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(54) METHOD AND APPARATUS FOR MAKING FILAMENTOUS PRODUCTS BY WINDING

(71) We, AMERICAN AIR FILTER COMPANY INC., a Company organised and existing under the laws of the State of Delaware, United States of America, of 215 Central Avenue, Louisville 8, Kentucky, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to a method and to apparatus for making filamentous mats by winding a curtain of separated filaments onto a rotating drum which provides collector. Specifically, the invention aims to provide a method and apparatus for forming groups of filaments or multifilament strands in such mats.

Previous apparatus for feeding a curtain of separated filaments to be wound on a rotating drum has in some instances included various means to collect selected numbers of individual filaments to form multifilament strands. Such previous collector means have included V-shaped guide means to draw a curtain of filaments to a common point to form a multifilament strand which can be collected on a rotating drum. Other collector means have included rotatable wheels disposed so that the filaments are drawn along the cylindrical surface of the wheel so that the lines of contact between the filaments and the wheel is parallel to the transverse axis of the wheel and in most such arrangements, the wheel is mounted to rotate freely in response to the movement of the filaments over the surface so the speed of the peripheral surface of the wheel is substantially the same as the linear speed of draw of the filaments. In such previous arrangements where the line of contact between the surface of the collector wheel and the filaments falls generally parallel to a transverse axis of the wheel, the path of the

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filaments is relatively narrow, and because of the abrasive nature of the filaments, grooves are normally cut into the surface of the wheel. Such grooves undesirably cause the filaments to break during operation and it is necessary to frequently resurface or smooth the surface of the guide means with resulting maintenance expense and decreased operating time.

Where rotating wheels have previously been used to collect separated filaments from a filament curtain to form multifilament groups it has neither been recognized nor has it been possible to alternately provide multifilament groups at selected locations along the width and intermediate the extremities of the filament curtain and separated filaments to be wound on the drum. In fact, in previous used apparatus it is necessary to assembly the collectors to form such groups before operation is started and the apparatus cannot be modified during operation. While some other previously used apparatus does provide means to alternately wind multifilament groups and separated filaments on the drum, the collector wheels are adapted for movement relative to the filament curtain and contact filaments only at the outer edges of the curtain so only two multifilament strands are formed, one at each end of the filter curtain. Heretofore, in winding a curtain of filaments onto a rotating drum in overlying layers it has neither been recognized nor has it been possible, without stopping operation and adjusting the apparatus, to wind separate filaments onto the rotating drum during selected portions of the operating period and alternately form multifilament strands, including strands at selected locations along the width of the curtain, to be wound on the rotating drum during other selected portions of the operating period.

The present invention aims to provide a

method and apparatus for winding a curtain of filament onto a rotating drum and forming multifilament groups or strands of filaments at selected locations along the width of the curtain by bringing a portion of the individual filaments into mutually contiguous contact on collector means.

In the method according to the invention of forming a condensed filamentous mat a curtain of separate filaments falls on to the cylindrical surface of a rotating drum so as to form a mat of filaments thereon which is subsequently removed by cutting the mat longitudinally of the drum and filament collector means are selectively introduced through the falling curtains at intervals across the curtain whereby at least those filaments adjacent the collector means are urged into contiguous relationship with each other so as to form multifilament strands in the curtain.

In apparatus according to the invention for carrying out this method curtain of separate filaments is fed from a feeder on to the cylindrical surface of a drum which rotates about its longitudinal axis so as to collect a cylindrical filamentous mat thereon from which drum the mat can be subsequently removed by cutting the mat and collector means are provided to be selectively inserted into the curtain of filaments during the feeding of the curtain so that filaments from a portion of the curtain contact the surface of the collector means to be urged into contiguous relation to form multifilament strands to be wound on the rotating drum.

Preferably means are also provided to significantly reduce the effect of the abrasive action of the filaments on the collectors to prevent formation of narrow grooves in the collector surfaces.

So that the invention will be better understood it will be further described by way of example and with reference to the accompanying drawings in which:—

Figure 1 is an elevational view of a filament collecting apparatus in embodying the present invention;

Figures 2a and 2b are reduced fragmentary views of winding apparatus illustrating one arrangement in accordance with the present invention, as hereinafter described;

Figure 3 is an enlarged sectional view taken along a plane passing through line 3-3 of Figure 1;

Figure 4 is a view taken along a plane passing through line 4-4 of Figure 3 where for clarity the filament curtain of Figure 3 is not shown.

