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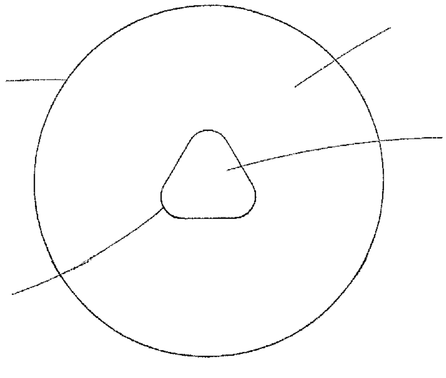
(54) **Title:** SHAPED FIBER FABRICS



(57) **Abstract:** The present invention relates to a fibrous fabric comprising at least one layer comprising a mixture of shaped fibers having two or more different cross sections. The variety of cross sections include solid round fibers, hollow round fibers, multi-lobal solid fibers, hollow multi-lobal fibers, crescent shaped fibers, square shaped fibers, crescent shaped fibers, and any combination thereof. The two or more different shaped fibers will also have two different fiber diameters.

WO 2005/075725 A1

SHAPED FIBER FABRICS

FIELD OF THE INVENTION

The present invention relates to fibrous fabrics comprising substantially continuous mixtures of shaped fibers.

BACKGROUND OF THE INVENTION

Commercial woven and nonwoven fabrics are typically comprised of synthetic polymers formed into fibers. These fabrics are typically produced with solid fibers that have a high inherent overall density, typically in the range of from about 0.9g/cm^3 to about 1.4g/cm^3. The overall weight or basis weight of the fabric is often dictated by a desired opacity and a set of mechanical properties of the fabric to promote an acceptable thickness, strength and protection perception.

One reason for the increased usage of polyolefinic polymers, mainly polypropylene and polyethylene, is that their bulk density is significantly lower than polyester, polyamide and regenerated cellulose fiber. Polypropylene density is around about 0.9g/cm^3, while the regenerated cellulose and polyester density values can be higher than about 1.35g/cm^3. The lower bulk density means that at equivalent basis weight and fiber diameter, more fibers are available to promote a thickness, strength and protection perception for the lower density polypropylene.

Another method of addressing consumer acceptance by increasing the opacity of a fabric is by reducing the overall fiber diameter or denier. In woven fabrics, the spread of "microfiber" technology for improved softness and strength has become fashionable. Other ways to improve opacity along with strength while reducing basis weight and cost at the same time is desired.

SUMMARY OF THE INVENTION

The present invention has found that using mixtures of various shaped fibers provides controllable improvements in opacity, barrier properties, and mechanical properties such as strength. These improvements are seen compared to an equivalent fiber denier and basis weight, through a reduction in overall bulk density of the fiber cross section for nonwovens containing substantially continuous filaments versus the use of solid round fibers. Further, nonwovens comprise a mixture of fiber shapes that can be used to manipulate the mechanical properties of the nonwoven.

The present invention relates to a fibrous fabric comprising at least one layer comprising a mixture of shaped fibers having two or more different cross sections. The variety of cross sections include solid round fibers, hollow round fibers, multi-lobal solid fibers, hollow multi-lobal fibers, crescent shaped fibers, square shaped fibers, crescent shaped fibers, and any combination thereof. The two or more different shaped fibers will also have two different fiber diameters. In one embodiment, at least one of the shaped fibers will have a spunlaid diameter. In other embodiments, at least two or all of the shaped fibers will have a spunlaid diameter. In other embodiments, at least one of the shaped fibers will have a meltblown diameter. The shaped fibers may be produced from at least one spunlaid process comprising a spinpack comprising at least one polymer metering plate and spinneret.

The fibrous fabrics of the present invention may be comprised on a single polymer or may be comprised of more than one polymer. Each shaped fiber may be comprised of a different polymer. One or more of the shaped fibers may be a bicomponent fiber. The ratio of mixed fiber shapes can be adjusted to target a specific opacity in combination with a fabric with specific mechanical properties. Each of the two or more different shaped fibers will typically comprise at least about 5% by weight of the total fibers. The ratio of one shaped fiber to anther may be about 5:95, 10:90, 25:75, or 50:50 or any suitable ratio depending upon desired properties. Typically, the basis weight of the fibrous fabric will be from about 3 gsm to about 70 gsm

Preferably, the fibrous fabric comprising shaped fiber of the present invention may have an opacity and/or mechanical properties higher than a fibrous fabric containing solid round fibers and produced with the same polymeric material, having fibers with an equivalent fiber denier and basis weight. The fibrous fabrics of the present invention comprising shaped fibers may also have an opacity greater than a higher basis weight fibrous fabric containing the same material and having an equivalent fiber denier and/or the same number of fibers. Additionally, the apparent bulk density of the fibrous fabrics of the present invention and comprising shaped fibers may be from about 2% to about 50% lower than the bulk density of a fibrous fabric containing all solid round fibers.

The present invention also relates to nonwoven laminates. The laminate will comprise at least one first layer comprising a mixture of shaped fibers having two or more different cross sections and at least one second layer comprising different fibers. The second layer may be a meltblown layer, nanofiber layer, spunbond layer, and combinations thereof. The second layer may also be a film or any other suitable material depending upon the final use of the product. The fibers in the second layer may be round or shaped as long as they fibers of the second layer are not identical to the fibers of the first layer. In one embodiment of the nonwoven laminate, a first layer containing shaped fibers of the present invention will be laminated on both sides of a meltblown layer. If the first layer contains shaped fibers having spunlaid size diameters, this laminate is commonly referred to as an SMS.

The present invention also relates to disposable nonwoven articles. The articles may comprise a fibrous fabric comprising at least one layer comprising a mixture of shaped fibers having two or more different cross sections. Suitable articles include diaper, a catamenial, and a wipe. When the article is a diaper, the fibrous fabric may be utilized as a topsheet, backsheet, outer cover, leg cuff, ear, side panel covering, or combinations thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawing where:

Figure 1 illustrates a round hollow fiber with a shaped hollow core.

Figure 2 illustrates a round hollow fiber which has a round hollow core.

Figure 3 illustrates several shaped fibers.

Figure 4 illustrates several shaped hollow fibers

Figure 5 illustrates a 90/10 by number trilobal and solid round spinneret with a single sided quench.

Figure 6 illustrates a 50/50 by number trilobal and solid round spinneret with a double sided quench.

Figure 7 illustrates a distribution metering plate that feeds each individual capillary orifice.

Figure 8 illustrates a single melt pump supplying polymer to all metering plates.

Figure 9 illustrates a two pump system for supplying and regulating the polymer flow to each orifice type located in the metering plate.

Figure 10 illustrates a single melt pump extrusion system.

DETAILED DESCRIPTION OF THE INVENTION

All percentages, ratios and proportions used herein are by weight percent of the composition, unless otherwise specified. Examples in the present application are listed in parts of the total composition.

The specification contains a detailed description of (1) materials of the present invention, (2) configuration of the fibers, (3) distribution of fiber mixtures, (4) material properties of the fibers, (5) processes, and (6) articles.

(1) Materials

Thermoplastic polymeric and non-thermoplastic polymeric materials may be used in the present invention. The thermoplastic polymeric material must have rheological characteristics suitable for melt spinning. The molecular weight of the polymer must be sufficient to enable entanglement between polymer molecules and yet low enough to be melt spinnable. For melt spinning, thermoplastic polymers having molecular weights below about 1,000,000 g/mol, preferably from about 5,000 g/mol to about 750,000 g/mol, more preferably from about 10,000 g/mol to about 500,000 g/mol and even more preferably from about 50,000 g/mol to about 400,000 g/mol.

The thermoplastic polymeric materials must be able to solidify relatively rapidly, preferably under extensional flow, and form a thermally stable fiber structure, as typically encountered in known processes such as a spin draw process for staple fibers or a spunbond continuous filament process. Preferred polymeric materials include, but are not limited to, polypropylene and polypropylene copolymers, polyethylene and polyethylene copolymers, polyester, polyamide, polyimide, polylactic acid, polyhydroxyalkanoate, polyvinyl alcohol, ethylene vinyl alcohol, polyacrylates, and copolymers thereof and mixtures thereof. Other suitable polymeric materials include thermoplastic starch compositions as described in detail in U.S. publications 2003/0109605A1 and 2003/0091803. Other suitable polymeric materials include ethylene acrylic acid, polyolefin carboxylic acid copolymers, and combinations thereof.

The shaped fibers of the present invention may be comprised of a non-thermoplastic polymeric material. Examples of non-thermoplastic polymeric materials include, but are not limited to, viscose rayon, lyocell, cotton, wood pulp, regenerated cellulose, and mixtures thereof. The non-thermoplastic polymeric material may be produced via solution or solvent spinning. The regenerated cellulose is produced by extrusion through capillaries into an acid coagulation bath.

Depending upon the specific polymer used, the process, and the final use of the fiber, more than one polymer may be desired. The polymers of the present invention are present in an amount to improve the mechanical properties of the fiber, improve the processability of the melt, and improve attenuation of the fiber. The selection and amount of the polymer will also determine if the fiber is thermally bondable and affect the softness and texture of the final product. The fibers of the present invention may be comprised of a single polymer, a blend of polymers, or be multicomponent fibers comprised of more than one polymer.

Multiconstituent blends may be desired. For example, blends of polyethylene and polypropylene (referred to hereafter as polymer alloys) can be mixed and spun using this technique. Another example would be blends of polyesters with different viscosities or termonomer content. Multicomponent fibers can also be produced that contain differentiable chemical species in each component. Non-limiting examples would include a mixture of 25MFR polypropylene with 50MFR polypropylene and 25MFR homopolymer polypropylene with 25MFR copolymer of polypropylene with ethylene as a comonomer.

