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PROCESSING TOW

Filed Feb. 11, 1958

3 Sheets-Sheet 1

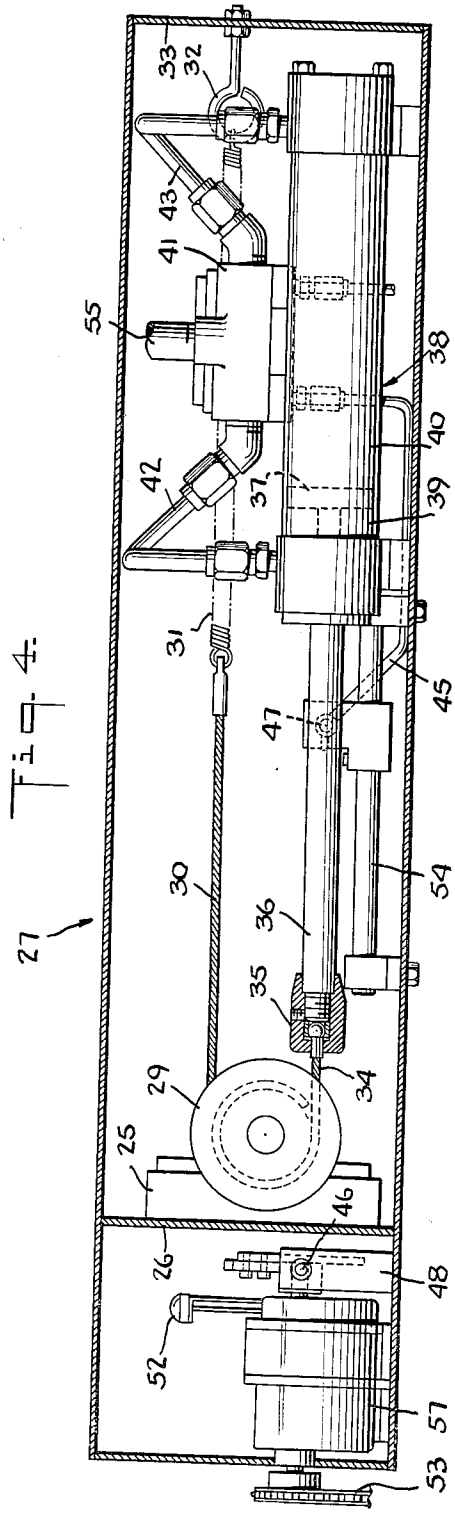

Fig. 4.

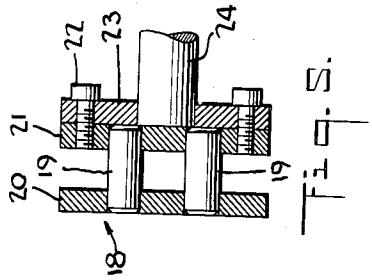

Fig. 3.

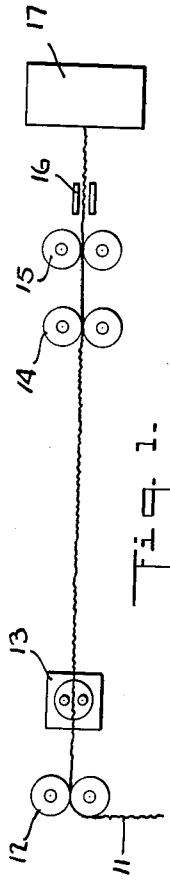

Fig. 1.

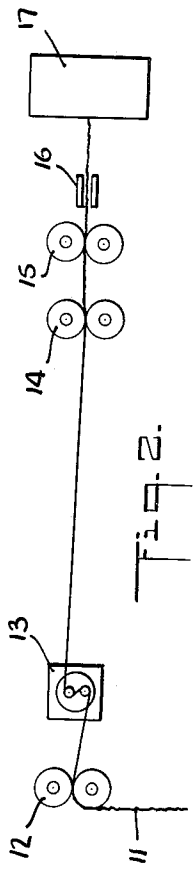

Fig. 2.