Figure 5 is a view taken along a plane passing through line 5-5 of Figure 3;

Figure 6 shows an example of a cylindrical filament collector in accordance with the present invention;

Figure 7 is a view illustrating the use of collector means as shown in Figure 6;

Figure 8 is another view illustrating the use of an example of a collector means shown in Figure 6;

Figure 9 is a fragmentary elevational view showing the use of an example of another type of collector in accordance with the present invention;

Figure 10 is an enlarged fragmentary view showing an example of such other collector means of Figure 9 in accordance with the present invention; and

Figure 11 is a view taken along a plane passing through line 11-11 of Figure 10;

Referring to the drawings which show examples of apparatus in accordance with the present invention wherein similar reference numbers indicate similar elements in the several views, Figure 1 shows a drum 1 mounted on pedestals 18 for rotation (by means not shown) and a filament feeder 2 which is adapted to feed a curtain 3 of separated filaments to drum 1.

Filament feeder 2 is mounted above the downturned edge of drum 1 and is adapted to traverse a selected portion of the length of the downturned edge of drum 1 in successive reciprocatory traverse to deposit filaments of curtain 3 on drum 1 in successive overlying layers to form a condensed filamentous mat of selected thickness on the drum. Feeder 2 can be, for example, a furnace adapted to supply filaments of molten glass to an orifice plate (not shown) in the bottom of feeder 2. Filament curtain 3 is drawn from feeder 2 by rotating drum 1 and the degree of attenuation of the filaments is dependent primarily on the speed of rotation of drum 1.

A filament collector apparatus is provided to group selected filaments of curtain 3 into multifilament strands and in the example shown in Figure 1 the collector apparatus includes spaced rotatable collector cylinders 8 mounted to extend laterally from an arm 12 which is generally parallel to the longitudinal axis of drum 1. In the application as shown in the Figures, where the feeder traverses a downturned edge of the rotating drum, arm 12 is adapted to move with feeder 2 through successive reciprocatory traverses along drum 1.

Thus collectors 8 are disposed in fixed relation relative to feeder 2. Arm 12 is attached to feeder 2 by means of support brackets 16 and 17 and support bracket 16 can advantageously be adapted for pivotal movement about pivot 17a so that the arm 12 can be moved relatively toward and away from filament curtain 3 to move filament collectors 8 into and out of filament curtain 3 as hereinafter described.

As best shown in Figure 3, collectors 8 are of cylindrical shape to provide a cylin-

drical surface 8b for collection of filaments. Each collector 8 has a tapered end including, for example, truncated conical end portions 8a as shown in the Figures and hemispherical end sections (not shown) to facilitate insertion of the collector into filament curtain 3 to form multifilament strands 4 without breaking filaments of the curtain.

Collectors 8 are preferably made of material having a relatively low coefficient of friction to reduce abrasive action of the filaments on the surface of the collector means. For example, when glass filaments are to be wound on the rotating drum the collectors can be made of moulded carbon.

Filament collectors 8 of the example shown in Figures 1-8 are rotatably mounted on arm 12 by means of spindles 19a (Figure 3) which can extend through arm 12 and carry cooperative sprockets 19 at the end opposite collector 8 whereby the shaft can be driven at a selected speed. This latter can be achieved for example by a variable speed motor 9 which mounted on a bracket 22 of arm 12. As can best be seen in Figure 4, motor 9 also includes a cooperative sprocket 23 fixed to the drive shaft and a chain 20 can be provided to connect drive sprocket 23 and driven sprockets 19 in co-operative driving relation to turn the collector wheels 8 at selected speed. Bearing means (not shown) can be provided to hold spindles 19a, sprockets 19, and collector wheels 8 in cooperative aligned relation with chain 20.

Spindles 19a can be fixed to collectors 8 in aligned relation with the longitudinal axis of the collector as shown in Figures 3-5 so that each collector 8 rotates about its longitudinal axis, or as shown in Figures 6-8, spindles 19a can be fixed to collectors 8 in off-center relation so that each collector 8 rotates in an orbital path. In the example of Figure 6, line 26 passes through the longitudinal axis of the collector and line 27 is a line parallel to the line 26 passing through the point where shaft 19 is fixed to collector 8 and the distance between lines 26 and 27 illustrates the degree of eccentricity of rotation of collector 8 when spindle 19a is rotated.

