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AU-AI-76955/87

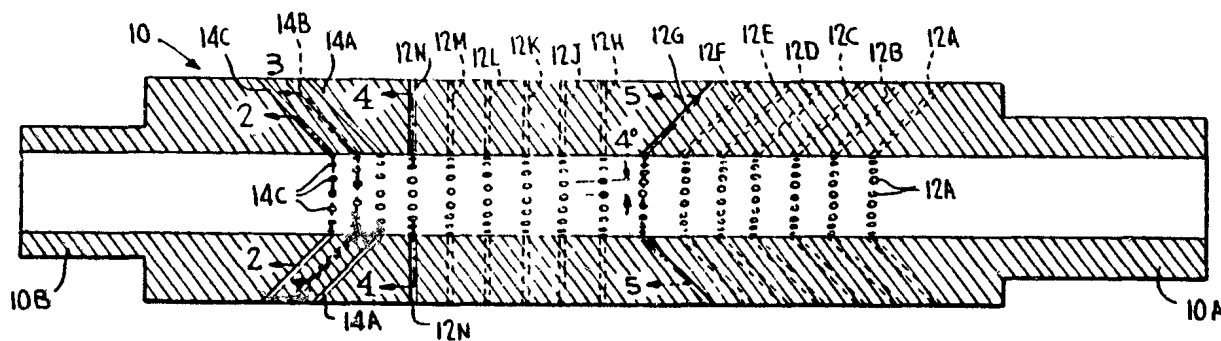
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : A24D 3/02	A1	(11) International Publication Number: WO 88/ 00440 (43) International Publication Date: 28 January 1988 (28.01.88)
(21) International Application Number: PCT/US87/01513 (22) International Filing Date: 24 June 1987 (24.06.87) (31) Priority Application Number: 888,211 (32) Priority Date: 23 July 1986 (23.07.86) (33) Priority Country: US (71) Applicant: AMERICAN FILTRONA CORPORATION [US/US]; 8401 Jefferson Davis Highway, Post Office Box 34668, Richmond, VA 23234 (US). (72) Inventor: BERGER, Richard, M. ; 3612 Quail Meadow Place, Midlothian, VA 23113 (US). (74) Agents: STERN, Marvin, R. et al.; Holman & Stern, 2401 Fifteenth Street, N.W., Washington, DC 20009 (US).		(81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent). Published <i>With international search report.</i> A.O.J.P. 17 MAR 1988 AUSTRALIAN 10 FEB 1988 PATENT OFFICE

(54) Title: FIBER SEPARATOR

This document contains the amendments made under Section 49 and is correct for printing.



(57) Abstract

Apparatus for use in the manufacture of rod like elements, for example cigarette filters formed of filamentary tow, for dissipating conveying gas from a conduit (10) through which the tow is conveyed pneumatically through a series of processing stations. To effectively dissipate the gas from the conduit (10), the invention provides axially spaced rings (12A-12N) of gas dissipating ports in the conduit. The ports in the upstream rings (12A-12G) are inclined rearwardly to provide gas dissipation in a direction which is counter-current the direction of travel of the tow through the conduit. The ports in adjacent rings are offset circumferentially so as to improve the distribution of ports around the circumference of the conduit in (10) in the section used for gas dissipation.

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FIBER SEPARATOR

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BACKGROUND OF THE INVENTION

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This invention relates to a fiber separator, alternatively referred to as gas dissipation apparatus, primarily for use in the manufacture of filter means, more particularly tobacco smoke filter elements, although the same device may be useful in dissipating excess air in the manufacture of other products which are pneumatically conveyed, such as reservoir elements for felt tip pens or the like. More specifically, the instant inventive concepts are primarily concerned with the manufacture of elongated rods such as filter means for cigarettes, although the apparatus of this invention is generally useful in other applications including reservoir elements and filters for tobacco smoking means, whether they be cigarettes, cigars, pipes or the like. Since filters for cigarettes are particularly commercially important, the basic embodiments of the instant invention will be discussed as they relate to the production of filtered cigarettes.

