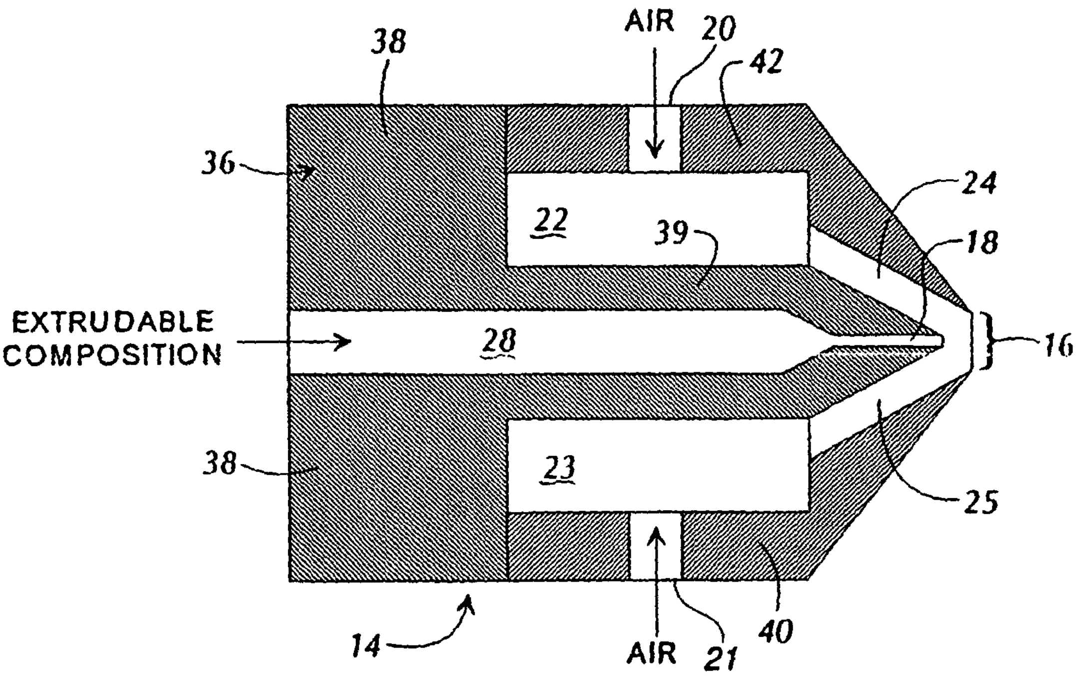
70. Appareil selon la revendication 32, dans lequel ledit fluide est de l'air.