In the embodiment shown in the Figures, filaments are drawn from feeder 2 in the form of a curtain 3 having rectangular cross-section with a width dimension measured along the longitudinal axis of the rotating drum and a depth dimension measured in a direction generally transverse thereto. In some instances as hereinafter described it is desirable to reduce the depth of filament curtain 3 so that the filaments are wound onto rotating drum 1 as a thin curtain and to this end a collector rod 11 as shown is provided in the filament path between arm 12 and feeder 2 to extend in a direction

generally parallel to arm 12 so that filament curtain 3 passes over the rod to form a relatively narrow filament curtain 3c. Rod 11, like collectors 8, is subject to abrasion from the filaments and the rod can be rotated to change the area of contact between the surface of rod 11 and the filaments to evenly distribute the abrasive action of the filaments over the circumferential surface of the rod. To rotate rod 11 at any selected speed a motor 13 can be provided and can be mounted on a bracket 21 fixed to arm 12. It will be noted that as feeder 2 travels in first one direction and then in another direction along the downturning edge of drum 1 to change the angle of the path of the filaments relative to a transverse axis of drum 1 filaments of curtain 3 likewise move longitudinally along the rotating rod so the abrasive action of the filaments is distributed along a portion of the length of the rod.

As shown in Figure 3, rod 11 is disposed relative to feeder 2 and the surface of drum 1 so that filaments of curtain 3c cross the cylindrical surface of each collector 8 at an angle relative to the transverse axis of the collector and the effective area of contact (defined by the dotted lines of Figure 3) of the filaments of curtain 3c on the surface of rotating drum 8 is wider than the depth of the filament curtain 3c. The width of the area of contact between the dotted lines is a function of the angle at which the filaments are drawn across the surface of collector 8 and can be selectively controlled by the position of rod 11 with respect to drum 1 and feeder 2.

The length of collectors 8 and the size of the multifilament strands gathered on the collectors are determined, in part, by the depth of the filament curtain 3c which contacts collector 8. As hereinbefore described, a collector rod can be provided to narrow the depth of the curtain of filaments and increase the number of filaments gathered into each multifilament strand. Rod 11 of Figure 3 can be provided to decrease the depth of filament curtain 3 so all of the filaments of curtain 3 which contact the cylindrical surface of collectors 8 are included in the multifilament strands 4. On the contrary, if a collector rod, for example rod 11, is not provided the depth of curtain 3 is substantially greater so that the length of the cylindrical surface must be increased to accommodate the increased depth of the curtain and only filaments lying in the same plane are collected as multifilament strands. Therefore, in apparatus where a collector rod is not provided, several smaller, multifilament strands are formed on the surface of the collectors.

Figures 9-11 illustrate another example of an apparatus in accordance with the pre-

sent invention which is in many respects similar to the apparatus of Figure 1 and similar reference numbers indicate similar elements. In the apparatus of Figure 9 a rotatable rod 31 is provided and includes collector wheels 32 disposed in spaced relation along collector rod 31 which are provided to selectively group filaments of curtain 3 to form multifilament strands 4. It will be noted that for a particular orifice plate configuration the number of filaments to be collected in each strand 4 is determined by the width of collector wheels 32 and that a variety of different size wheels can be used to selectively vary the size of multifilament strands 4 formed at various locations in curtain 3.

As shown in Figure 11 rod 31 can be disposed in the path of filaments drawn from feeder 2 to drum 1 so that the depth of filament curtain 3 is reduced in passing over rod 31 and the combined effect of the position of rod 31 and the separation of the filament curtain accomplished by wheels 32 provides separated thin curtain of filaments 3d including multifilament strands 4.

It will be noted that rod 31 is similar to collector rod 11 in that it can be rotated by means of a motor 29 joined to a bracket 21 carried by arm 12 to distribute the abrasive action of the filaments uniformly around the circumferential surface of rod 31 and collector wheels 32. The filaments of curtain 3 contact collector wheels 32 at an angle relative to the transverse axis of the wheels and it will be noted that the angular relationship between the filaments of curtain 3d and collector wheels 32 varies according to the direction in which feeder 2 is travelling and the speed of travel.

