PROCESS AND APPARATUS FOR MAKING GLASS FIBER STRUCTURES
INCLUDING COATING BEFORE AND AFTER ATTENUATION

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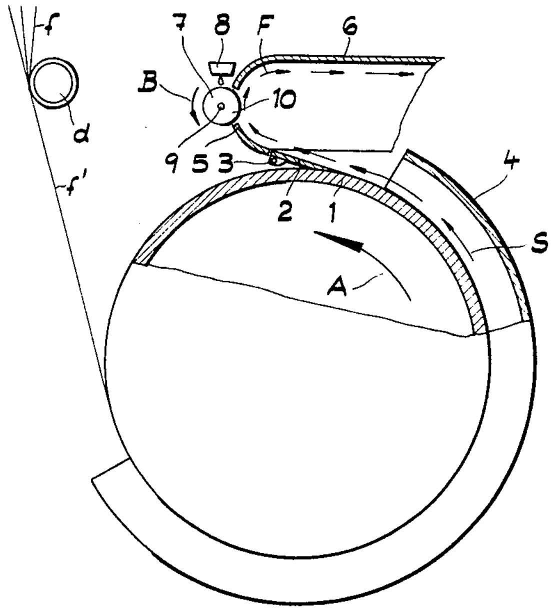
FIG.1



INVENTORS
Wolfgang Schuller
Harald Holzfeder
BY
Michael J. Striker
Atty

FIG. 2

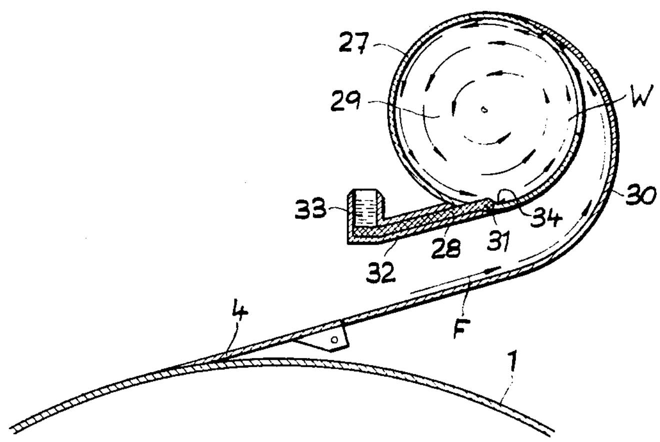
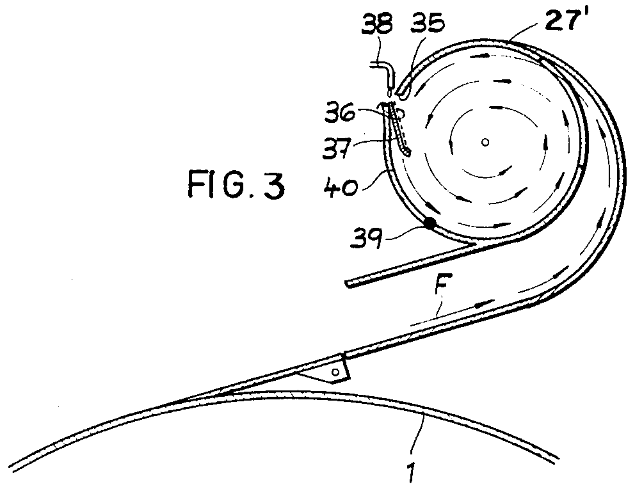


FIG. 3



INVENTORS
Wolfgang Schuller
Harald Holzfeld

BY

Michael S. Striker

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PROCESS AND APPARATUS FOR MAKING GLASS FIBER STRUCTURES INCLUDING COATING BEFORE AND AFTER ATTENUATION

Wolfgang Schuller, Wertheim am Main, and Harald Hohlfeld, Wertheim (Nord), Germany, assignors to Werner Hugo Wilhelm Schuller, Munich, Grunwald, Germany

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ABSTRACT OF THE DISCLOSURE

In making glass fiber structures, the strands of glass are first coated with a liquid, for instance a lubricant, prior to their delivery to the drawing drum, and the glass fibers formed on the drawing drum are then coated in a separate application, while separated from each other, with a liquid coating medium after their removal from the drawing drum and prior to their consolidation into a glass fiber structure.