PRIOR ART
FIG. 1A

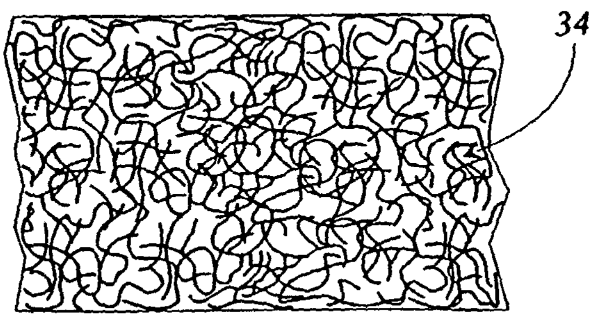


PRIOR ART
FIG. 1B



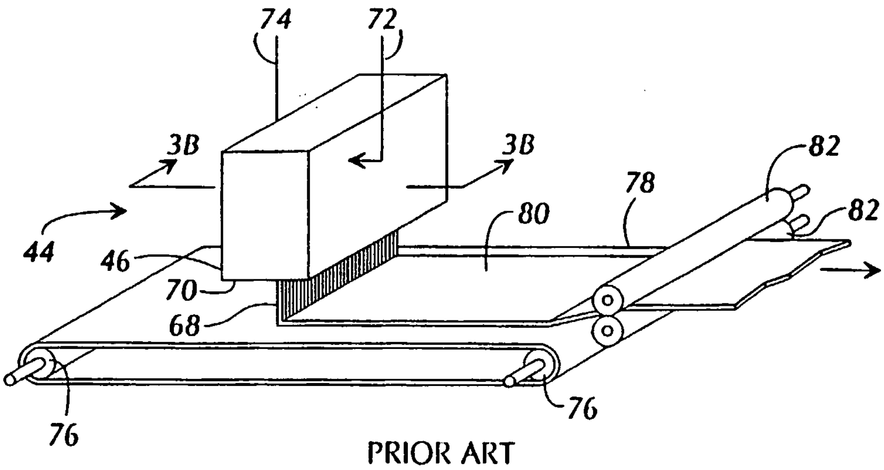
PRIOR ART

FIG. 1C

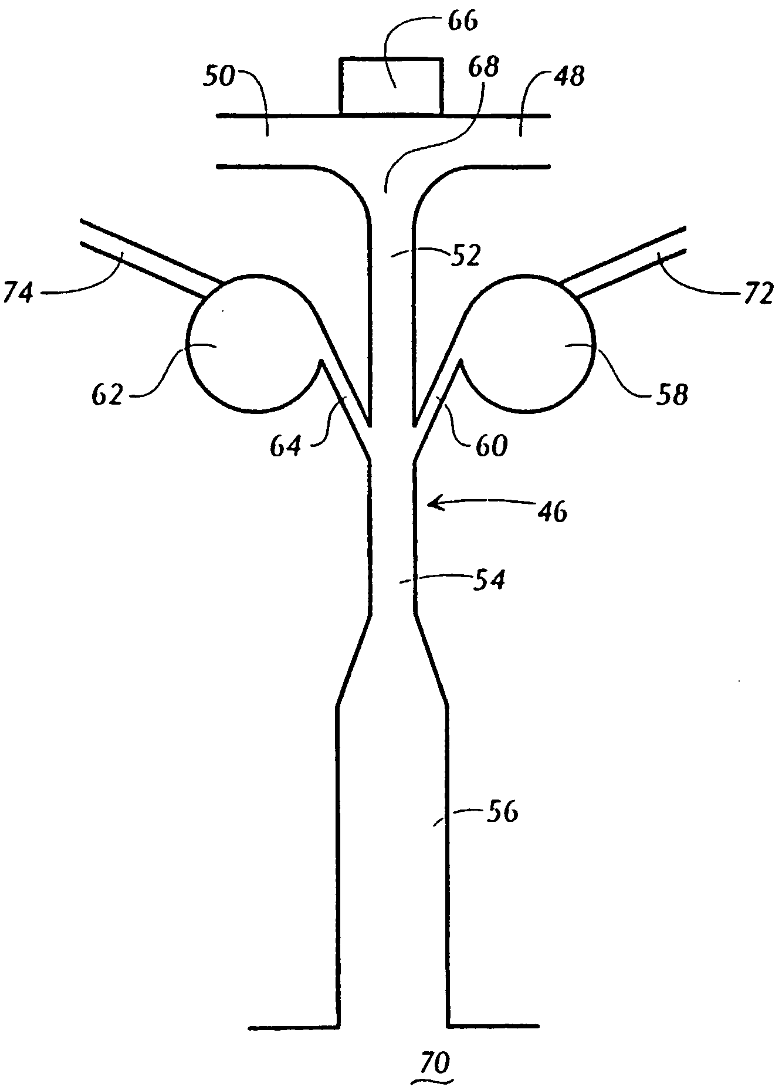


PRIOR ART

FIG. 2



PRIOR ART
FIG. 3A



PRIOR ART
FIG. 3B

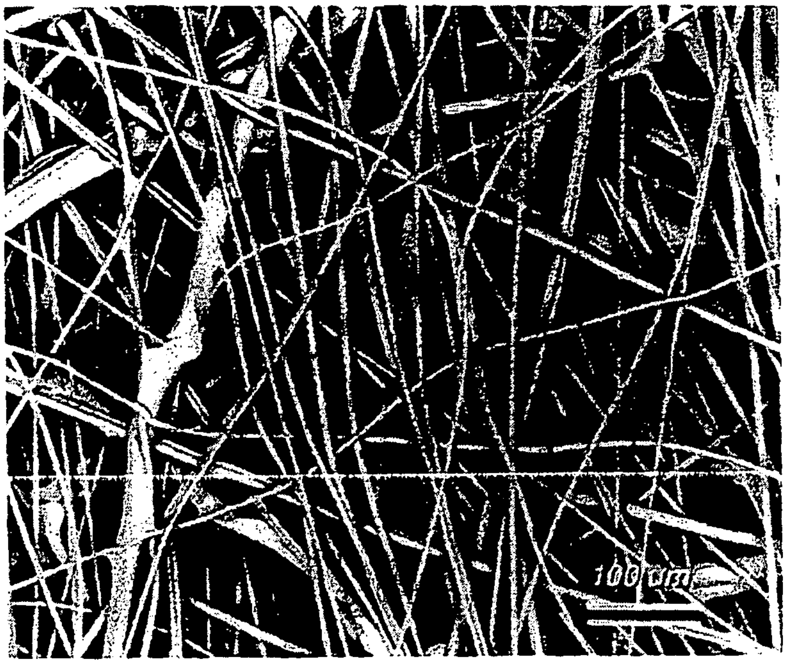


FIG. 4

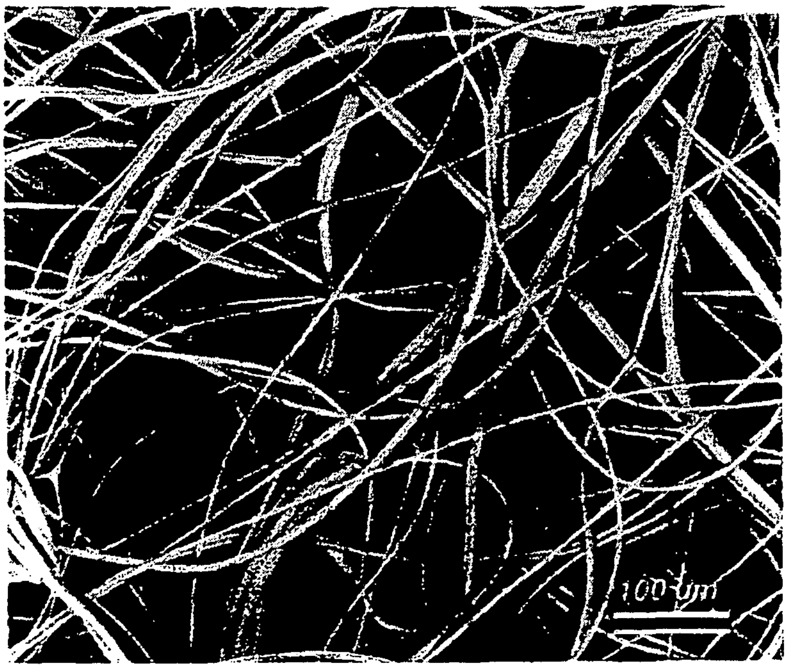


FIG. 5

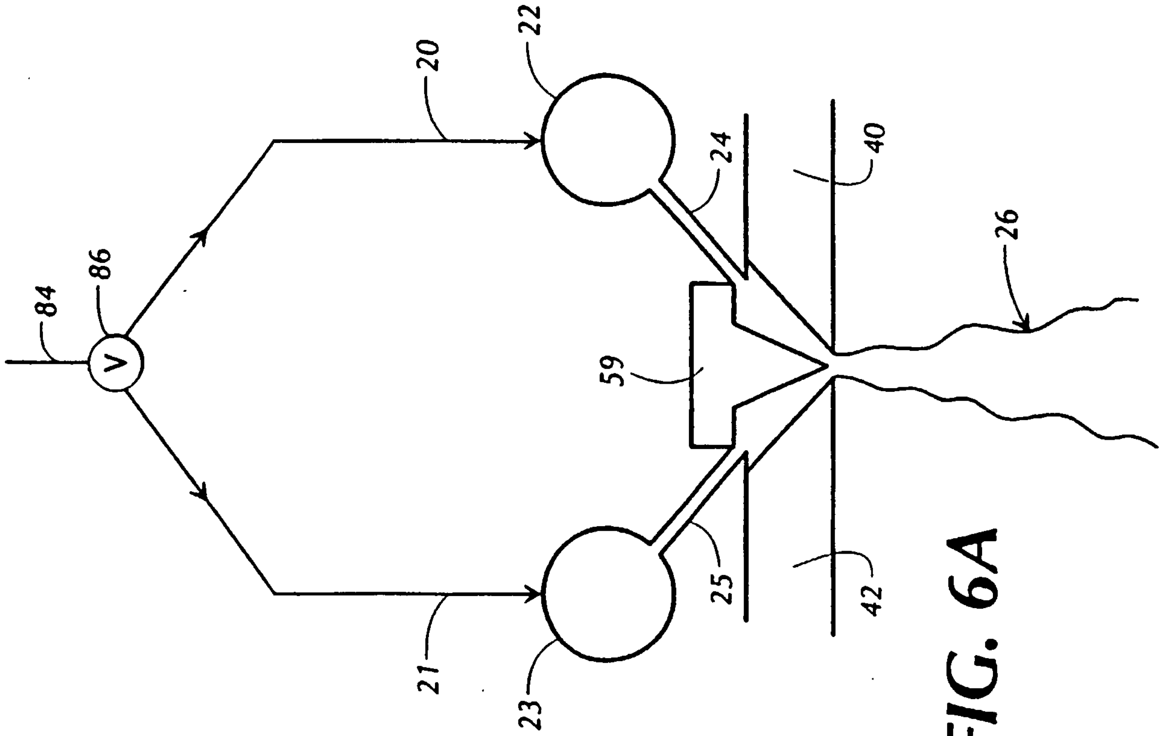

84
86
V
20
22
24
40
26
59
25
42
21
23

FIG. 6A

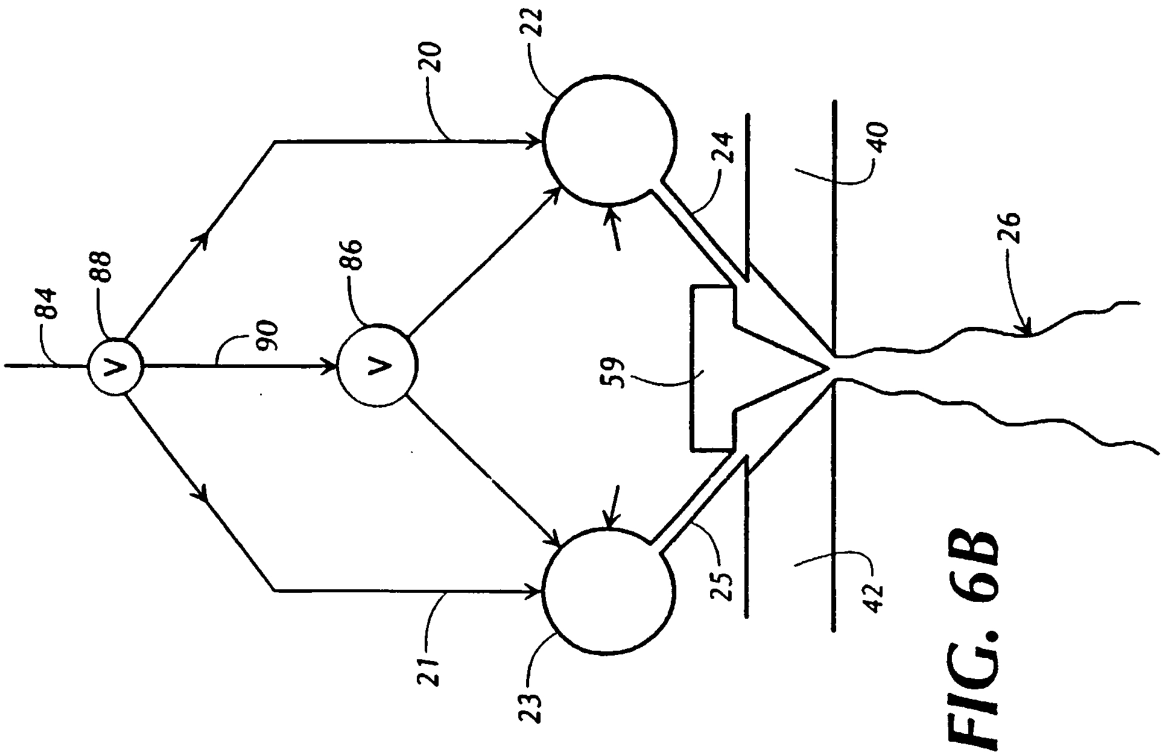

84
88
V
90
86
V
20
22
24
40
26
59
25
42
21
23

FIG. 6B

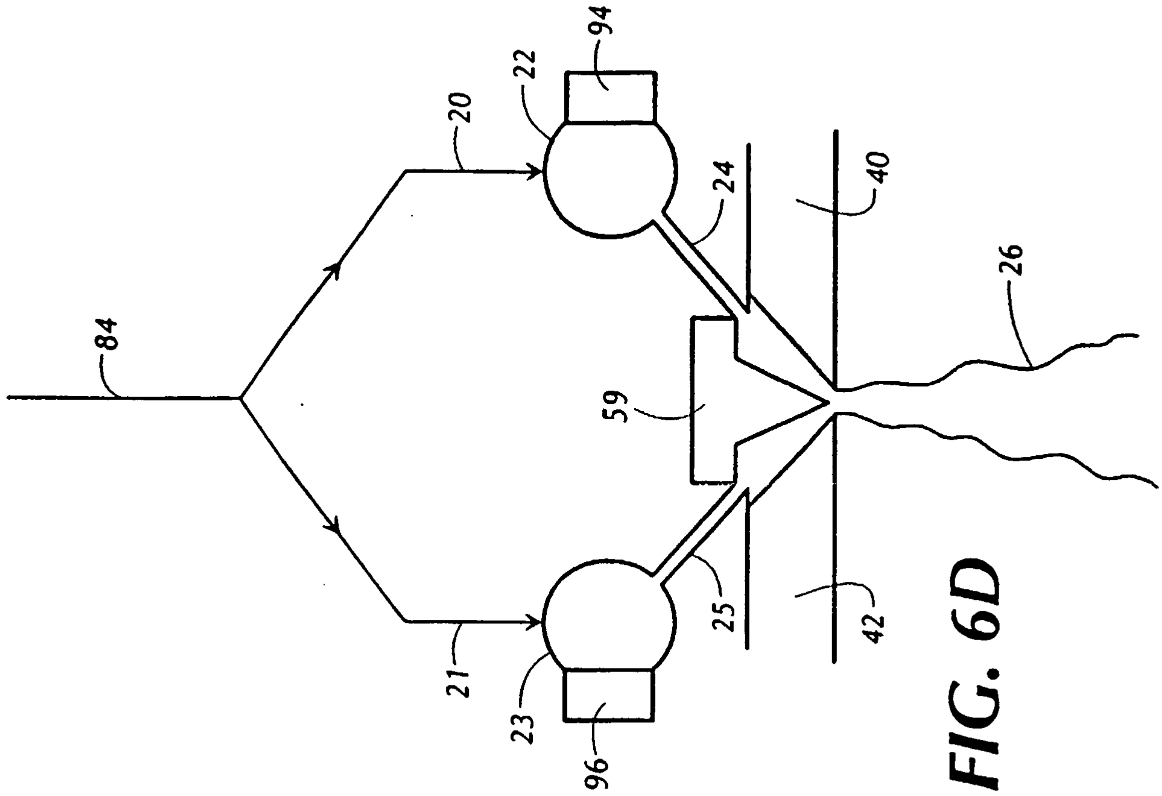

84
20
21
