June 11, 1968 J. VINICKI 3,388,194

METHOD OF FORMING MICRO-FIBERS

Original Filed Dec. 7, 1964

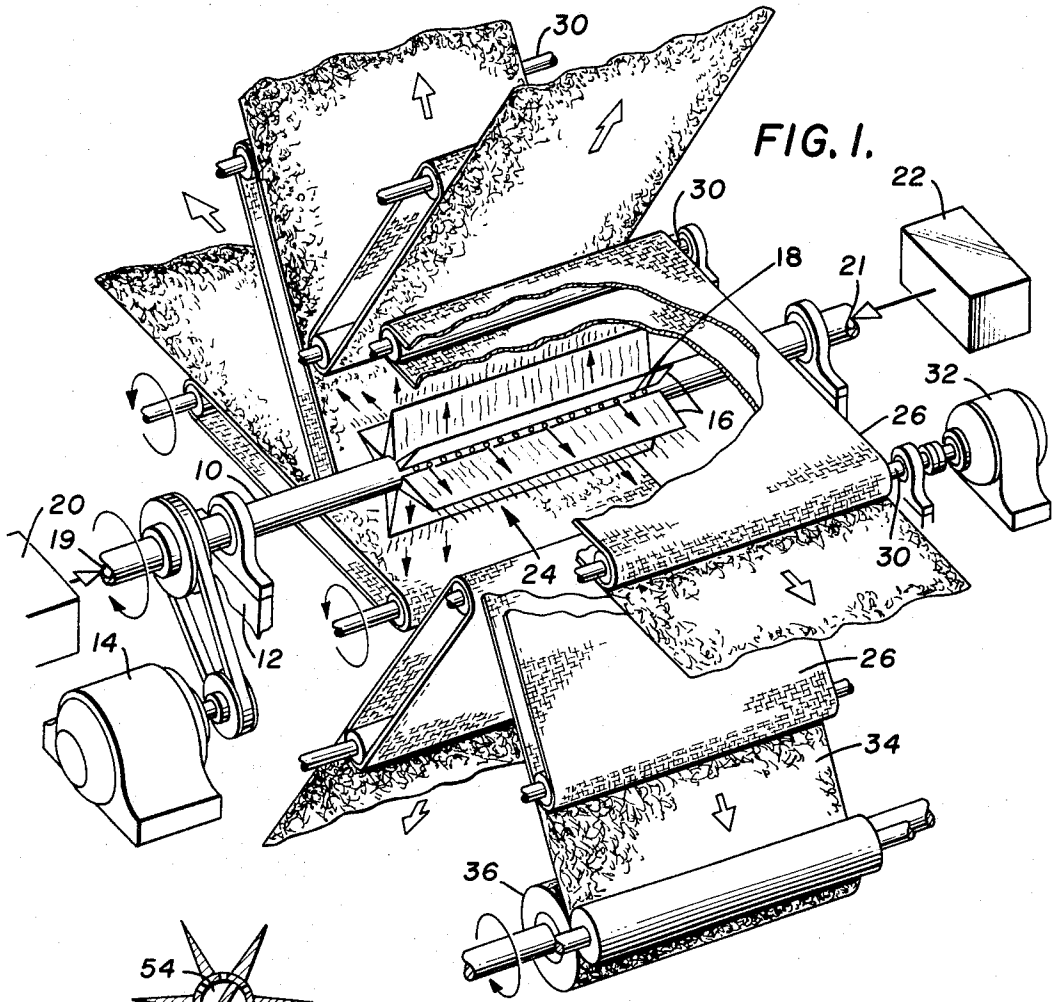


FIG. 1.

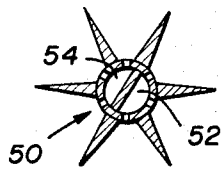


FIG. 3.