An apparatus for carrying out the second coating application includes an air channel leading away from the drawing drum and liquid transfer means protruding into the air channel so as to be contacted by the glass fibers carried through said air channel in a stream of air.

BACKGROUND OF THE INVENTION

Glass fiber structures are usually made by first forming filaments of glass in a continuous process from streams of liquid or softened glass by means of a drawing drum rotating at high speed. Before a complete revolution of the drum is effected with the filaments of glass laying side by side on it, they are lifted from the drum by a scraper or stripper and at that time split up into staple fibers of uneven length. The thus-formed fibers are then suspended in a stream of air, are conducted along guide walls and finally, after elimination of the air, consolidated to the fibrous structure desired as end product at a place remote from the drawing drum. The final product may for instance be a plane fibrous structure such as a mat or fleece or it may be a ribbon-shaped structure such as a sliver or a yarn, or it may also be a three-dimensional body such as tube sections (see German Pats. 824,456 and 976,782).

Both the filaments and the subsequent fibers must be coated with a liquid medium in order to effect the taking with or driving of the filaments by the drum and in order also to form the final body from the fibers. The filaments are usually coated on the way from the spinning place to the place where they first touch the drawing drum. The conventional device for this purpose is a pad which extends across the width of the moving filaments or across the width of the drawing drum and consists of an absorptive material.

This pad is placed in a manner that the sidewise aligned filaments will contact it if possible under tension. The pad is soaked with the liquid to be coated. The pad can also consist of a cloth supported on a rod and may be supplied with fresh liquid by a dropping device in accordance with the amount of use. For the practical execution of these devices it is not easy to transfer the liquid from the pad to the filaments which are drawn off at a high speed, that is above 2,900 m./min. There have been many proposals for devices of this kind. The one most successful is that published in Austrian Pat. 218,191.

The coating of the filaments taken by the drum with a liquid which in industrial practice is called "oiling" has a

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triple function. One purpose is to impart to the filaments an adhesion to the surface of the drawing drum during the high speed revolution, which adhesion must be sufficient to prevent slippage between the single filament and the drum surface. The coating should in addition make the individual glass filaments supple and flexible to prevent abrasion or other mechanical damage during the further processing. The glass fibers or staple fibers which are formed from the glass filaments in the subsequent processing and are consolidated to the glass fiber structure, for instance a sliver or a fleece, must in addition obtain a certain tensile strength which is secured by the cohesion or adhesion between the fibers.

Apart from these various purposes of the coating, liquid coating material may also be used for other reasons, for instance in order to dye the glass fiber structures.

The coating medium, mostly of the emulsion type consists of different organic or inorganic oils and additives which stabilize the emulsion, increase the flexibility of the filaments drawn, and have an adhesive, hardening and antistatic effect. Whereas flexibility is a feature which mainly concerns the drawing of the filaments by the drum and their taking-off therefrom, the adhesive nature of the coating medium is a property, which brings disadvantages for the drawing drum and the stripper insofar as their surfaces get sticky and dirty therefrom.

In practical use, it is difficult to perform all these three functions, the difficulties arising both as to the composition and as to the dosage of the coating material such as lubricant. Usually it was therefore necessary to make a compromise between the various requirements, that is to form a multicomponent liquid which would accomplish the various purposes. It should thus provide for adhesion of the filaments on the drum periphery; it should protect the drum surface; and it should improve the working of the stripper member on the drum. Finally, it should increase the cohesion of the fibers made from the filaments in the fibrous structure. This was quite difficult since the various components of the liquid had to be intermiscible and, in addition, it was desirable that they should take effect in sequence one after the other. Sometimes it was even necessary to add dyes or other coating materials.