Optionally, other ingredients may be incorporated into the spinnable composition. The optional materials may be used to modify the processability and/or to modify physical properties such as opacity, elasticity, tensile strength, wet strength, and modulus of the final product. Other benefits include, but are not limited to, stability, including oxidative stability, brightness, color, flexibility, resiliency, workability, processing aids, viscosity modifiers, and odor control. Examples of optional materials include, but are not limited to, titanium dioxide, calcium carbonate, colored pigments, and combinations thereof. Further additives including, but not limited to, inorganic fillers such as the oxides of magnesium, aluminum, silicon, and titanium may be added as inexpensive fillers or processing aides. Other suitable inorganic materials include, but are not limited to, hydrous magnesium silicate, titanium dioxide, calcium carbonate, clay, chalk, boron nitride, limestone, diatomaceous earth, mica glass quartz, and ceramics. Additionally, inorganic salts, including, but not limited to, alkali metal salts, alkaline earth metal salts and phosphate salts may be used.

(2) Configuration

The fiber shapes in the present invention may consist of solid round, hollow round and various multi-lobal shaped filaments, among other shapes. The multi-lobal shaped filaments may be solid or hollow. The multi-lobal filaments are defined as having more than one critical point along the outer surface of the fiber. A critical point is defined as being a change in the absolute value of the slope of a line drawn perpendicular to the surface of fiber when the fiber is cut perpendicular to the fiber axis. Shaped fibers also include crescent shaped, oval shaped, square shaped, diamond shaped, or other suitable shapes.

Solid round fibers have been known to the synthetic fiber industry for many years. These fibers have an optically continuous distribution of matter across the width of the fiber cross section. These fibers may contain microvoids or internal fibrillation but are recognized as being substantially continuous. There are no critical points for the exterior surface of solid round fibers.

The hollow fibers of the present invention, either round or multi-lobal shaped, will have a hollow region. A solid region of the hollow fiber surrounds the hollow region. The perimeter of the hollow region is also the inside perimeter of the solid region. The hollow region may be the same shape as the hollow fiber or the shape of the hollow region can be non-circular or non-concentric. There may be more than one hollow region in a fiber.

The hollow region is defined as the part of the fiber that does not contain any material. It may also be described as the void area or empty space. The hollow region will comprise from about 2% to about 60% of the fiber. Preferably, the hollow region will comprise from about 5% to about 40% of the fiber. More preferably, the hollow region comprises from about 5% to about 30% of the fiber and most preferably from about 10% to about 30% of the fiber. The percentages are given for a cross sectional region of the hollow fiber (i.e. two dimensional). If described in three dimensional terms, the percent void volume of the fiber will be equivalent to the percent of hollow region.

The percent of hollow region must be controlled for the present invention. The percent hollow is preferably not below 2% or the benefit of the hollow region is not significant. However, the hollow region must not be greater than 60% or the fiber may collapse. The desired percent hollow depends upon the materials used, the end use of the fiber, and other fiber characteristics and uses.

The fiber "diameter" of the shaped fiber of the present invention is defined as the circumscribed diameter of the outer perimeter of the fiber. For a hollow fiber, the diameter is not of the hollow region but of the outer edge of the solid region. For a non-round fiber, fibers diameters are measured using a circle circumscribed around the outermost points of the lobes or edges of the non-round fiber. This circumscribed circle diameter may be referred to as that fiber's effective diameter. Preferably, the fiber will have a diameter of less than 200 micrometers. More preferably the fiber diameter will be from about 3 micrometers to about 100 micrometers and preferably from about 3 micrometer to about 50 micrometers. Fiber diameter is controlled by factors including, but not limited to, spinning speed, mass throughput, temperature, spinneret geometry, and blend composition. The term spundlaid diameter refers to fibers having a diameter greater than about 12.5 micrometers. This is determined from a denier of greater than about 1.0dpf. The basis for using denier in this invention is polypropylene. A polypropylene fiber that is solid round with a density of about 0.900g/cm3 has a diameter of 12.55 micrometers. Spunlaid diameters are typically from about 12.5 to about 200 microns and preferably from about 12.5 to about 150 microns. Meltblown diameters are lower than spunlaid diameters. Typically, meltblown diameters are from about 0.5 to about 12.5 micrometers. Preferable meltblown diameters range from about 1 to about 10 microeters.

The hollow region of the hollow fibers may be of a particular shape. The perimeter or outside edge of the cross section of the hollow region will be substantially non-concentric to the outer perimeter or outer edge of the solid region or hollow fiber. As used herein, the term "non-concentric" is used to mean not having the same center point and/or not having the same shape or curvature (i.e. slope differential). Therefore, a hollow fiber is defined as being non-concentric if either the center point of the hollow region is not the same as the center point of the hollow fiber or if the perimeter of the hollow region is not the same shape or curvature as the outside perimeter of the hollow fiber. Most preferably, the shape of the hollow region is substantially non-circular. For example, the hollow region may be triangular or square in shape. The triangular or square shape will typically have rounded edges.

The shaped fibers of the present invention will have a lower overall apparent bulk density. The apparent bulk density is less than the actual density of the polymeric composition used or of a solid round fiber with the same circumscribed diameter and of the same polymeric composition. The apparent bulk density will be from about 2% to about 50% and preferably from about 5% to about 35% less than the actual density. Apparent bulk density, as used herein, is defined as the density of a shaped fiber with a circular circumscribed diameter as if it were a solid round fiber. The apparent bulk density is less because the mass of the fiber is reduced while the circumscribed volume remains constant. The mass is proportional at the area. For example, the apparent bulk density of a tribal fiber is the circumscribed area of the shaped fiber. Therefore, the apparent bulk density is calculated by measuring the total solid area compared to the total circumscribed area. Similarly, the apparent bulk density of a hollow round fiber is measured by the total circumscribed area of the fiber minus the area of the hollow region. The apparent bulk density of the collection of shaped fibers in a layer can also be calculated.

Without being bound by theory, it is believed that the hollow core allows for increased benefits in optical characteristics which increase opacity. The increase in opacity of the fibrous fabric may be due to changes in at least one light characteristic selected from the group consisting of reflection, refraction, diffraction, absorption, scattering, and combinations thereof. This increase in opacity may be even greater when the fibers are non-concentric hollow fibers versus solid fibers or concentric hollow fibers.

Figures 1 illustrates a round hollow fiber. The shape of the hollow region of this fiber is not round. Figure 2 is used to illustrate a round hollow fiber. As shown, the center of the hollow region and the center of the hollow fiber are the same. Additionally, the shape or curvature of the perimeter of the hollow region and the hollow fiber are the same. Figure 3 illustrates several different shapes of the fibers including various trilobal and multi-lobal shapes. Figure 4 illustrates shaped hollow fiber.

Multi-lobal fibers include, but are not limited to, the most commonly encountered versions such as trilobal and delta shaped. Other suitable shapes of multi-lobal fibers include triangular, square, star, or elliptical. These fibers are most accurately described as having at least one critical point. Multilobal filaments in the present invention will generally have less than about 50 critical points, and most preferably less than about 20 critical points. The multi-lobal fibers can generally be described as non-circular, and may be either solid or hollow.

The mono and multiconstituent fibers of the present invention may be in many different configurations. Constituent, as used herein, is defined as meaning the chemical species of matter or the material. Fibers may be of monocomponent in configuration. Component, as used herein, is defined as a separate part of the fiber that has a spatial relationship to another part of the fiber.

The fibers of the present invention may be multicomponent fibers. Multicomponent fibers, commonly a bicomponent fiber, may be in a side-by-side, sheath-core, segmented pie, ribbon, or islands-in-the-sea configuration. The sheath may be non-continuous or continuous around the core. If present, a hollow region in the fiber may be singular in number or multiple. The hollow region may be produced by the spinneret design or possibly by dissolving out a water-soluble component, such as PVOH, EVOH and starch, for non-limiting examples.

(3) Distribution of Fiber Mixtures

The fiber shapes in the present invention are mixed together in a single layer to provide a synergistic effect versus the presence of solid round fibers alone or a bilayer nonwoven with discrete layers. These effects are manifested in the difference in opacity and fabric mechanical properties.

Due to the need to control fabric opacity and mechanical properties, numerous combinations of fibers shapes mixed together are possible. In general, the fiber mixtures will comprise solid round and hollow round, solid round and multi-lobal, hollow round and multi-lobal, solid round and hollow round and multilobal and combinations thereof.

In order to manifest the additional benefits of fiber mixtures, the minor component of the mixture must be present in sufficient amount to enable differentiation versus 100% isotropically shaped fibers. Therefore, the minor component is present in at least 5 weight% by mass of the total fiber composition. Each of the two different shaped fibers can comprise from about 5% by weight to about 95% by weight. The specific percent of each fiber desired depends upon the use of the nonwoven web and specific shape of the fiber.

(4) Material Properties

The fibrous fabrics of the present invention will have a basis weight and opacity that can be measured. Opacity can be measured using TAPPI Test Method T 425 om-01 "Opacity of Paper (15/d geometry, Illuminant A/2 degrees, 89% Reflectance Backing and Paper Backing)". The opacity is measured as a percentage. The opacity of the fibrous fabric containing hollow fibers will be several percentage points of opacity greater than the fibrous fabric containing solid fibers. The opacity may be from about 2 to about 50 percentage points greater and commonly from about 4 to about 30 percentage points greater.

Basis weight is the mass per unit area of the substrate. Independent measurements of the mass and area of a specimen substrate are taken and calculation of the ratio of mass per unit area is made. Preferably, the basis weight of the fibrous fabrics of the present invention will be from about 1 grams per square meter (gsm) to about 70 gsm depending upon the use of the fabric. More preferable basis weights are from about 2 gsm to about 30 gsm and from about 4 gsm to about 20 gsm.

Additionally, the fibrous fabrics produced from the shaped fibers will also exhibit certain mechanical properties, particularly, strength, flexibility, elasticity, extensibility, softness, thickness, and absorbency. Measures of strength include dry and/or wet tensile strength. Flexibility is related to stiffness and can attribute to softness. Softness is generally described as a physiologically perceived attribute that is related to both flexibility and texture. Absorbency relates to the products' ability to take up fluids as well as the capacity to retain them. The fibrous fabrics of the present invention will also have desirable barrier properties.

(5) Processes

The first step in producing a fiber is the compounding or mixing step. In the compounding step, the raw materials are heated, typically under shear. The shearing in the presence of heat will result in a homogeneous melt with proper selection of the composition. The melt is then placed in an extruder where the material is mixed and conveyed through capillaries to form fibers. The fibers are then attenuated and collected. The fibers are preferably substantially continuous (i.e., having a length to diameter ratio greater than about 2500:1), and will be referred to as spunlaid fibers. A collection of fibers is combined together using heat, pressure, chemical binder, mechanical entanglement, hydraulic entanglement, and combinations thereof resulting in the formation of a nonwoven web or fabric. The nonwoven web or fabric may then be incorporated into an article.

