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METHOD AND APPARATUS FOR MAKING
A CONDENSED FILAMENTOUS MAT

3,092,533

Filed June 25, 1959

2 Sheets-Sheet 1

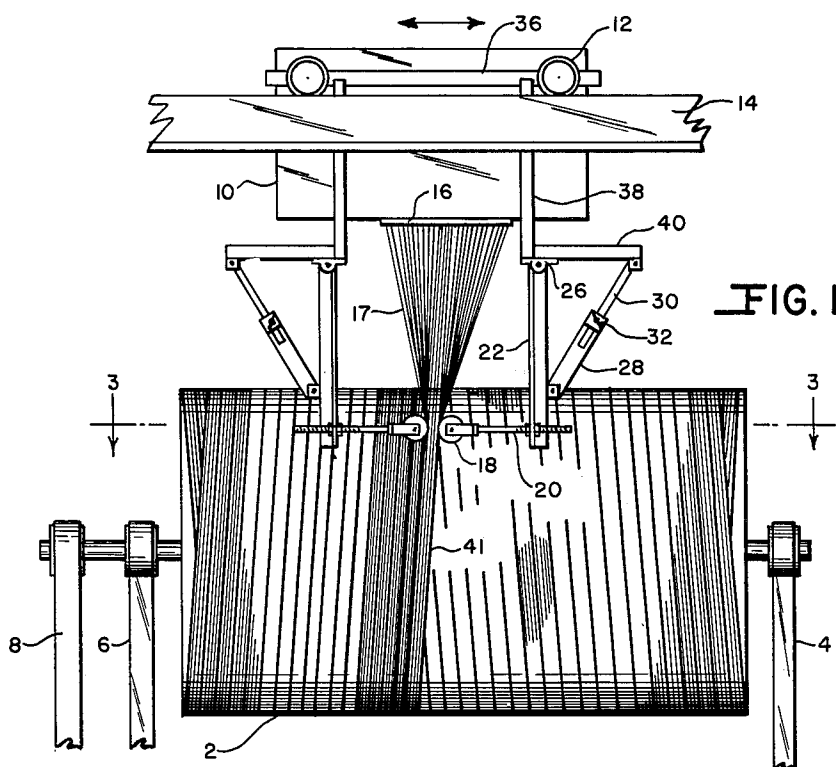


FIG. 1

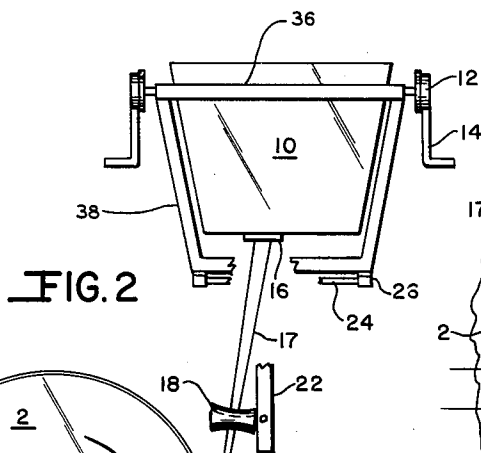


FIG. 2

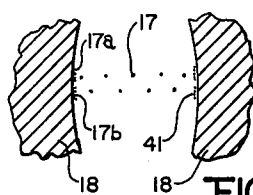


FIG. 3

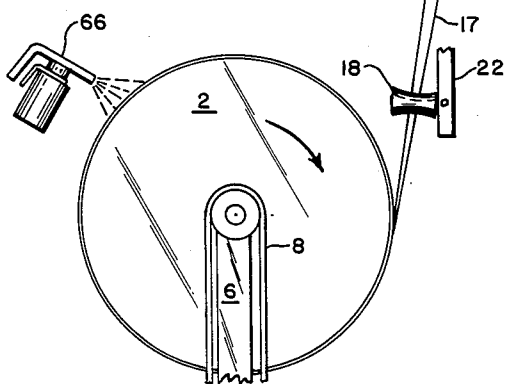


FIG. 4

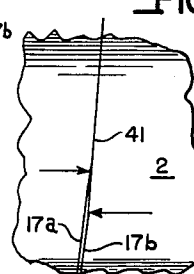


FIG. 5

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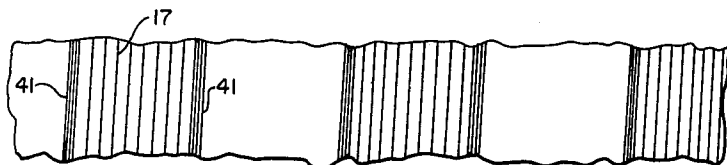


FIG. 6

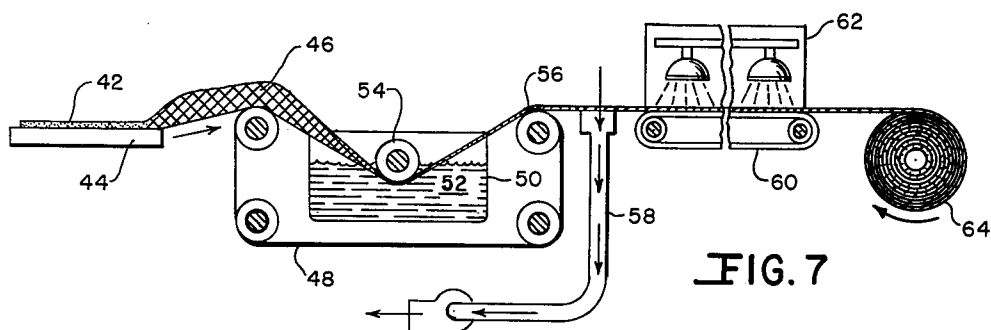


FIG. 7

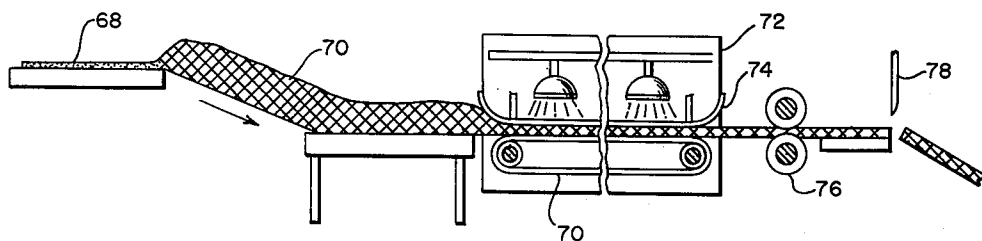


FIG. 8

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METHOD AND APPARATUS FOR MAKING A CONDENSED FILAMENTOUS MAT

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7 Claims. (Cl. 156-167)

This invention relates to a filamentous mat and a
method for making the same.

Jackson U.S. application Serial No. 621,907, filed No-
vember 13, 1956, now Patent No. 3,036,946, discloses
the method of making filamentous mats including the steps
of: reciprocating a glass filament feeder axially along and
between the ends of a drum; rotating the drum a multi-
plicity of times during each traverse of the feeder; feeding
a plurality of individual, or individual and collected,
continuous filaments from the feeder to the drum during
successive traverses to build up or wind a cylindrical con-
densed mat having a corresponding succession of layers,
each layer containing a multiplicity of continuous helical
turns of a single filament, or single and collected filaments;
slitting the cylindrical condensed mat axially to remove it
from the drum and to provide a planar condensed mat;
stretching the condensed mat axially to provide an elongate
web; applying a binder or the like to and compressing the
thickness of the elongate web to provide an elongate flat
web; and treating the flat web to set the binder and form
the finished mat material.

