Aug. 12, 1969 D. E. GILBERT 3,460,416

FIBRILLATION METHOD

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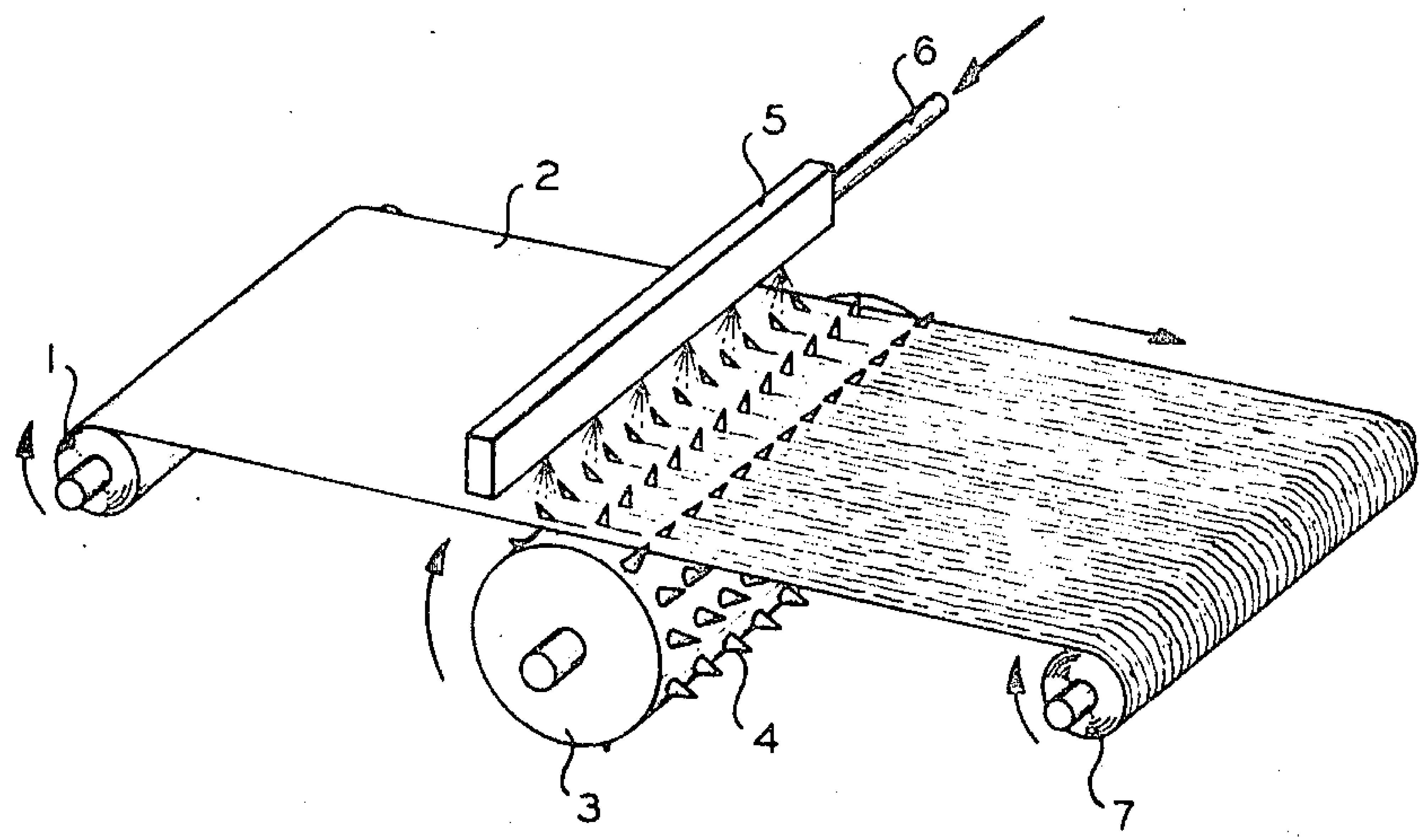

