Aug. 28, 1962 A. W. SCHAIRBAUM 3,051,602

MULTI-SPEED FURNACE TRAVERSE

Filed Jan. 12, 1959

Fig. 1.

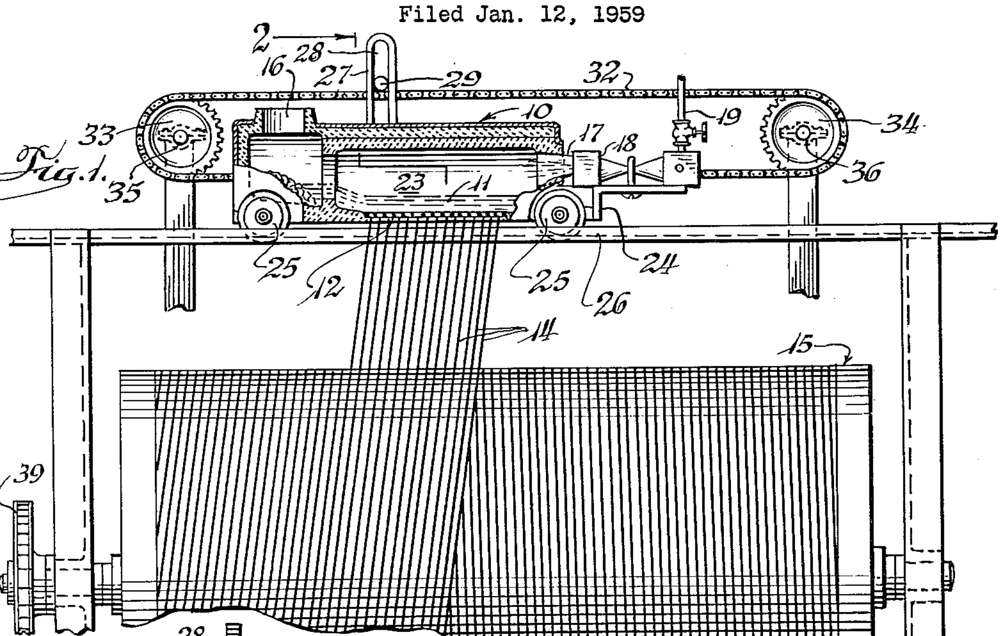


Fig. 2.

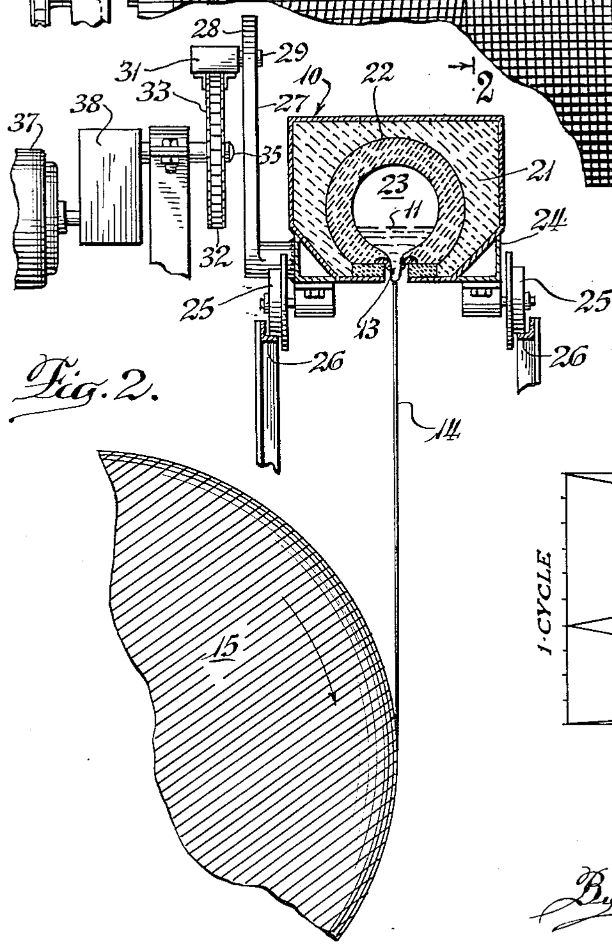
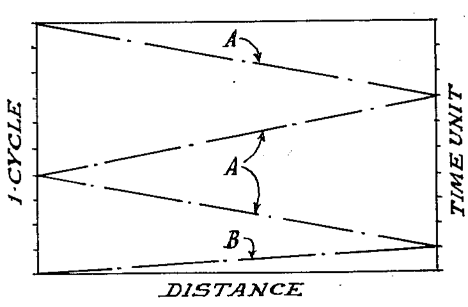


Fig. 3.