22
23
94
96
24
25
40
42
59
26

FIG. 6D

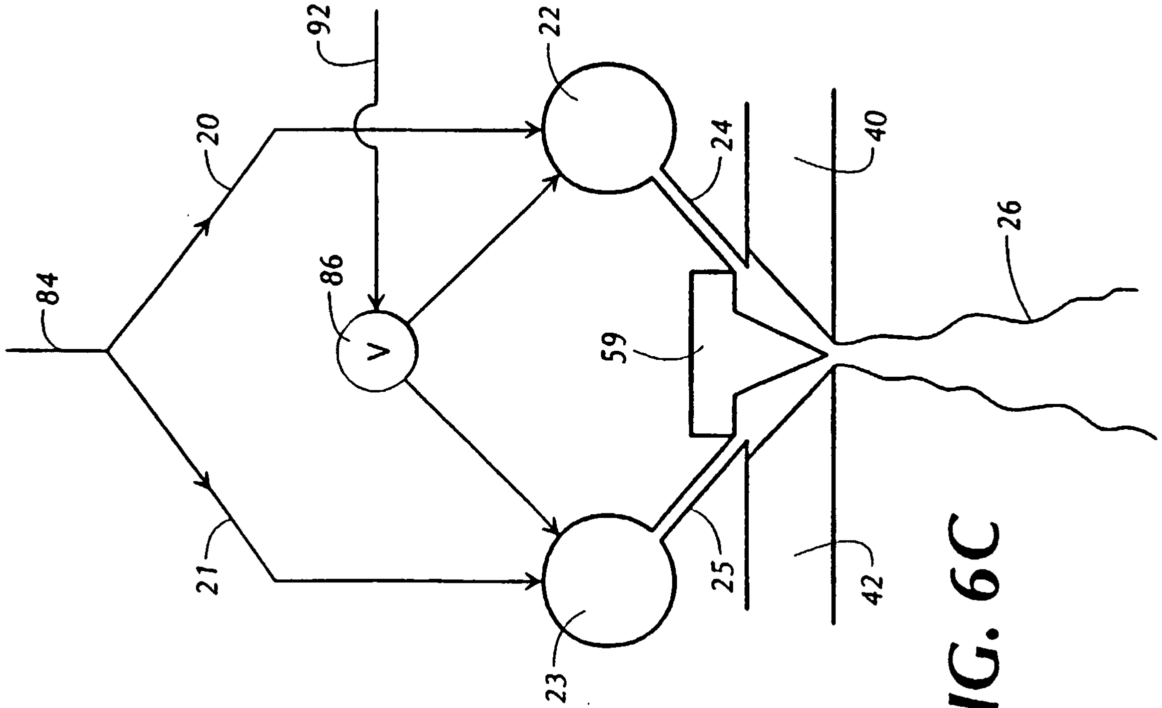

84
20
21
92
86
V
22
23
24
25
40
42
59
26

FIG. 6C

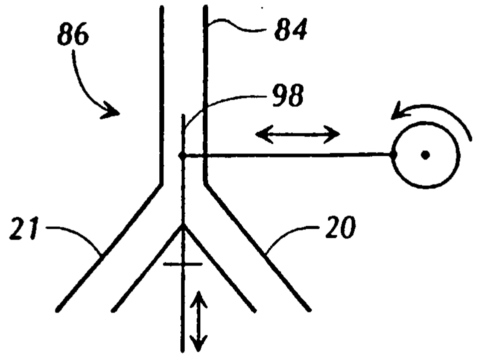


FIG. 7A

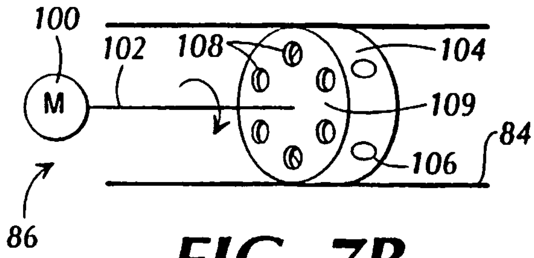


FIG. 7B

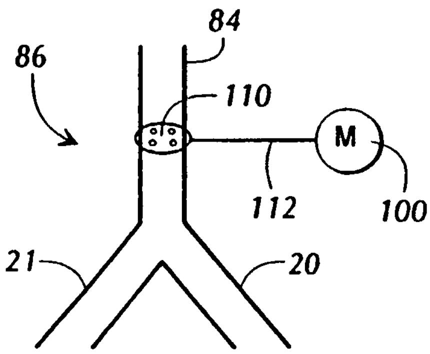


FIG. 7C

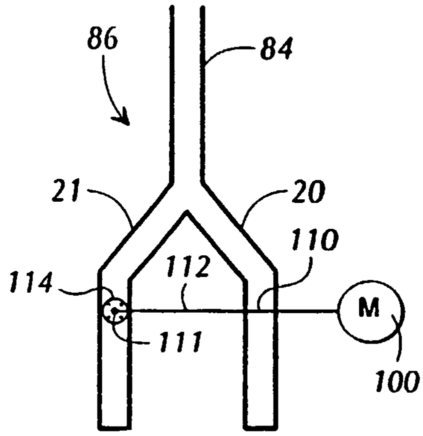


FIG. 7D

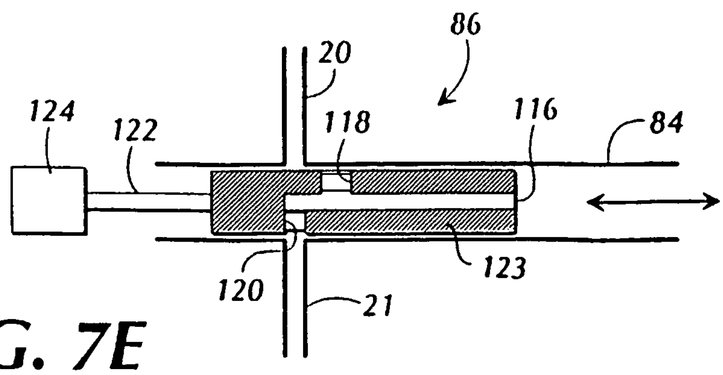


FIG. 7E

PRIOR ART

FIG. 8A

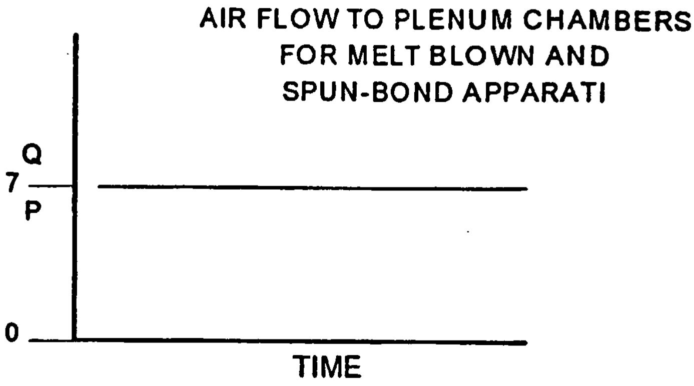


FIG. 8B

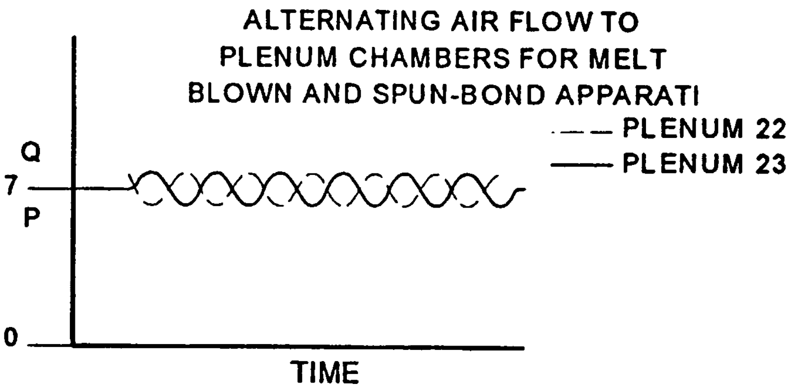
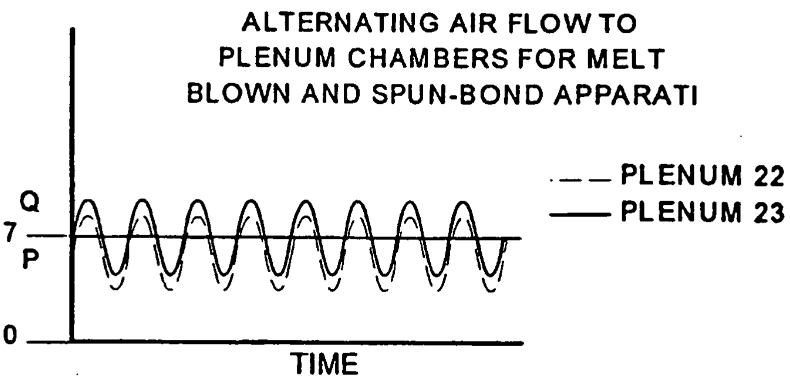
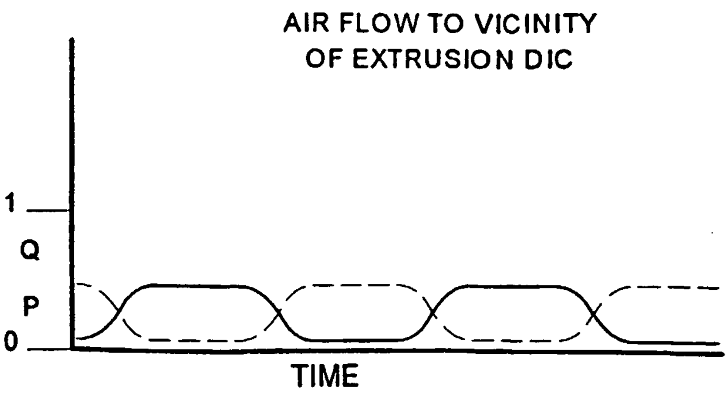