FIG. 1

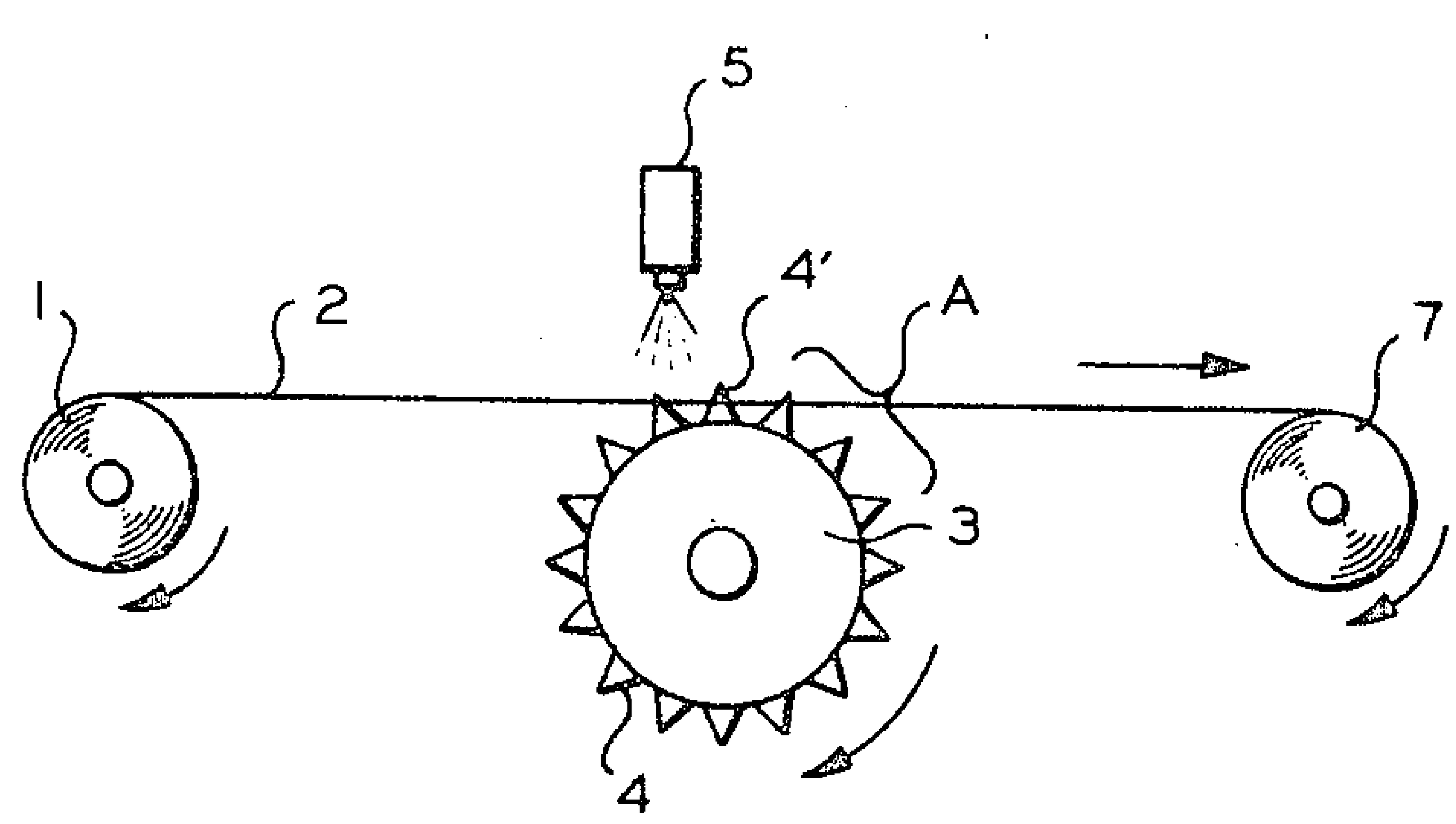

FIG. 2

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FIBRILLATION METHOD

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ABSTRACT OF THE DISCLOSURE

A fibrillatable film is fibrillated by passing the film past a plurality of piercing means and impinging a fluid against said film to cause said piercing means to at least partially penetrate said film.