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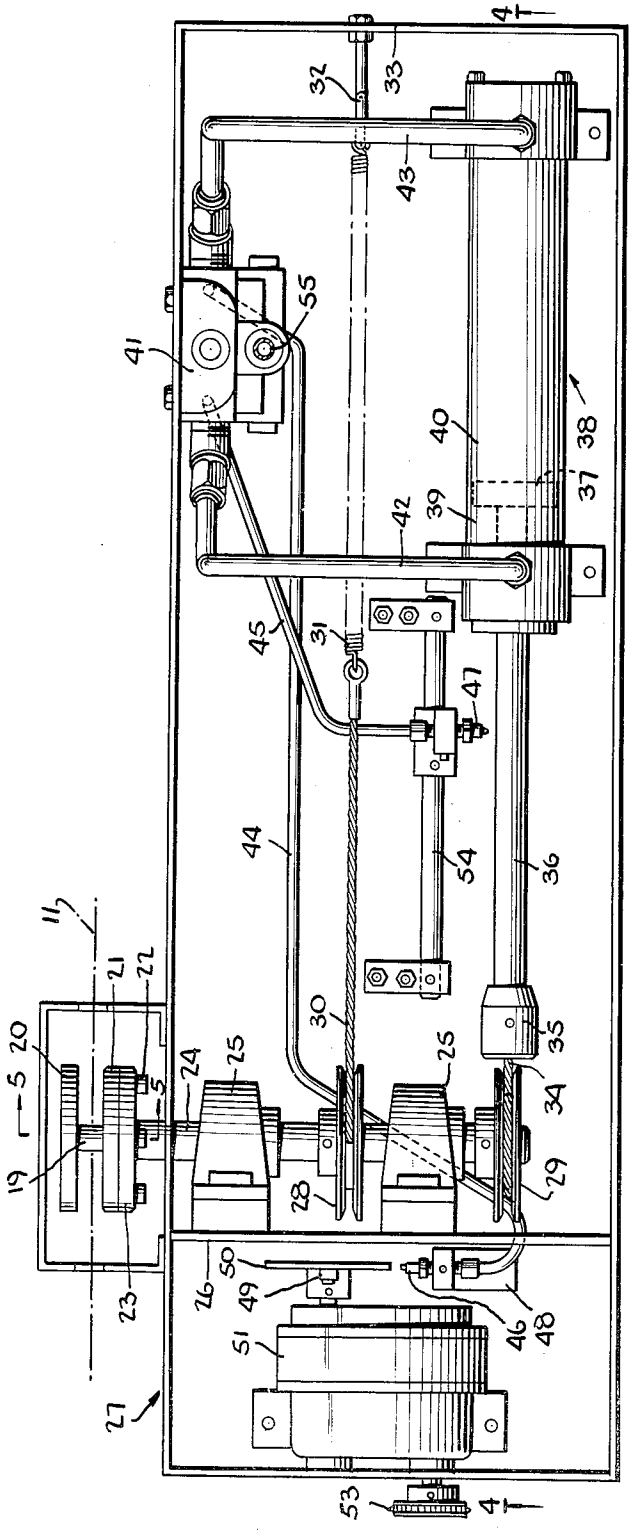

Fig. 5.

Fig. 6.