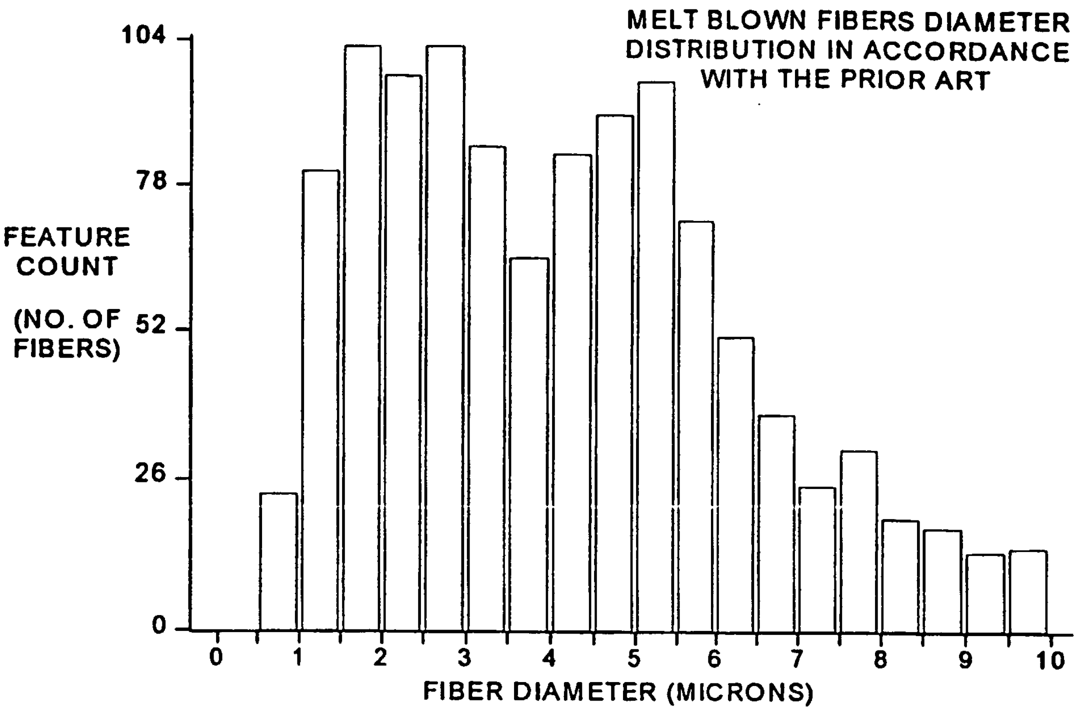
FIG. 8C



PRIOR ART

FIG. 8D





PRIOR ART

FIG. 9

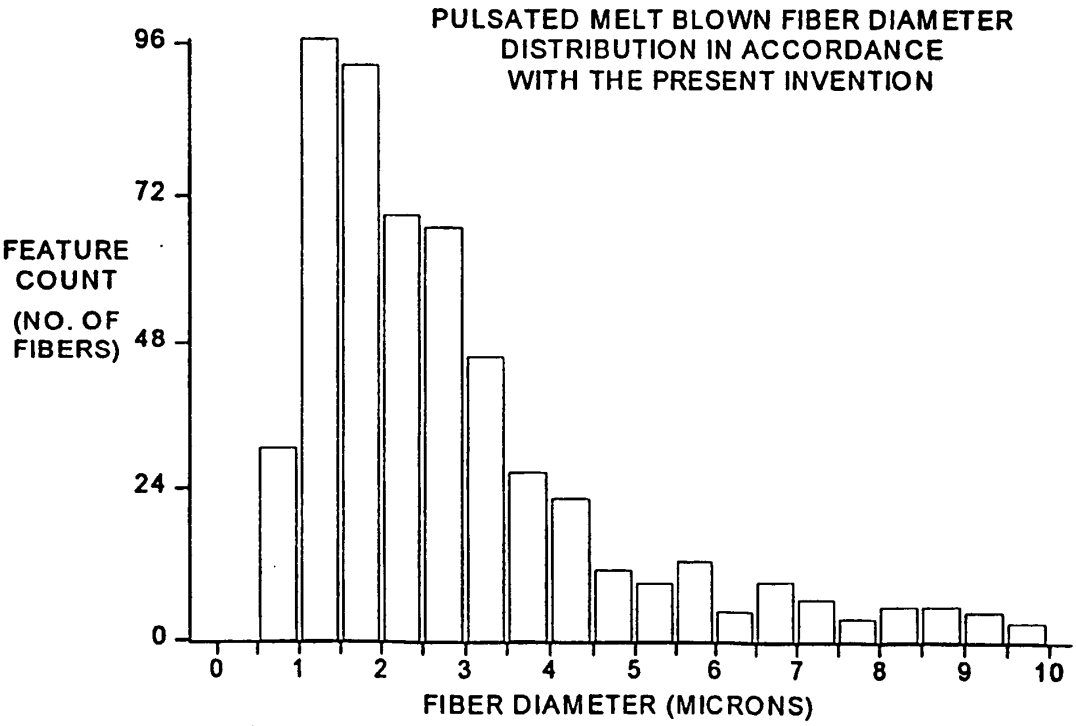
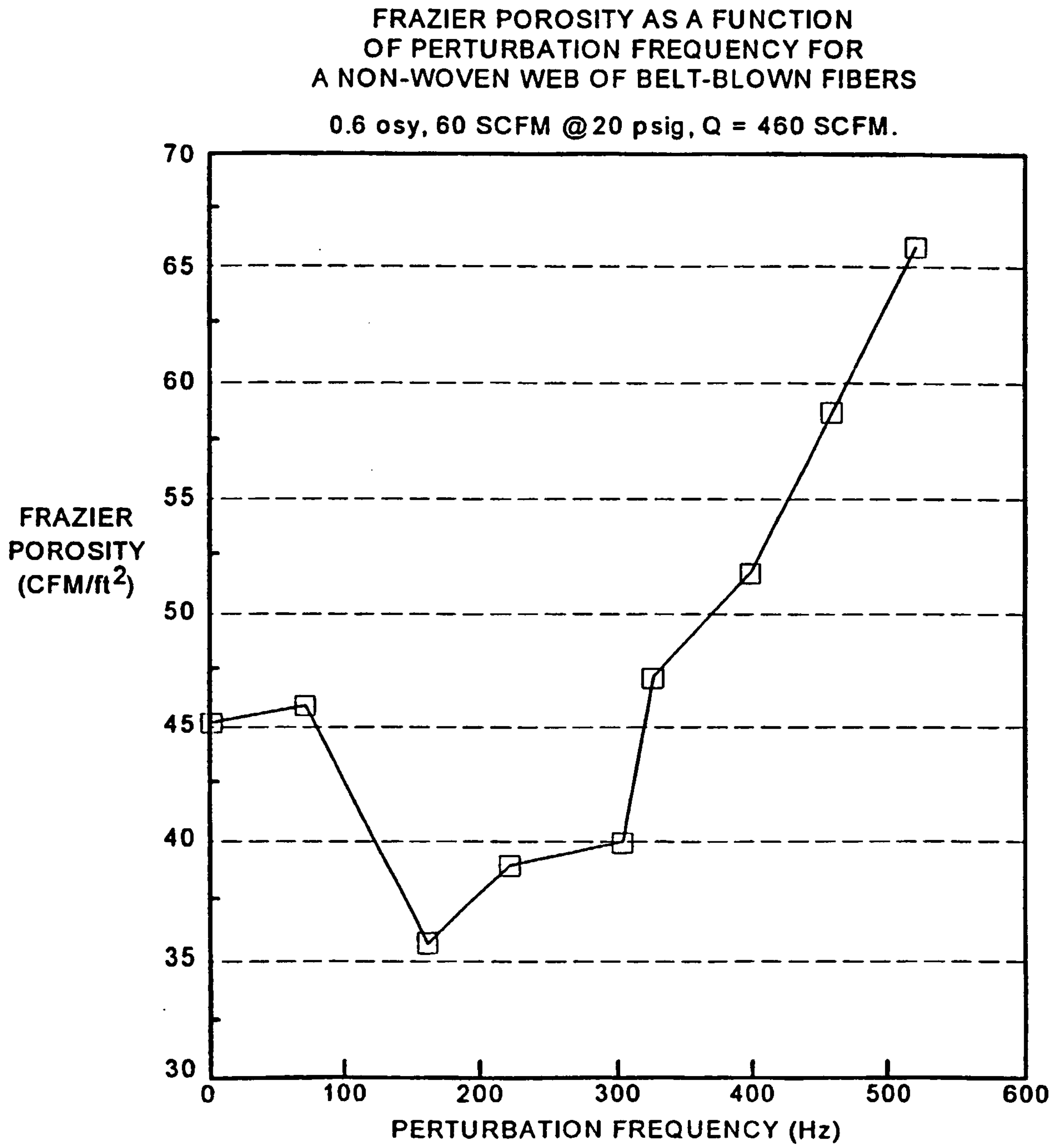