The dosage regarding the application of specific amounts of coating materials in a specific period of time of application was quite difficult because the various components could not be applied very often in the sequence of time. On the one hand, only as much coating liquid should be applied as is necessary to improve the taking of the fibers by the drum. On the other hand, it is desirable to provide individual fibers formed on the drum after removal therefrom, with sufficient coating material to improve their abrasion and the cohesion of the fibers in the fibrous structure. An overdose is harmful because the filaments, on their way along the periphery of the drum during the attenuation, and in their travel up to the stripper, have a tendency to lose part of the liquid such as a lubricant and deposit the liquid on the drum surface. The lubricant which then sticks to the drum surface has a tendency to soil the surface and it also decomposes because of the continuous friction between the stripper and the drum. As a result, residues are formed on the drum and on the stripper which interfere with the further drawing of the fibers by the drum and the splitting of the filaments to individual fibers. The residues which are finely divided and mixed with minute parts of the filaments themselves form a kind of emery paste which is harmful to the surface of the drum and makes it progressively less suited for further formation of fibers.

The problem, thus, is either to spare the surface of the drum by too low an amount of coating liquid and, in that case, to provide for too small a dose of liquid for the fibers to improve their cohesion, or on the other hand, to use an overdose which will result in the necessity to discontinue the production from time to time to clean the drum surface and the stripper.

Too low or too large an amount has also an undesirable effect on the spinning process itself, that is on the formation of the filaments on the spinning cones at the heated end section of glass rods or under the spinning nipples of the trough or channel which contains the liquid glass. The attenuation and drawing on the drum is also affected thereby. Whenever the filaments received on the drum have too little coating liquid, they will not adhere sufficiently to the drum surface and will then be drawn with uneven thicknesses because of the slippage. This again results in deviations of the diameter of the filaments and causes the jerky drawing of the filaments by the drum which thus may be subject to tearing or if the taking off is interrupted for just a brief instant, may be subject to burning away during taking-off.

The soiling of the drum surface and of the stripper has also a bad effect on the spinning process since the filaments will be liable to more or less "float" on the drum surface which again results in an uneven thickness of the filaments or fibers.

An adequate and sufficiently distributed lubricant is mainly indispensable in the manufacture of glass fiber-slivers with respect to the uniformity and the tensile strength of such a silver and the yarn eventually twisted from the sliver. The uneven amount of lubricant in particular results in an uneven strength which again causes uneven tensioning in the further processing and thus a yarn of uneven properties. In the conventional devices, it was usually up to the crew which operated the machine to provide the coating device with more or less lubricant or other coating liquid. Usually considerable and sometimes unacceptable variations occurred, such as a variation between 0.2 and 0.8% of lubricant. It must be borne in mind in this connection that the crew of course was, in the first place, interested in providing for smooth operation of the drum and the stripper, and in particular to avoid visible soiling of the drum surface. Therefore, even in those cases where the fibrous structure would have required a higher amount of lubricant the crew usually tried to get along with a smaller amount in order to make sure that the operation would not be interrupted. The defects in the fibrous structure were not as apparent immediately to the crew as any soiling of the drum.

A solution to all these problems appeared at first in a process where a lubricant which provided for only weak adhesion between the fibers was applied only after formation of the fibrous structure. This, however, was undesirable since in this case the fibers that were in the fibrous body structure at a greater distance from the coating device, which for instance might be a spraying device, would not receive a sufficient amount of lubricant, since the whole procedure was a surface application only. This is particularly apparent in case of the formation of a staple fiber ribbon or sliver. It was found in practical use that it was impossible to penetrate into the core of the sliver with the lubricant. This again affected the tensile strength of the sliver and was quite harmful in view of the subsequent winding operation which required several turns for the sliver and it also showed up in the subsequent treatment to a yarn.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide for a coating process for glass fibers wherein an adequate and evenly distributed amount of lubricant or other coating liquid is placed as well to the filaments as to fibers generating from the filaments.

Another purpose is a process of this kind wherein a soiling of the drum surface or stripper is avoided.

Another object of the invention is a coating process and apparatus for it wherein fibers of even thickness and

uniform properties can be produced, and in particular where in case of fibrous structures the fibers in the interior of the structures have the same properties as at the surface.