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MULTI-SPEED FURNACE TRAVERSE

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9 Claims. (Cl. 154—54)

The present invention relates to a novel apparatus, method and manner of manipulating a glass furnace in which the formed fibers are wound upon and across the length of a rotating drum to form a resulting mat of glass fibers adaptable for use in the production of air filter media and the like.

The present invention comprehends a reciprocating glass furnace having an orifice plate in the bottom thereof provided with multiple openings or apertures through which the molten fiber-forming material is discharged. The molten-fiber-forming material issuing through these openings is attenuated into glass fibers and wound upon a rapidly rotating drum. The furnace is moved back and forth across the length of the drum and in each traverse of the drum forms a layer of spun fibers extending completely across the drum. When sufficient traverses of the furnace have been effected to build up a desired number of layers on the drum to form a desirable mat thickness, this collected mat is slit through and across the drum and removed therefrom as a sheet. Subsequently, the sheet is expanded by pulling it at substantially a right angle to the lay of the collected fibers so that the resulting product is puffed up in thickness, is extremely open in texture compared to its original condensed condition and is greatly expanded in area.

In prior apparatus and methods of producing such a mat, the furnace traverse is either at a continuously uniform rate of travel or constant speed across the drum for each and all layers of the mat, or the speed of travel is varied during each traverse so that the lay angle of the fibers varies in each layer.

It has been determined that the degree of "puff" achieved when the mat is expanded and hence the resulting pattern is very much dependent on the speed of travel of the furnace in the spinning operation. It has also been found that where the furnace is moved at a high speed, it will yield a characteristic fiber pattern while its movement at a low speed will yield a very much different characteristic fiber pattern. It has also been determined that by repeated changing the speed of travel of the furnace between a maximum and minimum speed during each traverse produces yet another and characteristic fiber pattern.

In the present invention, a new, different and improved fiber pattern is accomplished by the novel method and manner of manipulating the furnace in which the furnace is moved back and forth at a predetermined constant speed for a predetermined number of traverses, and then moved back and forth through a predetermined number of traverses at a substantially different but constant speed to form one cycle. These novel cycles are repeated until a sufficient number of layers of the glass fibers are built up on the winding for the purpose intended.

By moving the furnace back and forth through the recited cycles in each of which the furnace makes one or more traverses at a given or predetermined constant but different speed from the preceding and succeeding traverses, the angle of lay of the fibers in one cycle varies between the traverses at different speeds with the movement at the greater speed laying the fibers at a greater angle.

It is, therefore, an important object of the present invention to provide a novel fiber-forming apparatus, method and manner of laying the fibers in one or more traverses at a different lay angle from those in one or more succeeding traverses, such different lay angles being caused by moving the furnace at constant but different speeds.

Another object of the present invention is to provide a novel method and manner of manipulating or moving the furnace through predetermined cycles of travel to produce a novel fiber pattern in the formed mat and resulting in a mat having properties unlike those resulting from the operation of prior apparatus and methods.

Further objects are to provide a construction and method of maximum simplicity and efficiency and such further objects, advantages and capabilities as will later more fully appear and are inherently possessed thereby.

In the drawings:

FIGURE 1 is a fragmentary view, part in side elevation and part in vertical cross section, of the present assembly including the reciprocating furnace and rotatable drum with the furnace being moved axially of the drum through predetermined cycles in each of which the furnace is moved at a constant or uniform speed for one or more traverses followed by movement at another but constant speed for one or more traverses to thereby effect a novel fiber pattern in the resulting mat.

FIG. 2 is a fragmentary enlarged view, part in end elevation and part in vertical cross section, of the assembly, the section being taken on approximately the irregular line 2—2 of FIG. 1 and viewed in the direction of the arrows.

FIG. 3 is a graph showing the winding arrangement and the furnace distance versus time graph for four traverses of the drum or one complete cycle with the cycle comprising three traverses of the furnace travelling at a relatively slow but constant speed throughout each of said traverses, and one traverse at a substantially greater but also constant speed.