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In making tobacco smoke filters for use in connection with cigarettes and the like, bondable continuous filamentary tows of substantially continuous

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1 thermoplastic fibers, such as plasticized cellulose
2 acetate fibers, polyethylene fibers, polypropylene
3 fibers, nylon fibers and the like, have conventionally
4 been employed as the starting material. The term
5 "continuous filamentary tow", as used in this
6 specification and the appended claims, is intended to
7 define a material such as that which results when
8 filaments extruded from a plurality of spinnerets are
9 brought together and combined to form a continuous body
10 of fibers randomly oriented primarily in a longitudinal
11 direction. In such a tow, the filaments are generally
12 longitudinally aligned in substantially parallel
13 orientation, but include crimped portions which may form
14 short sections running more or less at random in
15 non-parallel diverging and converging directions.
16 Although the apparatus of this invention is applicable to
17 the various filamentary materials of this type, since
18 plasticized cellulose acetate is the most common
19 thermoplastic fibers used in the manufacture of cigarette
20 filters, the specification hereof will be generally set
21 forth in terms of this material. However, it is to be
22 understood that the instant inventive concepts are not to
23 be limited to this preferred embodiment.

24 In the manufacture of filters for cigarettes and
25 the like, a number of different factors must be
26 considered. Filtration efficiency, which is the capacity
27 to remove unwanted constituents from smoke, while highly
28 desirable is only one factor important in producing a
29 commercially acceptable filter. Other factors, such as
30 pressure drop, taste, hardness and cost also determine
31 commercial acceptance of these products. For example,
32 cellulose acetate, one of the most commonly used
33 substances in manufacturing cigarette filters has a
34 relatively low filtration efficiency. Increased
35 filtration efficiency obtained by increasing the density

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1 or length of a cellulose acetate filter may cause a
2 pressure drop across the filter which is excessively and
3 commercially unacceptable. The use of activated carbon
4 or other such materials having higher filtration
5 efficiency may increase cost and deleteriously affect
6 taste.

7 In recent years, air dilution has become a
8 popular technique for compensating for the relatively low
9 filtration efficiency of cigarette filters which have a
10 pressure drop significantly low for commercial
11 acceptance. In this technique, ventilating air is drawn
12 into the filter peripherally and dilutes the smoke stream
13 from the tobacco to thereby reduce the quantity of tar
14 and other unwanted tobacco constituents drawn into the
15 smoker's mouth with each puff.

16 The air dilution technique provides several
17 obvious advantages:

18 It is an extremely economical method for
19 reducing various solid phase constituents of tobacco
20 smoke, generally referred to as "tar".

21 It also enables the removal or reduction of
22 certain gas phase constituents of tobacco smoke such as
23 carbon monoxide and nitrous oxide.

24 By varying the quantity of air introduced
25 into the filter with each puff, it permits control,
26 within reason, of the filtration process in order that
27 efficiency and taste can be balanced.

28 One of the major challenges to the cigarette
29 filter industry has been to design a filter and filter
30 production techniques and apparatus for producing, at
31 high speeds, large numbers of low costs filters capable
32 of utilizing the air dilution technique. When the air
33 dilution technique first became commercially important,
34 most cigarette filters were produced with an over-wrap
35 material applied to the outside of the filament bundle

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1 comprising the filter element in order to achieve a
2 dimensionally stable product. The manufacturing process
3 produced an axially elongated rod comprising a core of
4 filaments contained by a surrounding over-wrap material
5 called the "plug-wrap". After cutting the filter rods
6 into small segments or plugs suitable for use as
7 cigarette filters, a tipping over-wrap secured the
8 segments to a tobacco column comprising a core of tobacco
9 surrounded by a cigarette paper over-wrap. With the air
10 dilution technique, cigarette filters produced in the
11 foregoing manner required a porous or permeable plug-wrap
12 in order that the air introduced generally through
13 selectively provided perforations in the tipping
14 over-wrap merged with undiluted smoke coming from the
15 tobacco column.