Equipment

An example of the equipment that can be used to produce shaped fibers and nonwovens in the examples came is available at Hills Inc. located in Melbourne, FL. A line used to produce spunlaid shaped fibers and fabrics consist of five main parts: (1) Extruders and melt pumps to melt, mix and meter the polymer component, (2) polymer melt distribution system and spinneret (also referred to as a spin pack system) that delivers a polymer melt(s) to capillaries that have shaped orifices, (3) attenuation device driven by pneumatic air, positive pressure, direct force, or vacuum by which air drag forces act on a polymer stream to attenuate the fiber diameter to smaller than the orifice overall geometric shape, (4) fiber laydown region where fibers are collected underneath the attenuation device in a random orientation (defined by having machine direction and converse direction fiber orientation ratio less than 10), and (5) fiber bonding system that prevents long range collective fiber movement. Numerous companies manufacture fiber and fabric making technologies that can be used for the present invention, non-limiting examples include Hills Inc., Reifenhauser GmbH, Neumag ASON, Reiter, and others.

The extruders and melt pumps will be chosen based on the polymers desired. Figure 8 illustrates a single melt pump extrusion system 10 supplying polymer to all metering plates. This system 10 may be used with a single polymer or a blend of polymers. In Figure 8, the pump 11, pump block 12, pack top 13, filter 14, and filter support plate 15 are all shown. A metering plate 16 and spinneret 17 complete the system.

If two types of different polymers are used to spin fibers, it may be desired to have more control by using a two melt pump extrusion system 20 as shown in Figure 9. This system 20 may have a single extruder or two extruders. The use of two metering or melt pumps 21 is shown in Figure 9 where one pump 21 is used to feed one type of orifice and the second pump 21 is used to feed the other type of orifice. Similar to the single melt pump extrusion system of Figure 11A, a pump block 22, pack top 23, two filters 24, filter support plate 25, metering plate 26, and spinneret 27 complete the system. Each of the two pumps 21 may supply the same polymer, the same polymer with different additives (such as titanium dioxide), or a different polymer blend. The polymer temperatures feed to or from the two pumps 21 may also be adjusted to assist in creating the polymer conditions desired for producing the fibers such as the best cross sections and the desired shear rates.

Figure 10 also illustrates a single melt pump extrusion system. This system 30, which may also be used with a single polymer or a blend of polymers, is similar to the single melt pump system is Figure 8 except for the metering plate is not included. In Figure 10, the pump 31, pump block 32, pack top 33, filter 34, and filter support plate 35 are all shown with a spinneret 37.

The polymer melt may be distributed through the use of a distribution or metering plate. The metering plate may be used to distribute polymer from a filtration area to two types of spin holes placed across the spinneret. The metering plate can be used to help obtain the desired values of pressure drop and sheer rate to produce the desired diameter from a single pressured pool of polymer. Channels in the plate may deliver the polymer to the back side of selected spinneret orifices (the distribution function of the plate), and by selected polymer pressure drop, the channels selectively deliver the desired amount of polymer to the back side of each spinneret orifice (the metering function of the plate).

Figure 7 shows typical etched designs that can be used for distribution, metering and valve plates. Etched metering plates as shown in Figure 7 provide flexible distribution capabilities and can be produced economically. Alternatively, a drilled metering can be used. A drilled metering plate will typically have significant thickness which requires that hole length becomes a part of the pressure drop calculations. Therefore, different diameter holes can be used to adjust the flow rate through the drilled metering plate/spinneret combination to adjust the deniers of the two types of filaments being spun from the same melt pool. By using different metering plates, different denier ratios between the two types of spin holes can be obtained without requiring a new spinneret. Further examples of suitable metering plates and the low cost etching process are disclosed in U.S. Patent No. 5,162,074.

A metering plate is not required in the present invention but may be desired to add more control to the system. Other methods of distributing and metering polymer to the spinneret orifices may be used as long as the pressure drop, shear rate and jet stretch are controlled. The jet stretch is the ratio of the maximum spinning velocity of the fibers to the velocity of the polymer at the exit of the spinneret hole.

Figures 5 and 6 show examples of spinnerets that can be used to make the mixed shaped fibers. These figures show ratios from about 90/10 to about 50/50. The ratio of fibers can range from about 95/5 to about 5/95. The spinnerets may also have more than two different shapes of fibers such as a 25/40/35 ratio of trilobal, solid round, and hollow round.

It may be desired in some examples to control the orientation of the spinneret holes. Figure 5 illustrates a one-sided quench. It may be desired to have the tip of the trilobal filaments (or other multi-lobal filaments) are oriented into the quench flow as shown in Figure 5. This orientation may allow the quench air to contact the majority of all lobes, resulting in the most uniform quenching and physical properties for the fiber. This orientation also prevents the quench air from rotating the trilobal fibers which would cause turbulence and filament to filament collisions in the spinning process. A two sided quench, as shown in Figure 6, is often preferred in spunbond processing. For a two sided quench, it may be preferable to re-orient the direction of the trilobal filaments in the center of the spinneret so that the tips are oriented toward the closest source of quench air as shown in Figure 6. The orientation of the multilobal orifices should be controlled for spinnerets having more than one multilobal orifice per $1 cm^2$.

The location of the shaped fibers within the spinneret may also be controlled. The round holes, which are less costly to manufacture and easier to have good spinning with fewer breaks, may be positioned on the ends of the spinneret. The ends, or outside or middle rows, are where turbulence is greatest and the multilobal fibers may spin and tangle more. Also, the ends are typically where edges are trimmed for recycle or wasted. One example of such an arrangement is shown in Figure 6. The shaped fiber orifices can be arranged in hole patterns that are not straight rows of holes or in any suitable arrangement to help minimize turbulence and to maximize quench rate and stable processing.

It may be desired that the flexible spin pack system can be retrofitted to existing spunlaid lines. The term spunlaid is used to describe a spinning system that includes the extruder, polymer metering system, spinpack, cooling section, fiber attenuation, fiber laydown and deposition onto a belt or drum and vacuum. The spunlaid system does not denote the type of fiber consolidation. A spunbond line includes a spunlaid line and thermal point bonding. The equipment before the fiber consolidation or identical on a spunbond line or spunlaid line.

In the present invention the fiber mixtures are produced by distributing the various orifice geometries across the spinneret face to produce a relatively uniform fiber distribution of shapes on fiber laydown through their spatial location across the spinneret face. Several examples are shown for illustration although the particular geometries are endless.

Spinning

The present invention utilizes the process of melt spinning in its most preferred embodiment. In melt spinning, there is no intentional mass loss in the extrudate. Solution spinning may be used for producing fibers from cellulose, cellulosic derivatives, starch, and protein.

Spinning will occur at 100°C to about 350°C. The processing temperature is determined by the chemical nature, molecular weights and concentration of each component. Fiber spinning speeds of greater than 100 meters/minute are required. Preferably, the fiber spinning speed is from about 500 to about 14,000 meters/minute. The spinning may involve direct spinning, using techniques such as spunlaid or meltblown, as long as the fibers are mostly continuous in nature. Continuous fibers are hereby defined as having length to width ratio greater than about 2500:1.

The fibers and fabrics made in the present invention often contain a finish applied after formation to improve performance or tactile properties. These finishes typically are hydrophilic or hydrophobic in nature and are used to improve the performance of articles containing the finish. For example, Goulston Technologies' Lurol 9519 can be used with polypropylene and polyester to impart a semi-durable hydrophilic finish.

(6) Articles

The shaped fibers may be converted to fabrics by different bonding methods. In a spunbond or meltblown process, the fibers are consolidated using industry standard spunbond type technologies. Typical bonding methods include, but are not limited to, calender (pressure and heat), thru-air heat, mechanical entanglement, hydraulic entanglement, needle punching, and chemical bonding and/or resin bonding. Thermally bondable fibers are required for the pressurized heat and thru-air heat bonding methods. Fibers may also be woven together to form sheets of fabric. This bonding technique is a method of mechanical interlocking.

The mixture of shaped fibers of the present invention may also be bonded or combined with thermoplastic or non-thermoplastic nonwoven webs or with film webs to make various articles. The polymeric fibers, typically synthetic fibers, or non-thermoplastic polymeric fibers, often natural fibers, may be used in discrete layers. Suitable synthetic fibers include fibers made from polypropylene, polyethylene, polyester, polyacrylates, and copolymers thereof and mixtures thereof. Natural fibers include lyocell and cellulosic fibers and derivatives thereof. Suitable cellulosic fibers include those derived from any tree or vegetation, including hardwood fibers, softwood fibers, hemp, and cotton. Also included are fibers made from processed natural cellulosic resources such as rayon.

The single layer of shaped fibers of the present invention may be utilized by itself in an article, or the layer may be combined with other nonwoven layers or a film layer to produce a laminate. Examples of suitable laminates include, but are not limited to spunbond-meltblown-spunbond laminates. Because of the higher opacity and control over the mechanical properties, a spunbond layer of shaped fibers may have a lower basis weight than a typical spunbond layer made of only solid round fibers, but still provide the same opacity and mechanical properties as the higher basis weight solid round fiber layer. Alternatively, a shaped fiber layer may be utilized which enables the basis weight or denier of the meltblown layer to be reduced or can eliminate the need for a meltblown layer. A spunbond layer of the shaped fibers of the present invention can also be used in a spundbond-nanofiber-spundbond laminate. The shaped fiber layer can be used as both spunbond layers or only as one spunbond layer. Each separate layer in a nonwoven is identified as a layer that is produced with a different composition of fibers. As described in the present invention, a single layer may have a combination of different fiber shapes, diameter, configuration, and compositions. The shaped fiber nonwoven layer may also be combined with a film web. These laminates are useful as backsheet and other barriers on disposable nonwoven articles.

The shaped fibers of the present invention may be used to make nonwovens, among other suitable articles. Nonwoven or fibrous fabric articles are defined as articles that contain greater than 15% of a plurality of fibers that are non-continuous or continuous and physically and/or chemically attached to one another. The nonwoven may be combined with additional nonwovens or films to produce a layered product used either by itself or as a component in a complex combination of other materials, such as a baby diaper or feminine care pad. Preferred articles are disposable, nonwoven articles. The resultant products may find use in filters for air, oil and water; vacuum cleaner filters; furnace filters; face masks; coffee filters, tea or coffee bags; thermal insulation materials and sound insulation materials; nonwovens for one-time use sanitary products such as diapers, feminine pads, and incontinence articles; biodegradable textile fabrics for improved moisture absorption and softness of wear such as micro fiber or breathable fabrics; an electrostatically charged, structured web for collecting and removing dust; reinforcements and webs for hard grades of paper, such as wrapping paper, writing paper, newsprint, corrugated paper board, and webs for tissue grades of paper such as toilet paper, paper towel, napkins and facial tissue; medical uses such as surgical drapes, wound dressing, bandages, dermal patches and self-dissolving sutures; and dental uses such as dental floss and toothbrush bristles. The fibrous web may also include odor absorbents, termite repellants, insecticides, rodenticides, and the like, for specific uses. The resultant product absorbs water and oil and may find use in oil or water spill clean-up, or controlled water retention and release for agricultural or horticultural applications. The resultant fibers or fiber webs may also be incorporated into other materials such as saw dust, wood pulp, plastics, and concrete, to form composite materials, which can be used as building materials such as walls, support beams, pressed boards, dry walls and backings, and ceiling tiles; other medical uses such as casts, splints, and tongue depressors; and in fireplace logs for decorative and/or burning purpose. Preferred articles of the present invention include disposable nonwovens for hygiene applications, such as facial cloths or cleansing cloths, and medical applications. Hygiene applications include wipes, such as baby wipes or feminine wipes; diapers, particularly the top sheet, leg cuff, ear, side panel covering, back sheet or outer cover; and feminine pads or products, particularly the top sheet. Other preferred applications are wipes or cloths for hard surface cleansing. The wipes may be wet or dry.

Continuous Fiber Examples

The Examples below further illustrate the present invention. One polypropylene was purchased from ATOFINA as FINA 3860X. Two polypropylenes were purchased from Basell, Profax PH-835 and PDC-1274. A polyethylene was purchased from Dow Chemical as Aspun 6811A. Two polyester resins were purchased from Eastman Chemical Company as Eastman F61HC as a PET and Eastman 14285 as a coPET. The meltblown grade resin polypropylene was purchased from Exxon Chemical Company as Exxon 3456G.

The opacity measurements shown are made on an Opacimeter Model BNL-3 Serial Number 7628. Three measurements are made on one specimen with an average of three specimens for each material used.

Comparative Examples:

A polypropylene spunbond fabric is produced from Basell PH-835, except for examples C13-15 which are produced from FINA 3860X. C1-C7 and C13- have a through-put per hole of 0.4ghm. C8-C12 have a through-put per hole of 0.65ghm. The shape of the fiber is indicated in the table as solid round (SR), hollow round (HR) and trilobal (TRI). All comparative examples are using 2016 hole spinneret. The fiber are attenuated to an average fiber diameter or denier indicated in the table. These fibers are thermally bonded together using heat and pressure. The following nonwoven fabrics are produced, along with the opacity of the nonwoven measured on the samples in which the basis weight is determined.

Table 1: Comparative Opacity

No.	Shape	Basis Weight (gsm)	Fiber Diameter (µm)	Fiber Denier (dpf)	Opacity (%)
C1	SR	25	15.3	1.5	25.4
C2	SR	17	15.3	1.5	18.2
C3	SR	10	15.3	1.5	10.5
C4	SR	17	14	1.25	18.7
C5	SR	25	14	1.25	26.4
C6	SR	17	12.5	1.0	19.7
C7	SR	17	11.2	0.8	20.9
C8	SR	26	14	1.25	26.4
C9	SR	24	14	1.25	23.8
C10	SR	18	14	1.25	18.5
C11	SR	21	16	1.62	18.5
C12	SR	26	16	1.62	23.8
C13	SR	21	13	1.07	21.7
C14	SR	18	13	1.07	18.8
C15	SR	17	13	1.07	16.4
C16	HR	25	-	1.25	33.3
C17	HR	17	-	1.25	26.0

C18	HR	10	-	1.25	16.3
C19	TRI	25	-	1.25	41.8
C20	TRI	17	-	1.25	34.0
C21	TRI	10	-	1.25	21.6

Table 2: Comparative Mechanical Properties

No.	Shape	Basis Weight (gsm)	Fiber Denier (dpf)	Maximum CD Tensile Strength (g/in)
C22	SR	25	1.5	1370
C23	SR	25	1.25	1590
C24	SR	17	1.5	1170
C25	SR	17	1.25	1045
C26	SR	17	0.8	950
C27	SR	10	1.5	530
C28	HR	25	1.25	2040
C29	HR	17	1.25	1310
C30	HR	10	1.25	630
C31	TRI	25	1.25	810
C32	TRI	17	1.25	760
C33	TRI	10	1.25	470

Examples:

Example 1: Fibrous web containing mixture of hollow round, solid round and trilobal opacity and mechanical properties.

A polypropylene spunbond fabric is produced using solid round (SR), hollow round (HR) and trilobal fibers (TRI) made from Basell PH-835. A special spinneret is used that contains a mixture of fiber shapes and a metering plate to feed polymer to each orifice. The through-put per holes is 0.4ghm using 2016 hole spinneret. The fibers are attenuated to an average fiber diameter or denier indicated in the table. The fibers are thermally bonded together using heat and pressure. The following nonwoven fabrics are produced, along with the opacity of the nonwoven measured on the samples in which the basis weight is determined.

Table 3: Examples of shaped fiber web and opacity and mechanical properties .

Basis Weight (gsm)	**Fiber Ratio**			**Fiber Denier (dpf)**			**Opacity (%)**	**Maximum CD Strength (g/in)**
	SR	HR	TRI	SR	HR	TRI		
25	80	10	10	1.25	1.25	1.25	28.6	1560
25	60	20	20	1.25	1.25	1.25	30.9	1520
25	40	30	30	1.25	1.25	1.25	33.1	1500
25	20	40	40	1.25	1.25	1.25	35.3	1460
25	10	45	45	1.25	1.25	1.25	36.4	1450
17	80	10	10	1.25	1.25	1.25	21.0	1040
17	60	20	20	1.25	1.25	1.25	23.2	1040
17	40	30	30	1.25	1.25	1.25	25.5	1040
17	20	40	40	1.25	1.25	1.25	27.7	1040
17	10	45	45	1.25	1.25	1.25	28.9	1040
10	80	10	10	1.25	1.25	1.25	11.0	510
10	60	20	20	1.25	1.25	1.25	13.0	520
10	40	30	30	1.25	1.25	1.25	15.0	530
10	20	40	40	1.25	1.25	1.25	17.0	540
10	10	45	45	1.25	1.25	1.25	18.0	545
25	90	0	10	1.25	-	1.25	27.9	1510
25	50	0	50	1.25	-	1.25	34.1	1200
25	10	0	90	1.25	-	1.25	40.3	900
17	90	0	10	1.25	-	1.25	32.5	790
17	50	0	50	1.25	-	1.25	26.4	900

17	10	0	90	1.25	-	1.25	20.2	1020
10	90	0	10	1.25	-	1.25	10.3	490
10	50	0	50	1.25	-	1.25	15.3	490
10	10	0	90	1.25	-	1.25	20.3	470
25	0	90	10	-	1.25	1.25	34.2	1920
25	0	50	50	-	1.25	1.25	37.6	1425
25	0	10	90	-	1.25	1.25	41.0	930
17	0	90	10	-	1.25	1.25	26.8	1255
17	0	50	50	-	1.25	1.25	30.0	1033
17	0	10	90	-	1.25	1.25	33.2	815
10	0	90	10	-	1.25	1.25	16.8	610
10	0	50	50	-	1.25	1.25	19.0	550
10	0	10	90	-	1.25	1.25	21.1	490
25	90	10	0	1.25	1.25	-	27.1	1630
25	50	50	0	1.25	1.25	-	29.9	1815
25	10	90	0	1.25	1.25	-	32.6	1995
17	90	10	0	1.25	1.25	-	19.4	1070
17	50	50	0	1.25	1.25	-	22.4	1180
17	10	90	0	1.25	1.25	-	25.3	1280
10	90	10	0	1.25	1.25	-	9.7	510
10	50	50	0	1.25	1.25	-	12.7	670
10	10	90	0	1.25	1.25	-	15.6	620

Example 2: Fibrous webs containing two polymers and two shapes

A spunbond machine is set-up to run polypropylene at 220C or polyester at 290C. A spinneret as shown in Figure 6 may be used to produce the fibers. A metering system with two melt pumps may be used to control each polymer type and melt flow. Nonwovens can be produced at a range of mass flow ratios and deniers. Any combination of polymers and shapes may be used. For example, Basell PH-835 solid round fibers may be combined with Dow Aspun 6811A, Eastman F61HC trilobal fibers.

Alternatively, the Basell PH-835 could be used to make trilobal fibers and hollow round fibers made of ATOFINA 3860X.

Example 3: Fibrous webs containing two polymers and two shapes and a meltblown layer

The fibrous fabric of Example 2 is made and combined with a polypropylene meltblown layer made from Exxon 3546G. The average meltblown diameter is 3 microns at a through-put of 0.6ghm. The two layers can be thermally bonded together or hydroentangled or combined with other bonding methods.

Example 4: Fibrous webs containing one polymer and two shapes

A fibrous web is produced with solid round meltblown diameter fibers supplied at 0.15ghm and trilobal spunlaid diameter fiber supplied at 0.4ghm. In another embodiment, a solid round spunlaid diameter fiber is also produced in the same layer to create a three-fiber layer.

Example 5: Fibrous web containing a mixture of multicomponent solid round and multicomponent trilobal fibers.

A spunbond nonwoven is produced containing a 50/50 weight percent mixture of multicomponent solid round and multicomponent trilobal fibers. The multicomponent solid round fibers are sheath and core with a 50/50 weight percent ratio of ATOFINA 3860X as the sheath material and Basell Profax PH-835 as the core. The solid round fibers are attenuated to a range of diameters down to 1.0dpf, depending on the mass throughput per capillary. The trilobal fibers are composed of a 20/80 weight percent ratio of ATOFINA as the trilobal tip material and Basell Profax PH-835 as the core. The trilobal fibers are attenuated to a range of diameters down to 1.0dpf, depending on the mass throughput per capillary. These fibers are then consolidated together using conventional bonding methods, most commonly thermal point bonding, but hydroentangling can also be used. Basis weight down to 5gsm can be produced. If desired, a polypropylene meltblown layer can be produced using Exxon 3546G. The average meltblown diameter is 3□m at a through-put of 0.6ghm. The meltblown layer is then combined with the spunlaid layer either by direct collection or brought in from a second source. Other alternate layers can be added. The fibers are thermally bonded together using heat and pressure. This nonwoven has high opacity characteristics with improved strength due to the presence of the lower molecular weight ATOFINA 3860X outer component of the multicomponent fibers. The component ratio in individual fibers can be changed to further adjust the strength and the ratio of shaped fibers can be changed to alter the opacity and strength, as needed for a desired application.

Example 6: Fibrous web containing a mixture of multicomponent solid round and multicomponent trilobal fibers plus mixed meltblown diameter.

A spunbond nonwoven is produced containing a 45/45/10 weight percent mixture of multicomponent solid round, multicomponent trilobal fibers, and meltblown diameter fibers. The multicomponent solid round fibers are sheath and core with a 50/50 weight percent ratio of ATOFINA 3860X as the sheath material and Basell Profax PH-835 as the core. The solid round fibers are attenuated to a range of diameters down to 1.0dpf, depending on the mass throughput per capillary. The trilobal fibers are composed of a 20/80 weight percent ratio of ATOFINA as the trilobal tip material and Basell Profax PH-835 as the core. The trilobal fibers are attenuated to a range of diameters down to 1.0dpf, depending on the mass throughput per capillary. The solid round and trilobal spunbond orifice are supplied a polymer at 0.4ghm, while the meltblown diameter orifices are supplied polymer at 0.15ghm. All of these fibers are extruded from an etched metering plate and spinneret. The meltblown diameter fibers have an average diameter of 6□m. These fibers are then consolidated together using conventional bonding methods. This nonwoven also has high opacity characteristics with improved strength due to the presence of the lower molecular weight ATOFINA 3860X outer component of the multicomponent fibers. The component ratio in individual fibers can be changed to further adjust the strength and the ratio of shaped fibers can be changed to alter the opacity and strength, as needed for a desired application.

Example 7: Fibrous web containing a mixture of multicomponent solid round, monocomponent trilobal fibers, and meltblown diameter fibers .

A spunbond nonwoven is produced containing a 20/70/10 weight percent mixture of multicomponent solid round, monocomponent trilobal fibers and meltblown diameter fibers. The multicomponent solid round fibers are a 75/25 weight percent ratio of Eastman F61HC polyester as the core material and Eastman 14285 as the sheath material. The multicomponent round fibers are attenuated to a range of diameters down to 1.0dpf, depending on the mass throughput per capillary. The monocomponent trilobal fibers are composed of Eastman F61HC. The polyester meltblown fibers are produced using a Eastman F33HC. The monocomponent trilobal fibers are attenuated to a range of sizes down to 1.0dpf, depending on the mass throughput per capillary. The average meltblown diameter is 3□m at a through-put of 0.6ghm. This construction is used to produce a high strength and loft polyester spunbond. The component ratio in individual fibers and between fiber types can be changed to further alter the opacity and strength, as needed for a desired application.

Example 8: Fibrous web containing a mixture of multicomponent solid round and monocomponent trilobal fibers.

A spunbond nonwoven is produced containing a 20/70/10 weight percent mixture of multicomponent solid round, monocomponent trilobal fibers and meltblown diameter fibers from the same spinneret. Alternatively, a spunbond nonwoven can be produced containing a 30/70 weight percent mixture of multicomponent solid round and monocomponent trilobal fibers. The multicomponent solid round fibers are a 75/25 weight percent ratio of Eastman F61HC polyester as the core material and Eastman 14285 as the sheath material. The multicomponent round fibers are attenuated to a range of diameters down to 1.0dpf, depending on the mass throughput per capillary. The monocomponent trilobal fibers are composed of Eastman F61HC. If present, the polyester meltblown fibers are produced using a Eastman F33HC. The monocomponent trilobal fibers are attenuated to a range of sizes down to 1.0dpf, depending on the mass throughput per capillary. The average meltblown diameter is 6□m at a through-put of 0.15ghm. The nonwoven web with shaped fibers may be combined with a meltblown layer. Other alternate layers can be added.

Many examples have been shown and given here to demonstrate the breadth of fibers that can be produced to illustrate the invention. Although not limited by the data presented in this invention, further variations are known.

The disclosures of all patents, patent applications (and any patents which issue thereon, as well as any corresponding published foreign patent applications), and publications mentioned throughout this description are hereby incorporated by reference herein. It is expressly not admitted, however, that any of the documents incorporated by reference herein teach or disclose the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is intended to cover in the appended claims all such changes and modifications that are within the scope of the invention.

WHAT IS CLAIMED:

1. A fibrous fabric comprising at least one layer comprising a mixture of shaped fibers having two or more different cross sections and diameters.

2. The fibrous fabric of Claim 1 wherein the shaped fibers having two or more different cross sections are selected from the group consisting of solid round fibers, hollow round fibers, multi-lobal solid fibers, hollow multi-lobal fibers, crescent shaped fibers, square shaped fibers, crescent shaped fibers, and any combination thereof.

3. The fibrous fabric of Claim 1 wherein each shaped fiber has a different diameter.

4. The fibrous fabric of Claim 3 wherein at least one of the shaped fibers has a spunlaid diameter.

5. The fibrous fabric of Claim 4 wherein at least two of the shaped fibers has a spunlaid diameter.

6. The fibrous fabric of Claim 4 or 5 wherein at least one of the shaped fibers has a meltblown diameter.

7. The fibrous fabric of Claim 1 wherein at least one of the shaped fibers is a bicomponent fiber.

8. The fibrous fabric of Claim 1 wherein the fibrous fabric is comprised of a polymeric material, has a fiber denier and basis weight, and the fibrous fabric has an opacity and/or mechanical properties higher than a fibrous fabric produced with the same polymeric material at an equivalent fiber denier and basis weight.

9. The fibrous fabric of Claim 1 wherein an apparent bulk density of the shaped fibers is from 2% to 50% lower than the bulk density of solid round fibers.

10. A nonwoven laminate comprising at least one first layer comprising a mixture of shaped fibers having two or more different cross sections and diameters and at least one second layer comprising different fibers.

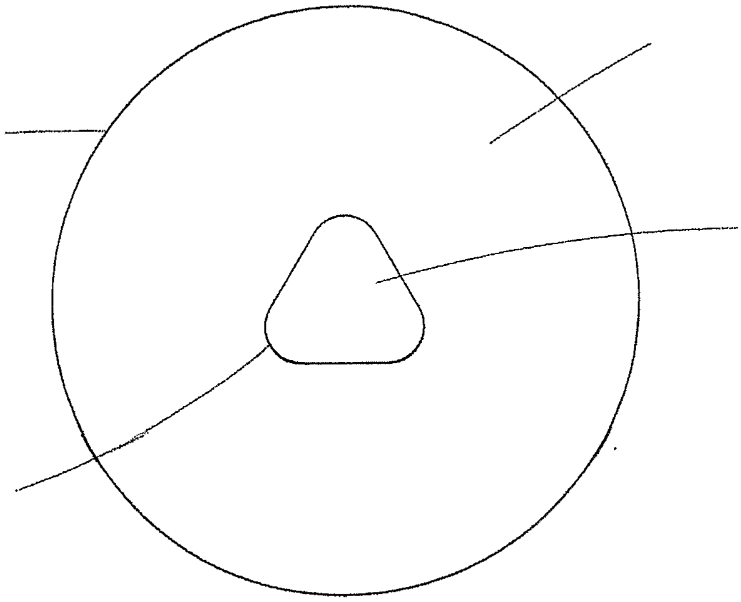


Fig. 1

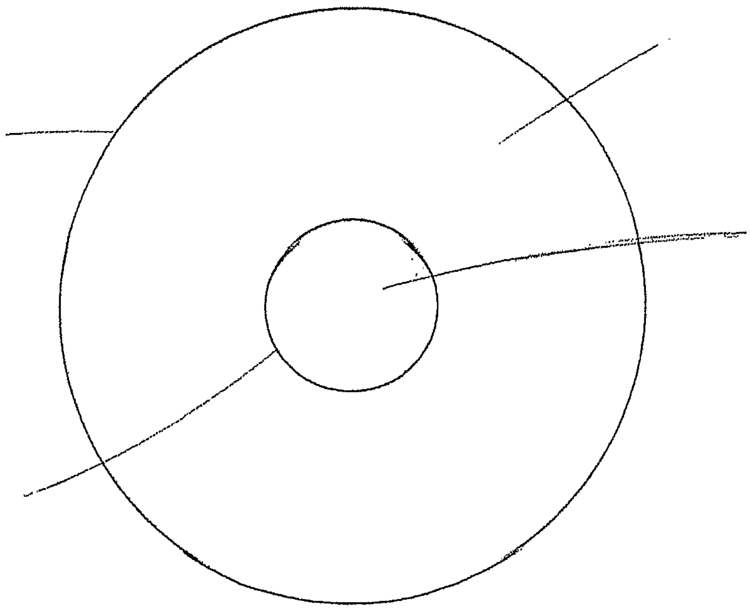


Fig. 2

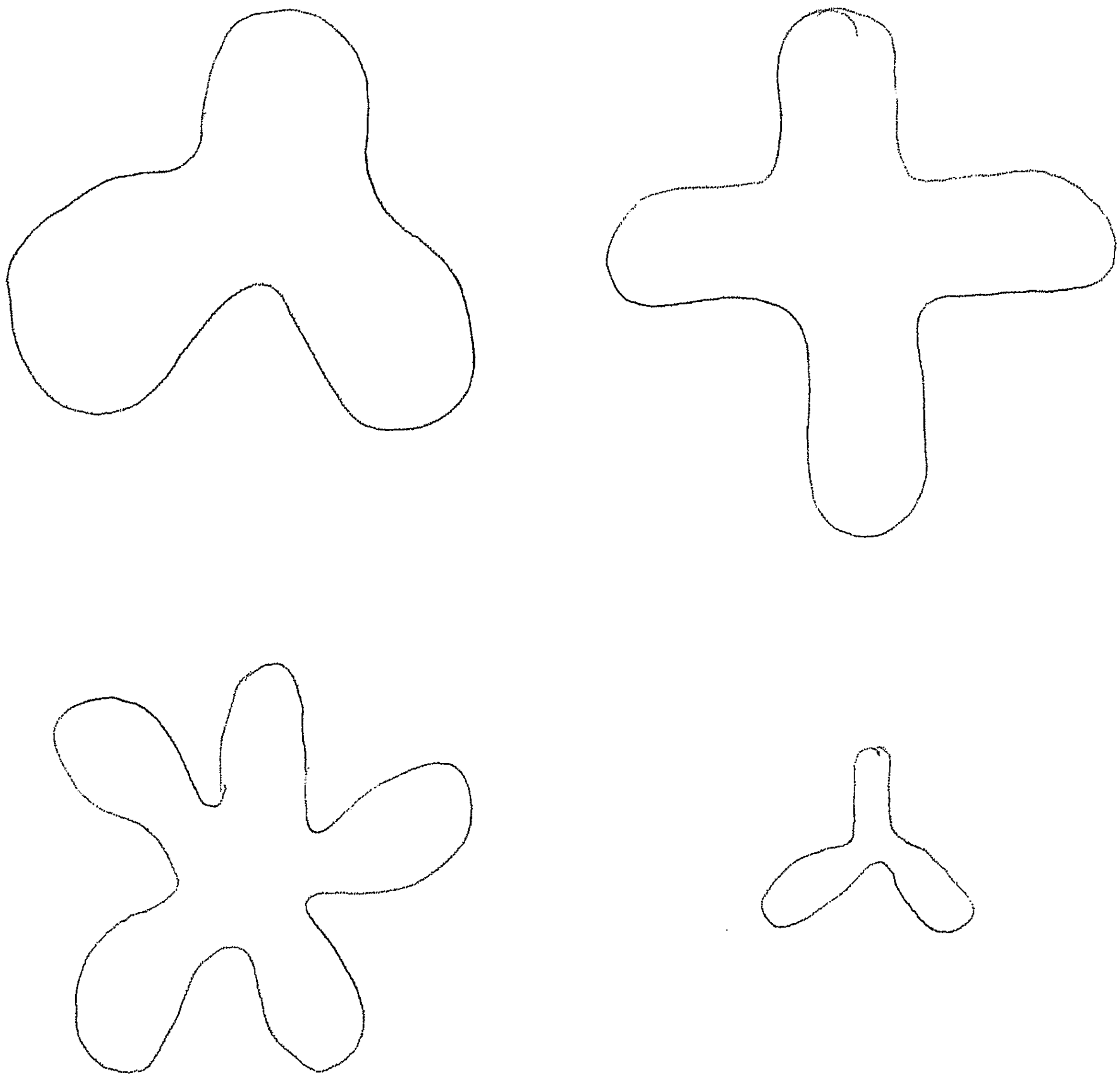


Fig. 3

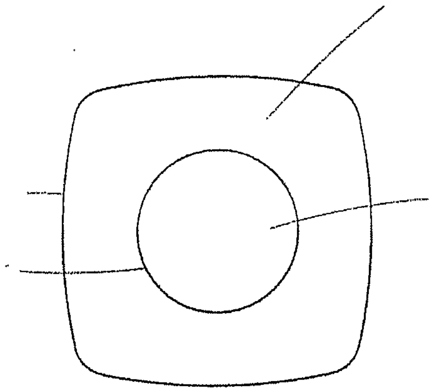


Fig. 4A

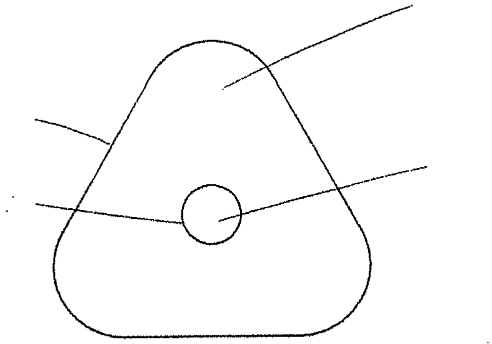


Fig. 4B

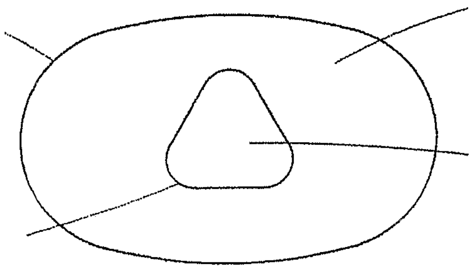


Fig. 4C

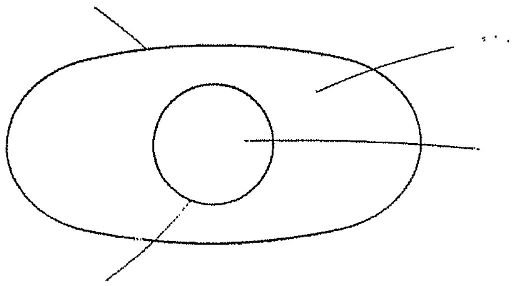


Fig. 4D

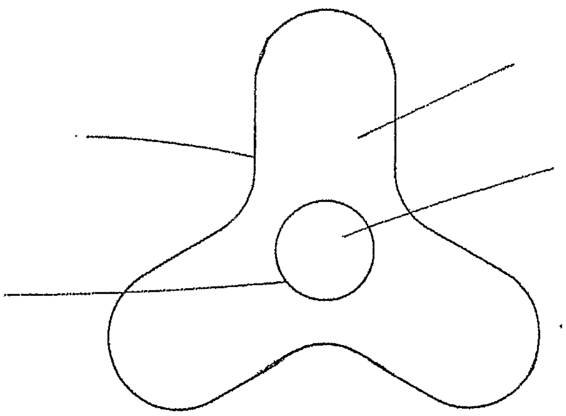


Fig. 4E

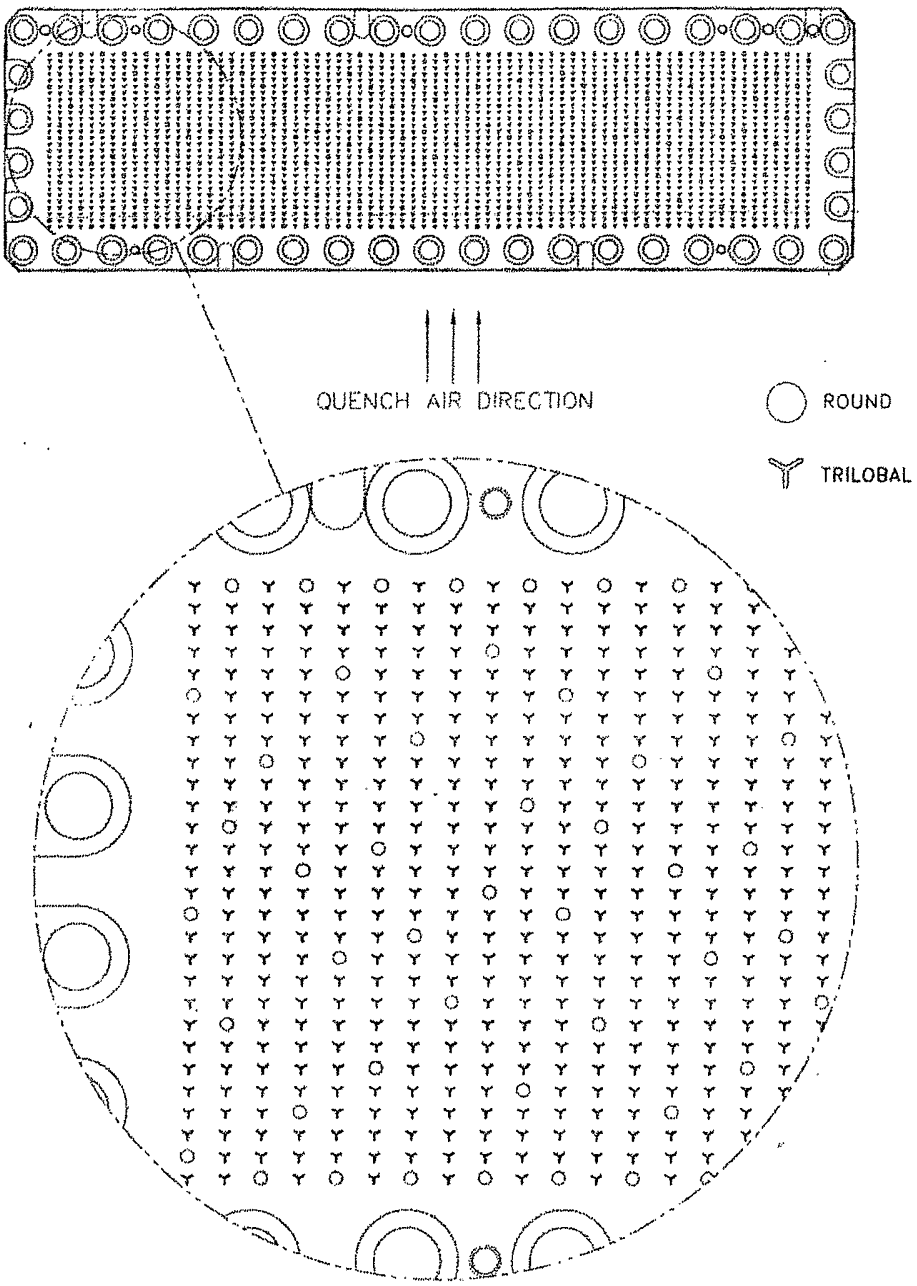


Fig. 5

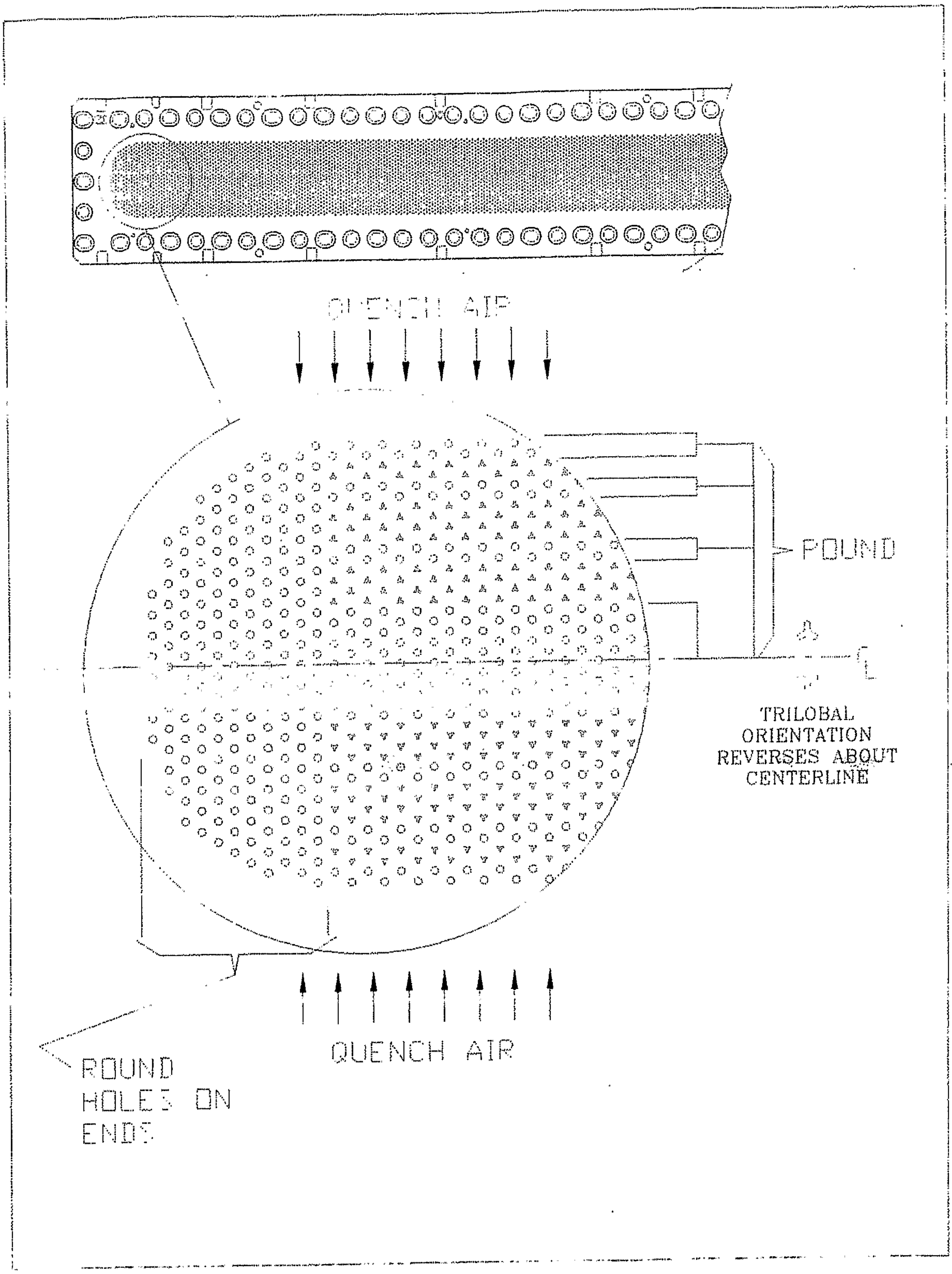

QUENCH AIR
ROUND
TRILOBAL ORIENTATION REVERSES ABOUT CENTERLINE
QUENCH AIR
ROUND HOLES ON ENDS

Fig. 6

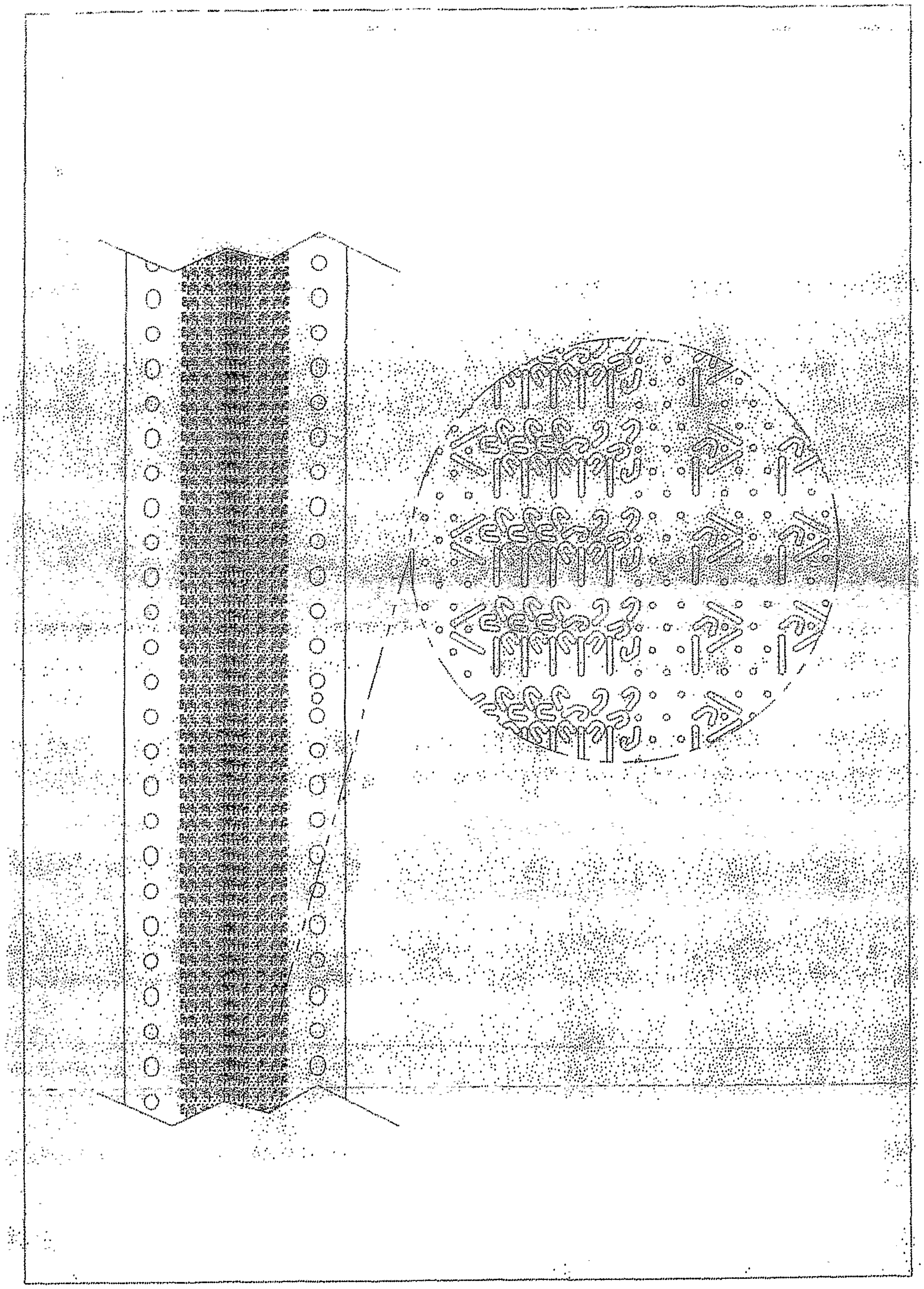


Fig. 7

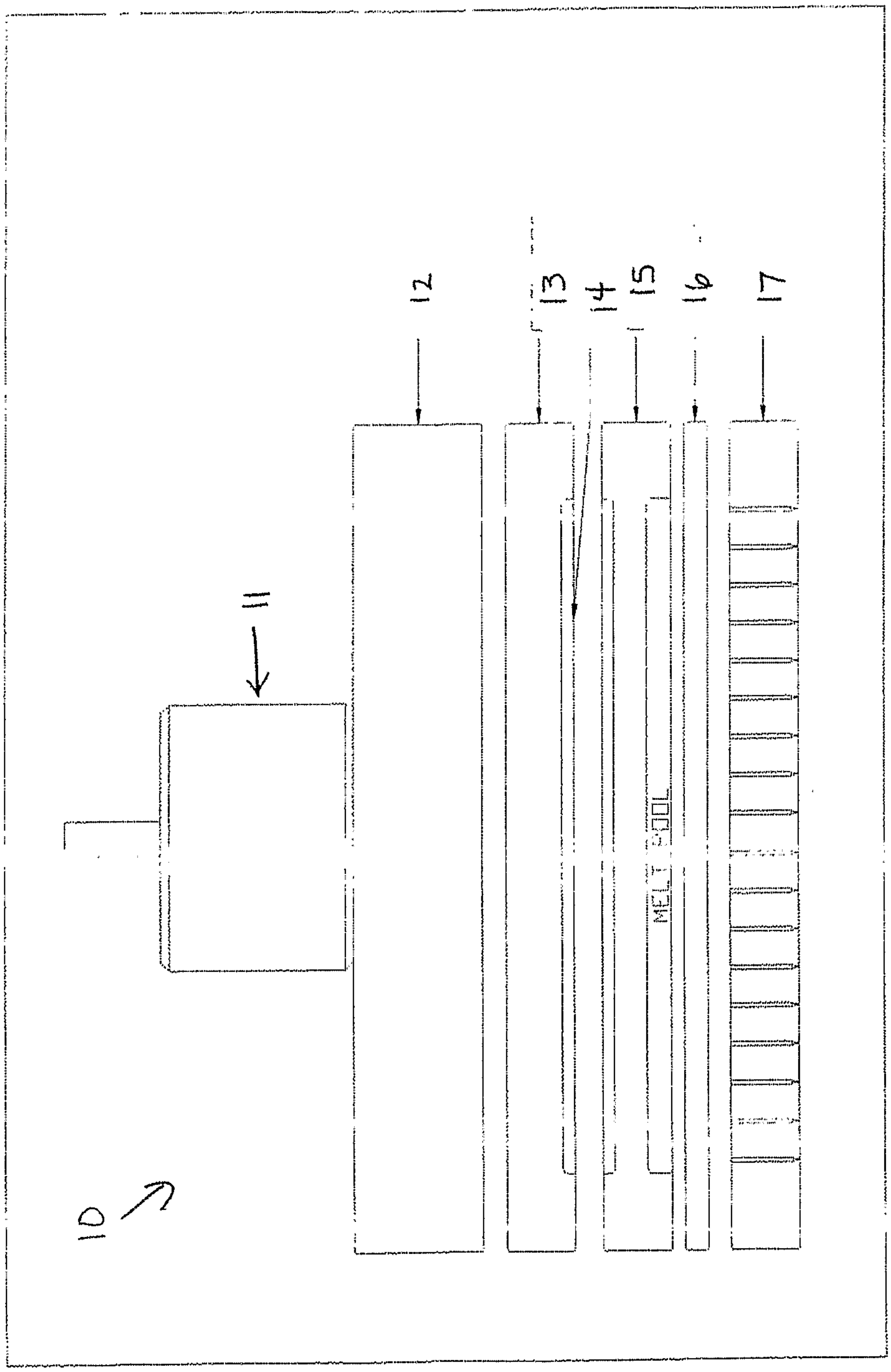


Fig. 8

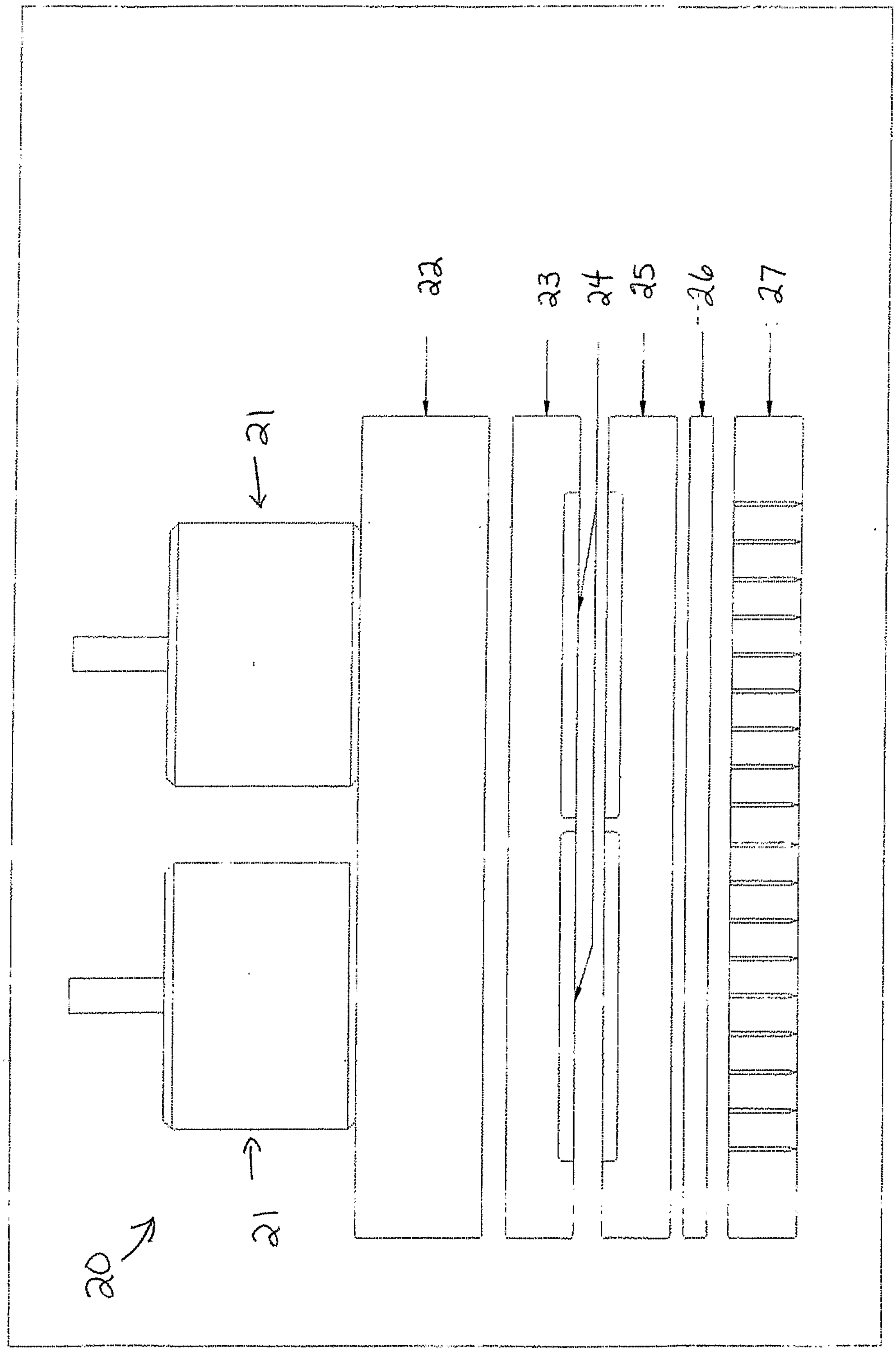


Fig. 9

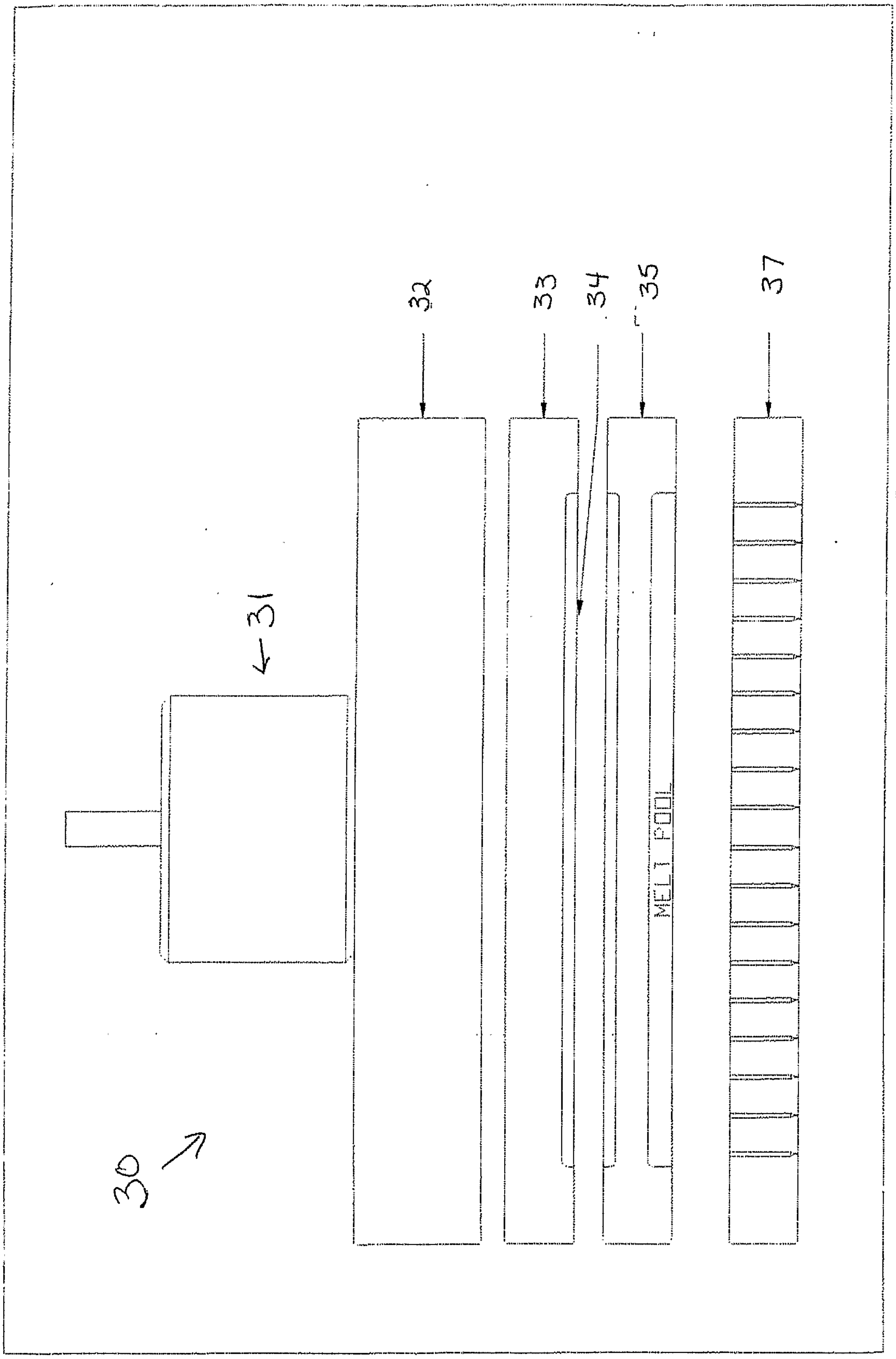


Fig. 10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/003146

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04H3/00 D01D5/253 D01D5/24 D01F8/06

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04H D01D D01F

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/106568 A1 (KECK LAURA ELIZABETH ET AL) 12 June 2003 (2003-06-12) paragraphs '0006!, '0063!, '0064!	1,10
A	EP 0 860 521 A (BASF CORPORATION) 26 August 1998 (1998-08-26) column 3, lines 29-50	1-10
A	EP 0 595 157 A (BASF CORPORATION) 4 May 1994 (1994-05-04) claim 1; examples 1,2	1-10
A	EP 0 573 376 A (RHONE-POULENC FIBRES) 8 December 1993 (1993-12-08) page 3, line 20 - page 4, line 41	1-10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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

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Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2005	24/05/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lanniel, G

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/003146

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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