Sept. 12, 1967 J. K. PANNILL, JR., ET AL 3,340,576

METHOD FOR BLOOMING TOW

Filed April 5, 1966 3 Sheets-Sheet 1

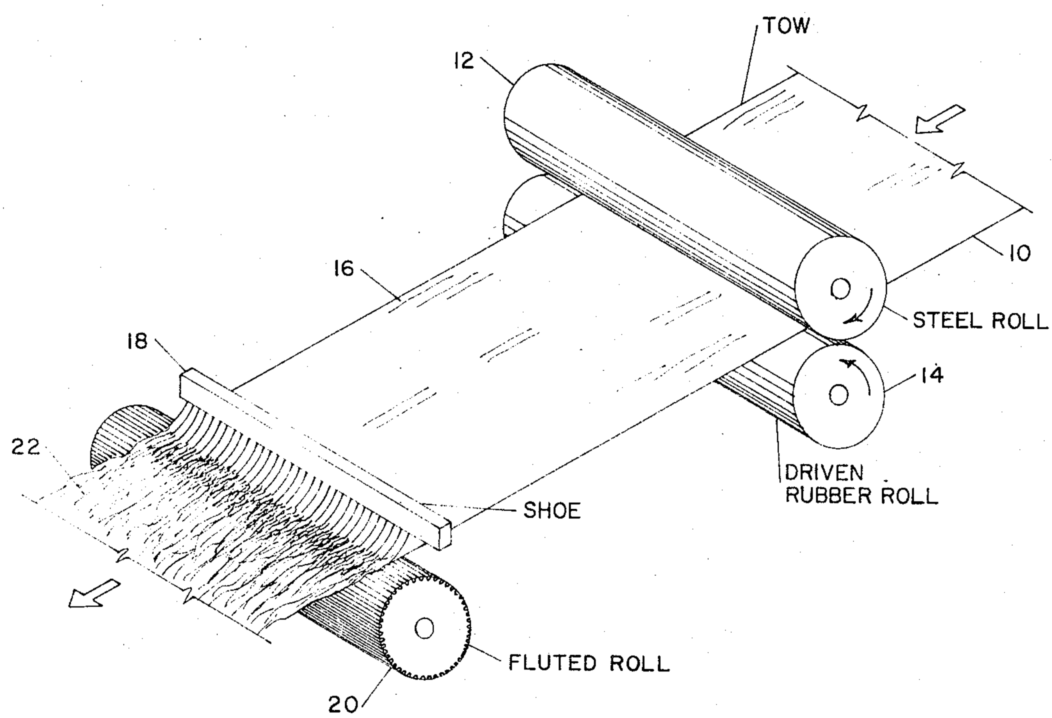

FIG. 1

JAMES K. PANNILL
PAUL GALLAGHER
INVENTORS

BY Harold N. Powell
Abram W. Hatcher
ATTORNEYS