FIG. 10

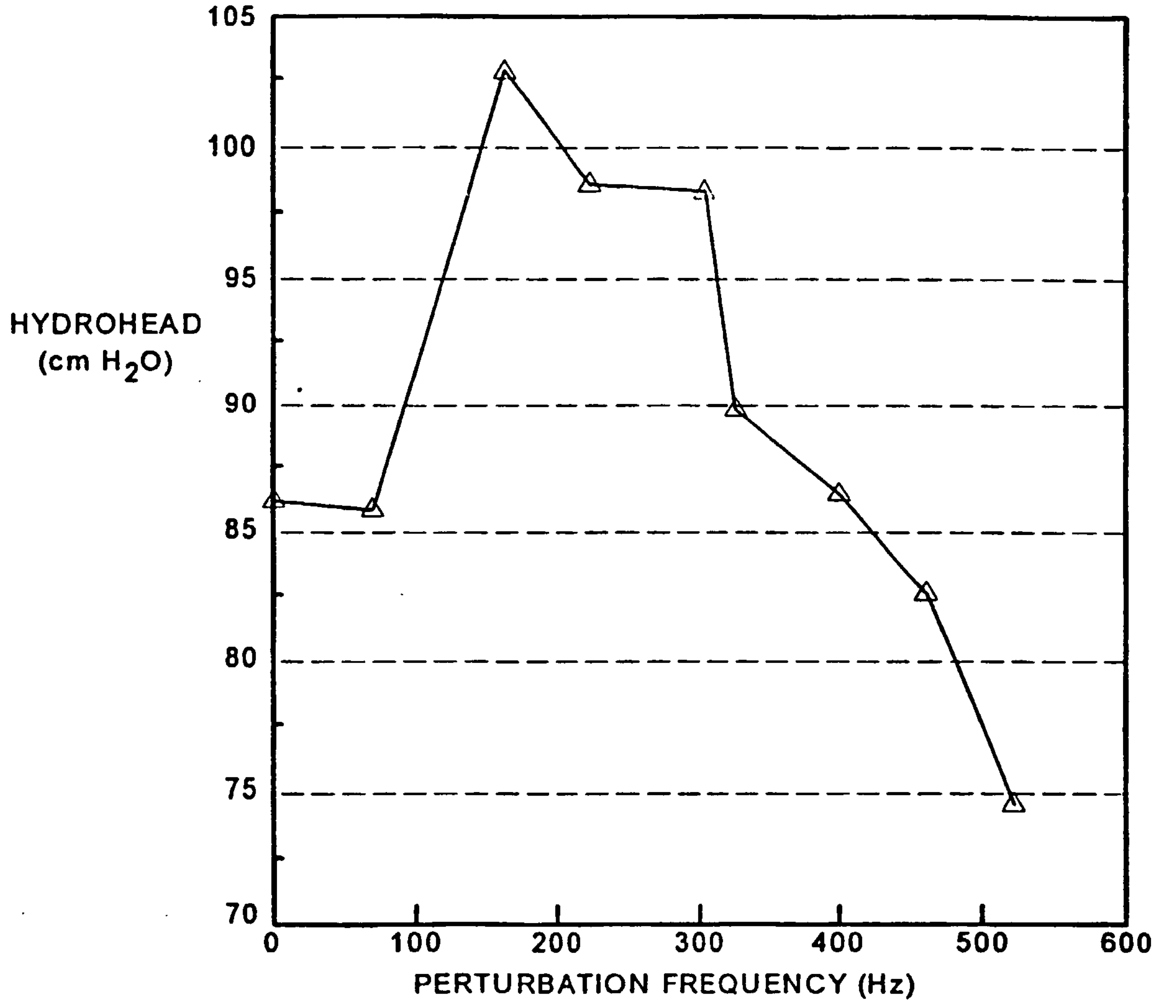


EFFECT OF PERTURBATION FREQUENCY ON FRAZIER POROSITY.

FIG. 11

HYDROHEAD AS A FUNCTION
OF PERTURBATION FREQUENCY FOR A NON-WOVEN
WEB OF MELT-BLOWN FIBERS

0.6 osy, 60 SCFM @20 psig, Q = 460 SCFM.



EFFECT OF PERTURBATION FREQUENCY ON
HYDROHEAD.

FIG. 12

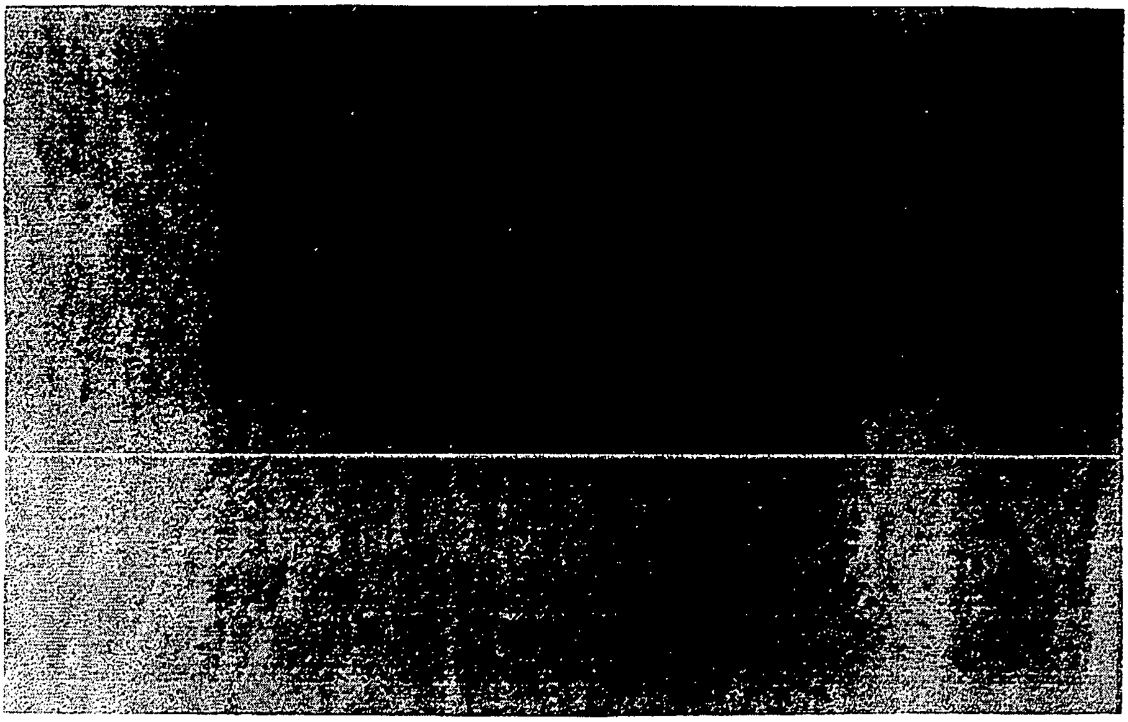


FIG. 13

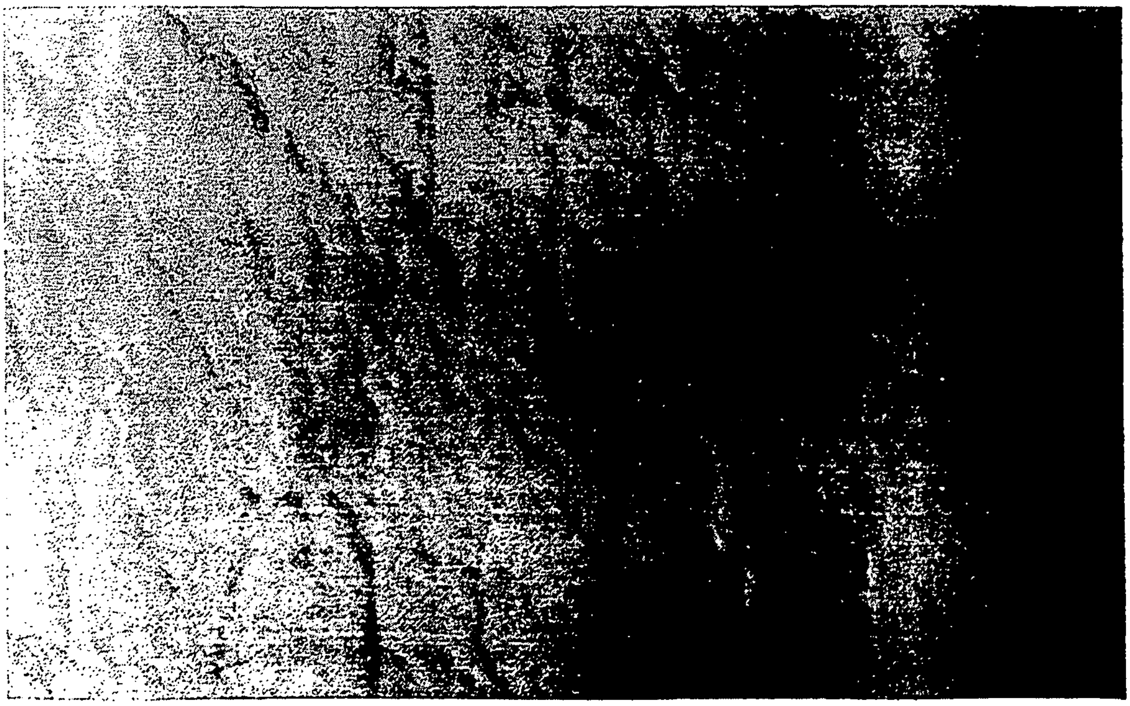
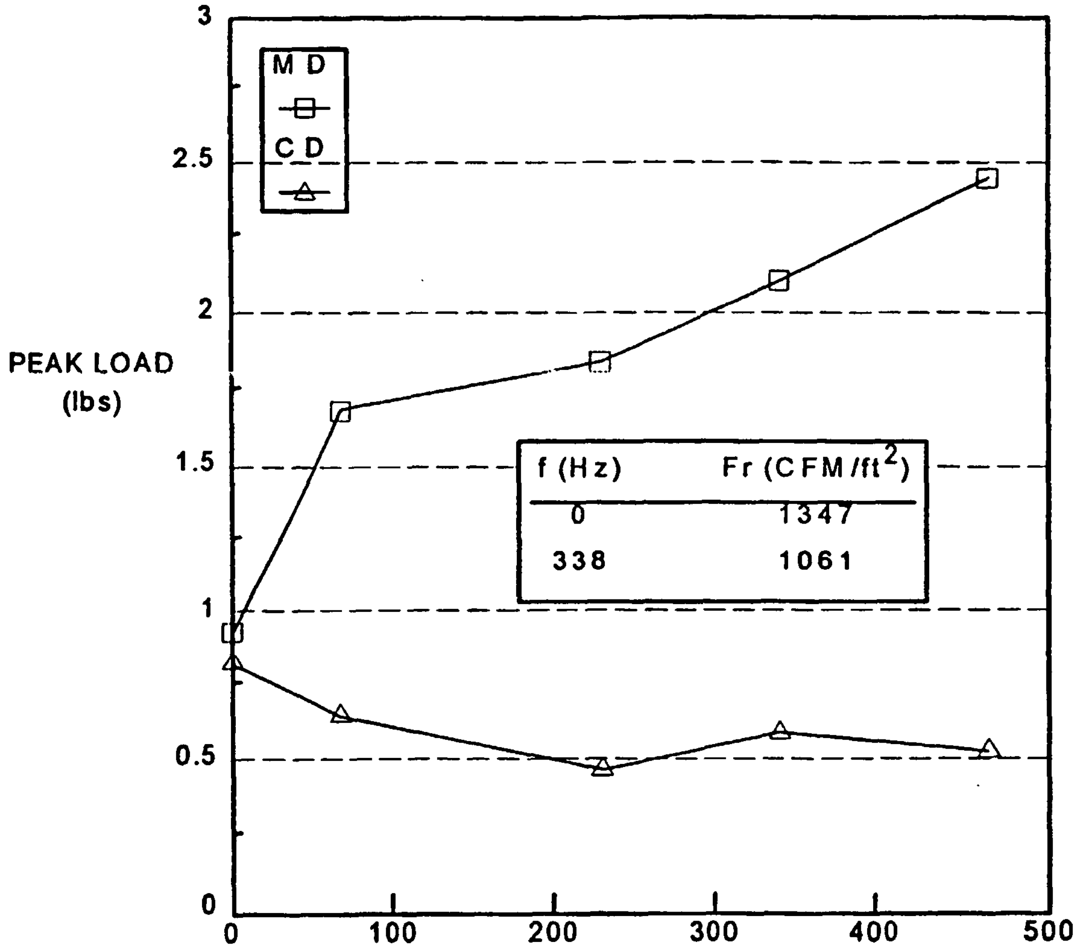


