Nov. 1, 1966 J. F. CAINES ETAL 3,282,768

APPARATUS FOR BLOOMING FILTER TOW

Filed Sept. 26, 1962 2 Sheets-Sheet 1

Fig. 1

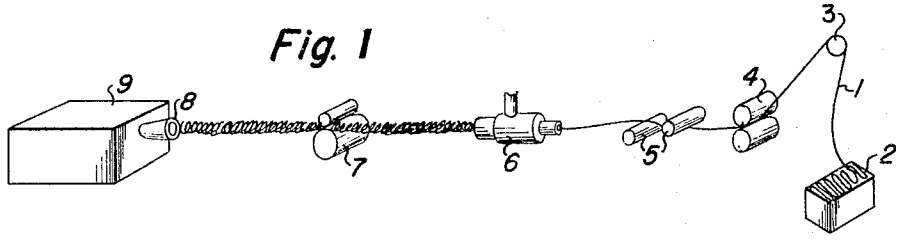

Fig. 2

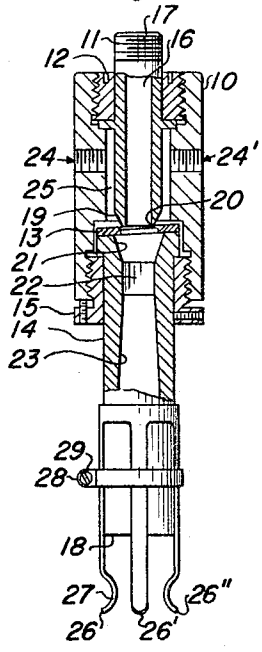

Fig. 4

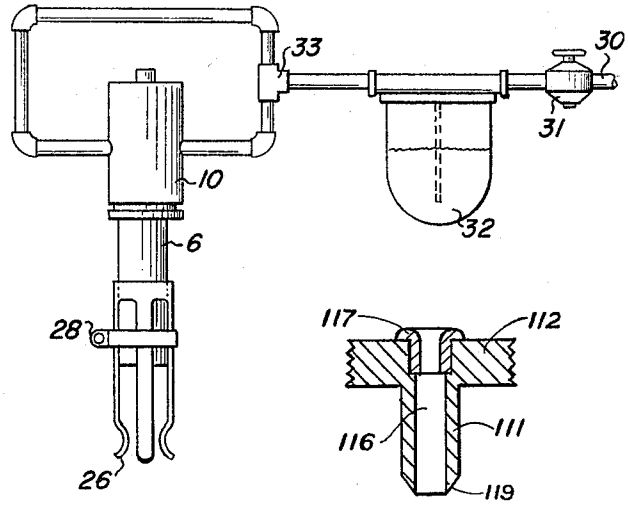

Fig. 3

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Fig. 6

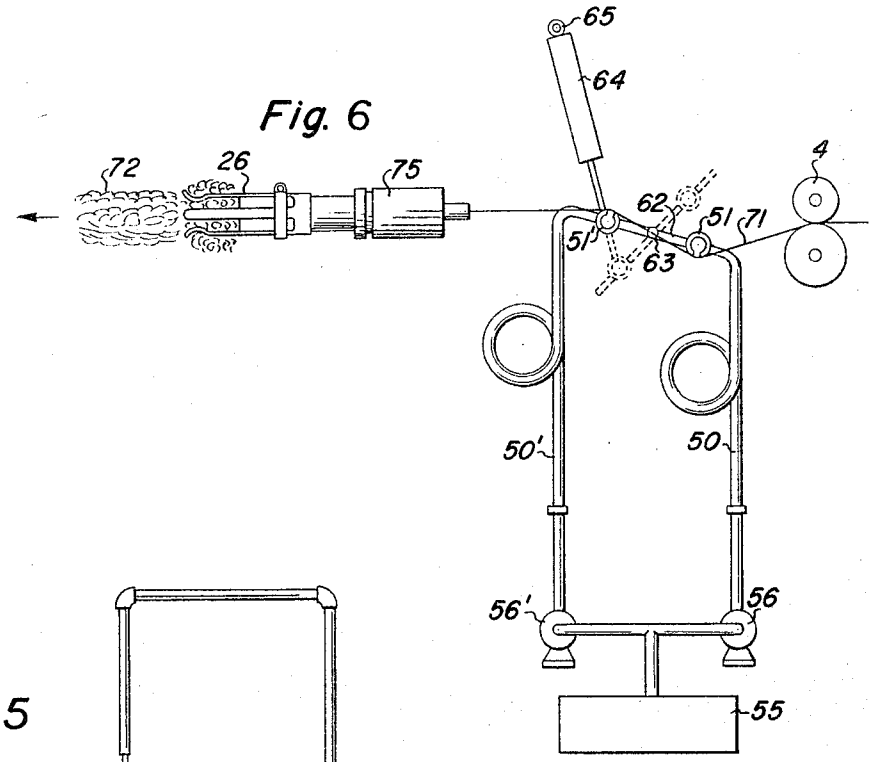
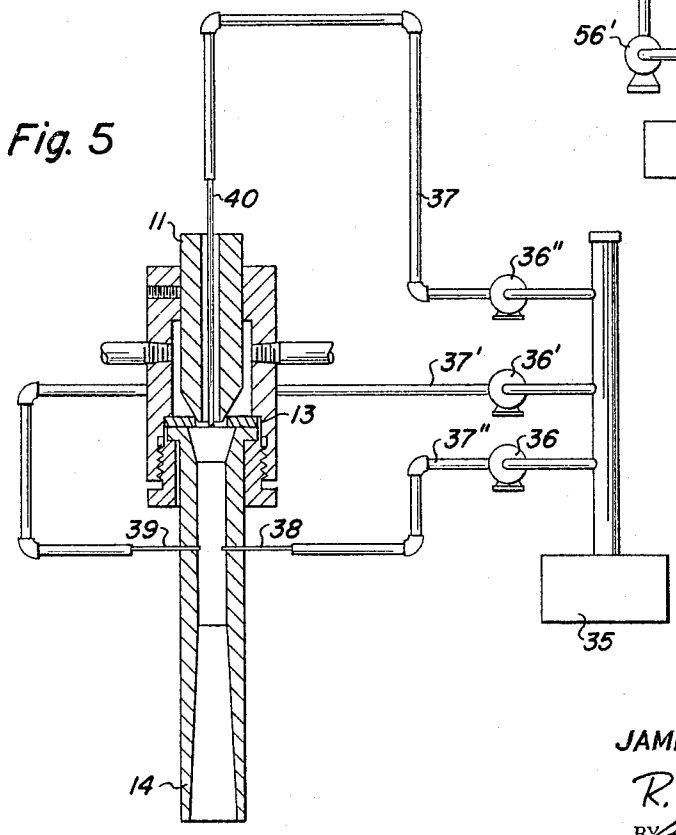


Fig. 5



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APPARATUS FOR BLOOMING FILTER TOW

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9 Claims. (Cl. 156—441)

This invention relates to new apparatus for processing tow into rod-like elements. More particularly, this invention concerns apparatus of the class indicated wherein tow may be manufactured into tobacco smoke filter elements of a high quality with fewer steps and with less apparatus than heretofore required.

This application is a continuation-in-part of our parent application Serial No. 27,091, now U.S. Patent No. 3,099,594.

The manufacture of tobacco smoke filter elements from special tows composed of filaments generally in accordance with the disclosure of Crawford and Stevens U.S. Patent No. 2,794,480 is already quite extensively carried out in the industry. In such processes the tow is usually opened up or banded by steps involving primarily mechanical treatment.

In a more recent disclosure of Dyer (one of the inventors herein) et al., Serial No. 736,900, now U.S. Patent No. 3,079,663, there has been described a slot jet construction and associated parts whereby existing installations in accordance with the aforesaid Crawford and Stevens inventions may be conveniently modified. That is, the said Dyer et al. invention of application Serial No. 736,900 is useful in connection with already existing installations for suitably modifying such installations to more efficiently and better handle tow. Also, such type modification with a slot jet permits the processing of tow of a wider denier range.

Although the foregoing processes and constructions satisfactorily fulfill the needs of many manufacturing installations, with the advent of the need of additional installations as well as the desirability of the greater facility for processing certain of the tow now available, a demand has arisen for further simplified and improved processes and apparatus as discussed in further detail in parent application Serial No. 27,091 aforesaid. It is apparent, therefore, that the development of new and simplified apparatus for the production of the rod-like elements useful for tobacco smoke filter elements represents a highly desirable result.

After extended investigation we have found apparatus for making elements of the class indicated and of a quality at least equivalent or in certain instances better than the presently produced elements, but wherein there is substantial apparatus saving in making the constructions needed for carrying out the instant process.

This invention has for one object to provide a novel and simplified apparatus for the manufacture of filter elements and the like rod-like product. Another object is to provide a simplified apparatus combination for converting tow to rod-like elements which is adaptable to the processing of a wide range of tow deniers. Still a further object is to provide special jet device construction specially suitable for processing tow which is being converted to filter elements. Another object is to provide such jet construction equipped with facilities for the introduction of addenda into contact with the tow and to prevent the escape thereof in the exhaust from the jet. A limited object is to provide a jet device construction wherein the entrance end of the jet is provided with a threaded section adapted to receive means to reduce entrance diameter of the yarn entrance. A further object is to provide a jet having a certain flexible finger construction on the exit end of the jet. Other objects will appear hereinafter.

For assistance in a better understanding of the present invention reference is made to the attached drawings forming a part of the instant application.

FIG. 1 is a semidiagrammatic side elevation view of an apparatus combination using the apparatus parts of the present invention such as may be used for manufacturing rod-like elements.

FIG. 2 is a cross-sectional view of a circular jet device such as may be used in the present invention.

FIG. 3 is a detailed side elevation view in section illustrating a modification of the jet inlet end whereby the inlet or entrance is of smaller diameter than the tube portion said inlet discharges into.

FIG. 4 is a side elevation view of a jet construction as in FIG. 2 but wherein the jet has been provided with additional parts for facilitating the introduction of addenda.

FIG. 5 is a side elevation view somewhat similar to FIG. 4 but wherein the jet is shown in section for better illustrating wherein the addenda adding conduits and the like parts may be associated with the jet.

FIG. 6 is a side elevation view somewhat of a schematic nature for illustrating the combination of addenda applying apparatus parts in association with the circular jet of the instant invention.

Referring now to FIG. 1, the utility of the apparatus of the present invention is illustrated as follows: A continuous multifilament crimped tow **1** is withdrawn from supply package **2** over guide **3** by feed roll pair **4**. It passes, under tension generated by the suction of jet **6** of the present invention over suitable addenda applicator(s) **5** into said jet **6**. Here it is subjected to an explosive expansion of compressed air in a specially adapted nozzle described in more detail hereinafter. While in the jet, the tow as it is bloomed is subjected by means hereinafter described to a spray or fog of an atomized, liquid, as for example a plasticizer for the tow being processed. The plasticized tow is expelled from the jet under the influence of the expanding air flow and passes to feed rolls **7**. Feed roll pair **7** is operated at a somewhat slower speed than roll pair **4** so that the tow is in a state of relaxation or under the very minimum of tension between jet **6** and roll pair **7**. The tow then advances to a stuffing jet **8** as described in Wexler U.S. Patent 3,016,945 or as in Crawford and Stevens U.S. Patent 2,794,480 and then to a cigaretting machine **9**.

Referring to FIG. 2, the basic circular jet will now be described. It will be noted that the jet is of the same general design and configuration as the jets described in Dyer U. S. Patent 2,924,868. However, differences reside in the provision of multiple air inlets to the jet body and a major revision of the venturi tube structure. Study has shown that efficient jets from the viewpoint of minimum energy losses have a relatively small ratio of throat length to throat diameter. However, it has been found that jets of conventional design are not effective in blooming and debundlizing continuous multifilament tow containing several thousand highly crimped filaments in the order of 0.6 to 16 denier per filament. It was found in certain instances that the effective blooming was obtained when the throat length to diameter ratio was increased to a ratio of about 6 to 1. For the present invention, the exit flare or diverging portion of the nozzle should have an included angle of about 3 to 5 degrees. Thus, the tube design is of some importance to obtain optimum tow blooming and complete debundlizing or separation of the individual filaments from each other.

Referring further to FIG. 2, the jet device is comprised of an outside shell **10** containing several inner members **11**,

13 and 14 held in place by threaded plugs 12 and 15. A passageway 16 extends through the jet device so that the continuous multifilament crimped tow may be passed from the threaded entrance 17 in member 11 to an exit 18 in member 14. Member 17 is threaded so that, for example, a ceramic yarn inlet eyelet may be attached of the type to be discussed in connection with FIG. 3. Or, another entrance assembly as shown in FIG. 3 may be screwed in in place of 12. The passageway in member 11 is substantially of uniform diameter. However, as apparent, if an inlet eyelet is used as just mentioned, the entrance diameter is reduced. The outer surface 19 of the lower end of member 11 is conical in shape with an included angle of about 40 to 80 degrees, for providing, in conjunction with the tapered surface 20 of thin plate orifice plate 13, an annular orifice or passageway for metering the air flow into the exit tube member 14.

The exit tube member 14 is provided with a converging entrance section 21 of about 30 to 40 degrees included angle, and in series a straight cylindrical tube passage 22 having a length of from 2 to 10 times the inside diameter of the passage 22, and a flaring or diverging exit section 23 with an included angle of from 2° to 7° angle. Good results have been obtained when the length of passageway 22 is about six times its inside diameter and the included angle of the exit passage 23 is about 3 to 5 degrees.

In addition, it is usually preferred that the inside diameter of passageway 22 should be about 0.75" for a tow of about 37,000 denier size, and should be about 163% of the diameter of the orifice plate orifice 20 and 400% of the inside diameter of the passageway 16 in inlet tube 11. The taper 19 of tube 11 should be about 60 degrees and about 30 degrees less than the angle of the taper of the orifice 20 in plate 13 which should be about 90 degrees. Proper sizing of these items insures that the jet will produce a suction at entrance 17 to facilitate threading the tow into the jet device. They also insure metering and impingement of the air onto the tow as it enters the orifice plate. It is also usually desirable that the passageways in the jet be in accurate concentric and axial alignment to insure uniform impingement of the air on the tow around the periphery of the tow and to insure a minimum of turbulence and swirling or twisting of the air flow. If the air flow swirls, it will tend to twist the tow, thus compacting it rather than blooming it and separating the filaments from each other.

Air is provided to the jet shell 10 through one or more openings 24 and 24' to an annular chamber formed by the outer surface of inlet member 11 and shell 10 and sealed at one end by threaded plug 12. It has been found that, while one inlet 24 is often adequate, better air flow distribution can be obtained with two or more openings equi-spaced around the shell periphery. The air from the chamber 25 then impinges on the tow by passing through the annular orifice formed by the tapered portion 19 of inlet tube 11 and the tapered opening 20 in orifice plate 13.

Relationships for a typical preferred jet for processing 37,000 total denier, 1.6 denier per filament tow are given in the following Table A:

TABLE A

Inside diameter of tube 11	0.250"
Angle of taper 19 on end of tube 11	60°
Orifice plate opening diameter	0.468"
Orifice plate entrance angle 20	90°
Orifice plate thickness	0.125"
Venturi tube entrance angle 21	35°
Venturi tube throat diameter 22	0.750"
Venturi tube throat length 22	4.50"
Venturi tube exit angle 23	5°

It has been further found as an important apparatus feature of the present invention that the blooming of the tow can be materially enhanced if the flow of the tow as it exited from the jet exit member 14 is retarded and partially confined. To achieve this end, a plurality of spring fingers 26, 26', 26" and others (not shown) are positioned about equidistant around the outer surface of the exit member 14 and extend beyond the end of the member 14 a distance of 3" to 8". The fingers 26 are curled slightly outward at 27 to avoid snagging the tow, are slidable axially on the member 14, and are held in place by a clamp ring 28 and suitable thumb screw tightening means 29 or the like. The force to spring the fingers outward is adjustable by moving the clamp 28 closer to or farther away from the end 18 of the member 14.

The effect of these fingers is to retard the exit of the tow from the jet and cause a temporary pile-up of a mass of dis-oriented filaments through which the exhaust air from the jet must pass. This serves two functions. First, the kinetic energy of the exhaust air causes some further debundlizing of the tow filaments, promoting better blooming of the tow. Secondly, the exhaust air is highly filtered by the tow bundle at this point so that any addenda not previously deposited and distributed on the tow filaments is now deposited and distributed. Thus, the need for a hood and exhaust system to remove addenda from the exhaust air is eliminated.

Reference is now made to FIG. 3 which, as indicated above, comprises an alternate embodiment which may be used when it is desired to reduce the inlet diameter of the yarn entrance to the jet device. Such structure is generally similar to that part of the structure of FIG. 2 which it is constructed to replace. That is, flange portion 112 would be adapted to screw into housing 10 as does part 12. The tube portion 111 is comparable to 11 and terminates in taper 119 of the order of, for example, 60°. The insert 117, which reduces the diameter of passageway 116, would be of ceramic as the commercially obtainable material Al-Si-Mag. Depending on the size of 117 the entrance diameter at the zone of yarn entry of, for example, one third to one fifth of the larger diameter of 116.

If it is not desired to substitute parts as just described, alternatively as shown in FIG. 2, member 11 is threaded at 17 and a cap may be screwed on at 17 containing a ceramic insert which reduces the diameter of passageway 16.

Referring now to FIG. 4, there is shown a modification of the basic circular device described in FIG. 2 whereby the plasticizer or like material may be incorporated on the tow as the tow passes through the jet. In further detail, referring to FIG. 4, the air supply line 30 to the circular jet 6 has connected in series along its length a pressure regulator 31 and a liquid atomizing unit 32. After leaving the atomizer unit 32 the air line is branched at 33 to provide as many smaller air supply connections as required by the jet shell 10. The plasticizer liquid in the form of an aerosol generated in the "atomizer" 32 is conveyed in the air to the jet 6 and impinges along with the air on the tow as it passes through the jet orifice plate. Several suitable means are commercially available for generating the aerosol from the plasticizer, such as the air line lubricators made by the Alemite Company, of Chicago, Illinois, and it is not desired to be restricted to any particular type of aerosol generator.

Reference is now made to FIG. 5 wherein there is shown another type modification of the circular jet whereby the plasticizer may be introduced directly into the jet and onto the tow being processed therein. A plurality of metering gear pumps 36, 36' and 36" are connected to a supply tank 35 of plasticizer liquid. The down-stream side of each pump is connected through pipe lines 37", 37', 37 respectively to a capillary tube probe having a small opening at the entrance end. One or more of these probes 38 and 39 are positioned in the exit flare of the venturi member 14. One or more other probes 40 are located in the tow entrance tube 11 and discharge near the orifice plate 13. As the plasticizer emerges from

these probes it is distributed by the high velocity jet air onto the tow filaments.

Consideration will now be directed to FIG. 6 which figure in certain respects corresponds with FIG. 2 and represents the preferred apparatus embodiment of the instant invention. In referring to FIG. 6, two metering gear pumps **56** and **56'** are connected to a supply tank **55** of plasticizer. The output of these pumps is connected by flexible hose or tubing **50** and **50'** to slit tube applicators **51** and **51'**. The tube applicators are stainless tubing having a narrow 0.01" to 0.06" slit cut longitudinally along one side. The tubes are sealed at each end by end plates. One end plate may be provided with a threaded connection to the flexible tubing **50** and **50'**. The slits may be covered with thin felt and/or a fine mesh screen to help evenly distribute the flow of the plasticizer along the length of the slits. The hollow tube applicators are rigidly fastened to an arm **62** pivoted about the axis **63**. At one end of the arm **62** the piston rod of an air cylinder **64** or solenoid is connected with a hinge pin. The cylinder is anchored to the machine frame by a hinge pin at **65**. The slot tube applicators are so mounted that one slot faces generally downward and the other generally upward. The tow **71** passes under the downward facing slot **51** and over the upward facing slot **51'**, snubbing 5° to 30° on each slot tube. As the tow, fed through the nip of feed roll **4**, passes under and over the slot tubes a controlled amount of plasticizer is metered onto the tow. The air cylinder or solenoid **64** is coordinated with the start-stop means of the tow blooming apparatus to rotate the slot tubes counterclockwise out of contact with the tow when the machine is stopped and clockwise into contact as the machine is started. This prevents wicking of too much plasticizer onto spots on the tow when the machine is at rest. The tow passes over the straight tube applicators as a flat ribbon about 2" to 6" wide and as it enters the jet **75** is compacted into a cylindrical form.

Thus, although every filament may not have received an application of plasticizer from the applicators, any local point in the cross-section of the tow has filaments that did receive plasticizer. The amount of plasticizer on these filaments is in general in excess of that required to bond the filaments together adequately. When the tow is subjected to the high velocity explosive blast of air in the jet orifice plate **13** (FIG. 3) and venturi tube **14**, the excess plasticizer on these filaments is blown off and impinges on the filaments that did not pick up plasticizer in passing over the applicator slots.

Thus, an aerosol of plasticizer is generated within the jet and an essentially completely uniform plasticizer distribution is achieved on all filaments in the tow by the time it emerges from the jet. The large mass of bloomed filaments retarded by the spring fingers **26**, **26'**, etc. (FIG. 2) at the exit of the venturi tube **14** insures that only an insignificant amount or no plasticizer will escape to the atmosphere. This is the result of the fact that, while the mass of emerging filaments not only acts as a highly efficient filter medium for the plasticizer, the exhaust air from the jet is so retarded and slowed down as it emerges from the mass of bloomed filaments that it no longer has sufficient velocity energy to blow off and remove plasticizer from the surface of the bloomed filaments. Without the presence of the retarding spring fingers **26**, **26'**, the filter mass would not be formed at the exit of the jet and poorer distribution of the plasticizer or other addenda would ensue as well as excessive losses of addenda to the atmosphere. However, in the present invention the processed tow **72** (FIG. 6) is well bloomed and plasticized.

An understanding of the functioning of the apparatus parts disclosed in the several figures is already apparent to a substantial extent from the preceding description. However, a further understanding of the apparatus functioning will be had from a consideration of the following specific example.

Example I

Filter rods were made by the round jet device of this invention using the general apparatus setup of FIG. 2 and the plasticizer application apparatus of FIG. 4 and using 37,000 denier tow containing about 23,200 filaments having an average size of 1.6 denier. For comparison, filter rods were made of the same tow using the slot venturi apparatus and method of Dyer et al. application Serial No. 736,900. Also, a comparison was made with the tension blooming method of the prior art with a 72,000 denier, 2.0 denier per filament tow. The physical characteristics of the filter rods and the processing comments were as follows:

	Present Invention Circular Venturi	Slot Venturi	Tension Blooming
Total denier	37,000	37,000	72,000
Denier/filament	1.6	1.6	2.0
Crimps/inch	16.0	16.0	17.0
Weight of 90 mm. rod, grams	0.63	0.670	0.87
Pressure drop of 90 mm. rod, in H_2O	15.4"	16.8"	13.3
Rod hardness	10.1	8.8	8.9
Pressure drop of 15 mm. tip, in. H_2O	2.94	3.07	2.4
Tar removal, percent	42.4	43.8	34.0
Jet air consumption, CFM free air	43	104	None
Rod test designation	1 CLY	4 ARK	1 AXM

With the circular jet of the present invention no difficulty was encountered with twisted tow, the air consumption was reduced about 60%, only one jet and two sets of rolls instead of three were required, and the need for spray booths and exhaust system were eliminated. As compared to tension bloomed filter processing, the tow was less damaged and the weight of filter material was reduced about 25% based on rod weight while tar removal was increased.

Therefore, it is apparent from the foregoing that filters of equivalent properties which require less material can be made using the apparatus of the present invention. Further, the size of the tow required to accomplish this may be considerably smaller than that used in the mechanical method of the prior art and this feature possesses some additional advantages.

In carrying out the above, any of the usually used plasticizers may be employed. That is, plasticizers such as triacetin, tripropionin, etc. may be employed. The exact addenda incorporated is not a limitation on the instant invention and will depend to some extent on the characteristics of the particular tow which is being processed in the apparatus and the type of rod which it is desired to produce.

In the instance of the type of filaments which are not susceptible to plasticization, the addenda applied to the crimped filaments may comprise a liquid monomer which will serve to bond the filaments at suitable points, areas or zones as the filaments pass through subsequent filter forming steps.

The amount of air pressure applied to the circular jet may and is for economical reasons usually kept to a reasonably low value. However, if desired, the pressure may be extended up to 90 p.s.i.

It is believed apparent from the foregoing that we have provided a simplified apparatus combination for the manufacture of rods from bundles of filaments particularly filter tow. It is thought apparent from the foregoing description that it may be noted because of the elimination of the need for rolls, spray booths and the like equipment that certain apparatus savings may be secured.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that 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. An apparatus arrangement for converting a bundle of filaments into a rod-like element comprising feed rolls for withdrawing the bundle of filaments from a supply thereof, means in series with the feed rolls for applying addenda to the filaments and for blowing the filaments including a circular air jet adapted to subject the filaments to relatively streamline air flow in series direction, spring finger filament retarding means between the exit from the jet and further rolls in series, said latter rolls being adapted to withdraw the processed filaments and supply the filaments to filter element forming and wrapping means in series.

2. An apparatus in accordance with claim 1 wherein the means in series includes a device for applying addenda on one side and then on the other side of said filaments.

3. A device adapted for blowing the filaments as set forth in claim 1, said device being comprised of a tube entrance element and a tube-type exit member, an orifice plate positioned between the aforesaid members, said orifice plate and adjacent portions of said tube members being enclosed in a housing whereby there is provided a chamber adapted to receive a gaseous fluid supplied thereto so that said fluid flows through the orifice plate and discharges through the exit member, said device being further characterized in that the exit member has attached to the end thereof spring means whereby the exit of the tow from the device may be retarded.

4. A device in accordance with claim 3 wherein the chamber is connected with an aerosol generating means.

5. A device in accordance with claim 3 wherein the inlet tube and outlet tube have associated therewith conduits which are connected with a source of plasticizer whereby said plasticizer may be injected into said tubes.

6. A device in accordance with claim 3 wherein means are provided on entrance member so that the diameter is reduced one third to one fifth the diameter of the passage beyond the entrance.

7. A jet device for the treatment of a material passing therethrough, an entrance element, an exit member, an orifice between said entrance element and said exit member, a housing enclosing said parts, and a plurality of spring retarding means arranged to cooperate with said exit member to reduce the speed of the material leaving said exit member.

8. A device in accordance with claim 7 wherein means are provided for reducing the diameter of the entrance of said entrance member.

9. A device in accordance with claim 7 wherein a plurality of conduit means are provided for introducing addenda to within the interior of the jet.

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