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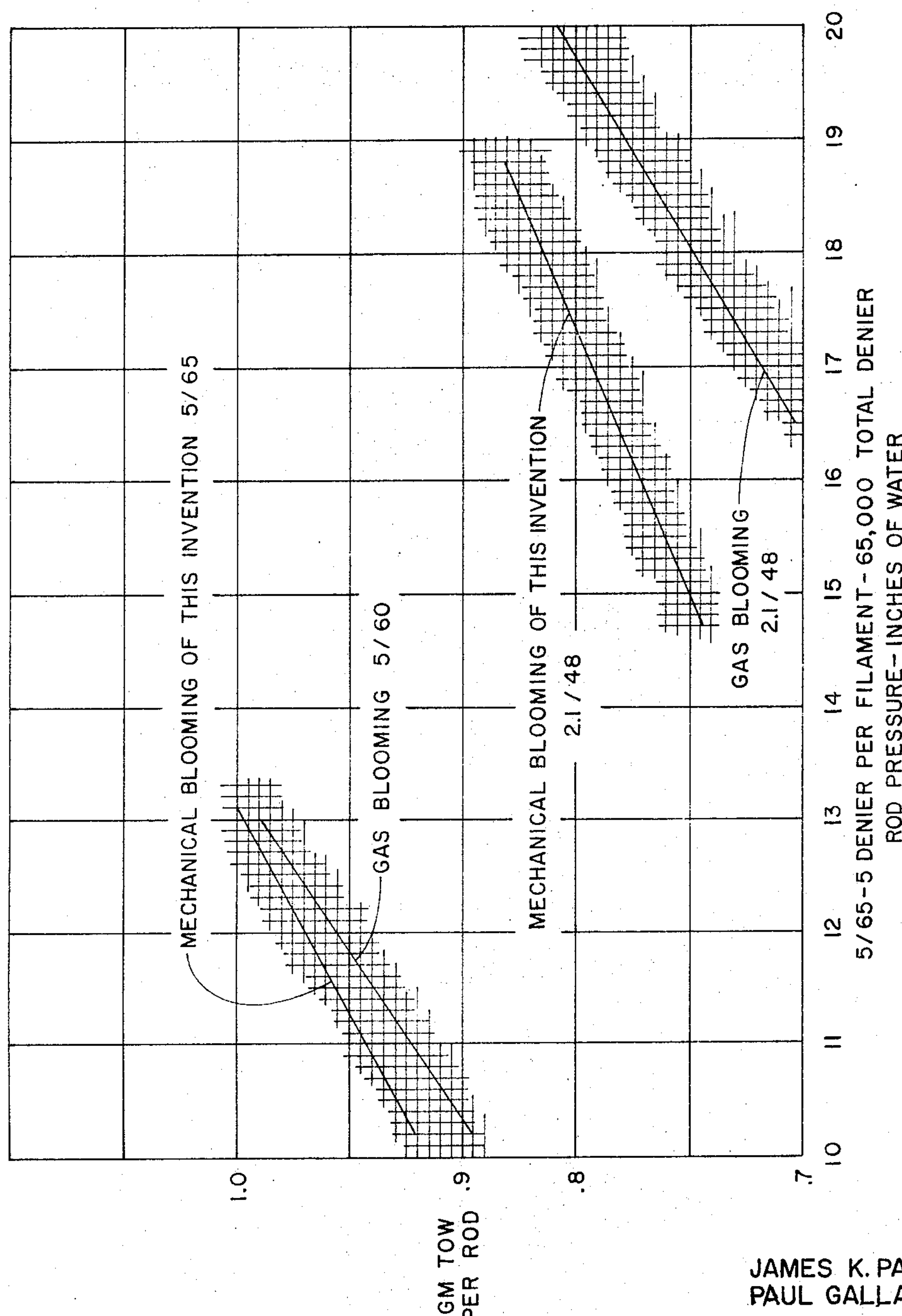

FIG. 2

JAMES K. PANNILL
PAUL GALLAGHER
INVENTORS

BY Harold N. Powell
Abram W. Hatcher
ATTORNEYS

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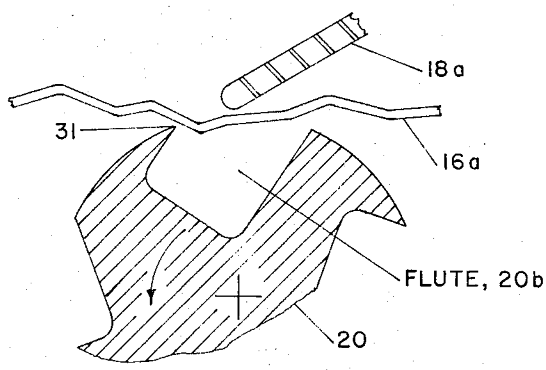

