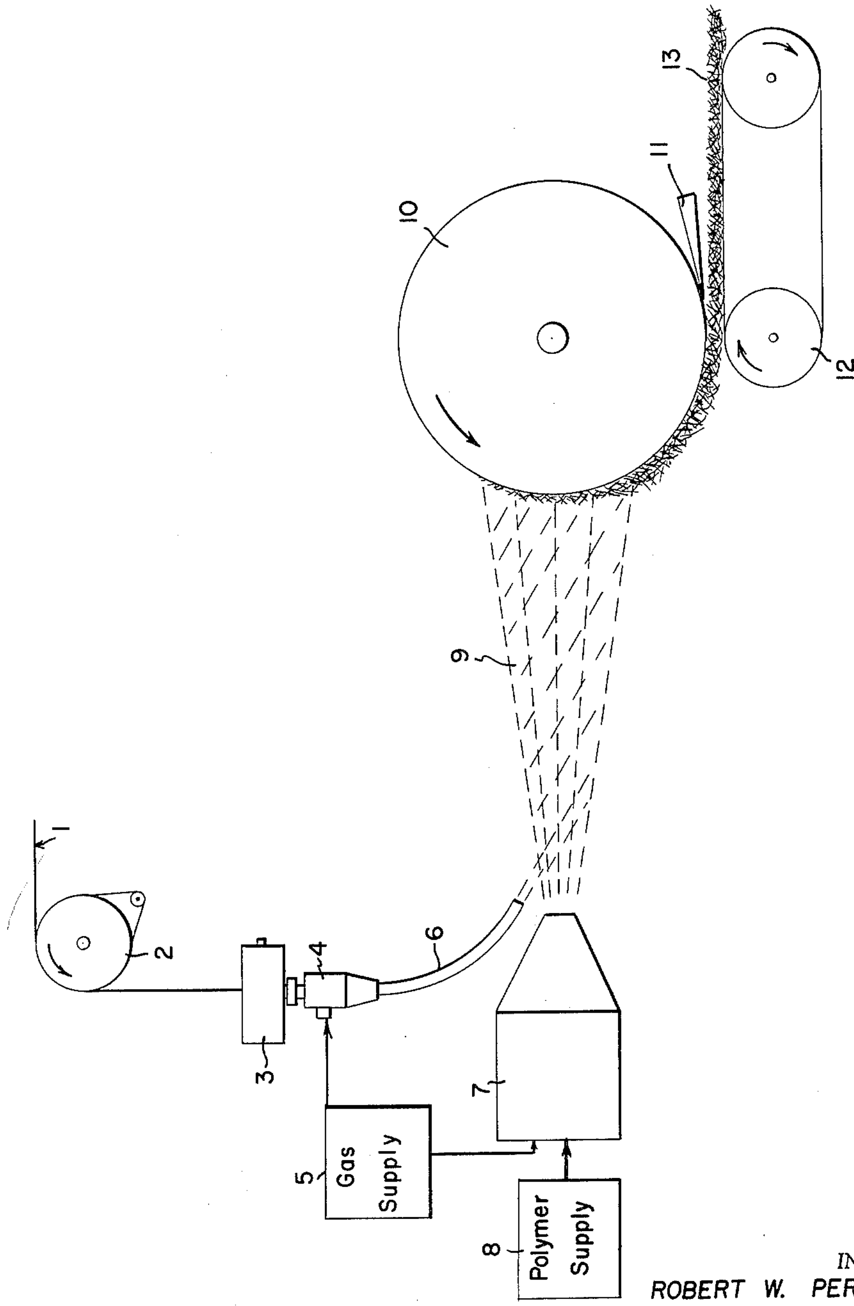
Jan. 16, 1962 R. W. PERRY, JR 3,016,599

MICROFIBER AND STAPLE FIBER BATT

Filed June 1, 1954



INVENTOR
ROBERT W. PERRY, JR.

BY Carl A. Hechmer

ATTORNEY

United States Patent Office

3,016,599

Patented Jan. 16, 1962

1

3,016,599

MICROFIBER AND STAPLE FIBER BATT

Robert W. Perry, Jr., Manchester, Tenn., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed June 1, 1954, Ser. No. 433,600
1 Claim. (Cl. 28—78)

This invention relates to a method of uniformly mixing microfibers as defined hereinafter with conventional textile staple fibers from synthetic materials and the products made thereby.

In the manufacture of textile materials it often is desirable to mix staple fibers of different origin. Mixing procedures include carding, picking, and blowing the fiber mixtures or the components into an enclosure. These methods are satisfactory only as long as the component staple fibers have relatively similar physical dimensions and specific weights. As these property differences become more pronounced, homogeneity becomes more and more difficult to attain. Unduly long processing times are often necessary. Indeed when very great differences exist in the dimensions of the staple fibers to be mixed it sometimes becomes impossible to obtain homogeneity by conventional processes.

It is an object of the present invention to provide a method of producing homogeneous mixtures of man-made staple fibers wherein one of the fibers has extremely small dimensions compared with the other.