FIG. 14

50 SCFM @ 15 psig. BUNDLE DEFLECTED AT
FDU EXIT WITH AIR KNIVES (MD SWEEP).



VARIATION IN PEAK LOAD WITH FREQUENCY IN A
SPUNDBOUND APPARATUS.

FIG. 15

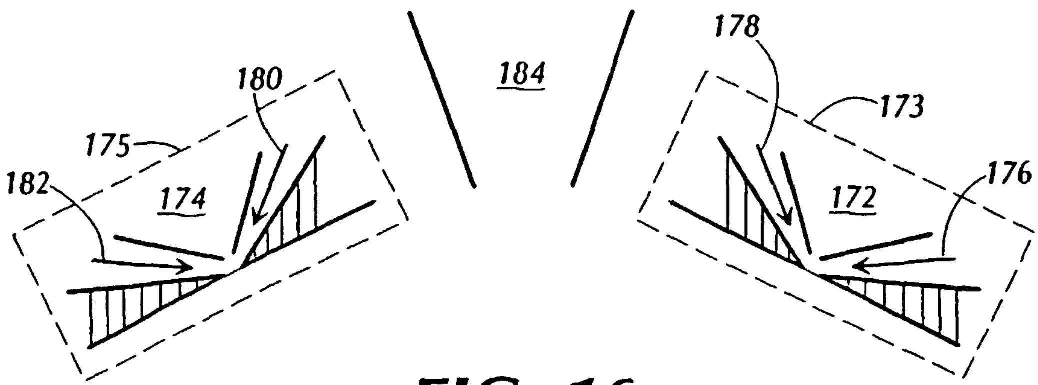


FIG. 16

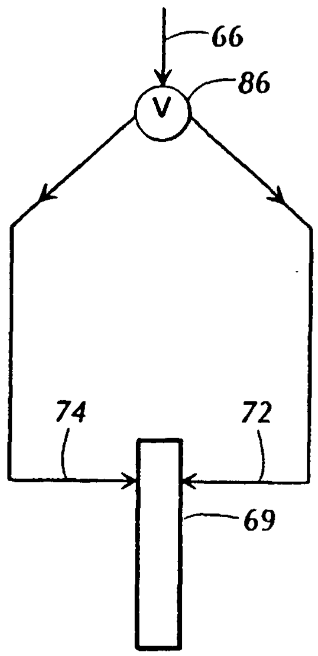


FIG. 17A

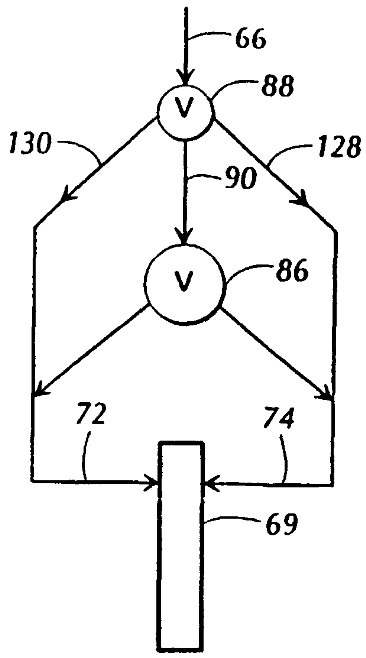


FIG. 17B

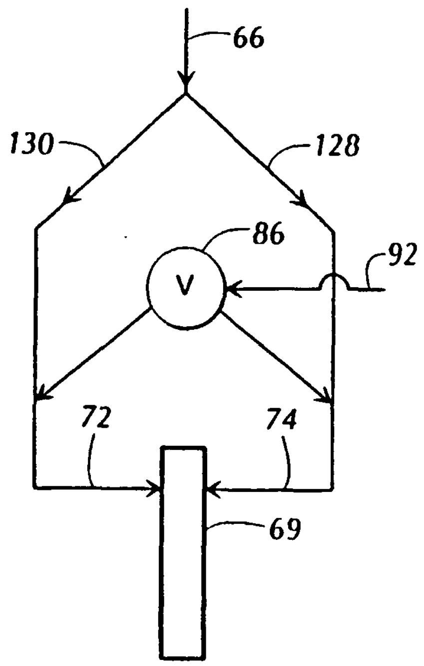


FIG. 17C

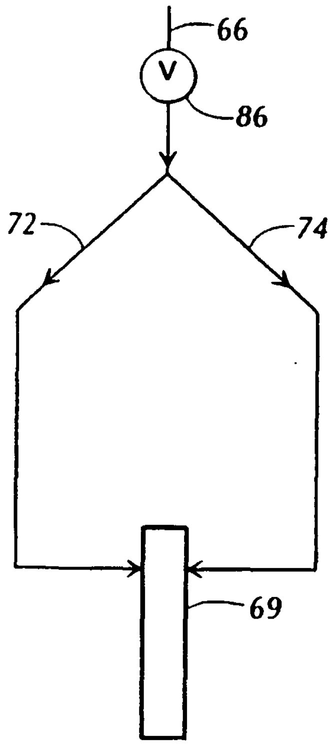


FIG. 17D

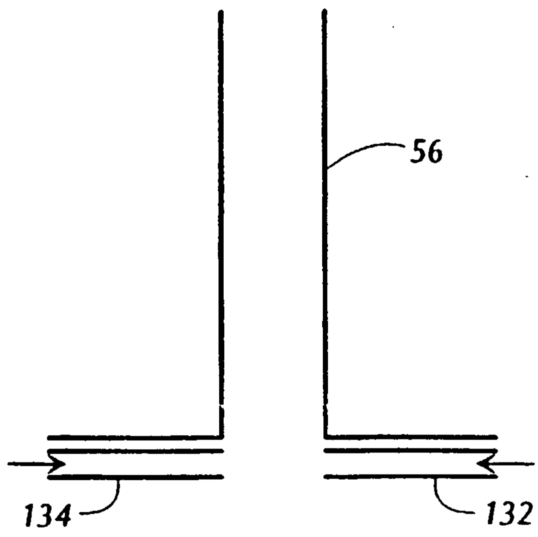


FIG. 18A

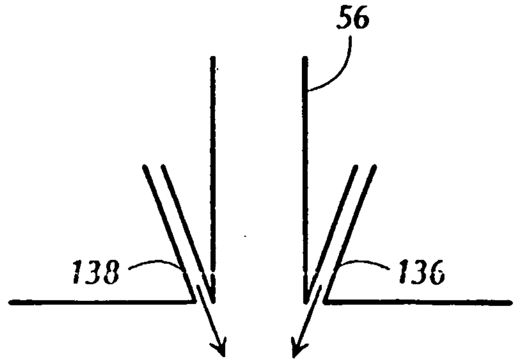


FIG. 18B

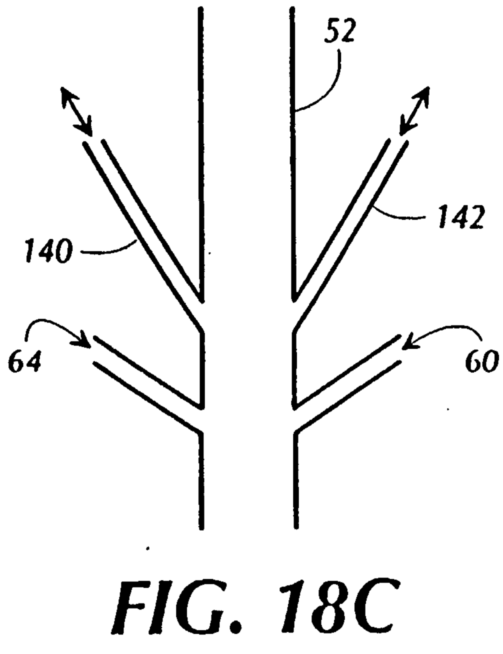


FIG. 18C

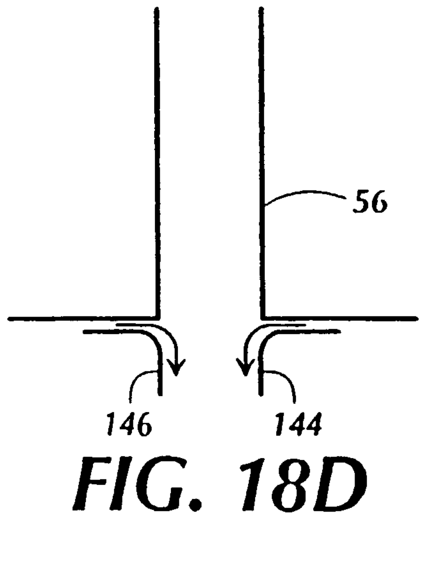


FIG. 18D

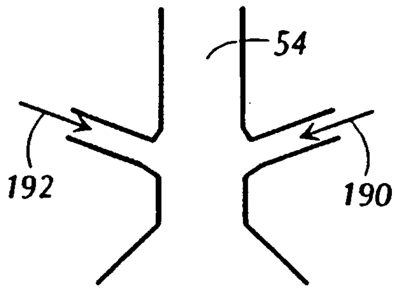


FIG. 18E

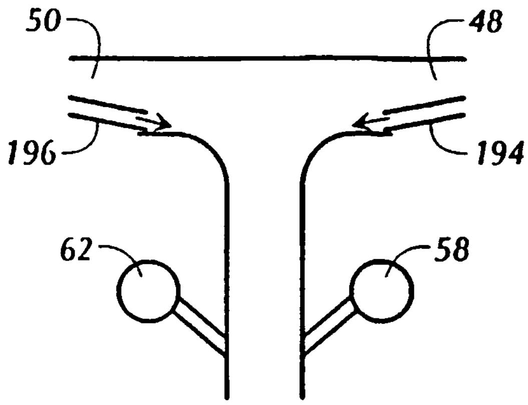


FIG. 18F

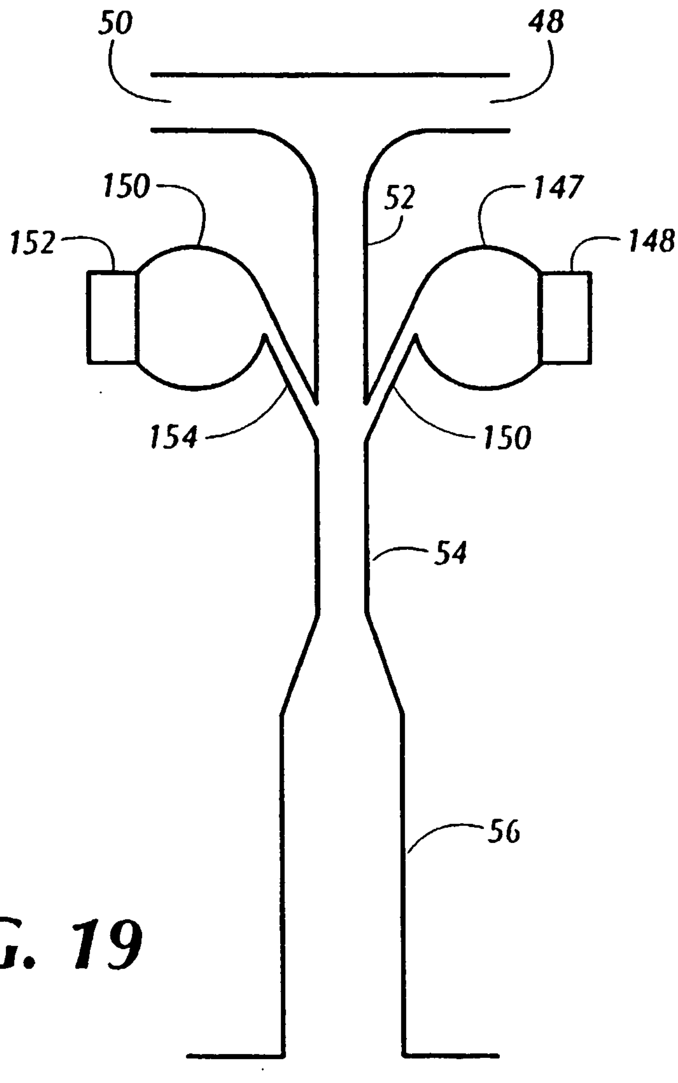


FIG. 19

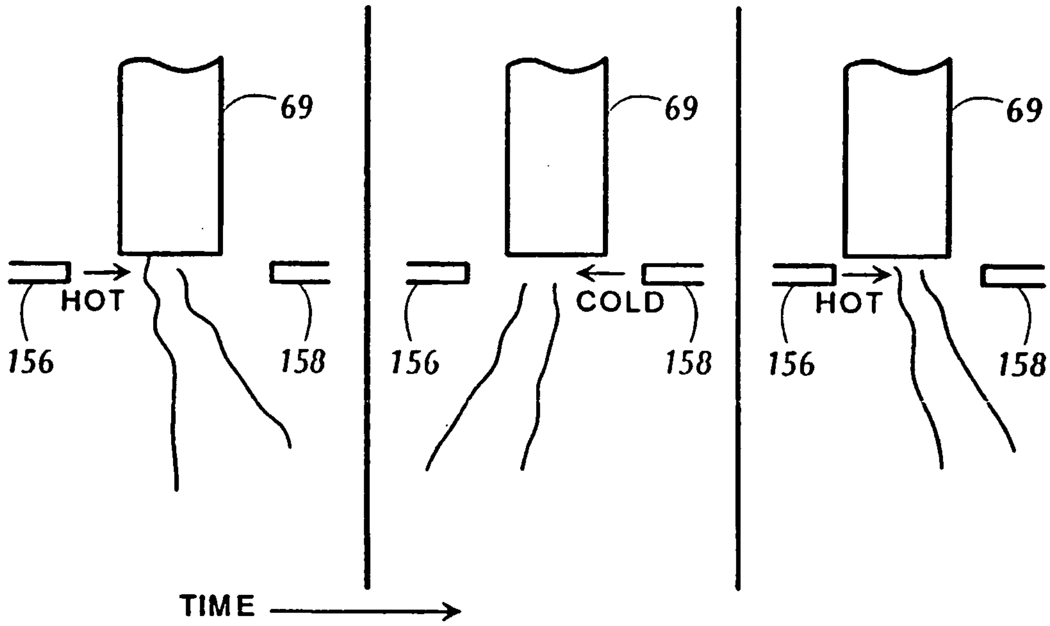


FIG. 20A

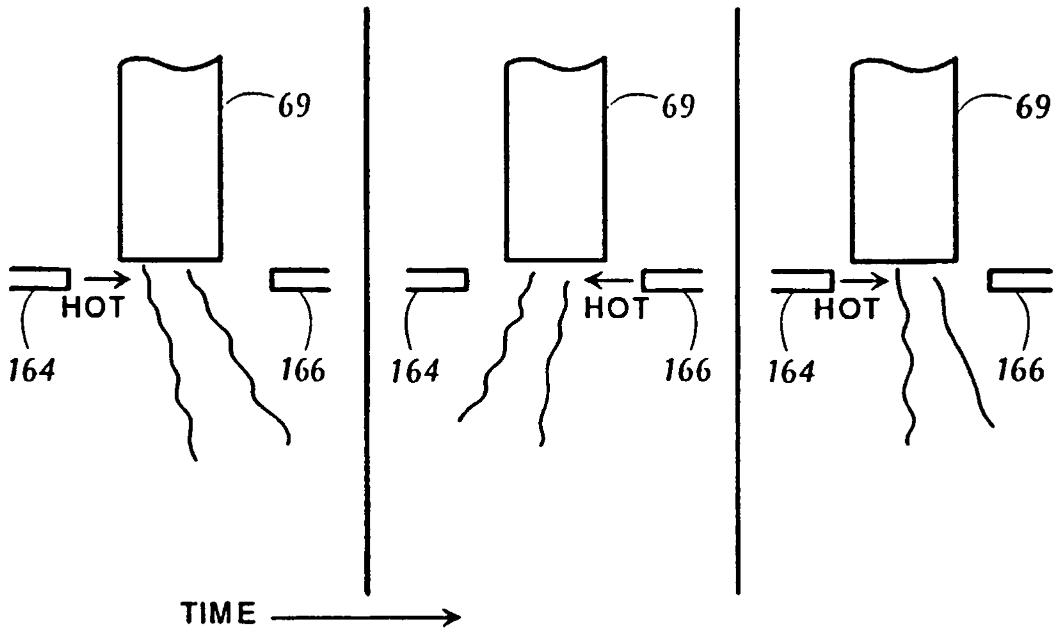


FIG. 20B

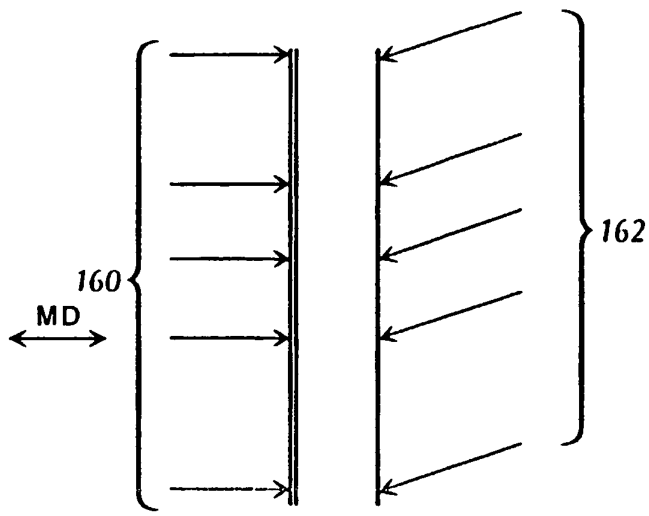


FIG. 21A

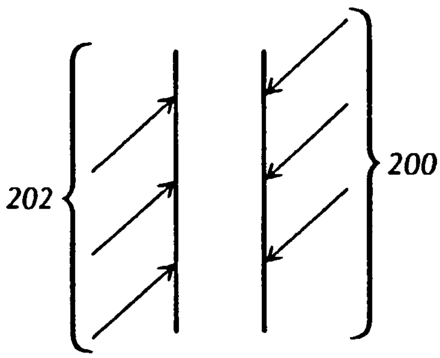


FIG. 21B

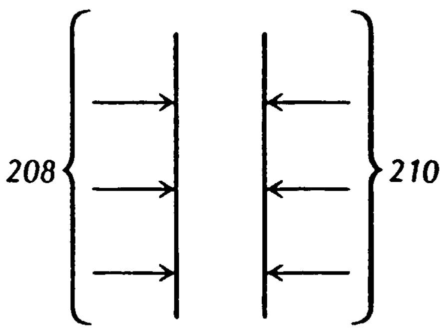


FIG. 21D

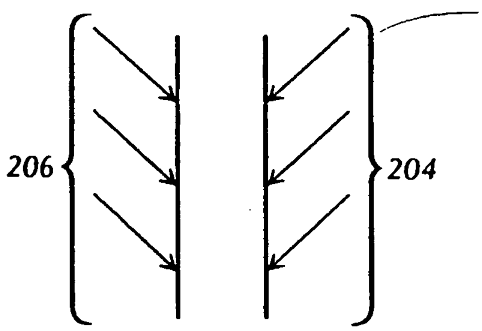


FIG. 21C

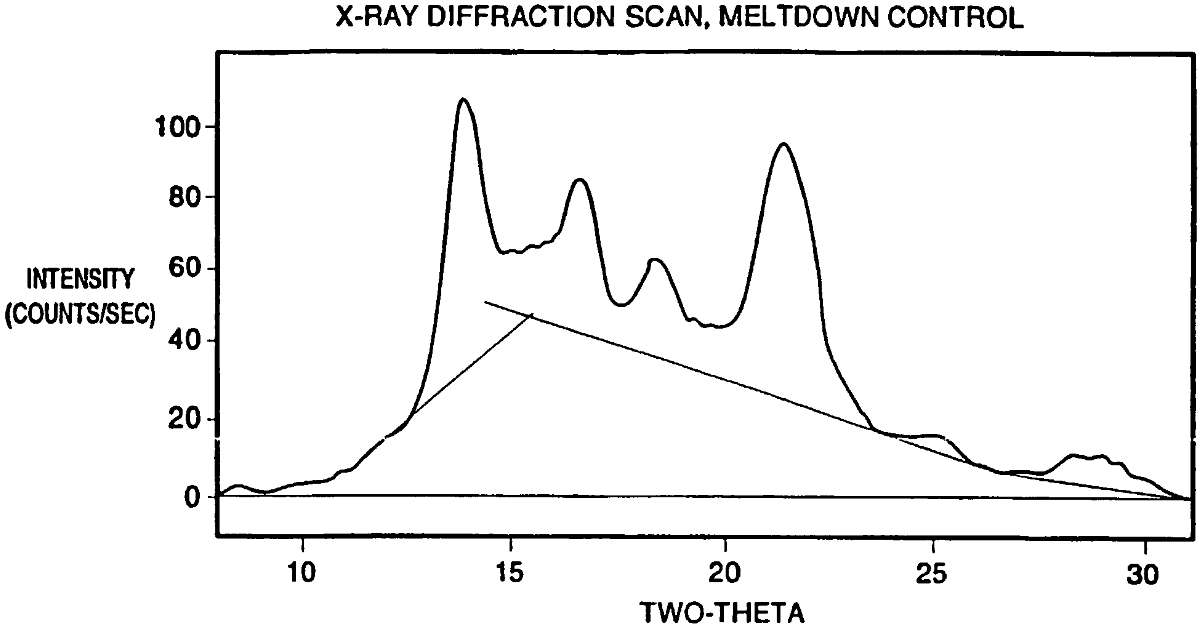