FIG. 4

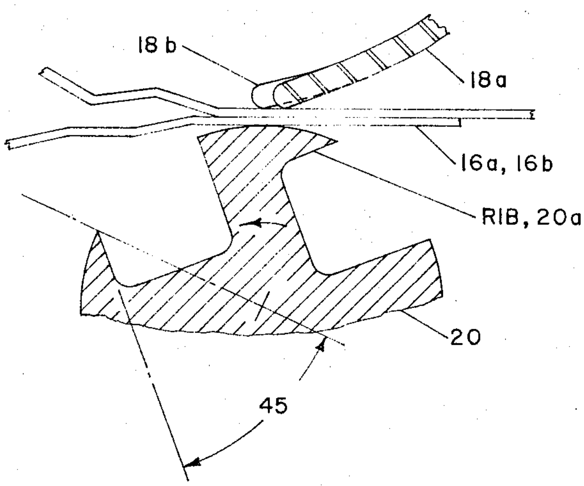

FIG. 3

JAMES K. PANNILL
PAUL GALLAGHER
INVENTORS

BY Harold N. Powell
Abram W. Hatcher
ATTORNEYS

United States Patent Office

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METHOD FOR BLOOMING TOW

James K. Pannill, Jr., and Paul Gallagher, Kingsport, Tenn., assignors to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

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3 Claims. (Cl. 19—65)

This is a continuation-in-part of Ser. No. 315,265, filed Oct. 10, 1963, now U.S. Patent No. 3,254,373, which issued on June 7, 1966.

This invention relates to blooming tow. More particularly it relates to a method for opening or blooming continuous filament tow which is especially useful in the production of rod-like elements adapted to be used in tobacco smoke filters and the like.

It has become well established in the man-made fiber industry, for example, as shown by U.S. Patents 2,794,239; 2,900,988 and 2,953,838 to Crawford and Stevens, that some sort of opening or blooming treatment for crimped continuous filament tow is desirable, especially for tow to be compacted into rod-shaped elements useful as tobacco smoke filters. One way of effectively accomplishing such blooming is by use of a gas-jet treatment such as taught by Inventor Gallagher and his coworker Dyer in U.S. Patent No. 3,081,951. Another is by apparatus such as that of our abovementioned parent application 315,269, now U.S. Patent No. 3,254,373. Mechanical methods are taught by Bishop and Tichenor and by Smith, respectively, in U.S. Patents 2,843,881 and 3,016,581. While such have proved highly acceptable in the industry, some manufacturers would prefer an alternate mechanical method employing an improved tension-relaxation cycle. After extended investigation we have found just such an improved mechanical method for opening tow.

In its broader aspects our invention involves advancing the tow through two nip points by means of repetitive tension-relaxation cycles. In one embodiment the tow is fed forward through the first or upstream nip point at a constant input rate with a positively controlled forwarding action. The tow forwarded by the upstream nip is then intermittently stretched and advanced through the second or downstream nip point.

The intermittent action may be obtained as follows. One of the coacting members which forms the downstream nip is positively moved in the direction of tow travel at a rate two to four times, preferably about three times, the speed of the tow. The surface of the positively moved member may be made discontinuous, e.g., by being made to consist of alternate flutes and ribs disposed transversely to the direction of motion. The perpendicular axes of such flutes are disposed at an angle other than 90° to the direction of movement, preferably at 30°–60° backward from the perpendicular. The other member of the downstream nip may consist of a stationary flexible member which yieldably engages the surface of the tow contacting moving member. The flexible member may be composed of a multiplicity of fingers, each of which forms a nip or contact for groups of filaments comprising the tow. According to this embodiment of our method, the relatively fast speed of the moving member advances and stretches the tow. The action is interrupted by the passage of the flutes under the flexible member. The interval of engagement and the yieldable nature of the nip combine to prevent substantial filament breakage. In this embodiment the positive feed of the upstream nip (e.g., by using a driven roll) controls the average tow feed rate and amount.

In an alternate embodiment the upstream nip is not positively driven. Instead controlled braking is used. In cooperation with the action of the downstream nip, this controlled braking produces a substantially uniform tow tension. In this embodiment the interaction of the speed of the moving member of the downstream nip, the pressure of the flexible member, and the controlled braking of the upstream nip combine to provide a uniform average tow feed rate and amount.