16 Because the use of plug-wrap has certain
17 disadvantages in general discussed in some detail in U.S.
18 Patents Nos. 3,313,306 and 3,377,220 granted April 11,
19 1967 and April 09, 1968, respectively, the subject matter
20 of which is incorporated herein in their entirety by
21 reference, techniques for producing non-wrapped
22 dimensionally stable filter elements were developed. The
23 significance of producing a non-wrapped, dimensionally
24 stable filter rod is even more pronounced for use in air
25 diluted cigarettes in view of the high cost of porous
26 plug-wrap materials.

27 The techniques for producing a non-wrapped
28 dimensionally stable filter rod disclosed in the
29 aforementioned U.S. patents and related patents commonly
30 assigned with the instant application, are highly useful
31 and were the best way known for such production at the
32 time of their development. In these processes, the
33 filtering material, which may be continuous filamentary
34 tow, staple fibers or particulate in form is carried
35 through the processing apparatus by an endless porous

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1 belt through which heated gas, such as steam, and coolant
2 gas, such as air, are passed peripherally into the
3 filtering material to bond the same into a dimensionally
4 stable rod needing no plug-wrap at all. Thus, two
5 advantages are gained from this very desirable method:
6 elimination of the steps involved in applying the
7 plug-wrap itself and the cost of the plug-wrap, the
8 latter being particularly significant when considering
9 the high costs of porous plug-wrap necessary for use in
10 an air-diluted filtered cigarette.

11 Although the endless belt method for formation
12 of non-wrapped filters has been the subject of wide
13 spread commercial interest, a number of disadvantages
14 exist with respect to its use. The woven nature of the
15 endless belt necessary to provide its porosity to steam
16 and air embosses the surface of the filter rod with the
17 pattern of the belt and leaves loose fibers which render
18 the adhesion of the tipping paper to the filter element
19 less efficient. The forming belt itself interferes with
20 the step of steam penetration necessary to the formation
21 of a dimensionally stable product and reduces the
22 efficiency of the machine because the belts wear out and
23 have to be changed, the belt-changing process resulting
24 in time down for the filter rod production line.

25 Thus, the elimination of the belt for carrying
26 the filtering material through the various processing
27 stations was desirable for obvious reasons. Yet, the
28 belt was introduced, in part, as explained in the
29 aforementioned patents, to eliminate the need to "pull"
30 the filamentary tow, which is the most desirable
31 commercial filtering material, through the system
32 producing an undesirable tension on the individual
33 filaments and producing a rod with size, shape and
34 functional characteristics which are difficult to
35 control.

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1 A highly desirable alternative to "pulling" the
2 tow through the system or using a belt to "carry" the tow
3 through the system is to "push" the tow through the
4 system. A pneumatic technique for making fibrous bodies
5 has been disclosed in commonly assigned U.S. Patent No.
6 3,313,665 granted April 11, 1965, the subject matter of
7 which is also incorporated herein in its entirety. In
8 this technique, air or other feeding gas under pressure
9 is used to "push" the tow through a confined zone where
10 it is heated and cooled to bond the product into a rod.
11 Moreover, this technique enables a reorientation of the
12 individual fibers transversely of the longitudinal
13 dimension of the rod. The process disclosed in U.S.
14 Patent No. 3,313,665 has found great commercial utility
15 in the production of relatively large diameter "wicking"
16 materials for felt-tip pens and the like, but was found
17 unsuitable for the production of much smaller diameter
18 cigarette filter elements because of the difficulty in
19 dissipating the large volume of air necessary for
20 propelling the fibrous material through the system shown
21 in U.S. Patent No. 3,313,665. Cigarette filter elements
22 normally have a diameter of about 8 mm in contrast to
23 "wicking" cartridges which are generally well over twice
24 that size in diameter. When the confined zone is
25 relatively large, the feeding gas may be substantially
26 dissipated through a foraminous area of relatively short
27 length due to the large circumference. Yet elimination
28 of at least a major portion of the air prior to
29 introduction of steam or the like is necessary to enable
30 transverse penetration of the steam to the core of the
31 tow for uniform bonding. Extension of the foraminous or
32 porous zone, which is produced by a multiplicity of
33 circumferential holes through the wall of the element
34 defining the confined zone, was undesirable since such
35 holes produce a rough inner surface which catch the tow