The noted Jackson application teaches that a plurality
of glass furnaces may be utilized, one furnace being ar-
ranged to traverse the drum back and forth between the
ends while the additional furnaces are stationary. The
filaments drawn from the traversing furnace may be
gathered or collected in part or in whole and fed by way
of a gathering wheel and a succeeding discharge wheel
onto the spinning drum in the form of a strand of gathered
filaments, while the non-gathered individual filaments
may be fed directly onto the drum as separate and discrete
filaments. The filaments discharged from the stationary
furnaces, which are spaced from and out of the traversing
path of the moving furnace, are formed into a strand on
gathering wheels and then are fed onto the drum by way
of discharge wheels arranged to traverse the drum simul-
taneously with the traversing furnace.

A finished mat so made has a high glass density and
certain other desirable characteristics and properties.
However, for some applications it has shortcomings. For
example, while the random distribution of collected cords
imparts a distinctively decorative or ornamental quality to
the mat as a whole, numerous areas of the mat have only
individual filaments lying thereacross; thereby presenting
an appearance of non-uniformity of glass distribution
throughout the finished mat. These areas of the mat are
sometimes characterized as voids. One disadvantage of
such voids is that the binder applied during the stretching
and curing of the mat causes the voids to wet out and show
up as low glass density areas. Another characteristic con-
sidered to be objectionable by some is that the collected
cords on or adjacent the surface of the mat give the mat a
somewhat bumpy or uneven surface.

In addition to shortcomings of the mat itself, the
method of fabricating the mat gives rise to certain diffi-
culties encountered during spinning of the mat. These
difficulties stem from so-called break-outs or breaking of
the fibers as they are discharged from the furnaces. Each
fiber which breaks as it is being drawn from the furnace
must ultimately be replaced on the spinning drum. If
a sufficiently large quantity of fibers from any one furnace
break, it is necessary that the traversing furnace and the
traversing carriage carrying the discharge wheels be

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parked at one end of the drum, the speed of the drum be
reduced and then, all of the fibers discharging from the
"broken out" furnace must be manually grasped and fed
around the peripheries of a collecting wheel and a dis-
charge wheel before being flung back on the drum. In
addition to this operation requiring considerable skill and
being quite time consuming for the operator, the glass
production from the properly discharging furnaces is lost.

An object of the present invention is to overcome some
of the foregoing disadvantages and to provide a mat which
is superior in certain characteristics, such as uniformity in
appearance and glass density distribution, to the prior art
mats.

In brief, my invention contemplates a method of mak-
ing a filamentous mat including steps in which a portion
of the filaments drawn from the traversing glass furnace
are concentrated, between the furnace and the drum, into
a substantially planar or ribbon-like group of very closely
spaced filaments, and feeding this group to the drum as
individual filaments lying closely together relative to the
filaments which are fed directly from the furnace to the
drum.

One embodiment of my invention is illustrated by way
of example in the accompanying drawing wherein:

FIGURE 1 is a somewhat diagrammatic front eleva-
tional view of a winding apparatus shown winding a cy-
lindrical condensed mat in accordance with the principles
of this invention;

FIGURE 2 is a partly broken end elevational view of
FIGURE 1;

FIGURE 3 is a fragmentary, horizontal sectional view
taken on the line 3-3 of FIGURE 1;

FIGURE 4 is a diagrammatic end view illustrating the
spacing between the points of tangency of several fila-
ments being drawn onto the drum in generally converging
relationship;

FIGURE 5 is a fragmentary front diagrammatic view
illustrating the axial spacing on the drum of the two fila-
ments of FIGURE 4;

FIGURE 6 is a representation of a fragmentary segment
of a single layer of condensed mat laid on the drum in a
particular fashion corresponding to a particular setting
of the apparatus;

FIGURE 7 is a diagrammatic side elevational view of
apparatus for stretching a condensed mat to form an
elongated web, for applying a binder to and flattening the
elongated web, and for treating the elongated web to set
the binder; and

FIGURE 8 is a diagrammatic side elevational view of
apparatus for stretching a condensed mat containing a
previously applied binder to form an elongated web, and
for further processing the elongated web to provide a
product of particular character.