Another object is to provide a method for producing a homegeneous batt of textile staple fibers and microfibers.

A further object is to provide a high strength sheet-like material having very fine pores.

These and other objects will become apparent in the course of the following specification and claim.

By the term microfiber as used herein is meant a funicular structure having a diameter of about one micron or less. It may or may not possess molecular orientation along its longitudinal axis. Such a fiber may vary in length from a few microns to several inches.

Microfibers are produced by melting a synthetic linear polymer and applying a gaseous jet to a thin layer of the molten polymer. Fine droplets of the polymer are torn off this layer and at the same time attenuated to fine fibers having on an average a diameter of less than 1 micron. The fibers are cooled by the gas stream sufficiently to solidify and at the same time they are carried by the gas stream away from the source of production. Apparatus suitable for the production of such fiber is described in U.S. 2,508,462. The equipment is operated with a fine jet orifice and at very high jet velocities.

The objects of the present invention are accomplished by continuously feeding a gaseous stream bearing staple fiber into a gaseous stream containing freshly-formed microfiber and thereafter collecting the mixture.

The invention will be more readily understood by reference to the drawing.

The figure is a diagrammatic representation of the essential components and their relationship in the production in accordance with the present invention of a batt of a mixture of staple and very fine fibers.

Referring more particularly to the figure, a continuous tow 1, of man-made material is fed over drive roll 2 into staple cutter 3. The staple cutter is fitted with a jet 4 into which a gas supply 5 leads so as to remove the staple substantially as rapidly as it is cut. The gas stream bearing the staple is directed by tube 6 to mesh with a jet of freshly formed microfiber. The microfiber is produced at microfiber jet 7 which is fed with polymer supply 8. The gas borne mixed fibers 9 are deposited on a rotating drum 10 from which they are removed by doctor knife 11 onto collecting screen 12. The formed batt 13 may thereafter be used as such or subjected to further treatment to produce strengthening ribs or the like.

2

Any fiber-forming polymeric material may be used for producing the microfibers provided that it can be heated to a temperature high enough above its melting or softening point to form a liquid melt without being substantially degraded before the gaseous jet is applied. Since many of the polymeric materials tend to decompose at elevated temperature, especially when exposed to air or other oxidizing gases it is often advantageous to blanket the melt with a non-oxidizing gas, for instance carbon dioxide, nitrogen, or superheated steam. The preferred polymers for microfiber production include the polyamides, for instance polyhexamethylene adipamide; the polyesters, for instance polyethylene terephthalate; the vinyl polymers, for instance polyvinyl chloride; and cellulose derivatives, for instance cellulose acetate. With many polymeric materials it may be of advantage to incorporate a solvent or plasticizer to lower the melting point sufficiently for microfiber formation. Such solvent or plasticizer may be subsequently removed as by flashing off in the gas stream, which may be heated for this purpose.

The dimensions of the microfibers may widely vary within the previously defined limits depending upon the design of the apparatus employed and the conditions of its use. The nature of the polymer, the temperature of its melt, the velocity and temperature of the jetted gas and the like are variables which will affect the dimensions of the microfiber. The mixing process of the invention is of particular importance with microfibers which have a diameter below about 0.5 micron. Those with diameters as low as $1/100$ of a micron or even lower are suitable. Their length may vary from a few hundred microns to several inches. Usually they are not oriented in the sense of the term as it is used in the art. However, under certain conditions they sometimes show some molecular orientation. Both oriented and non-oriented microfibers are suitable for use in this invention. They may be in the form of single fibers or webs or the like. They may be of variable cross-section.

No method is known whereby formed and collected microfibers can be uniformly distributed among textile staple fibers. It is important therefore, that the microfiber be mixed with the staple fiber while each is suspended in a gaseous stream. The fiber bearing streams must converge in such fashion that their jets are of sufficiently high velocity to cause homogeneous mixing of the two different types of fibers through turbulence. In order to obtain a uniform and substantially homogeneous mixture of the two types of fibers it is necessary to deliver the textile staple in a substantially continuous fashion. A very satisfactory way of uniformly delivering the staple fibers consists in cutting continuous fibers to the desired staple length and introducing them, e.g., with the help of a rapid gas stream, into the gas stream containing the microfibers as they are delivered from the nozzle. It is not feasible to collect them before they are introduced into the microfiber stream. Any conventional cutter system can be used which delivers the cut staple in one limited area at a very uniform rate. The cutter may be of the stationary or rotary type or of the oscillatory type. Apparatus as described in U.S. Patent 2,226,130 is suitable. The gas stream which carries the staple in a well dispersed form from the cutter may also be used for delivering the continuous filaments to the cutter. A cutter which provides about 1,000 cuts per minute gives satisfactory results. A cutter providing several thousand up to 3,000 or more cuts per minute is preferred.