In operation feeder 2 is driven on track 6 (by means not shown but known in the art) in successive reciprocatory traverses along the downturning edge of drum 1 and a curtain 3 of separated glass filaments is drawn from the feeder to be wound on the rotating drum in overlying layers to form a condensed filamentous mat of selected thickness.

As illustrated schematically in Figure 2a and 2b which relate to the apparatus of Figures 1-8, a curtain 3 can be deposited on drum 1 in the form of separated filaments (Figure 2a) and during the formation of alternate portions of the mat collectors can be inserted into and selectively through the curtain (Figure 2b) to urge filaments to contiguous relation to form multifilament strands at selected locations along the width of the curtain. Further the frequency of occurrence and distribution of such strands within the condensed mat can be controlled to provide filamentous mats having desired characteristics. As hereinbefore described, collectors 8 can be of generally cylindrical

shape and can have means to facilitate insertion of the collectors into curtain 3, for example truncated conical end sections 8a. When it is desired to form grouped filaments to be wound onto the drum arm 12 is moved toward filament curtain 3 so the apex of the conical section of each collector pierces filament curtain 3. As collectors 8 are moved further into curtain 3 increasing numbers of filaments on opposite sides of each collector are urged to contiguous relation and the size of multifilament strands 4 is increased. The collectors can be advanced selectively into only a portion of the curtain or entirely through the filament curtain 3 as shown in Figure 3. It will be noted the number of filaments included in each strand 4 is determined by the diameter of collector 8 and the spacing between adjacent filaments drawn from feeder 2. It will further be noted that the number of filaments in strands 4 at different locations along curtain 3 can be selectively varied by using collectors 8 of different diameter. In some applications the collectors 8 can be made very large so there is little free space between adjacent collectors and all of the filaments of curtain 3 are formed into groups so only multifilament strands are wound on drum 1.

Also, since the number of filaments in each multifilament strand varies directly with the degree of penetration of conical section 8a of collectors 8 the size of strands 4 can likewise be controlled by collecting filaments at selected locations on the conical surfaces of the collectors and regulating the penetration of the conical surface into curtain 3c to increase or decrease the size of multifilament strands 4.

Furthermore the collectors can be inserted through only a portion of the depth of the curtain of filaments so multifilament strands are formed in a portion of the depth of the curtain and the filaments of the remainder of the curtain is simultaneously wound on the rotating drum in separated form.

With reference to the example of collector apparatus shown in Figures 6-8, the present invention recognizes that if the transversing speed of feeder 2 along the downturning edge of drum 1 is substantially the same during successive traverses strands 4 will in some instances be deposited on drum 1 in overlying relation in alternate passes and result in an uneven surface where successive overlapping occurs in the areas of the condensed filamentous mat formed on drum 1. It has been found however that by mounting the collector wheels 8 in eccentric relation as shown in Figures 6-8, and by rotating the eccentrically mounted collectors in orbital paths at selected speed, strands 4 deposited on the drum 1 in successive passes

of feeder 2 are displaced laterally from each other so the multifilament strands are more evenly distributed across the width of the mat and throughout the thickness of the mat. The displacement between multifilament strands of successive layers is determined by the eccentricity of the mounting; the relative speed of rotation of collector 8 and the traversing speed of feeder 2. Furthermore, it has been recognized that in some instances it is desirable to deposit the multifilament strands in the filamentous mat in a sinusoidal pattern and by proper selection of the rotating speed of collectors 8, relative to the traversing speed of feeder 2, a sinusoidal pattern of multifilament strands can be developed in the condensed mat.

In operation of the apparatus shown in Figures 9-11 a collector rod 31, similar to collector rod 11 of the apparatus of Figure 1, is provided and includes a series of collector wheels 32 advantageously disposed on rod 31. As shown, collector wheels 32 can have tapered edges to facilitate insertion into filament curtain 3 by means of bracket 16. As indicated in Figure 11, filaments drawn from feeder 2 pass over rod 31 to form a narrow curtain 3d and the filament curtain is divided by collector wheels 32 so that displaced filaments are urged to contiguous relation on collector wheels 32 to form multifilament strands 4.

Regardless of the particular apparatus used, filaments can be wound on rotating drum 1 in overlying layers with selectively distributed multifilament strands until a filamentous mat of selected thickness has been formed and the mat can be removed from the drum for further processing, for example by slitting the mat axially of the drum and removing it as a planar mat.

WHAT WE CLAIM IS:—

1. A method of forming a condensed filamentous mat in which a curtain of separate filaments falls on to the cylindrical surface of a rotating drum so as to form a mat of filaments thereon which is subsequently removed by cutting the mat longitudinally of the drum and in which filament collector means are selectively introduced through the falling curtain at intervals across the curtain whereby at least those filaments adjacent the collector means are urged into contiguous relationship with each other so as to form multifilament strands in the curtain.

2. A method according to claim 1 wherein the collector means are rotated so that the peripheral speed of the surface at the area of contact with the filaments is different to the linear speed at which the filaments are drawn over the collector.

3. A method of forming a condensed filamentous mat substantially as herein described.

4. Apparatus for use in forming condensed mats of filamentous material wherein a curtain of separate filaments is fed from a feeder on to the cylindrical surface of a drum which rotates about its longitudinal axis so as to collect a cylindrical filamentous mat thereon, from which drum the mat can be subsequently removed by cutting the mat, and wherein collector means are provided to be selectively inserted into the curtain so that filaments from a portion of the curtain contact the surface of the collector means to be urged into contiguous relation to form multifilament strands to be wound on the rotating drum.

5. Apparatus according to claim 4 including means for moving the feeder back and forth relatively to the drum in successive reciprocating traverses to deposit said filaments along a portion of the length of the rotating drum; and, means for moving the collector means back and forth relatively to the drum in successive reciprocating traverses so that filaments and the multifilament strands are wound on said drum in successive overlying layers.

6. Apparatus according to claim 4 or claim 5 wherein the collector means includes at least two cylinders supported in spaced relation with the longitudinal axis of each cylinder transverse the rotational axis of the rotating drum; and, means for inserting the cylinders into the curtain of filaments to a depth so that separated filaments contact a portion of the cylindrical surface of each cylinder collector to be urged into contiguous relation.

7. Apparatus according to claim 6 having means for rotating at least some cylinders about their longitudinal axis.

8. Apparatus according to claim 6 or claim 7 wherein each cylindrical collector is mounted for rotation on a shaft which is eccentric to the longitudinal axis of the cylinder.

9. Apparatus according to any one of claims 6 to 8 wherein the cylindrical rotatable collector means are disposed, relative to the path of the filaments from the feeder to the downturning edge of the drum, so that the line of contact between the filaments and the surface of the collector means is at an angle relative to a longitudinal axis of the cylindrical rotatable collector means.

10. Apparatus according to any one of claims 6 to 9 wherein means are provided for moving a common support for the cylinders relatively toward and away from the curtain of filaments to move the collector means into the curtain to a depth and to move the collector means out of the curtain of filaments.

11. Apparatus according to any one of claims 6 to 10 wherein each cylinder in-

of feeder 2 are displaced laterally from each other so the multifilament strands are more evenly distributed across the width of the mat and throughout the thickness of the mat. The displacement between multifilament strands of successive layers is determined by the eccentricity of the mounting, the relative speed of rotation of collector 8 and the traversing speed of feeder 2. Furthermore, it has been recognized that in some instances it is desirable to deposit the multifilament strands in the filamentous mat in a sinusoidal pattern and by proper selection of the rotating speed of collectors 8, relative to the traversing speed of feeder 2, a sinusoidal pattern of multifilament strands can be developed in the condensed mat.

In operation of the apparatus shown in Figures 9-11 a collector rod 31, similar to collector rod 11 of the apparatus of Figure 1, is provided and includes a series of collector wheels 32 advantageously disposed on rod 31. As shown, collector wheels 32 can have tapered edges to facilitate insertion into filament curtain 3 by means of bracket 16. As indicated in Figure 11, filaments drawn from feeder 2 pass over rod 31 to form a narrow curtain 3d and the filament curtain is divided by collector wheels 32 so that displaced filaments are urged to contiguous relation on collector wheels 32 to form multifilament strands 4.

Regardless of the particular apparatus used, filaments can be wound on rotating drum 1 in overlying layers with selectively distributed multifilament strands until a filamentous mat of selected thickness has been formed and the mat can be removed from the drum for further processing, for example by slitting the mat axially of the drum and removing it as a planar mat.