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1 and cause binding within the processing lines. Once the
2 tow has been contacted with steam it shrinks slightly
3 from the walls of the confined zone and is somewhat
4 lubricated alleviating the foregoing problems. It has
5 been found that application of the pneumatic feeding
6 technique to the production of small diameter rods such
7 as cigarette filter rods can be accomplished if the
8 amount of air can be reduced significantly from that
9 required by prior art techniques to minimize the
10 dissipation problem, a procedure which has not been
11 possible heretofore, and/or if some of the air can be
12 dissipated after steam introduction, a procedure which
13 would result in non-uniform bonding at the core of the
14 tow unless compensation is provided by additional
15 residence time and significant transverse reorientation
16 of the filbers in the presence of the steam prior to
17 introducing cooling gas, in contrast to the almost
18 immediate cooling step of the prior art process. This
19 enhanced residence time is particularly important in the
20 high speed production lines necessary for commercial
21 production of cigarette filter rods, generally well in
22 excess of 75 meters/min and up to about 500 or more
23 meters/min.

24 Accordingly, a pneumatic feeding technique, as
25 disclosed in U.S. Patent No. 4,390,031 has been developed
26 for production of the small diameter filter rods. The
27 disclosure of this patent is also expressly incorporated
28 herein by reference. In the process according to U.S.
29 Patent No. 4,390,031, the filamentary tow is
30 pneumatically conveyed by means of a jet which feeds the
31 conveying gas, preferably air, at a specified angle into
32 a confined chamber. The air is preferably fed annularly
33 around the tow at the entrance end of the confined
34 chamber to produce a venturi effect which draws the
35 continuous filamentary tow into the chamber. The use of

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1 a particularly small acute angle of air feed through the
2 jet into the confined chamber, preferably between 0 and
3 20 , requires a much smaller volume of conveying gas to
4 convey a given amount of filamentary tow than with
5 previously available equipment. Because a much reduced
6 column of conveying gas is used, at least a major
7 portion, and preferably substantially all, of the
8 conveying gas may be conveniently dissipated through a
9 limited porous section of the confined chamber without
10 requiring a cross-section of the chamber so large that
11 the fibrous body formed in the confined chamber cannot be
12 used for a cigarette filter. The pneumatic feed in
13 combination with a reduced take-off cross-section and the
14 cooling zone bends the fibers of the tow perpendicular to
15 the longitudinal axis of the confined chamber. The
16 arrangement of the fibers in the filter thus formed is
17 substantially overlapping and generally transverse to the
18 longitudinal axis of the filter rod being formed. The
19 fibers are cured with steam or other heated gas in this
20 transverse overlapping relationship and the layers of the
21 fiber are even further compacted in a preferred
22 embodiment utilizing an extended steam soaking chamber
23 and reduced cross-section cooling zone, prior to the rod
24 being extruded from the apparatus. Because the formed
25 body is extruded, the filamentary material is in a
26 relaxed state and maintains its crimped shape.
27 Additionally, secondary crimp is imparted to the fibers
28 by extruding the filter rod at a linear rate of feed less
29 than that of the incoming tow. Furthermore, the material is
30 forced against the wall of the confined cooling zone of
31 reduced cross-section and thus a precision size and shape
32 of the filter can be easily maintained. The reduced
33 cross-section of the cooling zone bends some of the edges
34 of the filters axially rearward (i.e., about axes
35 generally perpendicular to the filter rod length) to

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1 provide a smooth peripheral surface which permits
2 reliable bonding of the wrap material thereto.

3 Because the product formed by this method is
4 manufactured from continuous fibers in which the folded
5 edges are bent rearwardly, there are substantially no
6 loose ends or fibers exposed on the surface of the filter
7 rod so formed. Significantly, because the process and
8 apparatus makes much more efficient use of the
9 filamentary tow, it may be divided into several portions,
10 and each portion fed to a separate rod-forming station.
11 Additionally, because the filter rod produced by the
12 instantly disclosed process may be bent without breakage,
13 subsequent processing of the filter rod into filter
14 elements may be accomplished at numerous stations arrayed
15 perpendicularly to the outlet end of the rod-forming
16 station. It should, however, be borne in mind, that
17 processing of the filter rods may also be accomplished at
18 stations generally in line with the rod-forming station.

19 The particular feed jet used in the patented
20 process offers considerable savings in the amount of
21 conveying gas required for manufacture of the filters. A
22 savings of from 50-85% compared to the jet used in prior
23 pneumatic processes has been achieved. Significantly,
24 because the process uses pneumatic means, machine
25 efficiency is increased by elimination of the belt and
26 belt drive apparatus and concomitant maintenance to both
27 required for other non-wrapped filter production
28 techniques.

29 The process and apparatus disclosed in U.S.
30 Patent 4,390,031 is generally effective in providing
31 pneumatic feed of the small size tow material required
32 for cigarette filters, particularly in regards to gas
33 dissipation prior to steaming, due to the use of a more
34 limited gas supply through the angled, venturi-type gas
35 feed, and a rod surface particularly receptive to tipping

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1 due to bending back of at least some of the tow fibers at
2 the edges of the tow. The present invention, however,
3 seeks, inter alia, to improve the process particularly in
4 regard to the tow surface effects.

5 More particularly, it is an object of the
6 invention to improve the surface characteristics of
7 filter tow by further reducing the tendency of the tow
8 fibers to hang in the apparatus thereby producing
9 undesirable surface roughness and blemishes.

10 Another object of the invention is to improve
11 the surface characteristics of the tow by providing a
12 more effective means for bending back the tow fibers at
13 the edges.

14 A further object of the invention is to provide
15 an improved fiber separator (gas dissipation apparatus)
16 for use in pneumatic feed-type manufacturing processes,
17 particularly adapted for effecting the above and other
18 objects.

19 SUMMARY OF THE INVENTION

20 The invention provides gas dissipation apparatus
21 for use in the manufacture of filter rod materials for
22 cigarette filters and the like or other pneumatically
23 formed rod-like elements, effective for discharging gas
24 from a conduit through which a tow of fibrous material is
25 conveyed by the gas, the apparatus comprising a conduit
26 element, which may form part of or be connected into the
27 conveying conduit, the conduit element having an inlet
28 end, an outlet end, and plural axially spaced rings of
29 circumferentially spaced gas discharge ports between the
30 inlet and outlet ends, the ports at least in selected
31 rings adjacent the inlet end being inclined rearwardly
32 toward the inlet end for discharging gas therethrough in

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1 a direction counter-current to the direction of movement
2 of the material through the element from the inlet end to
3 the outlet end.

4 By rearwardly inclining the gas dissipation
5 ports, it is found that the tendency for surface fibers
6 to hang on the port edges is reduced, providing freer
7 movement of the tow. Another beneficial effect of the
8 rearwardly inclined ports is to assist in bending back
9 the edges of the tow fibers as discussed in U.S. Patent
10 No. 4,390,031 thereby further improving the surface
11 characteristics of the product.

12 The most critical section of the apparatus is
13 where gas dissipation commences (adjacent the inlet end)
14 at which point gas at relatively high velocity is to be
15 released from the apparatus. As gas dissipation proceeds
16 along the length of the apparatus, the inclination of the
17 ports becomes less critical and the apparatus may include
18 downstream rings of ports which are perpendicular to the
19 direction of movement of the tow.

20 In accordance with a further feature of the
21 invention, in order to improve the distribution of gas
22 dissipation ports around the volume of the conduit
23 element used for gas discharge, the ports in adjacent
24 rings may be circumferentially set at an angle of offset
25 which is less than the angle between adjacent ports in a
26 ring, so as to provide substantially helically extending
27 lines of the ports lengthwise of the conduit.

28 The apparatus of the invention may be
29 incorporated in a conduit element which also includes
30 steam admission ports downstream of the gas dissipation
31 ports.

32 Apparatus in accordance with the invention is
33 particularly useful in processes for manufacturing small
34 size filter rods for cigarettes and the like, as
35 disclosed in U.S. Patent No. 4,390,031, but it can also

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1 be used to advantage in the processes previously noted
2 for manufacturing the larger wicking materials. It may
3 also be applied in other manufacturing processes
4 requiring gas release from a pneumatic conveying conduit
5 where similar considerations are prevalent.