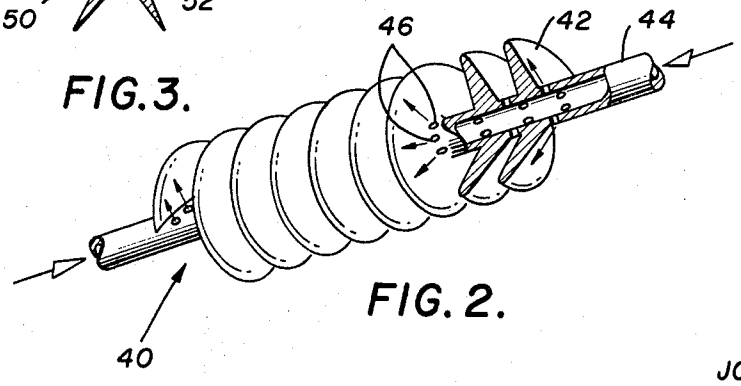


FIG. 2.

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United States Patent Office 3,388,194
Patented June 11, 1968

3,388,194

METHOD OF FORMING MICRO-FIBERS

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Original application Dec. 7, 1964, Ser. No. 416,499. Divided and this application Nov. 21, 1966, Ser. No. 595,972

1 Claim. (Cl. 264—6)

ABSTRACT OF THE DISCLOSURE

A method for producing a micro-fiber web composed of fibers having different characteristics wherein different fiber forming compositions are introduced into different chambers of a rotating common element wherein a rotating element centrifugally forces the compositions through orifices therein to attenuate the compositions into micro-fibers. The fibers are then collected to form a plurality of mats.

This application is a divisional application of copending application Ser. No. 416,499 filed Dec. 7, 1964, now abandoned.

Heretofore, micro-fibers have been produced by a process generally referred to as centrifugal spinning. This process is performed by introducing a fiber-forming material onto the surface of a rotating disc which slings the material in thin streams or droplets from the disc into the path of high-velocity air directed against the stream to convert them into fibers having micron-sized structures. Although centrifugal spinning has been utilized primarily by the glass fiber industry, the textile industry has made limited use of this process to produce so-called micro-fibers. By micro-fibers is meant fibers having substantially circular cross-sectional structures ranging in diameters from 0.5 to 25 microns.

While it is well known to produce micro-fibers utilizing centrifugal force, certain limitations are inherent to the centrifugal spinning processes used presently, probably the most serious being the low spinning rate. It is apparent that the rate of fiber formation is determined by the diameter of the disc which must be sized relatively small to provide a proper environment essential for the production of high quality fibers. Furthermore, the fibrous batt formed on the take-up screen is characterized by a narrow width and uneven depth.

Another disadvantage which has been experienced with the presently known spinning processes is the occurrence of particles of composition that failed to attenuate into fibers. These particles feel like sand in the fibrous web and are commonly called shot. When the web is pressed into a finished product such as paper, the shot form small clear spots which are obviously objectionable. It is believed that the abrupt change in directional forces imposed upon the partially attenuated streams of spinning composition by the air jets used in the known processes is responsible for most of the shot formation.

With the foregoing in mind, the primary object of this invention is to provide apparatus for producing micro-fibers in large quantities.

Another object of the present invention is to provide apparatus for producing continuous micro-fibrous batts having wide widths.

Another object of the present invention is to provide apparatus for spinning micro-fibers which are conveyed directly from the spinning surfaces to the collection surfaces without directional change to form shot-free webs.

Still another object of the present invention is to provide apparatus for producing micro-fiber batts having uniform depth.

A further object of the present invention is to provide a system for spinning and collecting a plurality of continuous webs or batts formed simultaneously.

In accordance with the present invention there is provided a method of producing fine fibers comprising the extrusion of a fiber-forming material through orifices onto elongated planar surfaces which are rotated at high speed to develop centrifugal forces having magnitudes sufficient to advance fine streams of the material radially across the planar surfaces and off the edges thereof to attenuate the streams of material to form continuous webs composed of micro-denier fibers.

One embodiment contemplated by the present invention is a hollow shaft having a plural number of fins extending from the shaft, the fins having triangular cross-sections with the base being adjacent to the shaft which has rows of small orifices therein between the bases of the triangular-shaped fins and means for introducing flowable organic materials into the hollow shaft and rotating the shaft to sling the material from the extending edges of the fins in the form of discontinuous super-fine fibers onto collecting screens which advance the fibers to take-up rolls.

Other objects and advantages will become apparent from the specification and drawing wherein

FIGURE 1 is a diagrammatical perspective view, partially in section, of one form of apparatus for the production of continuous webs in accordance with the present invention;

FIGURE 2 is a perspective view, partially in section, of another embodiment of the fiber-forming element; and

FIGURE 3 is a cross-sectional view of a fiber-forming element illustrating dual chambers.

There is shown in FIGURE 1 a typical arrangement of the apparatus used for carrying out the present invention. A tubular member **10** is mounted for rotation on a frame **12** and driven by a variable speed motor **14**. The tubular member has six (6) parallel fins **16** equally spaced around the outside diameter of a four (4) foot portion thereof. The fins have triangular cross-sections which extend from the member **10** a radial distance of about three (3) inches. A row of small orifices **18** in the tubular member are selectively spaced between the fins for receiving a flowable organic composition supplied at the inlets **19** and **21** from the sources **20** and **22**, respectively. The composition is pressurized by a suitable well known pump, not shown. The four-foot portion of shaft **10** which embodies the orifices and the fins is referred to hereafter as the spinning element **24**. It is to be understood however that the length of spinning element **24** may be changed to produce desired widths of fibrous batts.

As shown in FIGURE 1 the spinning element **24** is encircled by six endless take-up screens which are elevated at different angles so that fiber collection will be equally distributed on the several screens. The screens are supported on shafts **30** which are mounted for rotation and driven by motor **32**.

The formation of fibers by the apparatus described is accomplished when the spinning composition is pumped into the hollow shaft **10** at a uniform rate and hydrostatic pressure is developed therein to force the composition through orifices **18** onto the planar surfaces of fins **16** which are rotated at high speeds to sling the spinning composition from the edge of the fins by centrifugal force to form short fibers having structural cross-sections ranging from 0.5 to 25 microns depending upon the rotational speed of the spinning element **24**. The rapid rotation of the fins **16** creates a force having sufficient magnitude to attenuate and break the embryoic filaments to form a multiplicity of short micron-sized fiber structures. Curing

or solidification of the fibers occurs during transport to the take-up screens **26** where the fibers are deposited in the form of a web **34** having uniform depth. The web **34** is continuously removed from the take-up screens **26** and collected upon a roll **36**.

In FIGURE 2 there is shown another embodiment of a spinning element which is suitable for producing micro-fibers in accordance with the present invention. The spinning element **40** is characterized by a helical fin **42** that spirals around a portion of a tubular member **44**. A row of orifices **46** are spaced near the base of the fin. A composition of spinning material is extruded through the orifices **46** and the spinning element is rotated in the same manner as described for element **24** to form discontinuous micro-fibers which are collected in the form described previously.

Further in accordance with the present invention, the tubular fiber-forming element **50** may be divided into a plurality of chambers **52** and **54** as illustrated in FIGURE 3 to receive a different spinning composition in each chamber. For example, compositions having different shrinkage characteristics may be extruded from alternate rows of orifices using the triangular-shaped fins to produce bicomponent fibers, or the spiral-helical type may be employed to spin pigmented mixtures.

The apparatus of the present invention is applicable to all fiber-forming compositions generally spun into filaments on the common spinning systems. A heated environment may be provided as required for the removal of solvents or to accelerate fiber formation.

The fibrous webs produced in accordance with this invention have outstanding properties which make them useful for paper products, laminates, absorbent pads, filter media, thermal insulation, accoustical insulation, spin-formed objects, and others.

While it is apparent that many changes and modifications can be made in the above-described detailed specification without departing from the nature and scope of the invention, it is to be understood that the invention is not to be limited except as set forth in the appended claim.

I claim:

1. A method for producing a micro-fiber web composed of fibers having different characteristics comprising the steps of introducing a first fiber-forming composition into one chamber of a multi-chamber fiber-forming element, introducing a second fiber-forming composition into a second chamber in said element, said second composition being different from said first composition, rotating said element to centrifugally force said compositions through orifices therein to form fibers of different compositions, attenuating said fibers by centrifugal force, depositing the said fibers as webs upon a plurality of collecting surfaces, and removing the webs from said collecting surfaces.

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