Those parts of the apparatus for winding a condensed
filamentous mat which are disclosed in Jackson U.S.
Patent 2,798,531 and which are shown in FIGURES 1
and 2 include: a drum 2 having opposite end shafts jour-
naled for rotation in bearing supports 4 and 6; drum
driving means comprising a belt 8 driven by a suitable
power source (not shown) and driving a pulley keyed to
a shaft of the drum; a glass furnace 10 supported for
reciprocation in a path above and between the ends of the
drum on rollers 12 riding on spaced rails 14; a suitable
driving means (not shown) for driving the glass furnace
10 in its drum traversing movement; and a number of
spinnerets in the furnace orifice plate 16 and through
which a corresponding number of individual glass fila-
ments 17 are discharged from the furnace.

For practicing the present invention, additional appa-
ratus is provided. This additional apparatus includes
one or more spool-like elements disposed between the
furnace and drum, the spools having their axes generally

horizontal and perpendicular to the axis of the drum 2. The spools are supported in a manner permitting them to be swung outwardly to one position wherein the spools do not interfere with any of the filaments passing directly from the furnace to the drum, or swung inwardly therefrom to other positions wherein some of the filaments pass over a portion of the circumference of the spools in their passage from the furnace to the drum.

As shown in FIGURE 1 (which includes a numerical identification of the right side spool and spool support components only) the spools 18 are rotatably mounted on spindles carried by horizontal members 20 which are secured to the lower ends of vertical bars 22. The vertical bars 22 are in turn fixed at their upper ends to shafts 24 (FIG. 2) which are rotatably journaled at opposite ends in pillow blocks 26. The vertical bars 22 are held in a selected position by diagonally extending bracing and adjusting arms which include straps 28 pivotally secured at one end to the vertical bars 22 and having cylindrically formed opposite ends to receive the lower ends of rods 30. The upper ends of rods 30 are pivotally secured and a wing nut 32 is provided at the telescopic connection of the strap and rod to afford a simple release and securement mechanism.

The pillow blocks 26 are secured to the bottom framing elements of an open-work frame forming a cradle-like structure. This cradle includes an upper rectangular horizontal frame 36 to which the wheels 12 are secured, a pair of U-shaped members 38 secured at their upper ends to frame 36 and vertically depending therefrom, and a pair of outwardly directed horizontal members 40 providing a fixed securement point for the pivotally attached upper ends of rods 30.

The furnace 10 is nested within this cradle and is supported therefrom through the medium of a furnace weighing scale or balance (not shown).

In practicing the method with the described embodiment, the furnace, cradle and spool assembly (which form a unitary assembly) are reciprocated back and forth as indicated by the double-headed arrow of FIGURE 1, while the drum 2 is rotated a multiplicity of times during each traverse of the furnace. As illustrated in FIGURE 1, a central and minor portion of the filaments 17 discharged or fed from the furnace are fed directly onto the rotating drum while the axially outer filament portions are collected into two substantially planar or ribbon-like filament groups 41 by the opposed spools. In other words, each opposed spool 18 is adjustably positioned to displace or deflect a desired number of the outer or furnace end filaments axially inwardly to prevent their direct passage from furnace to drum. These displaced filaments are concentrated into pairs of opposed ribbons 41 which are fed to the point of contact with the drum in this ribbon form, as shown in FIGURE 6.

If a substantial number of filaments break out during the spinning process, one or both spools may be adjusted relative to the descending filaments, to an outer position so that the broken fibers may be grasped and replaced on the spinning drum. The spools may then be readjusted to their original position. This operation can be carried out with a negligible loss of production.