6 Additional features and advantages of the
7 invention will be apparent from the following description
8 and claims read in conjunction with the accompanying
9 drawings.

10 BRIEF DESCRIPTION OF THE DRAWINGS

11 Figure 1 is a sectional elevational view through
12 gas dissipation apparatus in accordance with the
13 invention;

14 Figures 2-5 are sectional views respectively on
15 lines 2-2, 3-3, 4-4, and 5-5 of Figure 1; and

16 Figure 6 is an enlarged view of a part of the
17 interior surface of the apparatus.

18 DESCRIPTION OF THE PREFERRED EMBODIMENTS

19 The illustrated apparatus comprises a conduit
20 element 10 particularly suitable for use as a fiber
21 separator (gas dissipation apparatus) in a process for
22 making filter rods from a fibrous tow wherein the tow is
23 conveyed pneumatically in a conduit through a variety of
24 processing stations. For example, the apparatus may be
25 used in connection with the process which is particularly
26 described in U.S. Patent No. 4,390,031 wherein the
27 fibrous tow is conveyed pneumatically through a conduit
28 60 (referring to Figure 9 in particular of the patent
29 drawings) by means of a venturi-type air jet assembly 64,

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1 a major part of the conveying air subsequently being
2 discharged from the conduit through a porous portion 74
3 thereof prior to the introduction of steam to the tow for
4 bonding same to form a filter rod. The apparatus
5 illustrated in the patent is particularly adapted to
6 low-volume air flow suitable for conveying a tow for a
7 small size cigarette-type filter rod, and apparatus 10 in
8 accordance with the present invention may be used in the
9 patented process in place of porous portions 74 of
10 conduit 60 (and the subsequent steaming means) as a means
11 for optimizing the air dissipation and improving the
12 surface characteristics of the tow as previously
13 discussed.

14 Conduit element 10 has an inlet 10A and an
15 outlet end 10B considered in the intended direction of
16 conveyance of the tow therethrough, and in the
17 illustrated embodiment the ends are of reduced outside
18 diameter (for example, for connection into conduit 60
19 above) although this is not essential.

20 Between its inlet and outlet ends, conduit
21 element 10 has a series of axially spaced rings of
22 circumferentially spaced air dissipation ports 12A-12N.
23 Rings of ports 12A-12G adjacent the inlet end 10A of the
24 conduit element are inclined rearwardly with respect to
25 the intended direction of travel of a tow from the inlet
26 end to the outlet end, so as to provide air dissipation
27 through the ports in a counter-current direction to the
28 travel of the tow with a view to reducing the tendency
29 for tow fibers to hang on these ports and to increase the
30 tendency for the fibers to become bent back at their
31 edges. The angle of rearward inclination of the
32 respective ports may be about 45 and there may be twenty
33 (20) ports per ring each of about 1/32" in diameter,
34 although these parameters may be varied for particular
35 applications.

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1 Downstream rings of dissipation ports 12H-12N
2 may also be provided in the conduit element, the
3 downstream ports being oriented perpendicularly to the
4 direction of travel of the tow. As previously
5 described, the reason that the downstream ports may be
6 perpendicularly oriented is that counter-current release
7 of the conveying gas is found to be less critical after
8 initial release of the high velocity gas. The downstream
9 rings of gas dissipation 12H-12N may have sixteen (16)
10 ports per ring, each of about .035" in diameter.

11 The conduit element 10 may also include rings of
12 steam admission ports 14A-14C downstream from the gas
13 dissipation ports, the steam ports being angled (for
14 example at 45) for counter-current injection of steam
15 into the tow, and in the case of the process illustrated
16 in U.S. Patent No. 4,390,031, taking the place of steam
17 ports 80. There may, for example, be sixteen (16) ports,
18 each of 1/32" in diameter in each steam ring.

19 In order to provide optimum distribution of gas
20 dissipation ports around the volume of the conduit
21 element used for gas dissipation, the individual ports in
22 the respective rings 12A-12N may be respectively offset
23 circumferentially in adjacent rings at an angle of offset
24 (for example, about 4) which is less than the angle
25 between the adjacent ports in a ring, as shown most
26 clearly in Figure 6, whereby substantially helically
27 extending lines of the ports are provided. The ports in
28 the steam admission rings 14A-14C may be similarly offset
29 ring-to-ring at an angle of about 4 .

