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(54) METHOD OF MAKING A FILAMENTOUS MAT

(71) We, AMERICAN AIR FILTER COMPANY, INC., a Corporation organised and existing under the laws of the State of Delaware, United States of America, of 215 Central Avenue, Louisville, Kentucky 40208, 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 an apparatus and a method of controlling the distribution of filaments being fed to a rotating collector and has application, for example, in the manufacture of filamentous mats.

One previous method and apparatus for collecting a curtain of filaments on a rotating drum includes filament feeder means, for example a glass melting furnace, successively reciprocated axially parallel to the downturning edge of the drum so a filament curtain is wound on the drum to form a multi-layer filamentous mat. The successive layers of filaments of the mat correspond to successive traverses of the feeder along the drum and the filaments of each layer lie in crossing relationship with filaments of the immediately preceding layer. In some applications the mat so formed is slit axially of the drum and removed as a planar mat. In such method and apparatus, the feeder is stopped and the direction of travel is reversed at each end of the drum. The end portions of the filamentous mat, formed in the feeder end reversal areas, are of significantly different, undesirable characteristics from the portion of the mat formed between the end reversal areas. The width of each end portion generally approximates the width of the curtain of filaments drawn from the feeder and is generally considered scrap to be trimmed from the finished mat and discarded as waste.

[Price 25p]

It is, of course, desirable to decrease the portion of the mat in the end reversal areas and one method of doing this is by decreasing the width of the curtain. In some instances the width of the feeder has been decreased without a compensating increase in any other dimension of the feeder, but the smaller feeder correspondingly decreases the quantity of glass drawn from the feeder per unit of time and therefore increases the amount of time required to form a completed mat on the drum.

In other methods and apparatus the width of the filament feeder, parallel to the axis of the drum, has been decreased with a corresponding increase in length of the feeder in a direction transverse the longitudinal axis of the drum so the same number of filaments issue from the feeder. In such apparatus the separation between the filaments is necessarily very small, and in many cases the filaments are undesirably deposited on the rotating drum in contiguous relation as groups of filaments rather than as separated filaments. The relatively narrow curtain of filaments permits such apparatus to likewise be used to wind a curtain of filaments onto a rotating drum in the form of separated convolutions, or wraps, to provide a filamentous mat of certain desired characteristics. This is accomplished by careful correlation between the rotational velocity of the drum and the traversing velocity of the filament feeder to prevent overlapping between successive convolutions of the curtain.

In other previous apparatus the width of the curtain of filaments has been reduced by intentionally collecting some of the filaments into multi-filament groups to be deposited on the drum. While the formation of such filament groups does reduce the width of the filament curtain, collected groups are very often not desirable and such an arrangement has not proved to be

a satisfactory means for reducing the formation of waste in the end reversal areas of the filamentous mat.

In virtually all previous apparatus for feeding a curtain of separated filaments from a feeder to be collected on a rotating drum, whether a reciprocating feeder is used or not, the separation between filaments wound on the drum is fixed by the separation of the orifices and the separation cannot be significantly changed without modification of the feeder apparatus.

The present invention provides a filament winding apparatus comprising: filament feeder means to feed a curtain of filaments; rotating filament collector means to receive the curtain of filaments from the feeder means; filament guide means, including at least one filament-contacting straight edge, disposed between the feeder and the collector so that the or each edge intersects the curtain of filaments such that a portion of the filaments of the filament curtain contact a part of the edge whereby the width, measured parallel to the axis of the collector, of a portion of the filament curtain contacting the or each edge is narrowed and the narrowed curtain of filaments may be supplied to the collector. The invention further provides a method for controlling the distribution of filaments in a curtain of filaments being fed to a rotating collector wherein filament guide means including at least one filament-contacting straight edge, disposed between the filament feeder and collector, so that the or each edge intersects the curtain of filaments such that at least a portion of the filaments of the filament curtain contact a part of the edge whereby the width, measures parallel to the axis of the collector, of the portion of the filament curtain contacting the or each edge, is narrowed, and the narrowed curtain of filaments may be supplied to the collector, the guide means being adjustable such that the width of the curtain may be varied.

The present invention aims to provide means for controlling the distribution of filaments in a curtain of filaments, drawn from a filament feeder to a rotating drum and change of the separation between the individual filaments of the curtain of filaments without necessarily resulting in contact between adjacent filaments.

The filaments can for example be glass. In accordance with another feature of the present invention, the extent of reduction in width of the curtain of filaments wound on the drum and the separation between filaments of the curtain, can be easily and selectively varied during collection of the curtain of filaments without substitution of parts in the filament feeder means or changing the position of the filament feeder

means.

Furthermore, the present invention recognizes and provides apparatus and method to reduce the width of a selected portion of a curtain of filaments drawn from a feeder to a collecting means while the remaining portion of the curtain is unaffected. Moreover, the method and apparatus of the present invention recognizes and provides means to narrow the width of a curtain of filaments to decrease the separation between individual filaments and, simultaneously, provide groups of filaments to form a multi-filament strand at a selected location within the curtain of filaments.

In applications where the feeder axially traverses a rotating drum to provide a filamentous mat of successive layers of crossing filaments on the rotating drum the present invention recognizes and provides an apparatus to narrow the width of the mat formed in the end reversal area to reduce the amount of waste. Likewise, the present invention provides an economical means to narrow the width of the curtain of filaments drawn from a feeder which axially traverses the rotating drum so the filaments can be alternately wound on the rotating drum as separate convolutions or overlapping convolutions by merely making an appropriate adjustment in the collecting device without modifying the position, size or traversing speed of the feeder.

The invention will now be further described by way of example with reference to the accompanying drawings, in which:— Figure 1 is an elevational view of an apparatus in accordance with the present invention;

Figure 2 is a view taken along a plane passing through line 2-2 of Figure 1;

Figure 3 is an enlarged, exploded view of an example of a filament collecting apparatus in accordance with the present invention;

Figure 4 is an enlarged schematic drawing of another filament collecting means in accordance with the present invention;

Figure 5 is an enlarged illustration of one example of collection of filaments in accordance with the present invention;

Figure 6 is an enlarged schematic illustration of another view of collection of filaments in accordance with the present invention; and

Figures 7a and 7b are schematic diagrams of the effect of the use of apparatus in accordance with the present invention.

In the example of one apparatus in accordance with the present invention as shown in the Figures a drum 1 is mounted between supports 5 for rotation about its longitudinal axis. A filament feeder 2, which can be a glass melting furnace to feed a curtain of separated glass filaments,

is disposed above a downturning edge of the drum and is adapted to axially traverse the rotating drum while the curtain of filaments 8 is drawn from the feeder to the rotating drum. In accordance with one feature of the present invention, a filament guide means 7, as hereinafter described, is disposed between the feeder and the rotating drum to narrow the width of the curtain of filaments 8 so a narrower curtain of filaments 9 is wound on drum 1.

Drum 1 can be of selected length and diameter and is mounted between bearing supports 5 for rotation about its longitudinal axis (by means not shown). Feeder 2 is supported on cooperative wheels 3 to roll easily back and forth along tracks 4, which are disposed above a down-turning edge of drum 1 in generally parallel relationship to the longitudinal axis of drum 1 as shown by Figure 2, as the filaments can be drawn from the feeder to the downturning edge of the drum.

Feeder 2 also includes an upstanding arm 11 having a slot 11a to receive a pin 12 which pin 12 is adapted to move freely in a vertical direction within slot 11a. Feeder 2 is driven back and forth along tracks 4 in successive reciprocatory traverses by pin 12 which is attached to an endless belts 13, for example a chain belt. Belt 13 is suspended between a drive sprocket 14a at one end and idler sprocket 14b at the other end where the spacing between sprockets 14a and 14b is selected in accordance with the desired width of the filamentous mat to be formed on drum 1. Sprocket wheel 14a is driven at selected speed by means of drive motor 21 to move feeder 2 back and forth along tracks 4 at selected speed.

It will be noted that as feeder 2 approaches each end of the tracks pin 12 passes around a sprocket (14a or 14b) so feeder 2 slows to a stop and reverses direction in accordance with the movement of pin 12 around the sprocket. In the central portion of the drum the filaments lie in generally parallel relation because the feeder traverses this portion of the drum at uniform speed. But during the end reversal period, when the feeder stops and reverses direction, the filaments are deposited on rotating drum 1 at various helical angles, as shown in Figure 1, in accordance with the decreasing and increasing speed of feeder 2. When the feeder is in the stopped position at the very end of the traverse the filaments are deposited in a position nearly transverse to the longitudinal axis of drum 1. The portion of the mat formed in the end reversal areas is approximately equal to the width of the feeder 2 and is tapered because of the decreasing number of filaments deposited toward the outer portions

of the end reversal areas. It will be realized that the number of filaments decreases toward the outer portion of the area because the entire width of feeder 2 does not pass over the entire end reversal area to deposit every filament across the entire area.

The guide means, as provided by the present invention, includes at least one filament-contacting surface disposed between the feeder and the collector at an acute angle relative to the normal uninterrupted path of the filaments from the feeder to the collector. In the example as shown in the drawings the guide means includes two probe assemblies which are similar and it will be understood throughout the following description that the *a* and *b* subreferences, where used, refer to the respective probe assemblies. Probes 7a and 7b of the assemblies can be, for example, carbon rods which are disposed to contact a selected portion of filament curtain 8. It will be noted, Figure 2, that each probe is disposed so the longitudinal axis of the probe forms an acute angle with the path of the filaments from the feeder 2 to drum 1 and contacts a portion of the curtain of filaments. While the purposes of the present example the probes are shown as directed downwardly, it will be understood that the probes can likewise be directed upwardly.

Each of the probes 7a and 7b is received by a probe holder 6a and 6b, respectively where each probe is suitably mounted for pivotable movement to rotate probes 7a and 7b to selected position. Referring to Figure 3 which shows an exploded, enlarged view of the pivotable holders 6a and b, each can comprise a channel 24a and 24b respectively having a bearing 23a and 23b to receive probe 7a and 7b, where each probe 7a and 7b extends through respective channel 24a and 24b and is connected to a motor 22a and 22b respectively which can be, for example, a frictional horsepower electric motor. Motors 22a and 22b are provided to rotate each probe 7a and 7b so the abrasive action of the filaments passing over the surface of the probe is distributed uniformly around the circumference of the probe and grooves are not worn into the probe. Holders 6a and 6b are pivotably mounted in overlying relation on a pivot 27 fixed to an arm 17, (Figures 2 and 3). Pivot 27 provides a reduced shank portion 27b cooperatively sized to be snugly received by apertures 26a and 26b of holders 6a and 6b, respectively. It will be noted that holder 6b rests on shoulder 27a of arm 27 and the flat surface of channel 24a of holder 6a rests on the flat surface of channel 24b or holder 6b. If desired, a spacer can be provided between holders 6a and 6b. Arm 27 includes a threaded portion 27c

to receive a fastener to retain holders 6a and 6b for pivotal movement on pivot arm 27.

As shown by the dotted lines of Figure 1, probe assemblies 6a and 6b can be independently pivoted to move probes 7a and 7b from a position generally parallel to arm 17 to a position in crossing relationship to define a V-shaped filament collection area between the probes to encompass all, or a selected portion of the width of filament curtain 8.

Pivotable holders 6a and 6b can be rotated on shank portion 27b by a suitable means, for example hydraulic cylinders 16a and 16b selectively powered by means (not shown) to selectively adjust the position of probes 7a and 7b. One end of cylinders 16a and 16b are pivotably fixed to arm 17 by anchors 15a and 15b, respectively while the piston arms 20a and 20b (Figure 3) of each of the cylinders 16a and 16b can be attached, respectively, to probe holders 6a and 6b by means of knuckles 25a and 25b which are attached to anchors 31a and 31b provided for each holder 6a and 6b. The arrangement as shown permits freely pivotable movement of holders 6a and 6b by cylinders 16a and 16b in response to movement of piston arms 21a and 21b.

The filament guide assembly mounted on arm 17, as hereinbefore described, is supported from an arm 18 which is attached to feeder 2 so that the filament guide means moves with feeder 2 in successive axial traverses along drum 1. Arm 18 can include slots 19a to receive fasteners 19 so that, as shown, the position of arm 17 can be adjusted with respect to feeder 2 by sliding arm 17 along slots 19a.

In operation, filament feeder 2 traverses rotating drum 1 and filament curtain 8 of separated filaments, for example glass, is drawn from feeder 2 through orifices in an orifice plate in feeder 2. Operation of the apparatus as shown can be initiated with probes 7a and 7b in a position parallel to arm 17, as shown by the dotted lines of Figure 1, so the curtain is drawn full width from feeder 2 to drum 1. When it is desired to narrow the width of the band of filaments, cylinder 16a and 16b can be actuated to pivot holders 6a and 6b so probes 7a and 7b are positioned to define the V-shaped collection area and contact curtain 8 to displace a portion of the filaments to narrow the width of the curtain of filaments to form the narrowed filament curtain 9, as shown.

As shown schematically in Figure 5, curtain 8 is drawn downward in ever narrowing width to probes 7 and the filaments which contact probes 7a and 7b, are redirected by the probes so the width of the curtain 9 is uniform between the probes

and the drum and the filaments are in mutually parallel relationship. Considering, for example, two filaments 9a and 9b, the filaments are drawn from the opposite sides of the feeder and filament 9a contacts probe 7a while filament 9b contacts probe 7b so both are drawn to drum 1 in parallel relationship.

In accordance with one feature of the present invention it has been recognized that when each probe is disposed in planes oblique to the normal path of filaments from the feeder to the drum the filaments of curtain 8 are distributed along probes 7 in accordance with the path of least resistance from feeder 2 to drum 1. In the example shown as in figures 5 and 6 where the probes are within planes oblique to the normal path of filaments from the feeder to the drum and from a V-shape collecting area which opens downwardly, the filaments move along probes 7 away from drum 1 so virtually all of the filaments move to a position further away from drum 1 than if they did not contact probes 7 as shown in Figures 7a and 7b. Figure 7a represents the pattern of filaments as drawn from feeder 2 and the pattern in which the filaments are drawn to drum 1, if the filaments are not displaced from their normal path. Figure 7b is a schematic illustration showing the pattern the filaments assume if filament collecting means in accordance with the present invention are interposed between the feeder and the rotating drum. It will be noted that, as shown, the width (b) of the curtain is reduced while the depth (a) of the curtain is increased because the filaments move along the probes. The present invention recognizes that because of the angular position of the probes within a plane oblique to the normal path of the filaments and because each filament moves to a position of least resistance, the separation of filaments in a direction transverse to the longitudinal axis of drum 1 is increased, while the separation between filaments in a direction parallel to the longitudinal axis of the drum is decreased as shown in Figures 7a and 7b. Furthermore, in accordance with the present invention, it has been recognized that the separation between the filaments is affected by the angle between the probes the normal path of the filaments from the feeder to the rotating drum. For example, if probes 7 were disposed at right angles to the normal path of travel of the filaments a number of the filaments would travel directly to the point where the probes cross, and thus would be grouped. It has been found that by disposing the probes at angles less than a right angle to the normal path from the feeder to the collector the separation between the filaments in a plane transverse to

the longitudinal axis of the drum is increased and the opening between the probes can be decreased to decrease the separation between filaments in a direction parallel to the axis to narrow the width of the filament curtain without gathering filaments at the point where the probes cross.

Figure 4 is an illustration of one modification of the probes and shows probes 28 having grooves 29 so that some of the filaments are selectively collected into multifilament strands 30, even though the probes are disposed at an angle relative to the normal path of the filaments from the feeder to the drum and normally no grouped filaments would be formed. It will be realized that by proper selection of the location of grooves 29 on probes 28, the filament groups can be interposed at any point within the narrowed filament curtain and the remaining filaments are distributed along the probes.

Furthermore, it has been recognized that in addition to narrowing the band of filaments to decrease the waste normally associated with the end reversal area, the apparatus in accordance with the present invention, as shown in the example, provides means to selectively vary the width of the curtain of filaments deposited on the rotating drum during the formation of a filamentous mat to provide unique characteristics not available with present apparatus. For example, a portion of the mat can be formed with a full width filament curtain and other portions of the mat can be formed with selectively narrowed filament curtains so the filaments of certain layers of mat are closer together than the filaments of other layers.

Likewise, without changing the traversing speed of the feeder or the position of the feeder, the width of the curtain of filaments can be selectively narrowed so separated convolutions are wound on the drum.

The method and apparatus of the present invention is not restricted to applications using a traversing feeder and can likewise be used in conjunction with a fixed feeder.

WHAT WE CLAIM IS:—

1. A filament winding apparatus comprising: filament feeder means to feed a curtain of filaments, rotating filament collector means to receive the curtain of filaments from the feeder means, filament guide means, including at least one filament contacting straight edge, disposed between the feeder and the collector so that the or each edge intersects the curtain of filaments such that a portion of the filaments of the filament curtain contact a part of the edge whereby the width, measured parallel to the axis of the collector, of a portion of the filament curtain contacting the or each edge is narrowed and the narrowed curtain of fila-

ments may be supplied to the collector, the guide means being adjustable such that the width of the curtain may be varied.

2. Apparatus according to claim 1 wherein the filament guide means comprises two members, over the edges of which the filaments run.

3. Apparatus according to claim 2 wherein the edges are disposed in crossing configuration to form a V-shaped collecting area so that filaments of the curtain of filaments contact the members within the V-shaped collecting area to narrow the width of the curtain.

4. Apparatus according to any preceding claim wherein the edges or surfaces have grooves so located that filaments contacting the edges or surfaces are collected in the grooves to form multifilament groups to be supplied to the collector.

5. Apparatus according to any preceding claim wherein guide means comprise a filament contacting member or members which is or are rotatable.

6. Apparatus according to any preceding claim wherein means are included for reciprocating the feeder parallel to the axis of the collector.

7. Apparatus according to claim 6 in which the guide means traverse the collector with the feeder.

8. Apparatus according to claim 5 or claim 6 wherein the member or members are pivotable.

9. Apparatus according to any preceding claim wherein the filament guide means comprise filament contacting edges downwardly directed at their intersection with the filament curtain.

10. A method for controlling the distribution of filaments in a curtain of filaments being fed to a rotating collector wherein filament guide means including at least one filament contacting straight edge, disposed between the filament feeder and the collector, so that the or each edge intersects the curtain of filaments such that at least a portion of the filaments of the filament curtain contact a part of the edge whereby the width, measured parallel to the axis of the collector, of the portion of the filament curtain contacting the or each edge, is narrowed, and the narrowed curtain of filaments may be supplied to the collector, the guide means being adjustable such that the width of the curtain may be varied.

11. A method for making a filamentous mat comprising feeding filament from a filament feeder to a cylindrical drum, reciprocating the feeder axially along a down-turning edge of the drum a multiplicity of times as the feeder moves from one end to the other of the drum, filament guide means including at least one filament contacting straight edge, disposed between the

the longitudinal axis of the drum is increased and the opening between the probes can be decreased to decrease the separation between filaments in a direction parallel to the axis to narrow the width of the filament curtain without gathering filaments at the point where the probes cross.

Figure 4 is an illustration of one modification of the probes and shows probes 28 having grooves 29 so that some of the filaments are selectively collected into multifilament strands 30, even though the probes are disposed at an angle relative to the normal path of the filaments from the feeder to the drum and normally no grouped filaments would be formed. It will be realized that by proper selection of the location of grooves 29 on probes 28, the filament groups can be interposed at any point within the narrowed filament curtain and the remaining filaments are distributed along the probes.

Furthermore, it has been recognized that in addition to narrowing the band of filaments to decrease the waste normally associated with the end reversal area, the apparatus in accordance with the present invention, as shown in the example, provides means to selectively vary the width of the curtain of filaments deposited on the rotating drum during the formation of a filamentous mat to provide unique characteristics not available with present apparatus. For example, a portion of the mat can be formed with a full width filament curtain and other portions of the mat can be formed with selectively narrowed filament curtains so the filaments of certain layers of mat are closer together than the filaments of other layers.

Likewise, without changing the traversing speed of the feeder or the position of the feeder, the width of the curtain of filaments can be selectively narrowed so separated convolutions are wound on the drum.

The method and apparatus of the present invention is not restricted to applications using a traversing feeder and can likewise be used in conjunction with a fixed feeder.

WHAT WE CLAIM IS:—

1. A filament winding apparatus comprising: filament feeder means to feed a curtain of filaments, rotating filament collector means to receive the curtain of filaments from the feeder means, filament guide means, including at least one filament contacting straight edge, disposed between the feeder and the collector so that the or each edge intersects the curtain of filaments such that a portion of the filaments of the filament curtain contact a part of the edge whereby the width, measured parallel to the axis of the collector, of a portion of the filament curtain contacting the or each edge is narrowed and the narrowed curtain of fila-

ments may be supplied to the collector, the guide means being adjustable such that the width of the curtain may be varied.

2. Apparatus according to claim 1 wherein the filament guide means comprises two members, over the edges of which the filaments run.

3. Apparatus according to claim 2 wherein the edges are disposed in crossing configuration to form a V-shaped collecting area so that filaments of the curtain of filaments contact the members within the V-shaped collecting area to narrow the width of the curtain.

4. Apparatus according to any preceding claim wherein the edges or surfaces have grooves so located that filaments contacting the edges or surfaces are collected in the grooves to form multifilament groups to be supplied to the collector.

5. Apparatus according to any preceding claim wherein guide means comprise a filament contacting member or members which is or are rotatable.

6. Apparatus according to any preceding claim wherein means are included for reciprocating the feeder parallel to the axis of the collector.

7. Apparatus according to claim 6 in which the guide means traverse the collector with the feeder.

8. Apparatus according to claim 5 or claim 6 wherein the member or members are pivotable.

9. Apparatus according to any preceding claim wherein the filament guide means comprise filament contacting edges downwardly directed at their intersection with the filament curtain.

10. A method for controlling the distribution of filaments in a curtain of filaments being fed to a rotating collector wherein filament guide means including at least one filament contacting straight edge, disposed between the filament feeder and the collector, so that the or each edge intersects the curtain of filaments such that at least a portion of the filaments of the filament curtain contact a part of the edge whereby the width, measured parallel to the axis of the collector, of the portion of the filament curtain contacting the or each edge, is narrowed, and the narrowed curtain of filaments may be supplied to the collector, the guide means being adjustable such that the width of the curtain may be varied.

11. A method for making a filamentous mat comprising feeding filament from a filament feeder to a cylindrical drum, reciprocating the feeder axially along a down-turning edge of the drum a multiplicity of times as the feeder moves from one end to the other of the drum, filament guide means including at least one filament contacting straight edge, disposed between the



feeder and the collector so that the or each edge intersects the curtain of filaments such that a portion of the filaments of the filament curtain contact a part of the edge
5 whereby the width, measured parallel to the axis of the collector, of a portion of the filament curtain contacting the or each edge is narrowed and the narrowed curtain of filaments may be supplied to the
10 collector; moving the filament guide means in successive reciprocatory traverses in fixed relation with the feeder means; and, slitting the mat so formed axially of the drum and removing the mat.
15 12. Apparatus for controlling the distri-

bution of filaments in a curtain of filaments being fed to a rotating collector substantially as herein described with reference to the accompanying drawings.

13. A method for controlling the distri- 20
bution of filaments in a curtain of filaments being fed to a rotating collector substantially as herein described.

14. A filamentous mat made by the
method of any of claims 10, 11 or 13. 25

For the Applicants:

LLOYD WISE, BOULY & HAIG,
Norman House,
105-109 Strand,
London, WC2R OAE.

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