United States Patent

Yazawa et al.

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[45] **May 16, 1972**

[54] **APPARATUS FOR FIBRILLATING UNIAXIALLY ORIENTED FILM**

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[73] Assignee: **Polymer Processing Research Institute Ltd.,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

Nov. 18, 1968 Japan.....43/84655

[52] **U.S. Cl.**.....**225/97,** 225/3, 225/93

[51] **Int. Cl.**.....**B26f 3/02**

[58] **Field of Search**.....225/3, 1, 93, 97, 96.5; 28/1.5; 57/31

[56] **References Cited**

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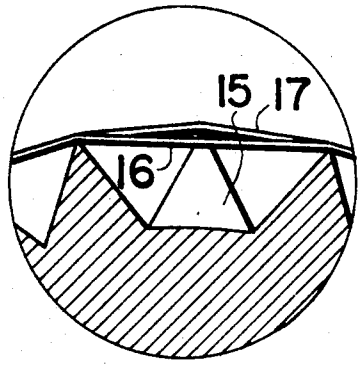
Primary Examiner—Frank T. Yost

Attorney—Fred C. Philpitt

[57] **ABSTRACT**

A web of small continuous fibers having a reticulated structure is prepared by slide-rubbing a uniaxially oriented film of a polymer, under a tension over a revolving bar like means having a coarse surface revolving around an axis in a longitudinal direction at a higher peripheral speed than the travelling speed of the film, in a direction perpendicular to the revolving axis of the revolving means. The revolving means is provided on its surface with a plurality of small roof-type projections formed by multiple screw threads having sharp crests and scraped grooves, intersecting with the said threads.

1 Claim, 9 Drawing Figures



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2 Sheets-Sheet 1

FIG. 1

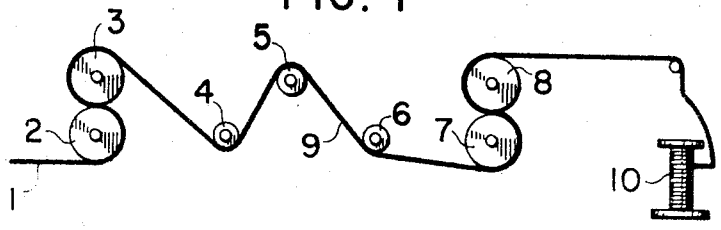


FIG. 2a

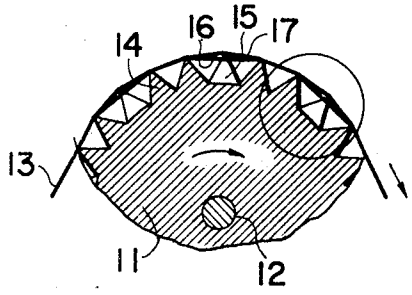


FIG. 2b

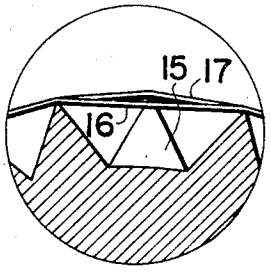


FIG. 3

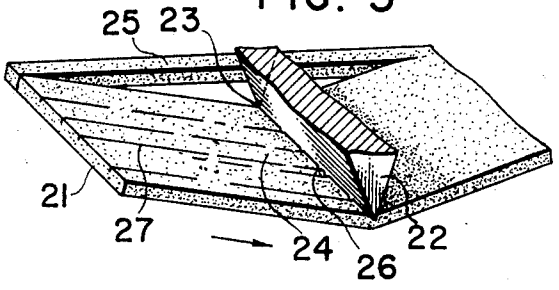


FIG. 4

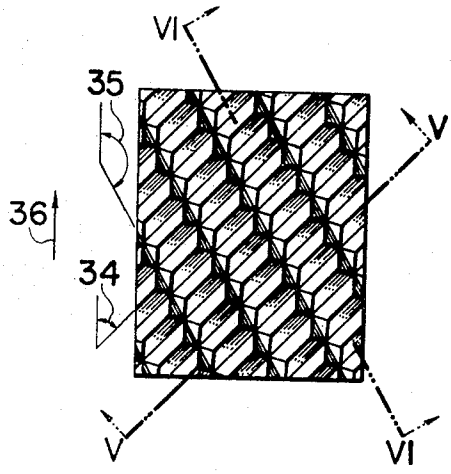


FIG. 6

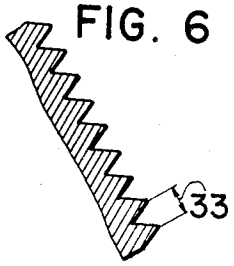


FIG. 5

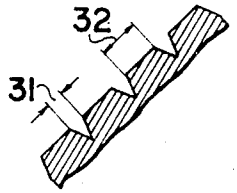


FIG. 7a

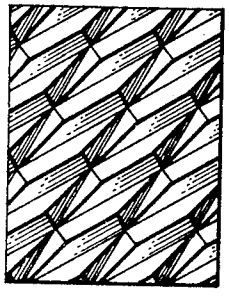
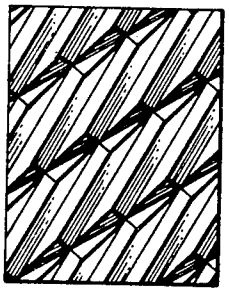