The staple fiber suitable for use in the present invention includes any staple fiber or mixture of fibers produced from man-made materials for use in non-woven or woven textile materials. These fibers may be oriented or unoriented. They may be elastic. Their deniers may vary from as low as 1 to as high as 100 or above. The length of the single staple fiber may vary from a few millimeters to 10 centimeters or more. Staple amenable to the process include those produced from regenerated cellulose, cellulose derivatives such as cellulose acetate, polycondensation products such as polyamides and polyesters and the polymers obtained by addition polymerization from ethylenically unsaturated low molecular compounds, for instance acrylonitrile, vinylidene chloride, vinyl chloride and copolymers thereof. Any desired microfiber can be mixed according to the present invention with any desired textile staple fiber. Furthermore, two or more different staple fibers may be mixed with one or several different microfibers. In this instance either the microfibers or also the textile staple used together may be different with respect to dimensions, physical properties and/or chemical composition.

The absolute velocity of either of the gas streams, i.e., that carrying the microfiber or that carrying the staple is not critical. Uniformity of product requires that the velocity in either gas stream be substantially constant during any particular operation. In general the microfiber stream should have a velocity as high as possible to promote production and distribution of microfiber. The gas stream for the staple fiber must be of sufficient magnitude to carry the staple from the cutting apparatus at least as far as the collecting screen.

The homogeneous fiber mixtures may be collected on a stationary screen-like surface in the form of loose felt-like batt. They are removed after they have attained the desired thickness and weight. Alternatively they may be collected in a continuous fashion on a rotating cylindrical, perforated surface or on a moving perforated belt-like conveyor from which they may be removed either intermittently or continuously.

The batts of the homogeneous fiber mixture can be handled and/or after-treated in the conventional manner. Thus, they can be pressed to form sheet-like structures. The mechanical strength and resistance of such structures is of the same order as that of sheets made from the same staple fibers alone. The presence of the staple fibers provides them with excellent dimensional stability which is of importance especially when the structures are employed in such uses as filtering, particularly of gases. The mechanical properties of the sheets prevent packing and clogging. At the same time the size of the pores is considerably smaller than those of sheets from the same staple fiber having no microfibers admixed. The pore size can easily be controlled by selecting microfibers with a smaller or greater diameter or by varying the proportion of microfiber and staple. Particles in a range of sizes of .01 to about 1 micron can be readily filtered from a gas stream. They are also very useful in a wide field of similar applications.

The mechanical strength of the sheet-like structures of the present invention can be increased using a potentially adhesive staple. By this is meant a staple which can be rendered temporarily adhesive by the use of heat, solvent, plasticizer or the like. After the batt is formed, one or several components can be made adhesive and in this fashion a bond can be created to improve structural rigidity. When a solvent or plasticizer is used for rendering one or all of the batt components adhesive, materials which would deleteriously affect any component must be avoided. Increased stability may be attained by "spot-bonding" leaving the greater portion of the batt highly porous. A preferred way of performing this is the application of a grid-like pattern wherein adhering components lie in narrow parallel lines to the surface. In the case of hexamethylene adipamide staple and polyethylene terephthalate microfiber mixtures, nitric acid can be used as plasticizer for the polyamide. The bonding may also be accomplished by addition of a known adhesive, with or without subsequent curing. Among such materials may be mentioned rubber latex, phenol-formaldehyde resins, urea-formaldehyde resins, cellulose acetate solutions and the like. In order to produce sheet structures with maximum strength according to this method it is of advantage to use textile staple, the average length of which is at least twice as long as the distance between adjacent lines of adherence.

Though generally the microfibers and staple fibers can be used in any desired ratio, mixtures containing between 25% and 70% by weight of microfibers are preferred. The microfibers and the staple forming the new mixtures of this invention may be formed from the same material. However, those wherein the microfibers are from a material different than that of the staple fibers are preferred.

The new method permits the production of homogeneous mixtures of microfiber and staple in a convenient and controllable manner in any desired composition and ratio. Many other equivalent modifications will be apparent to those skilled in the art from a reading of the description above without a departure from the inventive concept.

What is claimed is:

A composition of matter comprising a batt of homogeneously mixed microfiber produced from a synthetic linear polymer and staple, produced from a man-made continuous filament, said microfiber having an average diameter of less than about 1 micron and said staple fiber having a denier of at least 1, the mixture containing between 25 and 70% microfibers on a weight basis.

References Cited in the file of this patent

UNITED STATES PATENTS

1,695,805	Gatti	Dec. 18, 1928
1,928,699	Neal	Oct. 3, 1933
2,181,043	Boeddinghaus	Nov. 21, 1939
2,232,647	Zirkman	Feb. 18, 1941
2,287,815	Modigliani	June 30, 1942
2,336,797	Maxwell	Dec. 14, 1943
2,357,392	Francis	Sept. 5, 1944
2,370,365	Magill	Feb. 27, 1945
2,477,000	Osborne	July 26, 1949
2,496,665	Hermanson	Feb. 7, 1950
2,543,101	Francis	Feb. 27, 1951
2,626,213	Novak	Jan. 20, 1953
2,721,139	Arledter	Oct. 18, 1955
2,731,679	Kennette et al.	Jan. 24, 1956
2,765,247	Graham	Oct. 2, 1956