This invention relates to a method for fibrillating a fibrillatable film.

Heretofore fibrillatable plastic film has been shredded by use of a stationary brush. A problem with the use of a brush has been the entanglement of fibers from the fibrillated product with the bristles of the brush.

According to this invention fiber entanglement with the piercing means by which a film is fibrillated is substantially minimized if the film is caused to be pierced by use off a fluid under pressure and if during this piercing step there is substantially no relative motion between the film and the piercing means. Apparently the more gentle and more uniform pushing action of a fluid under pressure reduces the entanglement propensity of the fibers of the fibrillated product.

The product of the process of this invention is a uniform fibrous network of longitudinally extending stem fibers integrally joined to one another at random points along their length by a plurality of shorter, smaller diameter cross fibers.

The product of this invention is useful as a filtering or screening material, e.g., as a filtering medium for separating undesired solid particles such as rust flakes from a liquid such as hydrocarbon fuels.

Accordingly, it is an object of this invention to provide a new and improved method for fibrillating film.

Other aspects, objects, and advantages of this invention will be apparent to one skilled in the art from the following description, drawing, and appended claims.

In FIGURE 1 there is shown a system for carrying out the process of this invention.

In FIGURE 2 there is shown a side view of the system of FIGURE 1.

In FIGURE 1 there is shown a roll of longitudinally molecularly oriented, i.e. longitudinally fibrillatable, plastic film **1** from which film **2** passes by roll **3** and into contact with pointed projections **4** carried on the outer periphery of roll **3**. Spray **5** which can contain a plurality of individual orifices or a single longitudinally extending slit which sprays a fluid received from conduit **6** against film **2** thereby pressing same against projections **4** and causing those projections to at least partially penetrate the thickness of the film and cause at least partial fibrillation of that film. The fibrillated product passing from film **4** is rolled up on takeup roll **7**.

FIGURE 2 shows the piercing of film **2** by projections **4** with the aid of a fluid stream from spray **5**. Spray **5** can be placed to one side of projections **4** as shown in FIGURE 2 or directly over the projections when substantially vertical. Spray **5** can be reciprocated, if desired, to give a reciprocating fluid stream. Film **2** can be passed by roll **3** in a plane which intersects a lower portion of the actual base of projections **4** when they are on the uppermost point of drum **4**, i.e. when the projections are substantially vertical, so that the film is stretched somewhat over projections **4** at the point at which the fluid stream contacts the film. This slight stretching of the film over the projections facilitates penetration of the film and can allow the use of lower pressured fluid than otherwise would be required to cause fibrillation of the film if it were passing roll **3** in a plane that corresponds to the top of the uppermost projection **4'** rather than below the top of that uppermost projection.

Roll **3** is rotated and film **2** is drawn past roll **3** by conventional drive apparatus (not shown) which apparatus is coordinated so that the peripheral speed of roll **3** is substantially the same as the rate at which film **2** is drawn past roll **3**. Thus, while film **2** is being pierced by projections **4** there is substantially no or at the most very little relative motion between the film and projections **4** thereby causing substantially only piercing of the film. In this manner substantially no shredding of the film is realized by way of projections **4** moving longitudinally through the film instead of substantially only through the thickness of the film. The combination of gentle and continuous fluid pressure pushing of film **2** against projections **4** across a substantial area of film **2** together with the provision of substantially no relative motion between film **2** and projections **4** at least during the piercing portion of the process, substantially minimizes the entanglement of fibers from the fibrillated product and projections **4** which are being withdrawn from that fibrillated product in the area A of FIGURE 2.

Thus, the buildup of fibers on roll **3** is substantially minimized thereby permitting the significant advantage that the process can run continuously for longer periods of time without having to stop and clean the fiber buildup from roll **3**.