These various objects are met by an improvement in the process of making glass fiber structures wherein liquid coated glass filaments are passed to a drawing drum where they are attenuated and separated into individual glass fibers which are then consolidated to glass fiber structures, the improvement comprising the steps of applying coated liquid in separate applications, first by coating the filaments prior to their delivery to the drawing drum and then by coating the fibers after their formation on said drum and prior to their consolidation into glass fiber structures.

The invention also embraces an apparatus for applying a liquid coating medium to glass fibers, the apparatus comprising a drawing drum for attenuating the glass filaments to individual glass fibers, guide walls forming an air channel of a width extending substantially across all of the periphery of the said drum and of a general axial direction tangentially away from the periphery of the drum, means for generating a stream of air in said channel for carrying the fibers away from said drum, and liquid-transfer means projecting into the said channels so as to protrude into the paths of the fibers carried by said stream of air.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 illustrates in a partial cross-section and on a reduced scale an apparatus for making a flat fiber body such as a fleece or a mat;

FIG. 2 is a partial vertical section through another embodiment of the invention, the apparatus of this figure being useful particularly for making a ribbon-shaped fiber structure; and

FIG. 3 a partial vertical section through another embodiment of the invention showing this embodiment in a partial view in the same manner as in FIG. 2.

DESCRIPTION OF PREFERRED EMBODIMENTS

As has been stated, the process of the invention is characterized by the fact that the coating of the filaments being continuously drawn on the one hand, and of the individual fibers generating of the filaments on the other hand, is practiced in two separate application steps. As will be described further below, the coating may be effected, in case of the fibers, by carrying the fibers in an air stream along guide walls and bringing them into contact with coating means which protrude into the air stream and apply a coating before and while the fibers are consolidated to a fibrous body.

The fibers are thus coated separately from the filaments and, if wanted, different coating materials may be used, such as lubricants, adhesives, binders, dyes, etc. It is not necessary, during coating of the fibers, to take into account the requirements of the spinning process for the filaments, but rather the second coating may be directed only to the final use and processing of the product formed by the fibers. It is furthermore possible with this type of procedure to keep the surface of the drum clean from the lubricant for the further taking-off of the filaments and also to apply the coating in exactly the amounts that are necessary.

With specific reference now to FIG. 1, it should be noted that this type of apparatus is particularly useful for making two-dimensional glass fiber bodies, for instance by the process of German Pat. 976,682. The device comprises a drawing drum **1** that rotates with high speed and onto which are propelled the filaments *f* in parallel alignment and in a very large number, for instance 130 up to 500, after being coated by a coating device *d* of conventional structure, for instance a coating ledge, to a degree adequate to secure the adhesion of the filaments to the drum with the coating device *d* several rows of fibers can also become forced, as shown into one plane *f'*. The filaments are then attenuated on the drum and conducted to the stripper **2**. This movement is effected partly in direct contact with the surface of the drum and partly within an area of rotation which is generated by the revolving drum and carries the filaments within the adjacent layer of air that revolves with the drum. The stripper **2** extends tangentially or close to tangentially from the periphery of the drum and is secured on a pivot axis **3**. The drum **1** moves in a housing which partly encircles the drum and may be called the "apron" and which confines the area of rotation close to the drum surface. This apron is formed by the wall indicated as **4** in the drawing. A turn member for change of direction is formed by the continuation of the channel formed between the drum surface and the interior of the apron wall. This turn member is indicated as **5** in the drawing and connects with an adjacent guide wall **6** which will cause the fibers to move to the place where they are consolidated to a fibrous structure.

The filaments which move when the drum **1** revolves in the direction of the arrow A and which are, after completing less than one revolution, taken off from the drum, are then split up during the take-off into fibers of uneven length moving in an air stream S.

At a suitable place, there is provided a revolving coating roller **7**, the direction of revolution indicated by the arrow B. Conveniently, this roller is provided at the turn member **5**, but it could also be provided in the horizontally extending guide wall **6**. The coating roller either dips into a receptacle for the liquid medium or as shown is supplied continuously with the medium by means of a dripping or spraying device **8**.

The roller **7** has an axis **9** which is supported outside of the turn member **5**. The roller extends through a gap in the wall of the turn member into the interior of the air channel with a portion of its circumference indicated as **10**. Thus, the roller interrupts the guide wall formed by the turn member and the guide wall **6**. The individual fibers must therefore pass the surface of the coating roller and come into contact therewith and thus will carry away the necessary amount of liquid coating medium.

Thus, it is accomplished that the individual fibers receive a sufficient amount of coating medium between the place of their formation on the drum and the place of their consolidation to a fibrous structure. As a result of this kind of application procedure and apparatus, all of, or practically all of the fibers in the final product will be coated adequately with the liquid coating medium, and the amount of coating will not depend upon their relative position in the fiber structure or on the amount of coating applied to the intermediate product consisting of the glass fibers.

This is important, since it is very difficult to apply the right amount in case of thin glass fiber structures as they are for instance embedded in bituminous glass fiber mat roofings, continuous corrosion wrappings for tubes or containers, etc. The cross-section of glass fiber mats for these products usually is only a fraction of a millimeter and, in this case, it is almost impossible, with the conventional devices, to obtain a uniform distribution of a liquid coating material. The problem is even worse with conventional devices in case of the lubrication of the filaments by means of a pad or by using a spray device for making a ribbon-shaped fibrous structure. In this case, the coating liquid, for instance an adhesive containing liquid, can usually not be caused to penetrate into the core of the glass fiber ribbon or sliver. However, with the process and apparatus of the invention it is possible to cause the liquid to coat, even in case of a ribbon-shaped structure, the fibers throughout the cross-section and in a uniform and adequate manner. Tests have shown that this results in a substantial increase of the tensile strength of the sliver.

FIG. 2 shows in schematic form an embodiment wherein a cylinder **21** is provided with a transfer elements **28** to form a strip of absorbent material, for instance a felt, which extends through a gap into the cylinder **27** and is supplied from the exterior with liquid. The felt **28** extends to an extent into the interior **29** of the cylinder that the fibers, which move into the cylinder along the curved guide wall **30** and form a vortex *w* along the inner surface of the cylinder, will contact the inner edge **31** of the felt **28** and absorb liquid therefrom. The felt **28** can be supported in a housing **32** and may receive its liquid from a receiver **33** provided at the outer end of the housing. The amount of wetting of the fibers will depend on the absorptive properties of the felt, on the level of treating liquid in the receptacle **33** and on the length of protrusion of the portion **31** of the felt.

It will be understood that it is also possible to use several of the different types of transfer members in combination. Besides, there are other means of increasing the intensity of the wetting action. It is for instance possible to remove the felt **28** if a particularly high amount of coating liquid, for instance an amount above 1%, is required. A lip **34** may then be used which extends in the form of a groove or channel across the entire width of the cylinder **27** and replaces the stripper edge **31** of the felt. In this groove, a constant amount of liquid will be maintained by flowing from the receptacle **33** through the housing **32** that in this case forms a liquid supply channel and is not occupied by the felt. The whirling individual fibers will contact the lip formed at the one side of the groove **34** and will thus directly obtain a liquid coating.

FIG. 3 illustrates still another embodiment which may be used in producing staple fiber slivers and which is of a particularly simple design requiring very little service. This embodiment in addition permits an uninterrupted and particularly well adjustable wetting of the fibers. The cylinder **27** in this case is provided with a slit-shaped opening **35** that extends through its entire width or through the major parts of its width. The liquid transfer medium itself is disposed or suspended in this slit and thus protrudes into the cylinder **27'**. The member in the form of a shelf is indicated by the reference numeral **36**. A particularly useful form of transfer medium is a wire mesh of narrow openings which may for instance be fastened to a support tongue or shaft **37**. The interior end of the support member and wire mesh may be slightly bent inwards in order to present an obstacle to the fiber stream and to make sure that the fibers will contact the wire mesh. This type of a fine mesh wire sieve has the advantage of little service and longer life as against a felt which will be subject to wear after an extended time of operation and which also may be liable to rigidify and harden because of the clogging up with particles of the liquid medium which do not evaporate. Thus, this kind of embodiment is a further means to avoid variation of the coating liquid in the fiber product, such as a sliver of glass fibers, which may still occur with the use of a felt.