In both embodiments, subjecting of the tow to repetitive tension-relaxation cycles between the two nips effectively opens or blooms it. In addition, minute but effective variations in the duration or degree of stretch applied to groups of filaments sometimes result. These enhance the relative motion between groups of filaments. An advantage of this process is that since the tow is not tensioned for a continuous interval, little permanent straightening of the filaments occurs. Thus, a well bloomed tow results wherein the initial crimp in the filaments is substantially retained.

While we do not wish to be bound by a particular theory, we believe one reason for the improved efficiency of our process is that the change from tension to relaxation is substantially instantaneous rather than decreasing at a finite rate.

By using a stationary flexible member or shoe and the turning of the fluted roll, with the tow band being generally more than one filament thick, relative longitudinal displacement of filaments takes place during the tension interval of the cycle. When the shoe is composed of a multiplicity of parallel elements, this relative longitudinal displacement also occurs between some adjacent filaments because each element releases small groups of filaments at slightly different intervals. The variable release results from variable length of the flexible fingers or extensions of the flexible member, variable finger stiffness or the combination of both. As the trailing edge of the rib or finger on the roll moves beyond the main body of the shoe to which it is attached, it flexes rapidly and imparts lateral vibration to the filaments.

In blooming tow according to our process the original synchronized pattern of the crimp in the filaments is disturbed at a low average tension. This results in limited permanent straightening of the filaments. Thus the bloomed tow expands in volume.

When we use a fluted roll in our process and surface contact is involved, the dimension parallel to the movement of the tow is relatively small and less than the corresponding dimension of the notches. Thus, the contact between the moving and fixed surfaces is sufficiently yieldable to move the tow therebetween forward without breaking it. The tension resulting from contact between the moving and fixed surfaces is periodically interrupted by the notches in the moving surface. When flexible fingers are used in the stationary member or shoe, the line or area of contact and/or the contact force varies sufficiently to control or regulate as desired the interval and/or magnitude of tension applied to tow filaments or filament groups. This causes displacement of filaments or groups of filaments relative to others.

For a further understanding of our invention reference is made to the attached drawing which forms a part hereof.

In the drawing:

FIG. 1 is a perspective view of a representative shoe-roll blooming arrangement which may be used according to our process, including feed rolls.

FIG. 2 is a graph plotting weight against rod pressure for two samples of cellulose acetate tow treated according to the instant process as compared to the same tow treated by gas-jet blooming. The weight-pressure drop relationship for the shoe-roll formed filament rods of this invention is seen to compare favorably to that already found acceptable to the industry for rods made of gas-jet bloomed filaments.

FIGS. 3 and 4 are cross sections of the shoe and roll of FIG. 1 described more specifically hereinafter.

A preferred embodiment of apparatus for use in our tow-blooming method is shown in FIG. 1. Tow **10** passes first through the nip formed between rolls **12** and **14**, which comprise upstream members. Preferably one of these rolls is provided with a resilient, yieldable cover such as rubber to form a nip for the tow and is positively driven by conventional means (not shown) to forward the tow at a uniform average rate. A ratch for the tow **16** is formed between upstream rolls **12** and **14** and downstream members shoe **18** and fluted roll **20**. Fluted roll **20** also has a resilient, flexible cover. FIG. 1 shows how flutes extend across the face of roll **20** parallel to its axis.

FIGS. 3 and 4 are both cross-sectional views of roll **20** and shoe **18**. FIGS. 3 and 4 have been intentionally distorted somewhat to illustrate the blooming action of our process. FIG. 3 depicts a shoe in contact with a roll. FIG. 4 shows a flute passing under the contact portion of the shoe. In FIG. 3, **18*a*** represents one finger element of the shoe, generally indicated by **18** in FIG. 1. Rib **20*a***, the periphery of the roll, deflects finger **18*a*** slightly forming a nip in which two single filaments **16*a*** and **16*b*** are shown. Actually the thickness of the tow varies rapidly from a single filament to several at any given point across the nip. The finger will press against the rib even if no filament is between them. **18*b*** represents a second finger adjacent to **18*a***. The nip contact area of **18*b*** may or may not fall on the extension of the axial line through the contact area of **18*a***. Likewise the stiffness, the amount of deflection, or the contact pressure of one finger may or may not be equal to the corresponding characteristic of another finger. Such differences in the fingers thus cause differences in the tensioning of groups of filaments.