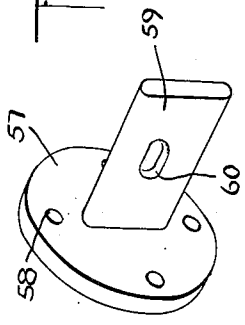

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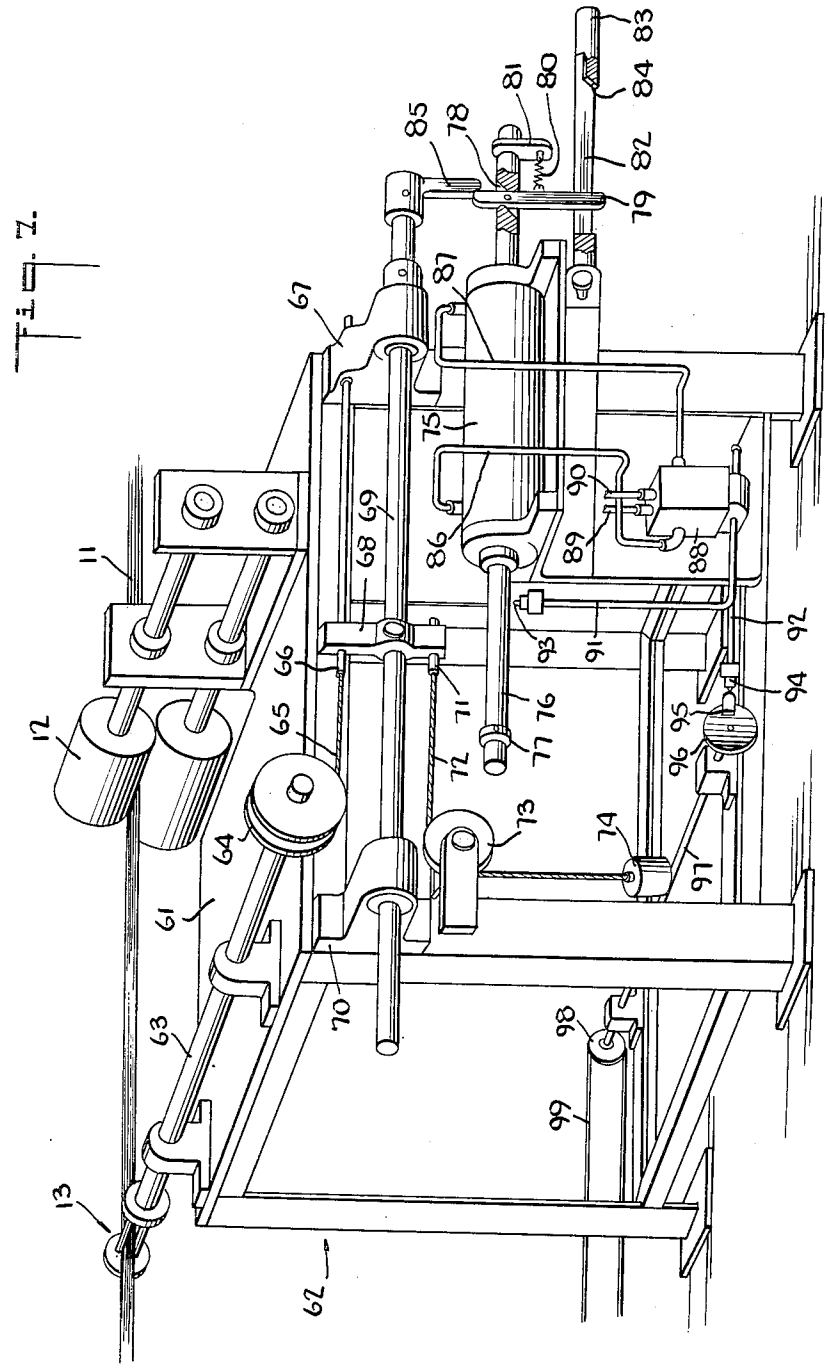
Fig. 7.



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2,978,752

PROCESSING TOW

Eugene Francis Cloutier and Svend A. Petersen, Charlotte, N.C., assignors to Celanese Corporation of America, New York, N.Y., a corporation of Delaware

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25 Claims. (Cl. 19—65)

The present invention relates to a novel process for opening a filamentary tow such as is used in the formation of cigarette filter plugs, and to apparatus for performing the process.

Cigarette filters are generally formed of a multiplicity of crimped filaments, starting with a crimped tow or bundle of several thousand continuous filaments. As received from the tow producer, the filaments are more or less adhered to each other with the crimps of adjacent filaments in registry. In processing into filters, the tow is formed into a wide fluffed up band which is fed through a chamber in which plasticizer is applied; it is thereafter condensed to the cross-sectional area of a cigarette and maintained in that form by such means as wrapping in paper or fusing, followed by being cut into suitable lengths for incorporation into cigarettes.

In commercial operation it has been found that the filters so produced are not all identical in their filtering action. Specifically, it has been found that the filters occasionally differ in weight, in filtering efficiency and in the ease of draw, i.e. resistance to gas flow. In addition, after smoking many filters show uneven darkening which indicates non-uniform passage of smoke therethrough, the darkened areas identifying zones through which the smoke was preferentially drawn.

It is accordingly an object of the present invention to provide a process for treating tow in a manner which facilitates formation of uniform cigarette filters.

It is a further object of the invention to process a tow in a manner which provides cigarette filters of improved properties.

Another object of the invention is to provide an apparatus for processing tow in accordance with the novel procedures.

Other objects and advantages will be apparent from the following detailed description and claims.

Our investigations have revealed that the cause of irregularities in the filter tips and their filtration characteristics can be traced to tow which has not been properly opened. Specifically, in the crimping of the tow the filaments are simultaneously acted upon and adjacent filaments may have their crimps in registry and may be bundled together; if such crimp registration and bundling is not done away with there will be channels in the filter through which smoke can pass without contacting any filament surface. In addition, as produced, the tow may contain individual filaments or groups of filaments which do not extend longitudinally but rather which extend at an appreciable angle transversely of the tow. In processing, these transversely extending filaments or "cross-overs" tend to prevent those filaments which they overlie from being spread apart laterally.