The wire mesh which is secured to a support tongue is of almost unlimited durability and can easily be cleaned by washing in case of soiling. By means of a dosing device (not shown) the liquid is supplied to the transfer element through a dropping device **38**. The coating liquid may for instance comprise an adhesive or a dye. The wire mesh in this case has the function to distribute uniformly the applied coating liquid and to keep it available while, with the use of a smooth surface, the coating liquid may be subject to uncontrolled draining or dripping. A hinge **39** permits to snap open the portion **40** of the cylinder for cleaning or similar purposes.

We claim:

1. In a process of making glass fiber structures, the steps of passing glass filaments over a drawing drum to attenuate the filaments; lifting the attenuated filaments from said drum and separating the same into individual fibers; transporting said individual fibers separated from each other in an air stream away from said drum; applying a coating liquid to said filaments prior to their delivery to said drawing drum; and applying a further coating liquid to said individual fibers while they are transported by said air stream and prior to their consolidation into a glass fiber structure.

2. The process of claim **1**, wherein the glass fiber structure is a glass fiber mat, fleece, sliver, or three-dimensional body.

3. The process of claim **1**, wherein at least one of the coating liquids is a lubricating liquid.

4. The process of claim **1**, wherein the fibers after leaving said drum are carried in a continuous air current within definite boundaries on a path leading to the place of consolidation to a fibrous structure and wherein the said application of said further coating liquid is effected by bringing the individual fibers in physical contact with liquid transfer members, while the fibers move within said boundaries along said path.

5. In an apparatus for making glass fiber structures, a combination comprising a rotating drawing drum for attenuating glass filaments to individual fibers; means for applying a coating liquid to the filaments upstream of said drawing drum; guide wall means forming an air channel of a width substantially equal to the length of said drum and leading in substantially tangential direction away from the periphery of said drum; means for generating a stream of air in said channel for carrying the fibers separated from each other away from said drum; and coating liquid transfer means projecting into said channel so as to protrude into the path of the fibers carried by said air stream to apply a coating liquid to the individual fibers while they are transported by said air stream.

6. The combination as defined in claim **5**, wherein said transfer means revolves in a plane substantially parallel to the direction of said channel.

7. The combination as defined in claim **6**, and including means to apply fluid to the periphery of said revolving transfer means.

8. The combination as defined in claim **5**, which includes a stripper member extending substantially across the entire periphery of said drum and being directed tangentially way from said drum for removing said fibers from said drum, the stripper member forming part of said channel-forming guide walls.

9. The combination as defined in claim **5**, wherein said channel-forming guide walls comprise a cylinder and wherein a gap is provided in the peripheral wall of said cylinder, said transfer means protruding through said gap into the interior of said cylinder.

10. The combination as defined **in 9**, wherein the transfer means is in the form of at least one stationary member.

11. The combination as defined in claim **9**, wherein the transfer member is in the form of a strip of absorptive material extending with one edge into the cylinder through the periphery thereof.

12. The combination as defined in claim **11**, and including a hollow holding member for said strip disposed substantially outside said cylinder and having one end extending through said gap in said cylinder into the interior thereof, and a receptacle for the liquid, said receptacle being disposed at the other end of said holding member and in communication with the opposite end of said strip of absorptive material.

13. The combination as defined in claim **9**, and including a liquid holding receptacle, a duct leading from said receptacle through said gap in said cylinder into the interior thereof, and means defining a groove formed at the inner end of said duct and extending in axial direction of said cylinder, the level of liquid in said groove being thereby dependent on the level of liquid in said receptacle.

14. The combination as defined in claim **9**, and including a shelf extending from said gap into the interior of said cylinder, said shelf being adapted to hold and dispense liquid to the fibers when contacted by the same, and means for applying said liquid to said shelf through said gap.

15. The combination as defined in claim **14**, wherein said shelf is in the form of a wire mesh.

16. The combination as defined in claim **14**, wherein said shelf is in the form of a support member and including a wire mesh secured to the top side of said support member.

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S. LEON BASHORE, Primary Examiner

R. H. ANDERSON, Assistant Examiner

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