FIGURE 3 is intended to diagrammatically illustrate in somewhat exaggerated detail the relative disposition of the filaments as they pass downwardly through a generally horizontal plane intersecting the axes of the opposed spools 18. If, in a spinning operation, a furnace orifice plate 16 having two rows of spinnerets with each row containing 51 spinnerets is used, and the opposed spools 18 are spaced approximately 1 inch apart, then, about 7 to 9 central portion filaments 17 will be drawn directly onto the drum while the remaining 93 to 95 displaced filaments will arrange themselves in ribbon-like form and in relatively closely spaced relationship as they pass over a portion of the spool circumference. It will be understood that about half of the 93 to 95 dis-

placed filaments will contact one spool while the other half will contact the opposed spool. The illustrated slightly concave spool surface is preferable to a straight spool surface to prevent straying of individual filaments forming the ribbons 41 towards the ends of the spool.

The central portion filaments 17 and the filament ribbons 41 are simultaneously fed onto the periphery of the rotating drum 2 to build up a cylindrical condensed mat composed of a succession of layers formed during corresponding successive traverses of the furnace from one end reversal area of the drum through a central area to the opposite end reversal area of the drum.

It will be apparent that as the furnace traverses the drum in one direction and then the opposite direction, the filaments will be laid on the drum in helical turns having an angular disposition in first one direction and then an angular disposition in the opposite direction.

At this time it should be noted that since the orifice plate 16 contains several spaced rows of spinnerets, any descending filament spaced forwardly from any other descending filament will have a lower point of tangency or contact with the drum. This is illustrated in FIGURE 4 wherein 17a and 17b indicate a rearward and a forward filament respectively of ribbon 41. The upper arrow indicates the point of tangency of filament 17a on the drum, while the lower arrow indicates the point of tangency of filament 17b on the drum. It is this difference in points of tangency coupled with drum rotation and furnace traversal which results in the filament ribbon 41 being laid onto the drum in the form of individual, closely spaced filaments instead of a somewhat unitary group or strand or cord of collected filaments. This close spacing in an axial direction is accomplished as illustrated in FIGURE 5 wherein the upper and lower arrows correspond to the points of tangency of the filaments 17a and 17b of FIGURE 4. Since the upper end of ribbon 41 (containing filaments 17a and 17b) of FIGURE 5, is moving to the right as the surface of the drum 2 is moving downwardly, the ribbon 41 is, in effect, twisted 90° and deposited on the drum surface as individual closely spaced filaments.

The precise form and character of the finished mat fabricated in the manner described will be dependent, in part, upon controllable operating factors such as the speed of the furnace relative to the drum rotational speed, the particular spacing of the opposed spools, the particular orifice plate used, the processing of the condensed mat after its formation on the drum, and other factors.

To the end of describing the possibility of varying the character of different mats or webs which may be formed by practicing the subject inventive method, certain particulars of operating technique for forming different finished products will be outlined briefly.

In fabricating one type of mat of a character having utility for reinforcing purposes and imparting a decorative quality to a plastic sheet material into which the mat is integrally bonded, the drum may be rotated at a rate of approximately 32.5 revolutions of the drum per single traverse of the furnace in one direction. With this particular speed ratio, and with the spacing of the spools adjusted to approximately 1 inch between the spool surfaces, a single layer configuration of condensed mat similar to the illustration of FIGURE 6 will be formed. This figure is intended to illustrate a fragmentary horizontal segment of a single layer of mat with successive bands of filaments being formed during successive revolutions of the drum. Each band includes a pair of border-like ribbons, which are designated 41 since they are constituted of the same filaments forming the ribbons 41 of previous figures, and a number of individual relatively widely spaced filaments 17. If the drum speed is increased relative to the furnace traversing speed, the bands as a whole will be more closely spaced. Also, if the spools are spaced apart to increase the overall width of the bands, the bands of filaments can be laid on the drum

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in closely adjacent relationship (as illustrated on the drum in FIG. 1), or in overlapping relationship. For example, if the previously noted relationship of 32.5 drum revolutions per traverse in one direction is maintained, a spool spacing exceeding approximately 2" between spools would provide some degree of overlap.

When the subject method is being used to produce a so-called flat mat of the reinforcing or decorative type, the filaments are collected onto the drum in a dry state. That is, no lubricant or binder is applied to the filaments during the spinning process. After a desired thickness of cylindrical condensed mat is formed on the drum, the mat is removed by slitting it axially and laying it flat to provide a planar condensed mat.

The planar condensed mat is further processed by stretching or elongating it axially to form an elongate and expanded thickness web, compressed in thickness to form an elongate flat web, treated with a binder, treated to remove the excess binder, and then treated to set the binder and form the web of finished filamentous flat mat material. FIGURE 7 illustrates these steps and shows the planar condensed mat 42 supported on a table 44 and being axially stretched to form an elongate expanded thickness web 46. The expanded web 46 is received on the endless conveyor 48 mounted on suitable rollers, which convey it downwardly into a receptacle 50 of binder liquid 52. A flattening roller 54 is spaced above the conveyor 48 and compresses the expanded web 46 as the web moves through the binder liquid to form an elongate flat web 56. As the elongate flat web 56 leaves the conveyor, it passes over a suction slot device 58 where excess binder liquid is removed. The flat web then is received by a second conveyor 60 which carries it through a heat treating oven 62 to set or harden the binder. After the binder is set the web of finished flat mat material is then wound into a suitable roll 64 for later use.

The present inventive method is also applied advantageously to the production of a semi-stiff web suitable for use as a self-supporting air filter. To this end, a suitable binder applicator 66 (FIGURE 2) is utilized to spray binder onto the drum as the filaments are being spun thereon, an orifice plate 16 having spinnerets of relatively larger diameter is used, and the ratio of drum speed to furnace travel speed is increased to provide a closer spacing between the bands composed of the relatively widely spaced central filaments 17 and the border or ribbon forming filaments 41. The condensed cylindrical mat thus formed on the drum is slit axially, removed from the drum to provide the planar condensed mat 68 of FIGURE 8. The planar mat 68 is stretched axially to form an elongate expanded web 70 having a thickness appreciably greater than the desired final thickness.

The expanded web 68 is received upon slowly moving conveyor 70 which carries it through a heat treating oven 72 to cure and harden the binder material. Suitable compression means, such as adjustable pressure plate 74, is provided to compress the expanded web 68 to a predetermined desired thickness coincidentally with the curing of the binder material during the passage of the web through the oven. Upon being discharged from the oven, the cured filamentous mat of the desired thickness may then be conveniently edge trimmed and cut to width by suitable slitting apparatus 76 and subsequently severed into sections of predetermined length by a guillotine type cutter 78.

It is noted that the traversing speed of the furnace and other traversing elements may be varied in a cyclically repetitive pattern between maximum and minimum values, one or more times, during each traverse, as disclosed in Jackson U.S. Patent 2,798,531.

It has been observed that by opening the spacing between the spools 18 and thereby increasing the number of filaments spun in relatively widely spaced relationship, the bulkiness of the finished mat for a given weight of glass is increased. This relationship may be used to

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advantage in determining the spacing to be used between spools for obtaining a desired final mat or web.

The invention claimed is:

1. The method of making a filamentous mat, comprising: transversely reciprocating a furnace, from which separate glass filaments are discharged, axially back and forth along a drum; rotating the drum a multiplicity of times during each traverse of said furnace; gathering a first portion of said filaments, in a zone intermediate said furnace and said drum, into at least one substantially flat ribbon of separate filaments lying closely together relative to the spacing of the remaining portion of said filaments as they are discharged from said furnace; feeding said first portion of closely spaced filaments onto said drum in relatively closely spaced ribbon form; and simultaneously feeding the remaining portion of filaments directly from said furnace onto said drum adjacent said first portion of closely spaced filaments in relatively widely spaced form approximately equalling the spacing between individual filaments discharged from said furnace; axially slitting the cylindrical filamentous mat so formed on said drum and removing it therefrom to form a planar mat; and stretching said planar mat in a direction transverse to the general lay of the said filaments.