X-RAY DIFFRACTION SCAN, MELTDOWN CONTROL
INTENSITY (COUNTS/SEC)
100
80
60
40
20
0
10
15
20
25
30
TWO-THETA

FIG. 22

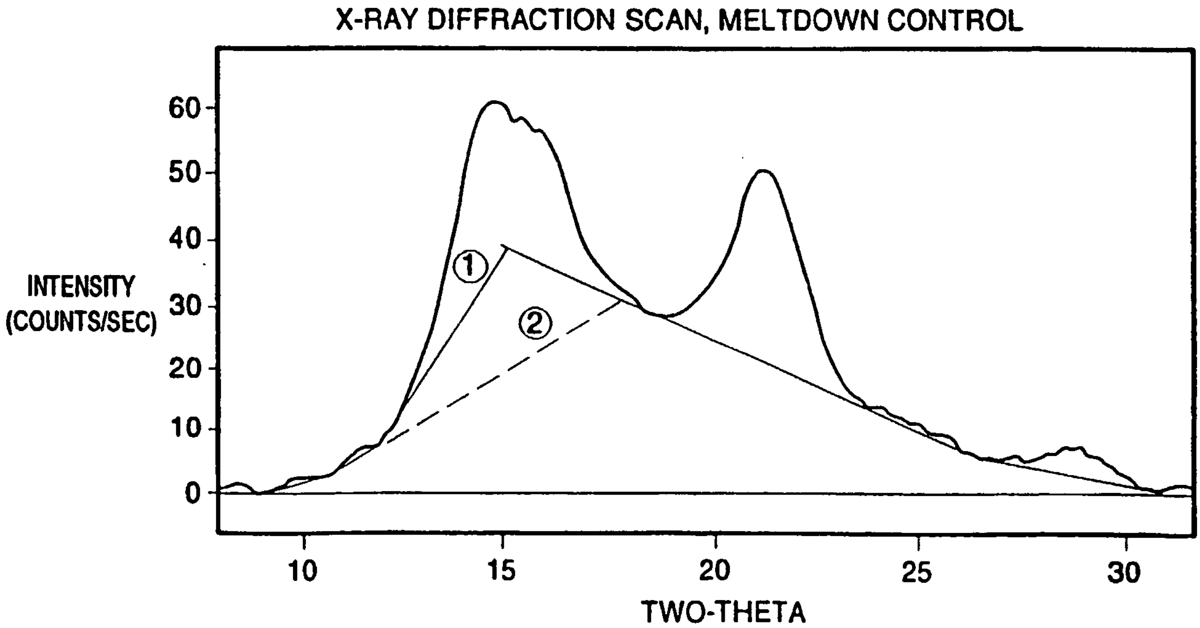

X-RAY DIFFRACTION SCAN, MELTDOWN CONTROL
INTENSITY (COUNTS/SEC)
60
50
40
30
20
10
0
1
2
10
15
20
25
30
TWO-THETA

FIG. 23

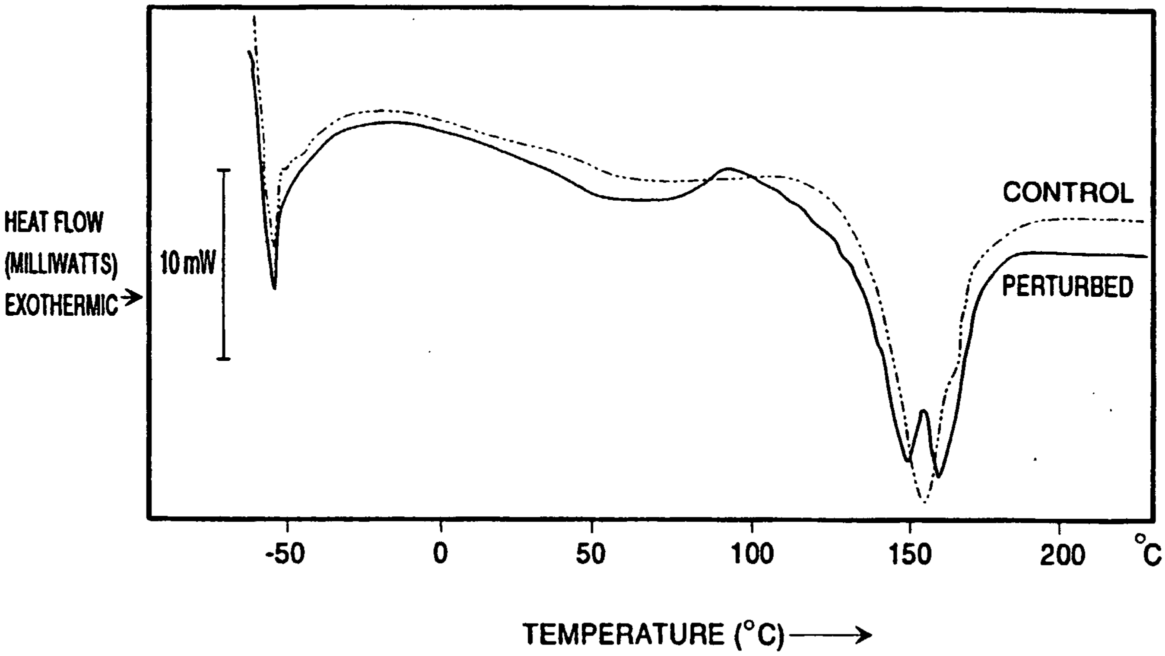

HEAT FLOW
(MILLIWATTS)
EXOTHERMIC
10 mW
CONTROL
PERTURBED
-50
0
50
100
150
200
°C
TEMPERATURE (°C)

FIG. 24

REFERENCES CITED IN THE DESCRIPTION

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- SU 1015013 **[0010]**
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