WHAT WE CLAIM IS:—

1. A method of forming a condensed filamentous mat in which a curtain of separate filaments falls on to the cylindrical surface of a rotating drum so as to form a mat of filaments thereon which is subsequently removed by cutting the mat longitudinally of the drum and in which filament collector means are selectively introduced through the falling curtain at intervals across the curtain whereby at least those filaments adjacent the collector means are urged into contiguous relationship with each other so as to form multifilament strands in the curtain.

2. A method according to claim 1 wherein the collector means are rotated so that the peripheral speed of the surface at the area of contact with the filaments is different to the linear speed at which the filaments are drawn over the collector.

3. A method of forming a condensed filamentous mat substantially as herein described.

4. Apparatus for use in forming condensed mats of filamentous material wherein a curtain of separate filaments is fed from a feeder on to the cylindrical surface of a drum which rotates about its longitudinal axis so as to collect a cylindrical filamentous mat thereon, from which drum the mat can be subsequently removed by cutting the mat, and wherein collector means are provided to be selectively inserted into the curtain of filaments during the feeding of the curtain so that filaments from a portion of the curtain contact the surface of the collector means to be urged into contiguous relation to form multifilament strands to be wound on the rotating drum.

5. Apparatus according to claim 4 including means for moving the feeder back and forth relatively to the drum in successive reciprocating traverses to deposit said filaments along a portion of the length of the rotating drum; and, means for moving the collector means back and forth relatively to the drum in successive reciprocating traverses so that filaments and the multifilament strands are wound on said drum in successive overlying layers.

6. Apparatus according to claim 4 or claim 5 wherein the collector means includes at least two cylinders supported in spaced relation with the longitudinal axis of each cylinder transverse the rotational axis of the rotating drum; and, means for inserting the cylinders into the curtain of filaments to a depth so that separated filaments contact a portion of the cylindrical surface of each cylinder collector to be urged into contiguous relation.

7. Apparatus according to claim 6 having means for rotating at least some cylinders about their longitudinal axis.

8. Apparatus according to claim 6 or claim 7 wherein each cylindrical collector is mounted for rotation on a shaft which is eccentric to the longitudinal axis of the cylinder.

9. Apparatus according to any one of claims 6 to 8 wherein the cylindrical rotatable collector means are disposed, relative to the path of the filaments from the feeder to the downturning edge of the drum, so that the line of contact between the filaments and the surface of the collector means is at an angle relative to a longitudinal axis of the cylindrical rotatable collector means.

10. Apparatus according to any one of claims 6 to 9 wherein means are provided for moving a common support for the cylinders relatively toward and away from the curtain of filaments to move the collector means into the curtain to a depth and to move the collector means out of the curtain of filaments.

11. Apparatus according to any one of claims 6 to 10 wherein each cylinder in-



cludes a truncated cone end section for insertion through the curtain of filaments.

12. Apparatus according to any one of claims 6 to 10 wherein the cylindrical guide means include semi-hemispherical shaped end sections to be inserted through said curtain of filaments.

13. Apparatus according to any one of claims 6 to 12 wherein the diameter of one said rotatable cylindrical collector means is greater than the diameter of another rotatable cylindrical guide means.

14. Apparatus according to any one of claims 6 to 13 including a collector rod extending parallel to the drum rotational axis and disposed between the feeder and the collector means in the path of the filaments from the feeder to the rotating drum to contact at least a portion of the filaments in the curtain to narrow the depth of the curtain of filaments drawn from the feeder.

15. Apparatus according to claim 4 or claim 5 wherein the collector means includes a shaft extending parallel to the drum rotational axis and disposed in the path of

the filaments from the feeder means to the rotating drum to contact at least a portion of the filaments of the curtain to narrow the depth of the curtain and, cylindrical collector wheels disposed in axially aligned spaced relation along the shaft, which wheels are inserted into the curtain of filament to urge a portion of said separated filaments to contiguous relation to form multifilament strands on opposite sides of the collector wheels.

16. Apparatus according to claim 15 or claim 16 wherein the collector shaft rod is rotatable about its longitudinal axis.

17. Apparatus for use in forming condensed mats of filamentous material and substantially as herein described.

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