Referring to the disclosure in the drawing in which is shown an illustrative embodiment of the present invention, the apparatus includes a furnace **10** containing molten glass **11** and having a plate or base **12** provided with multiple orifices **13** through which the molten glass is discharged and attenuated into glass fibers **14**. The furnace is reciprocated back and forth over a relatively large and rapidly rotating drum **15** on which the formed fibers are collected. Thus for each traverse of the furnace from one to the other end of the drum, a layer of fibers is collected and after a suitable number of traverses to build up a desired mat thickness on the drum, the mat is slit longitudinally of the drum and at substantially a right angle to the collected fibers and removed from the drum as a sheet.

The opposite ends of the removed sheet are trimmed to remove that portion where the furnace has slowed down in reversing its direction of travel, and the trimmed sheet is then expanded by pulling at approximately a right angle to the lay of the fibers to produce a resulting product that is puffed up in thickness, open in texture compared to its original condensed condition and greatly expanded in area.

The furnace **10** is shown provided with a charge hole **16** at one end and at its other or open end **17** provided with a burner **18** supplied with fuel from the supply pipe **19**. The interior of the furnace is preferably provided with a refractory fill **21** about a refractory lining **22** defining a chamber **23** for the molten fiber-forming material **11**.

To reciprocate the furnace back and forth the furnace carriage **24** is provided adjacent its opposite ends and at each side thereof with flanged wheels **25** carrying the furnace upon spaced tracks **26**. On this carriage is affixed an upstanding cam bracket **27** provided with an elongated and vertically disposed cam slot **28** conformably receiving a cam **29** projecting laterally from a block **31** secured to and carried by a roller chain **32**.

The roller chain **32** is carried upon and driven by sprocket wheels **33** and **34** one of which is mounted on a drive shaft **35** and the other upon a driven or stub shaft **36**. Thus the chain **32** and its block **31** and cam **29** reciprocate or move the furnace carriage **24** and the furnace **10** back and forth with the cam retained in the vertical slot **28** and movable vertically therein depending upon the location of the block on the moving chain.

This drive mechanism moves the carriage **24** and the furnace **10** at a constant or uniform rate for each traverse from one to the opposite end of the drum **15**, while the latter is rotated at a relatively high speed to wind up the fibers being spun.

The drive shaft **35** is driven from a motor or other power source **37** through a change-speed mechanism **38** whereby the speed of travel is varied to obtain one or more traverses at one constant or uniform speed and then one or more traverses at another or different constant or uniform speed constituting one cycle. Thus in each successive cycle the fibers of one or more traverses lay at one desired angle and the fibers in the next one or more traverses lay at a different angle, the angle of lay depending upon the speed of travel of the furnace, with drum **16** rotated at a relatively high but continuous uniform speed through succeeding cycles by means of a sprocket and chain at **39** from a motor or other power source.

By way of illustration, the furnace during one cycle is cause to move at the rate of 12 feet per minute for three traverses and then is caused to travel at the rate of 36 feet per minute for one traverse. If this cycle is repeated over and over again until the desired number of layers have been formed to build up a desired thickness of mat, it will be seen that on every fourth traverse a layer of fiber is laid on the drum with the furnace travelling at the rate of 36 feet per minute and the other layers are laid down with the furnace travelling at 12 feet per minute.

With the drum revolving and winding the formed fiber at a constant rotational speed for each and all of the traverses of the furnace, it will be evident that the angle of the fiber laid down on the drum during each traverse will depend upon the speed of travel of the furnace. More specifically, the tangent of this angle is equal to the furnace speed divided by the tangential velocity of the drum with the latter rotating continuously at a constant speed.

Assuming the above-suggested traverse speeds and assuming that the tangential velocity of the drum is 2000 feet per minute, then every fourth traverse during a cycle lays down fibers of a constant angle of lay X, while in the other traverses in said cycle the furnace moving at the slower but also constant speed lays down fibers at an angle of lay Y, wherein:

$$X = \text{arctangent}\,\frac{36}{2000}$$

and

$$Y = \text{arctangent}\,\frac{12}{2000}$$

It has been further determined that the angle at which the fibers are laid on the drum determines the length to which the condensed mat can subsequently be expanded, and the greater the angle of lay the shorter is the expanded length. In the present invention and as set forth above, the angle X being the greater angle will yield fibers tending to make a shorter expanded mat than fibers laid down at the lesser angle Y, and that the fibers laid down at the angle X will determine the actual length of the mat when expanded.