If a tow has not been evenly crimped initially, failure to open the tow properly will result in uneven application of plasticizer and this in turn results in uneven density so that there is channeling of smoke through the filter.

In accordance with one aspect of the present invention the tow is opened by being drawn along from a first point to a second point, preferably under a slight tension,

past a normally inactive snubbing device. Periodically the snubbing device acts on a point of the tow intermediate the first and second points to prevent that intermediate point from advancing while still pulling the tow along by drawing means. The periodic locking action by the snubbing device in conjunction with the pull by the drawing means intermittently places a considerable tension on the tow and it has been found that the tow beyond the second point is evenly opened and free of crimp registration. Cross-overs are not evident in the opened tow and it can be directly passed to a banding jet and then treated with plasticizer.

Preferably the tow is acted on by a braking device, such as a pair of rolls urged into contact with each other, positioned intermediate the snubbing device and the drawing means. The loading of the braking device is such that the now opened tow is stretched a predetermined amount between the braking device and the drawing means, and thus ensures formation of uniform plugs. The invention thus permits independent control of tow opening and tow stretching. Actuation of the snubbing device temporarily increases the tension on the tow between the snubbing device and braking device to a value approaching but not ordinarily equalling the tension on the tow between the braking device and drawing means.

As noted, especially good results are obtained when the tow passing to the snubbing device is under some tension, e.g. a tension of 0.01 to 0.06 and preferably 0.015 to 0.03 gram per denier. Such tension may be applied by passing the tow, before it reaches the snubbing device, between a pair of contacting rolls urged lightly toward each other.

The braking device is conveniently arranged close to the drawing means and is loaded so that when the snubbing device is inactive the tension on the tow between the braking device and drawing means ranges from about 0.025 to 0.15 and preferably 0.03 to 0.06 gram per denier. Preferably the braking device comprises rolls which are driven or idly mounted and rotate upon drawing of the tow therebetween.

The distance between that intermediate point where the snubbing device acts on the tow and that second point where the tow first contacts the drawing means or the braking device, if the latter is included, is conveniently a minimum of about 6 feet and preferably is a minimum of about 8 feet.

The time interval between successive snubbings will vary with the speed of the tow but should be sufficiently small so that none of the tow passes between the first and second points without having been subjected to the intermittent snubbing action at least once, i.e. the speed of the tow is correlated to the frequency of snubbing so that each segment of the tow is between the intermediate and second points sufficiently long for at least one snubbing cycle.

The tow is preferably composed of continuous filaments of an organic derivative of cellulose, e.g. ethers or esters of cellulose such as cellulose acetate, cellulose propionate, cellulose acetate propionate, highy esterified cellulose containing less than 0.29 free hydroxyl groups per anhydroglucose unit such as cellulose triacetate, and the like. Other filamentary materials such as rayon (regenerated cellulose), linear superpolyamides such as nylon-6 and nylon-66, linear polyesters, such as polyethylene terephthalate, acrylonitrile polymers and copolymers, and the like can also be employed. The number of filaments and the total denier can vary within wide limits, but in preparing filters for conventional cigarettes which are about 25 mm. in circumference the number of filaments generally varies between about 5000 and 35,000 and the total denier ranges from about 60,000 to 160,000.

The number of crimps per inch in the tow can range

up to about 20 but preferably averages between about 4 and 12. After leaving the driven rolls the tow is still crimped but is longer than initially, i.e. the tow has been stretched so that the distance between the crests of adjacent crimps has been increased and the amplitude reduced. In addition, the crimps are deregistered and more regular than initially.

The identity of the plasticizer will of course depend upon the composition of the tow. With cellulose acetate there may be employed methyl phthalyl ethyl glycolate, triethyl citrate and dimethoxy ethyl phthalate, but glycerol triacetate is preferred. The proportion of plasticizer applied generally varies from about 2 to 30% by weight of the tow to which it is applied, and preferably from about 4 to 15%.

Because of the openness of the tow the plasticizer attacks all the filaments uniformly so that the density of filters produced therefrom is uniform. The openness of the tow and the deregistration of the crimp of adjacent filaments prevents channeling and makes a firm filter even with a tow of a smaller total denier than normally utilized. In addition, the filtering efficiency is increased so that a given efficiency can be achieved using less tow and thus with less resistance to draw, i.e. at a lower pressure drop.

The tow, in accordance with the present invention, need not be fed in perfectly flat condition and it is accordingly possible for a single operator to supervise feed of many tows from a central bale room to a plurality of openers. Since a cigarette making plant has many filter making units simultaneously in operation, this represents a considerable saving in labor. In addition, considerable saving in space results since it is not necessary to store two bales of tow, i.e. that being fed and a spare, adjacent each unit as is necessary when the tow must be fed carefully and over short distances to prevent twisting as it is drawn from its bale.

The invention will now be described more fully with reference to the accompanying drawings wherein:

Fig. 1 is a schematic lateral elevation of a tow conditioning apparatus in accordance with the present invention;

Fig. 2 is a view similar to Fig. 1 with the snubbing device shown in a different operative position;

Fig. 3 is a top plan view of a mechanism for actuating the snubbing device of Fig. 1;

Fig. 4 is a lateral elevation of the mechanism of Fig. 3 with the housing shown in section, being broken off along line 4—4 of Fig. 3, to expose the mechanism;

Fig. 5 is a section taken along line 5—5 of Fig. 3;

Fig. 6 is a perspective of an alternate snubber, and

Fig. 7 is a perspective view of another mechanism for actuating the snubbing device.

Referring now more particularly to the drawings wherein like numerals have reference to the same element, in Fig. 1 there is shown a tow **11** drawn from a bale (not shown) between a pair of tension rolls **12** urged toward each other and idly mounted for rotation. The tow **11** passes an inactive snubbing device **13** and then enters between a pair of contacting braking rolls **14** urged toward each other and idly mounted for rotation. From the braking rolls **14** the tow **11** passes between rolls **15** which are positively driven at a speed correlated to that of a machine (not shown) for forming opened tow into cigarette filter plugs.

The tow **11** upon leaving the rolls **15** passes through a banding jet **16** of conventional type through which compressed air is directed at the tow. The tow next enters a plasticizing chamber **17** wherein there is provided a mist of plasticizer such as glycerol triacetate. The plasticized tow upon emerging from chamber **17** is in a uniformly opened condition for passage to conventional rod-forming equipment (not shown) in order to be continuously formed into cigarette filter plugs having the desirable properties previously noted.

Periodically during the advance of the tow the snubbing device **13** is rotated about its axis about 360 degrees as shown in Fig. 2 and serves to lock the tow **11**, preventing slipping of the tow past the snubbing device. During such locking, the driven rolls **15** pull on the tow **11**, the tow continues to move past rolls **15** and also past rolls **14** so that rolls **14** continue rotating. The tension on the tow between rolls **14** and snubbing device **13** thus increases considerably. Upon rotation of the snubbing device **13** in reverse direction, the tow is unlocked and again advances, the tension being for the most part relieved.

The mechanism for controlling the actuation of the snubbing device **13** is shown in Figs. 3, 4 and 5. The snubbing device comprises a snubbing head **18** including a pair of spaced stubs **19** extending between a pair of spaced plates **20**, **21**. The plate **21** is bolted at **22** to a flange **23** supported on a shaft **24**. The tow **11** passes through the space defined by stubs **19** and plates **20**, **21** and it is the movement of head **18** upon suitable rotation of shaft **24** which serves to lock and then release the tow.

The shaft **24** is supported for rotation by a pair of bearings **25** mounted on a vertical wall **26** of a housing **27**. The shaft **24** carries a pair of pulleys **28**, **29** keyed thereon to rotate therewith. One end of a cable **30** is fixed to the pulley **28** and the other end is coupled to a spring **31** which is anchored by an eye **32** to end wall **33** of housing **27**. The spring **31** thus opposes rotation of shaft **24** and pulleys **28**, **29** in counter-clockwise direction as viewed in Fig. 4.

Another cable **34** is fixed at one end to pulley **29**. The other end of cable **34** is enlarged and is held in a recess provided between an internally threaded collar **35** and the threaded end of a piston rod **36** coupled to the collar **35**. The other end of the piston rod **36** carries a piston head **37** which is disposed inside an air cylinder **38** and which is reciprocated therein as hereinafter described.

The piston head **37** divides the air cylinder **38** into two separate chambers **39**, **40** respectively in communication with a four-way valve **41** of conventional construction by means of conduits **42**, **43**. Conduits **44**, **45** also extend from valve **41** and terminate respectively in poppet valves **46**, **47** of conventional construction. Poppet valve **46** is held by a bracket **48** in the path of a cam or detent **49** mounted on a plate **50**. The plate **50** is rotated by a variable speed mechanism **51** bolted to housing **27**. The output speed of the mechanism **51** is controlled by a lever **52** while the input speed is set by a sprocket **53** driven at a fixed speed.

Poppet valve **47** is mounted on a bar **54** which is secured to the housing **27**, the position of the valve **47** along the bar **54** being capable of adjustment.

A hose **55** supplies compressed air to the valve **41** and then through conduit **43** into chamber **40** of air cylinder **38** to maintain the piston head at the left-hand end of the cylinder, chamber **39** venting to the atmosphere through conduit **42** and through valve **41**, the latter being provided with an adjustable exhaust opening (not shown).

Operation commences as follows: With the elements starting in the positions shown in Figs. 1, 3 and 4, sprocket **53** is driven from a motor (not shown) and drives mechanism **51** to rotate plate **50**. Detent **49**, on plate **50**, strikes poppet valve **46** and instantaneously relieves the pressure which prevails in conduit **44**. The connections in valve **41** are thereby switched so that compressed air is supplied through conduit **42** and conduit **43** vents to the atmosphere. Compressed air is thus supplied to chamber **39** and withdrawn from chamber **40** so that piston head **37** is moved to the right in cylinder **38**. This movement carries piston rod **36** to the right together with cable **34**. The size of the adjustable exhaust opening (not shown) of valve **41** controls

the speed of displacement of piston head 37, piston rod 36 and cable 34.

Because the end of the cable 34 is fixed to pulley 29, the pulley is rotated in counter-clockwise direction as viewed in Fig. 4, carrying shaft 24, pulley 28 and snubbing head 18. The head 18 is rotated a predetermined amount sufficient to cause stubs 19 to lock the tow which passes therethrough. Rotation of the head 18, as well as of the shaft 24 and all other elements which it carries, is opposed by spring 31 which is extended during rotation.

As the piston rod 36 moves to the right, the collar 35 which it carries strikes poppet valve 47. The disposition of valve 47 along bar 54 determines the amount of rotation which snubbing head 18 undergoes. The momentary release of pressure in conduit 45 as poppet valve 47 is struck again switches the supply and exhaust conduits on valve 41. Compressed air is then fed to chamber 40 and vented from chamber 39 carrying the piston rod 36 to the left. This permits pulley 29 together with shaft 24 and snubbing head 18 to be rotated in clockwise direction under the force of spring 31, thereby restoring all elements to the positions shown in Figs. 1, 3 and 4.

Fig. 6 shows an alternate snubbing head 56 which can be attached to the flange 23 of Fig. 5. Head 56 includes a flat plate 57 with holes 58 for passage of bolts therethrough and provided with a perpendicularly projecting member 59 having an aperture 60 for passage of tow therethrough. The portions of member 59 above and below aperture 60 function in the same manner as stubs 19 in locking the tow upon rotation.

Fig. 7 shows a slightly modified snubbing mechanism which operates in generally similar manner except that it utilizes the force of gravity in place of spring distension to oppose tow locking and it also includes a quick return mechanism. In this embodiment, the tow 11 passes between rolls 12 supported on the cover 61 of a frame 62. The tow then passes through a snubbing device 13 carried on a rotatable shaft 63 which has a pulley 64 keyed thereto. A cable 65 is fastened at one end to the pulley and at its other end to a bar 66 mounted for longitudinal movement through a bracket 67 on frame 62. The bar 66 carries fixed thereto a crosspiece 68 which in turn carries a bar 69 mounted for longitudinal displacement in bracket 67 and another bracket 70. Crosspiece 68 also has rigidly fixed thereto a rod 71. A cable 72 is connected at one end to rod 71, runs about a pulley 73 and carries a weight 74 at its other end.

An air cylinder 75 is supported on frame 62 and has a piston rod 76 projecting therethrough at both ends. The left hand end of piston rod 76 carries a collar 77 and the right hand end has an inclined slot 78 extending in a vertical plane. A lever 79 extends through slot 78 in both directions and is mounted so as to be able to pivot only between the position illustrated and another position displaced therefrom by about 45°. A spring 80 extends between lever 79 and an element 81 on piston rod 76 so as to pull lever 79 into vertical position.

The lower end of lever 79 extends through an elongated slot 82 in a member 83. The right hand end of slot 82 has an incline 84 for a purpose hereinafter described. The upper end of lever 79 is aligned with a projection 85 on the end of bar 69.

The piston rod 76 carries a piston head (not shown) inside cylinder 75 which divides the cylinder into two chambers (not shown) respectively communicating through conduits 86, 87 with a four way valve 88. Compressed air is supplied to valve 88 by conduit 89 and is vented through outlet 90. Conduits 91 and 92, respectively terminating in poppet valves 93 and 94, also extend from valve 88. Poppet valve 93 is disposed to cooperate with collar 77 on piston rod 76 while poppet valve 94 is disposed to cooperate with a detent 95 on a plate 96 keyed to a shaft 97. A pulley 98 is also keyed to shaft 97 and is driven by a belt 99.

As the shaft 97 rotates plate 96, detent 95 engages poppet valve 94, as shown, and the sudden release of pressure in conduit 92 trips four way valve 88. Compressed air from four way valve 88 is supplied through conduit 86 to the left-hand chamber (not shown) in cylinder 75 and air is vented from the right-hand chamber (not shown) through conduit 87. The piston head (not shown) within cylinder 75 is displaced to the right carrying piston rod 76 therewith.

Lever 79 is moved with the piston rod 76 and abuts against projection 85 on bar 69, carrying bar 69 to the right along with crosspiece 68, bar 66 and rod 71. The weight 74 resists this movement but cannot prevent it. Bar 66 carries cable 65 therewith and causes shaft 63 and snubbing device 13 to rotate, thereby locking the tow for deregistration.

As the bottom of lever 79 moves through slot 82 it contacts incline 84 and is thereby caused to rotate in clockwise direction about its pivot against the action of spring 80. The top of lever 79 then passes beneath projection 85 and permits bar 69 to return rapidly to the left under the influence of weight 74, thereby permitting the snubbing device 13 to unlock the tow 11 and return to its initial position.

The piston rod 76 continues moving to the right until collar 77 contacts poppet valve 93, thereby reversing the four way valve 88 and causing the piston rod 76 to begin moving to the left. Lever 79 strikes projection 85 and is pivoted thereby sufficiently to permit passage beneath projection 85. Spring 80 then again snaps lever 79 to upright position and all the elements are thus returned to their initial positions.

It will be noted that release of the snubbing device 13 can be made to occur prior to contact between lever 79 and incline 84, by moving collar 77 further away from its end of piston rod 76. The disposition of incline 84 can also be varied by adjusting the member 83 relative to the frame 62.

The intermittently acting force to open the tow can also be applied in ways other than locking the tow at a point intermediate the first to the second points. For example, the speed of the tow passing the second point can be periodically instantaneously increased or a rapidly acting pulling force can be periodically applied at a point intermediate the first and second points to tension the tow between the first and intermediate points. In another embodiment a braking force can be applied to the tow at an intermediate point to increase the tension thereon. The embodiments illlustrated in the drawings are preferred, however, since they actually lock the tow and thus prevent any slippage. In addition, the eccentric location of the stubs 19 serve to pull the tow in reverse direction as they rotate so that the preferred embodiment combines the advantages of locking with a reverse pull.

Tows processed in accordance with the present invention are more uniformly opened than similar tows subjected hundreds of times each minute to a vibrating or beating action between rolls 14 and 15 but without a positive lock such as snubbing device 13.

The following example is given to illustrate this invention further.

Example

In a run employing the apparatus shown in Figs. 1 to 5, a tow of 10,000 continuous cellulose acetate filaments having an average of 8 crimps per inch and a total denier of 80,00 is passed between rolls 12 which are 2½ inches in diameter and are urged against each other sufficiently to require a pull of 3 to 5 pounds to draw the tow manually therebetween. The driven drawing rolls 15, 12 inches in diameter, are operated at a peripheral speed of 250 feet per minute and rubber-covered braking rolls 14, 12 inches in diameter, are urged against each other sufficiently to require a manual pull of about 10 pounds to advance the tow therebetween with the driven rolls idle. The tow upon leaving the driven rolls 15 is opened,

and picks up about 10% of its weight of glycerol triacetate in chamber 17. Upon subsequent processing in conventional manner it forms cigarette plugs which are firm and uniform in weight and in filtering characteristics.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made therein without departing from the spirit of our invention.

Having described our invention, what we desire to secure by Letters Patent is:

1. The process which comprises longitudinally pulling a crimped multifilament tow from a first point to a second point and intermittently preventing advance and slippage of said tow at a location intermediate said two points while still pulling at said second point.

2. The process set forth in claim 1, wherein the tow is normally under a tension of about 0.01 to 0.06 gram per denier in moving from said first point to said second point.

3. The process set forth in claim 1, wherein said tow comprises continuous cellulose acetate filaments.

4. The process set forth in claim 1, wherein said intermediate location at which advance is prevented is at least about six feet from said second point.

5. The process set forth in claim 1, wherein the time for said tow to travel from said intermediate location to said second point is at least equal to the time interval between successive advance preventions, whereby all lengths of said tow are acted upon at least once between said intermediate location and said second point.

6. The process set forth in claim 1, wherein the prevention of advance of said tow is effected by pulling said tow in a direction different from its direction of advance.

7. The process which comprises passing a crimped multifilament tow under tension through one zone, next passing the tow through a second zone where the tension is increased, releasing the tension on said tow beyond said second zone, and intermittently increasing the tension in said first zone while maintaining the tension in said second zone at a higher value than in said first zone.

8. The process which comprises longitudinally pulling a crimped cellulose acetate tow past a first point under tension, intermittently preventing advance of said tow at an intermediate point beyond said first point while still pulling on said tow, thereby to snub said tow, the speed at which said tow is pulled being correlated to the frequency of snubbing so that all lengths of said tow are snubbed at least once, relaxing said tow beyond the point at which said tow is pulled, and applying a plasticizer to said tow.

9. The process set forth in claim 8, wherein the prevention of advance of said tow is effected by pulling said tow in a direction different from its direction of advance.

10. The process set forth in claim 9, wherein advance of said tow is continuously retarded at a location between said intermediate point and said point at which the tow is pulled.

11. The process set forth in claim 10, wherein the distance between said intermediate point and the point where advance is continuously retarded is at least six feet.

12. A tow opening apparatus comprising, in combination, means for pulling a crimped multifilament tow past a first point, braking means acting on said tow intermediate said first point and said pulling means, and intermittently acting means to place said tow under considerable tension intermediate said first point and said braking means.

13. A tow opening apparatus as set forth in claim 12, including a tension device disposed at said first point to place said tow under a slight tension even when said intermittently acting means is inactive.

14. A tow opening apparatus as set forth in claim 13, including a banding jet disposed to band out said tow beyond said pulling means, and means for applying plasticizer to said tow beyond said banding jet.

15. A tow opening apparatus as set forth in claim 12, wherein said intermittently acting means is positioned to act on said tow at least six feet from said braking means.

16. A tow opening apparatus comprising, in combination, means for pulling a crimped multifilament tow in longitudinal direction, and means acting intermittently on said tow to prevent its advance and slippage, thereby to open said tow.

17. A tow opening apparatus as set forth in claim 16, wherein said intermittently acting means includes means for pulling said tow in a direction different from its direction of advance.

18. A tow opening apparatus as set forth in claim 16, wherein said intermittently acting means includes a snubbing device which is intermittently actuated to prevent advance and slippage of said tow.

19. A tow opening apparatus as set forth in claim 18, wherein said snubbing device includes a pair of spaced members between which said tow passes, and means for intermittently rotating said members so as to lock said tow.

20. A tow opening apparatus as set forth in claim 16, including means acting on said tow before it reaches said intermittently acting means to maintain said tow under a light tension even when said intermittently acting means is inoperative.

21. A tow opening apparatus comprising, in combination, means for pulling a crimped multifilament tow in longitudinal direction, means acting intermittently on said tow to prevent its advance, thereby to open said tow, and braking means disposed to act on said tow intermediate said intermittently acting means and said pulling means.

22. A tow opening apparatus comprising, in combination, means for pulling a crimped multifilament tow in longitudinal direction, means acting intermittently on said tow to prevent its advance, thereby to open said tow, including a snubbing device intermittently actuated to prevent advance and slippage of said tow, said snubbing device including a rotatable shaft, means opposing rotation of said shaft in one direction, and intermittently acting means for rotating said shaft against the action of said opposing means, said shaft returning to its initial position under the force of said opposing means when said intermittently acting means is inactive.

23. The process of claim 1, wherein said tow passes said second point at a constant speed.

24. A tow opening apparatus as set forth in claim 22, wherein said means for intermittently rotating said shaft includes a displaceable piston rod in eccentric operative connection with said shaft, a piston head on said rod, a cylinder surrounding said piston head, and means for supplying a fluid selectively to said cylinder on either side of said piston head and for venting said fluid from that side to which said fluid is not supplied, thereby to displace said piston head and piston rod.

25. A tow opening apparatus as set forth in claim 22, including a pivotally mounted lever operatively connecting said piston rod with said means for intermittently rotating said shaft, said means for intermittently rotating said shaft being operatively connected to said opposing means and both being operatively connected with said lever for displacement thereby upon displacement of said piston rod, and a track provided with an incline upon which said lever impinges and by which it is pivoted to sever the connection between said lever on one hand and said opposing means and means for intermittently rotating said shaft on the other hand, said opposing means returning said shaft to its initial position.

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