In FIG. 4 the position of the turning roll is such that flute **20*b*** is beneath finger **18*a***. Consequently no nip exists to grip the filaments. While only one filament, **16*a***, is shown in FIG. 4 even when the tow bundle is several

filaments thick, it will not be held. There is a vibrating action of the trailing edge of the rib at **31**.

The following examples are illustrative of our invention.

Crimped continuous cellulose acetate tows of various denier per filament (DF) and total denier (TD) were bloomed or opened according to our process. The results of this tow treatment are recorded in the following table.

TABLE

Sample No.	1	2	3	4	5	6	7	8	9
Denier (DF/TD in 1,000's)	2.1/48	2.1/48	5/65	2.1/48	2.1/48	2.1/48	5/65	5/60	2.1/48
Gms. Tow/1 Rod	.878	.768	.996	.917	.773	.764	.940	.878	.738
Rod Pressure (inches of water)	18.8	14.7	13.1	10.2	16.0	15.3	10.7	10.0	14.7
Std. Dev. Press. (inches of water)	.987	.566	.827	.373	.820	.606	.255	.270	.483
Plasticized Wt. (grams)	1.009	.932	1.210	1.120	.957	.928	1.094	1.039	.893
Std. Dev. Wt. (grams)	.0239	.0196	.0245	.0222	.0191	.0205	.0210	.0162	.0176
Avg. Circ. (millimeters)	24.88	24.99	25.06	24.89	24.86	24.88	24.95	25.00	24.95
Circ. Range (millimeters)	.55	.70	.25	.3	.25	.25	.25	.35	.35
Std. Dev. Circ. (millimeters)	.189	.180	.066	.074	.041	.096	.058	.094	.082
Percent Plasticizer	5.1	7.4	11.3	11.8	12.0	10.4	8.5	8.5	9.4
2 Hours Hardness	7.3	7.0	1.8	7.6	6.0	8.4	5.3	3.8	7.0
Roll Ratio	3.46	4.6	3.88	4.26	4.74	4.6	4.6	2.94	2.93
Bloom Rating [1]	Fair	Fair	Fair	Fair Minus	Fair Minus	Fair	Fair	Good Minus	Good Minus
Shoe Type	(2)	(2)	(2)	(3)	(3)	(4)	(4)	(5)	(5)

1 The Bloom Rating represents a judgment decision.
2 Piano wire on steel roll.
3 Spring steel on steel roll.
4 29 pcs. spring steel on steel roll.
5 29 pcs. spring steel on 4" rubber roll.

From the foregoing description and examples it is thought apparent that we have provided a novel and highly efficient mechanical method for blooming continuous filaments.

Although the invention has been described in considerable detail with reference to certain preferred embodiments thereof, variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. The method of applying blooming forces to a crimped continuous multifilament tow comprising the steps of maintaining said tow under controlled tension during application of the blooming forces, and continuously advancing said tow while under controlled tension between (1) a discontinuous movable surface of transverse ribs and flutes having perpendicular axes disposed at angles other than 90° to the direction of tow movement and (2) at least one member cooperating therewith with elements of varying characteristics such that the action between the discontinuous movable surface and member induces lateral vibration to the filaments resulting in blooming of the tow.

2. The method according to claim **1** wherein the discontinuous movable surface of transverse ribs and flutes forms the surface of a cylindrical roll.

3. The method according to claim **1** wherein said tow is fed forward through said discontinuous movable surface and member at a substantially constant input rate, and said discontinuous movable surface is moved in the direction of tow travel at a rate between about two and four times the speed of said tow.

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ROBERT R. MACKEY, *Primary Examiner.*