FIG. 7b



APPARATUS FOR FIBRILLATING UNIAXIALLY ORIENTED FILM

This invention relates to a method for fibrillating a uniaxially oriented film, and more particularly to a method for preparing a split fiber web from a uniaxially oriented film by slide-rubbing the film over a bar-file-like, revolving means having a coarse surface.

Recently the split fibers have come to attention and various methods for preparing split fibers have been proposed. One of the present inventors proposed also in U.S. Pat. Application No. 818529, a method for fibrillating a uniaxially oriented film by a bar file or similar means having a coarse surface and revolving at a high speed.

That is, the present invention relates to a method for continuously fibrillating a uniaxially oriented film, where the uniaxially oriented film of a polymer having a fiber formability is split into a web of small continuous fibers having reticulated structure by slide-rubbing the film under a tension over a bar file-like means having a coarse surface revolving around an axis in a longitudinal direction at a high speed, in a direction perpendicular to the revolving axis of said revolving means, characterized by using a bar-like means having a surface on which are provided a plurality of small roof-type projections formed by (I) multiple screw threads having more than **10** to several tens of sharp crests at a helix angle of 2.5° or more and usually at a pitch of 0.2 to 2.0 mm and (II) scraped grooves which intersect with said thread crests at an angle of 2.5° or more to the travelling direction of said uniaxially oriented film, have the same each width as said pitch and are scraped at a distance wider than the width of the scraped groove; the projections so formed being regularly arranged on the surface and having such an effective height that said uniaxially oriented film cannot be split through only one contact of each crest extended in an oblique direction with the film, while the film is slide-rubbed; passing the uniaxially oriented film under a tension over the surface of said bar-like means revolving at a higher peripheral speed than the travelling speed of the film at an angle (contact angle) of less than 180° to allow the portion of the film on the slide-rubbing section to come in contact with a plurality of small projections, while the film covers a portion of said surface and is slide-rubbed in contact with the surface; and splitting said uniaxially oriented film into a web of small continuous fibers having a reticulated structure through repetitions of shearing stress due to a difference in tension caused between the portion traversing over the projections on the surface and the portion passing over the grooves adjacent to the projections. The object of the present invention is to fibrillate a wide, uniaxially oriented film having a width over 1 m as well as more than **100** narrow, tape-like, uniaxially oriented films arranged in parallel at a speed as high as 500 to 1,000 m/min., while keeping the number of revolution of the revolving means having a coarse surface, i.e. an essential constituent of the fiber splitting apparatus, below the hazzardous rate of revolution. According to the present method, the production capacity of a splitter exceeds 10 tons per day and it is made possible to fabricate a truly practical production scale splitter.

The maximum diameter of commercially available bar file used in the method of the prior application filed by one of the present applicants as regards said method for fibrillation, is about 20 mm and its effective length is 400 to 500 mm.

Further, in case of such small diameter, it is necessary that the number of revolution be such that the revolution is effected at a peripheral speed 3 to 5 times as high as the travelling speed of the uniaxially oriented film, and thus, if the travelling speed is 300 m/min., the number of revolution exceeds the hazardous rate of revolution of the revolving means and becomes 14,000 r.p.m. in case that the file diameter is 20 mm, and a span between the supporting bearings is only about 600 mm. Thus, it is impossible to use the film having an effective width of over 500 mm and traveling at a higher speed.

In designing a practical splitter having a large capacity, said conventional splitter cannot be employed, because its capacity is too small. Particularly in case of producing split fibers from a wide film, it is necessary to make a span between the bearings of the splitter larger. Accordingly, in order to perform operation at a safety rate of revolution while trying to increase the capacity of production by increasing the travelling speed of the film, it is indispensable to employ a splitter having a larger diameter.

From the view point of a method for preparing the bar-like file, the length for fabricating a file is about 500 mm even either in case of manual processing using a chisel or in case of mechanical processing using a chisel-like tool. It is almost impossible to commercially obtain a file having an effective length of over 1 m to obtain a uniform split state covering a large width. The present invention is proposed to obtain a uniform, split fiber web by means of a splitter having a uniform surface structure through threading that can be worked uniformly.

As a splitter tool made by threading, Japanese Pat. Publication No. 16909/68 proposes a tap-like tool having male threads prepared by threading one or several rows of screws and scraping the screws at a several locations on the circumference.

Said conventional tool looks like, at a glimpse, as if it were a splitter used in the present invention, but its structure and function are fundamentally different. That is, the tool used in Japanese Pat. Publication No. 16909/68 has one or several threads of screws and the helix angle of the screw is very small, and does not exceed 1°, and is less than several minutes. Its crest forms a sharp edge and its object is to cut the film. Thus, reticulated slits of various sizes are obtained on the film by number of said screw crests, number of scrapes on the circumference, diameter of the tool and number of revolutions. The reticulated structure of the thus obtained product is regular and consists of main reticulated fibers running almost obliquely and a large number of small fibers connecting to said reticulated fibers one with another in form of a ladder.

Generally in case a plastic film is cut by an edged tool, the wearing of the edged tool is considerable. For example, when a polypropylene film having a thickness of about 0.05 mm is to be slitted by means of safety razor edges, the life of edges is about 20 hours even the in case of a film consisting of pure resin. Particularly in case of a film containing a coloring pigment, the life cannot exceed several hours, though it depends upon its content. This is indeed a surprising but a well-known fact.

In view of these facts, one of the present inventors invented in the prior invention a method for splitting a film not based on the "cutting" method. The present invention is to provide a novel mode of a bar-like revolving means having a coarse surface to be used in said prior invention. The crests of small projections on the surface of the revolving means of the present invention are at certain angles to the travelling direction of said film so as not to cut the uniaxially oriented film. Such angles are the helix angles of said screw threads (I). If said angles are less than 2.5°, the crests of the screw threads often exert a "cutting" action. Of course, such cutting action depends upon the surface properties of metals constituting said projections and the polymer film slide-rubbing over the metals, for example, a degree of smoothness and a coefficient of friction between the metals and the film, but most of polymers do not receive the cutting action hardly at all if the helix angle is 2.5° or more. Further, the crests of the present invention do not require a sharpness of the edge of edged tools. It is only necessary that the film undergoes an elevational difference from one position to another on account of the irregularity of the surface of the means having a coarse surface while the film is slide-rubbed over the coarse surface. It is rather convenient that the crests have sharp but elevationally somewhat rugged tiny projections inevitablly brought about by fabrication, because the sidewards slipping of the film can be thereby prevented. In that case, there takes place some flaw on the slide-rubbing surface of the film, but such a flaw is convenient for starting the fibrillating action when the shearing stress due

roof-type small projections exactly and regularly arranged on the surface by threading, which is used in the splitter to effect uniform splitting, and the said polymer having a fiber formability is selected from the group consisting of high density polyethylene, polypropylene, polyvinylchloride, polyvinylalcohol, polyacrylonitril, polyvinylidenchloride, and copolymer thereof, polystyrene, polytetrafluoroethylene, copolymer of hexafluoropropylene and tetrafluoroethylene and other fluoro-resins, nylon-6, nylon-66 and the like polyamides, polyethylene-terephthalate and the like polyesters, polycarbonates, polyurethanes, regenerated cellulose and derivatives thereof.

We claim:

1. An apparatus for continuously fibrillating film which includes:

a. two spaced apart revolving feed means for causing a sheet of uniaxially oriented film to travel in a first direction,

b. a revolving coarse surface positioned intermediate said two spaced apart revolving feed means and adapted to be pressed against said film at a contact angle of between 60° and 120° so that said film will be maintained under tension in moving between said two spaced apart revolving feed means,

c. the axis of revolution of said revolving coarse surface being disposed perpendicular to the said "first direction" set forth in (a),

d. means for making the peripheral speed of said revolving coarse surface faster than that of the travelling speed of the film set forth in (a),

e. said revolving coarse surface having a multiplicity of small roof-shaped projections disposed over its surface,

f. the roof-shaped projections of said revolving coarse surface resembling the surface of a discontinuous multithread screw,

g. the helix angle of said screw thread crests being at least 2.5° with respect to the travelling direction of said film so as to not cut the uniaxially oriented film,

h. the pitch of said screw threads being within the range of 0.2 mm to 2.0 mm,

i. the screw threads being intersected by helical grooves,

j. the angle of the helical grooves with respect to the travelling direction of the film being within the range of about 5° to 170°,

k. the length of each roof-shaped projection on said revolving surface being at least equal to the width of said helical grooves.

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