Generally, any molecularly orientable plastic film which can be fibrillated can be employed in this invention. The film can be uniaxially oriented or multiaxially oriented in any manner which allows fibrillation of the film. The film can be oriented in any conventional manner known in the art including supercooling the film and then orienting same by plastic stretching and the like or heating the film to a temperature below that at which the film is in the molten state and then plastically stretching same. By molecular orientation, what is generally meant to be covered is plastically deforming the film, e.g. stretching the film below that temperature at which the film is substantially in a molten state to thereby increase the strength of the film at least in the direction in which it is plastically deformed.

Generally, films of polymers of 1-olefins having from 2 to 8 carbon atoms per molecule which have been molecularly oriented by stretching in at least one direction so that the film after stretching is at least three times longer in the direction of stretching than it was before stretching, i.e. a draw ration of 3/1, can be used. When the film is polyethylene which has a density of at least 0.94 gram per cubic centimeter, the draw ratio of the length in the stretched direction to original length should be at least 4/1 and when polypropylene is employed this draw ratio should be at least 6/1. Polymers of 1-olefins can be made in any conventional manner, a particularly suitable method being that disclosed in U.S. Patent 2,853,741. The films can be made from the polymers in any conventional manner such as by extrusion, casting, flattening blown tubing, and the like.

Other conventional films that can be employed in this invention include blends of 1-olefin polymers and copolymers of 1-olefins as above described with each other and with other polymers such as polyamides, polyesters, polyvinyl alcohol, acrylic polymers, polyvinvl chloride, polyvinylidene chloride, polyvinyl acetate, and the like. Homopolymers as well as copolymers of the 1-olefins and other materials described can be employed in this invention. A draw ratio of at least 3/1 can also be employed with these other plastic films.

The film itself can be of substantially any length, width, and thickness, the minimum thickness of the film being that which will produce a substantially self-sustaining film and the maximum thickness being dictated by the piercing capability of the apparatus employed. Preferably, the film thickness will vary from that which is sufficient to form a self-sustaining film to about 6 mils. Thicker films can be treated by using heavier duty apparatus or by passing the same films through the same apparatus two or more times.

The projections on roll **3** can be formed from substantially any material and made in any configuration suitable for piercing a film in a plurality of locations. The projections can be pointed or blunt needles, pointed triangular projections similar to saw teeth, or of the type found in conventional carding machinery. The projections can be of any length so that they are able to pierce a substantial portion of the thickness of the film to be fibrillated. It is preferable that a large number of projections be employed so that the film is pierced in a large number of locations. For example, it is preferable that there be at least 50 projections per square inch of film to be fibrillated, the maximum number of projections per square inch being limited only by physical considerations such as how close the projections can be placed to one another without making the individual projections too structurally weak to pierce the film. It should be noted that the greater the density of projections per square inch the finer the fibers of fibrillated film so that, depending upon the desired degree of fibrillation of the final product, projection densities will vary widely. Also, one or more rolls **3** can be employed in a single fibrillation process so that greater projection densities can be obtained by using a plurality of rolls **3** instead of a greater density of projections on a single roll **3**.

The fluid under pressure which is impinged on the film (e.g., spraying or gravity flow of liquid down on the film) to cause piercing thereof with projections **4** can be any fluid which is substantially inert and nondeleterious to the physical or chemical state of film **2**. Such fluids include air, water, nitrogen, inert gases such as argon, hydrocarbon liquids that are nonsolvents for the film being fibrillated, and mixtures thereof such as a mixture of air and water droplets. The fluid is impinged across the width of the film and along the length of the film for a substantial distance so that a large area of film **2** receives substantially the same gentle pushing against the projections **4**. The pressure under which the fluid is maintained can vary widely depending upon the nature of the fluid itself, e.g., a more dense fluid will require lower pressures. Generally, a gas can be under pressures of at least about 20 p.s.i.g. whereas a liquid can use pressures of at least about 10 p.s.i.g. or only the force of gravity. The maximum fluid pressure employed will vary widely and will generally be that pressure at which piercing of the film is accomplished since any additional pressure is uneconomic in that no additional desired results are obtained thereby and it is possible that with greater pres-

sures more entanglement of fibers from the fibrillated product with projections **4** will be promoted.