30 While the apparatus has been described in
31 particular for application in the process disclosed in
32 U.S. Patent No. 4,390,031, it is not limited thereto and
33 numerous modifications can be made within the scope of
34 the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. In an apparatus for the manufacture of filter rod material from a fibrous tow including a conduit means through which the tow is to be conveyed pneumatically to a steam injection station, gas injections means for delivering conveying gas to the conduit means for conveying the tow therethrough in one direction of travel, and a gas dissipation means for discharging the gas from the conduit means downstream from the injection means, the improvement wherein the gas dissipation means includes at least one ring of circumferentially spaced gas dissipation ports in the conduit means adapted for reducing the tendency of tow fibers to hang on said ports and increasing the tendency of the fibers to become bent back at their edges, said ports being inclined rearwardly for outflow of gas from the conduit means in a second direction which is counter-current to the direction of travel of the tow through the conduit means.

2. The improvement as defined in Claim 1 including plural axially spaced rings of gas dissipation ports inclined as aforesaid wherein the individual ports in adjacent rings are offset circumferentially at an angle which is less than the angle between adjacent ports in a ring.

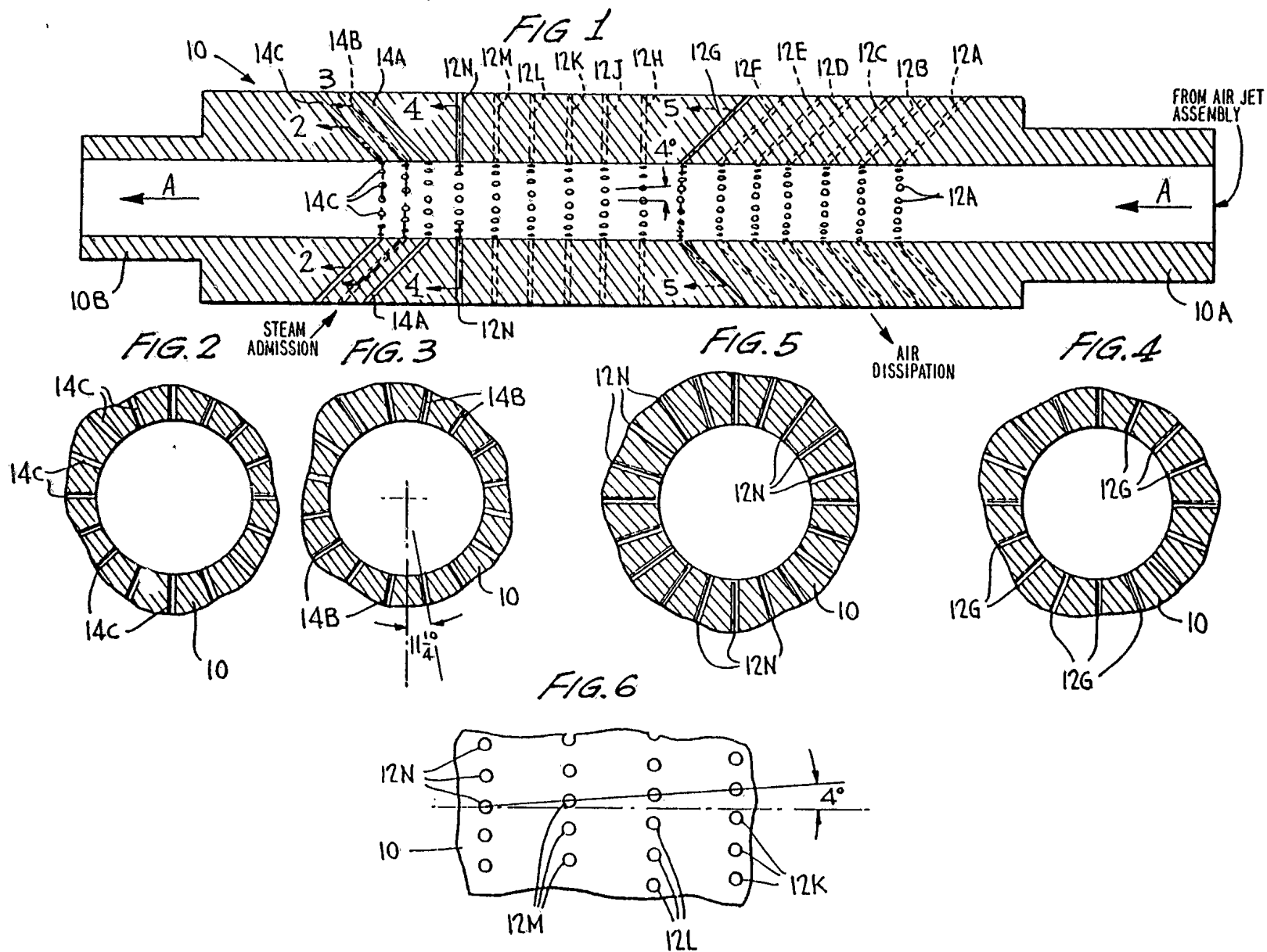
3. In an apparatus for the manufacture of filter rod material from a fibrous tow including a conduit means through which the tow is to be conveyed pneumatically to a steam injection station, gas injection means for delivering conveying gas to the conduit means for conveying the tow therethrough in one direction of travel, and a gas dissipation means for discharging the gas from the conduit means downstream from the injection means, the improvement wherein the gas dissipation means includes at least one ring of circumferentially spaced gas dissipation ports in the conduit means inclined rearwardly for outflow of gas from the conduit means in a second direction which is counter-current to the direction of travel of the tow through the conduit means wherein said at least one ring of gas dissipation



ports is followed in the direction of travel of the tow by at least one further ring of circumferentially spaced gas dissipation ports perpendicularly oriented with respect to the direction of travel of the tow.

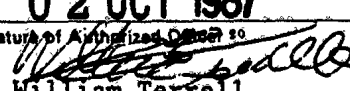
- 5 4. The improvement as defined in Claim 3 wherein the individual ports in adjacent rings are offset circumferentially at an angle which is less than the angle between adjacent ports in a ring.





INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/01513

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ² According to International Patent Classification (IPC) or to both National Classification and IPC IPC(4) A24D 3/02 U.S. CL. 493/44						
II. FIELDS SEARCHED Minimum Documentation Searched ⁴ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 30%; text-align: left; border-bottom: 1px solid black;">Classification System</th> <th style="text-align: left; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">U.S.</td> <td style="padding: 5px;">493/44, 48, 156/180, 441, 226/97</td> </tr> </table> Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁵			Classification System	Classification Symbols	U.S.	493/44, 48, 156/180, 441, 226/97
Classification System	Classification Symbols					
U.S.	493/44, 48, 156/180, 441, 226/97					
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴						
Category [*]	Citation of Document, ¹⁵ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸				
Y	US, A, 3,095,343 (BERGER) 25 June 1963. (Note ports 140)	1-4, 6				
Y	US, A, 3,127,080 (ALLANDER et al) 31 March 1964. (Note Figure 2 and column 2, lines 18-20).	2-8, 11				
A	US, A, 3,334,161 (DE GUZMAN) 01 August 1967.					
A	US, A, 3,898,118 (YAMAOKA et al) 05 August 1975.					
A	US, A, 3,917,141 (SATORI) 04 November 1975.					
<u>X</u>	US, A, 4,069,961 (NICKLAUS et al) 24 January 1978. (Note Figure 4)	<u>9</u>				
Y		1-4, 6				
Y	US, A, 4,390,031 (BERGER) 28 June 1983. (Note Figure 9)	1-13				
A	US, A, 3,313,306 (BERGER et al) 11 April 1967.					
A	US, A, 3,313,665 (BERGER) 11 April 1917.					
A	US, A, 3,377,220 (BERGER et al) 09 April 1968.					
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IV. CERTIFICATION						
Date of the Actual Completion of the International Search ² 01 September 1987		Date of Mailing of this International Search Report ³ 02 OCT 1987				
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