The fibers laid down at the angle Y and capable of making a longer expanded mat but restrained from doing so, will buckle of necessity in order to fit into the shorter length as determined by the fibers from the layers laid

down at the angle X. Thus, in the resulting mat produced as herein disclosed there are layers laid down at the angle X which are stretched to their limit and alternate layers laid down at the angle Y which are forced to buckle. This arrangement of alternate layers of fibers stretched to their limit and the others in which the fibers are forced to buckle produces a unique and novel characteristic pattern.

The above is but illustrative for the invention comprehends a wide choice or combination of furnace speeds and the numbers of layers laid at each speed, so long as the speed for each traverse is maintained constant from one to the other end of the drum. Furthermore it is contemplated by the present invention to change from one combination to another during the course of producing a single mat to obtain a desired characteristic fiber pattern.

It will be evident that when the furnace is travelling in one direction of traverse and at a constant speed of travel, the fibers laid down on the drum will be disposed at an equal angle and spacing except at the extreme ends where the furnace slows down as it reverses its direction of travel. The next traverse of the furnace will be in the opposite direction, and if at the same constant speed the lay of the fibers will be at the same angle and spacing but in the opposite direction, so that the fibers of adjacent layers cross at an acute angle. As each layer is formed by the reversal of travel of the furnace, a suitable binder, such as a thermosetting resin, is applied preferably by spraying onto the formed fibers as they are collected on the drum. The extreme ends of the sheet upon removal of the drum are then trimmed or removed and the sheet expanded in the manner described above.

In FIG. 3 is presented a graph showing the winding arrangement and the furnace distance versus time graph which illustrates one complete cycle comprising four traverses of the furnace in accordance with the above recited example where the cycle consists of three traverses made at a constant speed of 12 feet per minute and one traverse made at a constant speed of 36 feet per minute. The traverses of the furnace at the lesser speed are designated at A while that at the greater speed is designated at B.

From the above description and the example given but which is to be taken as illustrative only, it will be evident that by operating the furnace through alternate cycles in each of which cycles the furnace is moved at a constant speed for one or more traverses and then at a constant but greater speed for one or more traverses, the angle of lay of the fibers at the different speeds of traverse will produce in the resulting expanded product a novel and unique fiber pattern. The characteristic pattern so produced assures an expanded product in which, in the example given, the fibers of every fourth traverse are expanded to their limit and determine the actual length of the expanded product, while the fibers from each of the other traverses, although tending to make a longer mat, are restrained from doing so and buckle into the shorter length.

Having thus disclosed the invention, I claim:

1. The method of forming a sheet composed of multiple layers of fibers comprising the steps of reciprocating a furnace containing molten fiber-forming material axially along and over a rotating drum, discharging the molten material through orifices in the furnace and attenuating the molten material into fibers, collecting the fibers on the drum as the furnace is moved axially of the drum, moving the furnace through a cycle in which the furnace is moved through a first set of one or more traverses substantially from one to the other end of the drum at a first constant speed to lay fibers on the drum at a desired angle of lay and then through another set of one or more traverses substantially from one to the other end of the drum at another constant speed to lay fibers at a different angle of lay than the preceding set, applying a binder to said fibers, repeating said cycle to build up a collected

condensed mat of fibers so laid on the drum to a desired thickness, slitting the mat so formed axially of the drum and removing it as a sheet, and expanding the sheet by pulling it at substantially a right angle to the lay of the fibers.

2. The method of forming a sheet composed of multiple layers of fibers comprising the steps of reciprocating a furnace containing molten fiber-forming material axially along a rotating drum, rotating said drum at a constant speed, discharging the molten material from the reciprocating furnace and attenuating the molten material into fibers, collecting the fibers on the rotating drum as the furnace is moved axially of the drum, reciprocating the furnace axially of the drum through multiple cycles in each of which the furnace is moved through one set of one or more traverses substantially from one to the other end of the drum at a predetermined constant speed to lay fibers on the drum at a desired angle of lay and then through another set of one or more traverses substantially from one to the other end of the drum at a substantially greater constant speed to lay fibers on said drum at a greater angle of lay than the preceding set whereby the angle of lay of the fibers from succeeding sets of traverses varies in accordance with the speed of travel of the furnace back and forth across the drum, applying a binder to said fibers, building up a collected mat of fibers so laid on the drum to a desired thickness, slitting the mat so formed axially of the drum and removing it as a sheet, and expanding the sheet by pulling it at substantially a right angle to the lay of the fibers.