Example I

A film about 12 inches wide and 4 mils thick in the unoriented state and formed from a homopolymer of propylene having a melt flow of 1.7 (ASTM D1238–62T, Condition L, grams per 10 minutes) was oriented by heating to a temperature of about 300° F. and stretched using a draw ratio of 10/1.

This film was fibrillated by passing same into contact with a drum carrying a plurality of triangular-saw teeth type projections $\frac{3}{64}$ of an inch in height and having a base length where they joined the drum of $\frac{3}{64}$ of an inch. There were approximately 300 of these projections per square inch of film to be fibrillated. The roll carrying the projections was 12 inches wide and had a diameter of 11 inches.

The molecularly oriented film was passed by the roll at a rate of 600 feet per minute and the roll was rotated itself at a rate such that its peripheral speed substantially matched the 600 feet per minute film rate.

Air under pressure of 120 p.s.i.g. was impinged across the width of the film as it passed over the roll as shown in the drawings.

The product obtained was a fibrillated network comprising a nonwoven, integral fibers as described hereinabove.

Example II

The process of Example I was repeated except that polypropylene having a melt flow of 0.7 was used instead of polypropylene having a melt flow of 1.7. A fibrillated product similar to that of Example I was obtained.

Example III

The process of Example I was repeated except that instead of air under pressure, water under a pressure of about 50 p.s.i.g. was employed to force the film against the saw tooth projections on the roll. A fibrillated product similar to that of Example I was obtained.

Example IV

The process of Example III was repeated except that polypropylene having a melt flow of 0.7 was employed instead of polypropylene having a melt flow of 1.7. A fibrillated product similar to that of Example I was obtained.

Reasonable variations and modifications are possible within the scope of this disclosure without departing from the spirit and scope thereof.

What is claimed is:

1. A fibrillation method comprising passing a fibrillatable plastic film past and into contact with a plurality of piercing means, impinging a fluid under at least one of pressure and the force of gravity against said film and toward said piercing means to cause said piercing means to at least partially penetrate the thickness of said film and thereby at least partially fibrillate same, maintaining substantially no relative motion between said film and said piercing means at least during the piercing portion of said process so that there is substantially no shredding of said film.

2. The method according to claim **1** wherein said piercing means are supported on a rotating piercing device and said rotating piercing device is rotated at a speed such that its peripheral speed is substantially the same as the speed at which said film passes by said rotating piercing device thereby providing for substantially no relative motion between said film and said piercing means during at least the piercing portion of said process.

3. The method according to claim **1** wherein said film is composed of at least one of homopolymers, copolymers, and blends thereof of 1-olefins having from 2 to 8 carbon atoms per molecule, said films being molecularly oriented so that their oriented length is at least three times that of their unoriented length.

4. The method according to claim **1** wherein said film is composed of one of polyethylene and polypropylene and said fluid under pressure is air under a pressure of at least 20 p.s.i.g.

5. The method according to claim **1** wherein said film is composed of one of polyethylene and polypropylene and said fluid under pressure is water under a pressure of at least 10 p.s.i.g.

6. The method according to claim **4** wherein said polymer is one of a homopolymer of ethylene and a homopolymer of propylene.

7. The method according to claim **5** wherein said polymer is one of a homopolymer of ethylene and a homopolymer of propylene.

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JAMES M. MEISTER, Primary Examiner

U.S. Cl. X.R.

83—169, 660; 225—3, 97; 264—147; 28—1

Disclaimer and Dedication

3,460,416.—*Dixie E. Gilbert*, Bartlesville, Okla. FIBRILLATION METHOD. Patent dated Aug. 12, 1969. Disclaimer and dedication filed Dec. 28, 1971, by the assignee, *Phillips Petroleum Company*.

Hereby disclaims said patent and dedicates to the Public the remaining term of said patent.

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