2. The method of making a filamentous mat, comprising: transversely reciprocating a furnace, from which separate glass filaments are discharged, axially back and forth along a drum; rotating the drum a multiplicity of times during each traverse of said furnace; gathering a first portion of said filaments, in a zone intermediate said furnace and said drum, into a substantially flat ribbon of separate filaments lying closely together relative to the spacing of the remaining portion of said filaments as they are discharged from said furnace; feeding said ribbon from said zone, and the remaining portion of filaments discharged from said furnace, onto said drum to form a cylindrical mat of overlying layers, each of which contains a multiplicity of helical turns having both relatively closely spaced and relatively widely spaced filaments; axially slitting said cylindrical mat and removing it from said drum to form a planar mat; and stretching said planar mat in a direction transverse to the general lay of said filaments.

3. The method of making a filamentous mat, comprising: transversely reciprocating a multi-row filament furnace, from which separate glass filaments are discharged and which has each row extending in an axial direction, axially back and forth along a drum; rotating the drum a multiplicity of times during each traverse of said furnace; selectively displacing a portion of said filaments in an axial direction in a zone directly between said furnace and said drum to form at least one ribbon of filaments spaced closely relative to the spacing of the remaining portion of said filaments as they are discharged from said furnace; feeding said ribbon onto said drum as individual filaments to lay a first helix composed of a multiplicity of helical turns having relatively closely spaced separate filaments; coincidentally feeding at least a part of the remaining portion of said filaments directly from said furnace onto said drum to lay, adjacent said first helix, a second helix composed of a multiplicity of helical turns having relatively widely spaced separate filaments; axially slitting the cylindrical filamentous mat so formed on said drum and removing it therefrom to form a planar mat; and stretching said planar mat in a direction transverse to the general lay of said filaments.

4. The method of claim 3 including the steps of: selectively displacing another portion of filaments in an opposite axial direction to form at least one additional ribbon of filaments spaced closely relative to the filament spacing at said furnace; and feeding said additional ribbon onto said drum as individual filaments to lay a third helix composed of a multiplicity of helical turns having closely spaced separate filaments.

5. The method of claim 3 including the step of cyclically varying the traverse speed of said furnace during each reciprocation thereof.

6. The method of making a filamentous mat, comprising: transversely reciprocating a filament furnace, from which separate glass filaments are discharged, axially back and forth along a drum; rotating the drum a multiplicity of times during each traverse of said furnace; displacing at least a portion of said filaments in a primarily axial direction with a spool to form a ribbon of closely spaced filaments conforming to the shape of said spool; transversely reciprocating said spool axially back and forth along said drum coincidentally with said furnace; feeding said ribbon onto said drum as individual, relatively closely spaced filaments; coincidentally feeding the remaining portion of said filaments directly from said furnace onto said drum in relatively widely spaced relationship; axially slitting the cylindrical filamentous mat so formed on said drum and removing it therefrom to form a planar mat; and stretching said planar mat in a direction transverse to the general lay of said filaments.

7. In apparatus for spinning filamentary material onto a rotating drum, a material melting furnace having a substantially straight-line row of orifices in its base wall through which filaments descend, means for moving said

furnace in a reciprocatory path generally overlying the downturned face of said drum, filament displacing means, depending from said furnace for simultaneous movement therewith and disposed between said furnace and said drum, presenting a filament gathering surface substantially at a right angle to both said row and said filaments, means for selectively positioning said filament displacing means relative to said furnace to displace a portion only of said filaments out of a direct path from said furnace to said drum to form a substantially flat ribbon of closely spaced filaments relative to the spacing of the filaments as they issue from said furnace.

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