3. The method as in claim 2 and wherein each of said cycles consists of an odd number of traverses at each of said constant speeds.

4. The method of forming a condensed sheet composed of multiple layers of fibers comprising the steps of reciprocating a furnace containing a molten fiber-forming material axially along a rotating drum, discharging the molten material from the furnace and attenuating the molten material into fibers, collecting the fibers on the drum as the furnace is moved axially of the drum, moving said furnace through a cycle which includes a first set of one or more traverses substantially from one to the other end of the rotating drum at a predetermined constant speed of travel to lay fibers on the drum at one angle of lay and a second set of one or more traverses substantially from one end to the other of the drum at another constant speed of travel whereby to lay fibers on the drum at a different angle than the fibers from the preceding set, applying a binder to said fibers, repeating said cycle to build up layers of fibers into a mat of desired thickness in which the angle of lay of fibers from succeeding sets differs, slitting and removing the mat to form a condensed sheet capable of being expanded.

5. The method of forming an expanded sheet, comprising the steps recited in claim 4 and including the step of expanding the sheet by pulling at substantially a right angle to the lay of the fibers, wherein the fibers disposed at the greater angle of lay determine the length to which

the sheet is expanded and the remaining fibers are buckled substantially throughout their length.

6. The method of forming a condensed fibrous mat composed of multiple layers of fibers, comprising the steps of reciprocating a furnace containing molten fiber-forming material axially along a continuously rotating drum, discharging the molten material through orifices in the furnace and attenuating the discharged molten material into fibers, collecting the fibers on the drum as the furnace is moved axially of the drum, moving the furnace in a cycle consisting of a set of one or more traverses substantially from one end to the other of the drum at a constant and uniform speed to build up a layer of fibers for each traverse and another set of one or more traverses substantially from one to the other end of the drum at another constant and uniform speed to build up a layer of fibers for each such traverse but at a different angle of lay than the fibers from the preceding set, applying a binder to said fibers, and moving the furnace back and forth along the drum through repeated cycles until sufficient layers of the fibers are collected on the drum to form a condensed mat of the desired thickness.

7. A condensed, filamentous, sheet-like mat of the type normally produced by winding fibers upon a drum and applying a binder material to form a cylindrical mat, slitting the mat axially to remove it from the drum and trimming it longitudinally to remove its axial end areas comprising: a series of overlying sets of layers or fibers, each layer being substantially coextensive with said mat and consisting of parallel fibers disposed at one angle to the longitudinal axis of the mat, each set consisting of one or more layers of fibers, the fibers within each set of layers disposed at equal angles to the longitudinal axis of the mat, the fibers of each successive set of layers disposed at a different angle to the longitudinal axis of the mat than the preceding set, the angular disposition of said sets of layers of fibers varying in a repetitive sequence through said series.

8. A condensed, filamentous, sheet-like mat as in claim 7 and wherein successive layers are disposed at opposite angles to the longitudinal axis of the mat, alternate sets of layers being disposed at the same angle to the longitudinal axis of the mat, and wherein alternate sets each comprise a plurality of layers.

9. A filamentous, sheet-like mat as in claim 8 and wherein the mat has been expanded substantially transversely of said longitudinal axis of said mat and the fibers of alternate sets of layers are buckled substantially throughout their length.

References Cited in the file of this patent

UNITED STATES PATENTS

2,135,072	Forster	Nov. 1, 1938
2,546,230	Modigliani	Mar. 27, 1951
2,664,375	Slayter	Dec. 29, 1953
2,798,531	Jackson	July 9, 1957

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,051,602 August 28, 1962

Albert W. Schairbaum

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 10, after "efficiency" insert a comma; column 3, line 28, for "cause" read -- caused --; column 6, line 29, for "or" read -- of --.

Signed and sealed this 11th day of December 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents