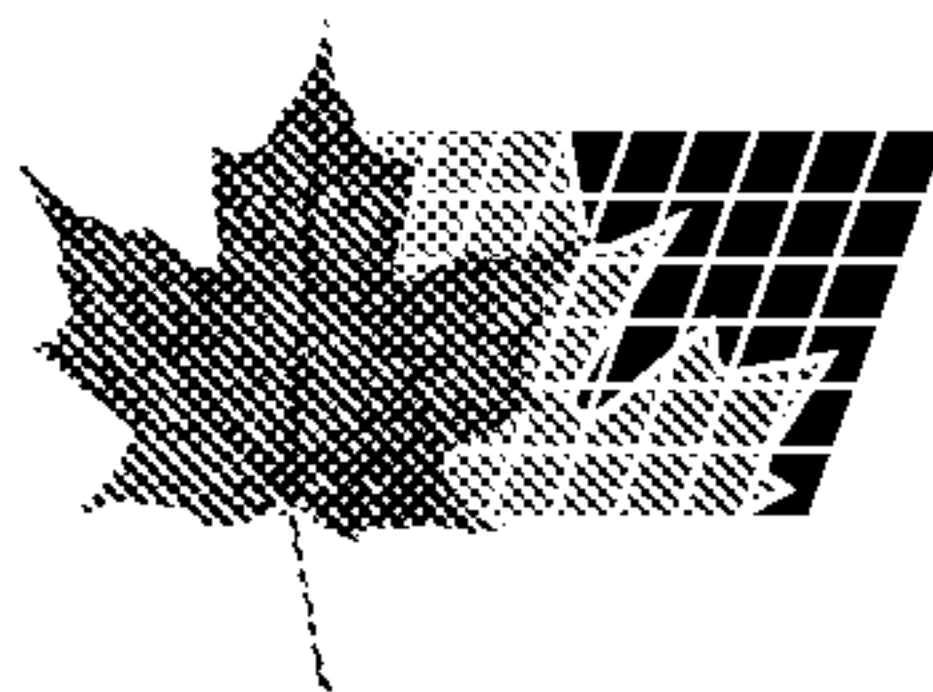




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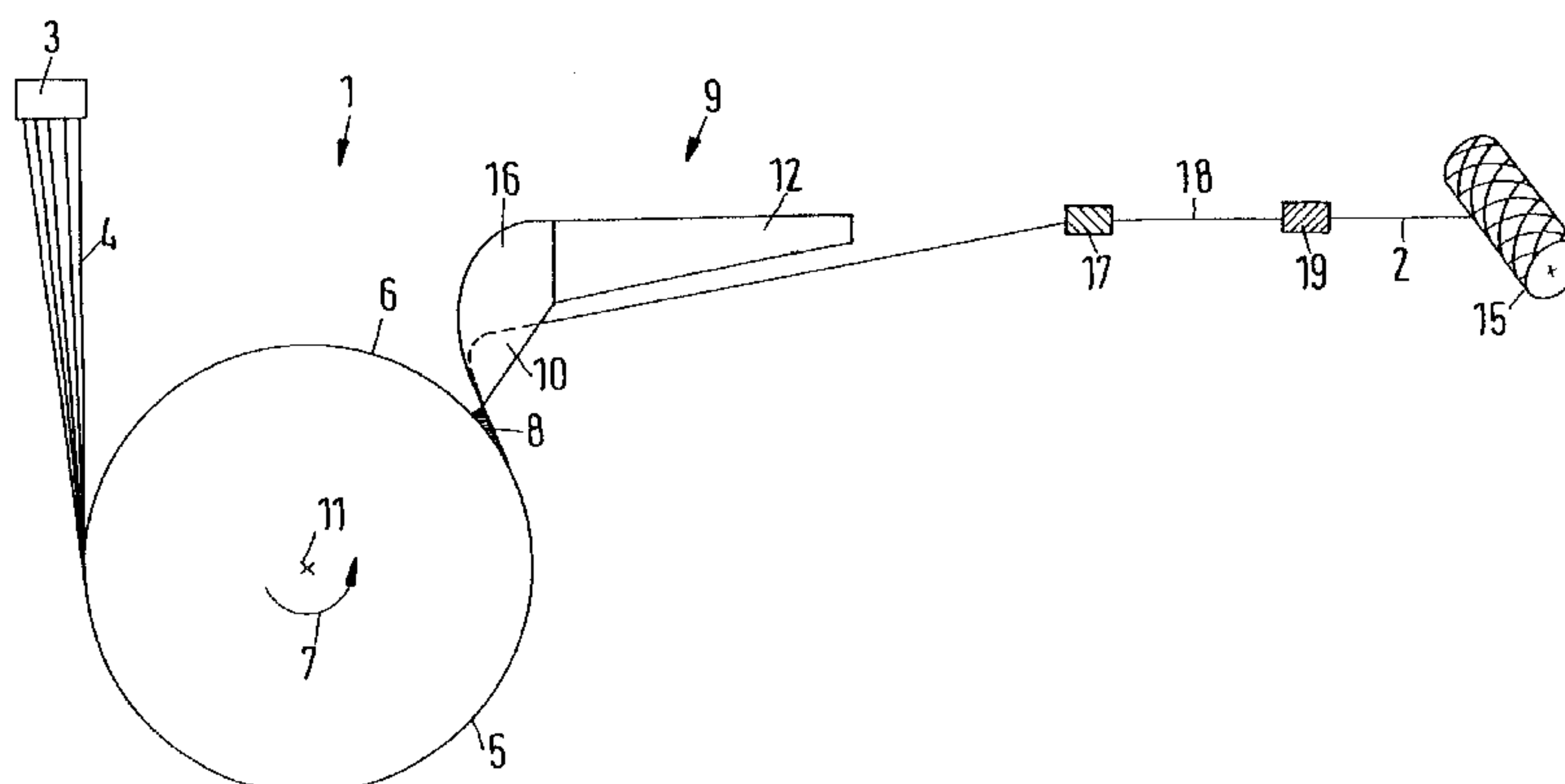
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(54) **PROCEDE ET APPAREIL POUR FABRIQUER DES
TORONS DE FIBRES DE VERRE**

(54) **PROCESS AND APPARATUS FOR FORMING A
CONSOLIDATED STRAND OF GLASS FIBERS**



(57) In a process for the manufacture of a strand of glass fibers, glass filaments are withdrawn from a source with the aid of a rotating pulling surface. The glass filaments are caused to dwell on the pulling surface adjacent and parallel to one another. After an angle of rotation around the pulling surface, the glass filaments are lifted from the pulling surface and the glass filaments are turned at a turn-around in a direction away from the pulling surface. The glass filaments are cushioned as they are turned in the direction away from the pulling surface with an air cushion. After lifting the glass filaments, the glass filaments are consolidated in a direction transverse to a direction of rotation of the pulling surface and the glass filaments are drawn in another direction parallel to a direction of a radius extending from an axis of rotation of the pulling surface. An apparatus capable of carrying out the process is also provided.

Abstract of the Disclosure

In a process for the manufacture of a strand of glass fibers, glass filaments are withdrawn from a source with the aid of a rotating pulling surface. The glass filaments are caused to dwell on the pulling surface adjacent and parallel to one another. After an angle of rotation around the pulling surface, the glass filaments are lifted from the pulling surface and the glass filaments are turned at a turn-around in a direction away from the pulling surface. The glass filaments are cushioned as they are turned in the direction away from the pulling surface with an air cushion. After lifting the glass filaments, the glass filaments are consolidated in a direction transverse to a direction of rotation of the pulling surface and the glass filaments are drawn in another direction parallel to a direction of a radius extending from an axis of rotation of the pulling surface. An apparatus capable of carrying out the process is also provided.

PROCESS AND APPARATUS FOR FORMING A CONSOLIDATED STRAND OF GLASS FIBERS

Background and Summary

The invention concerns a process for the manufacture of a consolidated strand of glass fibers (i.e., a compact elongated mass of glass fibers). According to the process adjacently situated parallel aligned glass filaments are withdrawn from a source of fibers by a rotating pulling surface. Subsequent to a specified dwell time on the pulling surface, the filaments are lifted from the pulling surface and are redirected away from that surface. After being lifted from the pulling surface, the glass filaments are consolidated together transversely to a direction of rotation of the pulling surface and are drawn away in a direction parallel to a direction extending radially from the pulling surface. Further, the invention is concerned with an apparatus for the production of a consolidated strand of glass fibers. The apparatus possesses a rotating pulling surface onto which a lifting device is placed. A forwardly extending guide means is connected to the lifting device.

A process and an apparatus of this kind are disclosed in United States Patent No. 2,621,444. In this patent, the glass fibers are drawn by a pulling drum and lifted with a knife. Air is blown between the knife blade and the pulling drum in order to improve the lifting procedure. Ahead of the knife a hold-down arrangement with an adjustable wall is placed. An opening is defined between the adjustable wall and the pulling drum. Glass threads proceed through the opening before they can be lifted by the knife. A turn-around section is disposed after the knife blade. Behind the turn-around section a hopper is provided. At the hopper, the glass fibers are consolidated and brought together in a direction transverse to the direction of rotation of the pulling drum. At the turn-around section, the glass fibers are guided along a of the turn-around section.

An additional process and an additional apparatus is disclosed in German Offenlegungsschrift No. 3634904 A1. In this instance the glass fibers are directed into a spinning funnel, the axis of which lies essentially parallel to the axis of rotation of a drum. The circumferential surface of the drum forms the pulling surface. From the front end of the spinning funnel consolidated fibers can be withdrawn and later wound up. The dwell time on the drum is determined by the angle of contact of the fibers with the circumference of the drum and the speed of rotation.

Observation shows that although the glass fibers on the pulling drum are practically present in an endless condition, the fiber composite produced in this manner is actually a composite of staple fibers. Staple fibers have a limited length of a few centimeters. Fibers of this length consolidate themselves well together because of the vortexing in the spinning funnel. However, the structural strength, or the tensile strength, or the maximum modulus of elasticity of the resulting composite fibrous strand is limited. This leads, for instance, to difficulties when such a fibrous strand is put into use as a warp thread. In order to make such a staple fiber yarn capable of performing as a warp yarn, further reworking is often required which is costly in labor and expense.

Thus, the invention has a purpose of manufacturing a fibrous strand that is well-suited for use as a warp yarn and has a higher strength than a staple yarn.

This purpose will be achieved by a process of the generic type discussed above wherein an air pillow is formed for cushioning the glass filaments at the turn-around.

This purpose will be achieved by a process of the generic type discussed above wherein the glass filaments subsequent to being lifted from a pulling surface are brought together in a direction transverse to the rotational direction of the pulling surface and are drawn away in a direction parallel to a direction extending radially from the pulling surface.

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In this way, one obtains a so-called "direct-yarn". The multiple glass filaments, which lie parallel on the drum are as has been previously done lifted from the drum. The vortexing spinner, however, in the present invention is not employed. With the conventional process having a vortexing step, most of the fibers break during the vortexing step. In the conventional process, the glass filaments are much more consolidated including consolidation in a direction parallel to the axis of the pulling drum. Contrarily, in the present invention the fibrous bundle is not withdrawn parallel to the axis of the pulling drum, but rather in a direction at a right angle to the axis of the pulling drum.

Basically, glass filaments issue from a melt-spinning device situated rearwardly of the pulling drum reach the pulling drum and are lifted from the pulling drum on a front side of the drum. As a result, the consolidated fibrous composite is pulled in the same direction. In this way, one achieves the construction of a fiber bundle in the form of composite fibrous strand. Even if as a matter of fact not all of the glass fibers are endless a greater strength will be achieved than where staple fibers are used, as these are present in the above-mentioned German Offenlegungsschrift No. 3634904 A1. Moreover, a very compact material is obtained. The quality of this direct-yarn approaches the quality of a roving. In the case of the production of a roving an aqueous sizing is applied, and the water content thereof must subsequently be removed on the final spools. There will always be some water content in a spool of a wound roving. This disadvantage is done away with by the present invention. The process can be run through on a "dry" basis. The glass filaments when they make the turn should not touch on any wall. Instead they float on a conducting air cushion.

Advantageously, the turn-around is accomplished with such a radius and at such an angle such that at least a predetermined portion (i.e., a substantial portion) of the glass filaments do not break. Evaluation is done empirically. In this way, the strength of the resulting fibrous strand is additionally increased. If care is

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taken at least 50% to 70% of the glass filaments survive the turn-around without danger and a fibrous strand is obtained with relatively long individual fibers.

Advantageously, the combined glass filaments are subjected to a closure procedure. This closing can, for instance, take place in a vortexing device, wherein a flow of air is employed. This further increases the strength of the yarn. The closure procedure bundles and compacts the fibers into a "direct-yarn" so that no more parallel individual fibers wind onto the spool, and a coherently bound composite can be withdrawn.

In an advantageous manner, after the consolidation of the glass filaments, a sizing composition is applied. This application of sizing composition can be carried out either before or simultaneously with the closure procedure. The function of the sizing composition is to improve the handling or running characteristics of the yarn.

Advantageously the consolidation of the threads can be done by the use of an air stream. The single glass fibers are thereby run practically untouched through the components of the apparatus. This lessens the danger of breakage even further. For the guidance of the air stream, a selection of guide partitions or conduits is necessary. The individual glass filaments can then be borne in the air flow.

Preferentially, except for a movement upon the consolidation, all glass threads remain moving in one plane. Thereby, the movements associated with the turn-around are kept as small as possible. The danger of damage, such as filament breakage, is thereby reduced. Moreover the filament guidance is thereby simplified. The fewer necessary turns there are, so much greater is the speed with which the glass filaments can be wound-up.

The purpose is achieved by an apparatus of the type described in the introductory passages of the description, in that the guiding arrangement is

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directed forwardly at least section-wise and comprises a hopper shaped construction and the turn-around is provided with an over-run space.

The purpose of the apparatus described in the introductory passages of this description is achieved in that the guiding arrangement is directed forwardly at least section-wise, and comprises a hopper-shaped construction of forwardly diminishing cross-section.

With this formulation, it is possible to consolidate into a bundle the glass filaments which have been positioned parallel to one another on the pulling drum. This is done without running them through a vortexing apparatus. The consolidated glass filaments then can be drawn out directly from the front. Insofar as a turn-around is necessary for the filaments, except for the consolidation, this can be executed in one plane. The glass filaments, when they make the turn, should not touch on any wall. They float much more on a conducting air cushion. If an over-run space is allowed in the turn-around, then the carrying air can build up a correspondingly greater cushion therein, so that the filaments upon reversal are better protected. In this way one can compensate small deviations from the velocity of filament infeed.

Advantageously, the guide means possesses a turn-around section which is located after a device to lift up the glass filaments from the drum. This turn-around is less than 120° . The turn-around angle provides at this point the change in direction. Because of the small change in direction the danger that a break in the glass filaments will occur is relatively small. This feature allows the making of a very stable fibrous glass strand with substantial strength.

Further, it is advantageous to keep the turn-around radius greater than the buckling radius at which a predetermined portion of the glass filaments break. The smaller the radius, the greater the danger of glass filament breakage. With a conservative turn-around, which allows a greater radius, the danger of such breakage is proportionally less.

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Advantageously, the turn-around section possesses a section for the glass filaments making the unavoidable wide turn. The glass filaments, when they make the turn, should not touch on any wall. They float much more on a conducting air cushion. If an over-run space is allowed in the turn-around, then the carrying air can build up a correspondingly greater cushion therein, so that the filaments upon the reversal are better protected. In this way, one can compensate for small deviations from the velocity of filament infeed.

In the direction of the running of the strand, it is advantageous to have a subsequent treatment apparatus located after the guide arrangement. This can be designed, for instance, as a closure, vortexing, or texturizing device. It can also be simply an air nozzle. The strand so worked can, more or less be immediately used as a warp yarn.

Advantageously, the glass threads can be C-glass. With the construction here described a strand can be made which is comparable to strands which are made out of E-glass. The C-glass raw material in any event is generally less expensive. Alternatively, one can utilize within the scope of the present invention other glass starting materials including E-glass.

In accordance with one aspect of the present invention, in a process for the manufacture of strands of glass fibers, glass filaments are withdrawn from a source with the aid of a rotating pulling surface. The glass filaments are caused to dwell on the pulling surface adjacent and parallel to one another. After dwelling on the pulling surface, the glass filaments are lifted from the pulling surface and the glass filaments are turned at a turn-around in a direction away from the pulling surface. The glass filaments are cushioned as they are turned in the direction away from the pulling surface with an air cushion. After lifting the glass filaments, the glass filaments are consolidated in a direction transverse to a direction of rotation of the pulling surface and the glass filaments are drawn in another direction parallel to a direction of a radius extending from an axis of rotation of the pulling surface.

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In accordance with another aspect of the present invention, an apparatus for manufacturing a strand of glass fibers includes a rotating pulling surface, a lifting device disposed on the rotating pulling surface, and a guide assembly associated with the lifting device and extending downstream of the pulling surface, the guide assembly including a hood and a turn-around section with the turn-around section including an over-run space.

Brief Description of the Drawings

The features and advantages of the present invention are well understood by reading the following detailed description in conjunction with the drawings in which like numerals indicate similar elements and in which:

Fig. 1 is a schematic perspective view of an apparatus for the manufacture of a strand of glass fibers, and

Fig. 2 is a schematic profile view of the equipment of Fig. 1.

Detailed Description

As seen in Figs. 1 and 2, an apparatus 1 for the manufacture of a so-called direct yarn comprises melt-extrusion device 3, that includes small melting crucibles for glass with the glass being preferably in the shape of pellets, which crucibles possess on their undersides a multiplicity of extrusion orifices, out of which glass filaments 4 issue. The glass filaments proceed in a conventional manner to the rear side of a spinning drum 5, which can also be called a pulling drum. The circumferential surface 6 of the pulling drum 5 forms, as the drum 5 rotates in the direction of the arrow 7, a rotating pull surface 6. To this surface, the glass filaments 4 cling and can thus be withdrawn from their source. After an angle of rotation around said pulling surface, the glass filaments are lifted from the surface 6 of the drum 5 by a pick-up device 8, namely a scraping knife or blade.

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The scraping knife acts in this function not directly in mechanical contact with the glass filaments 4, which filaments, as may be seen in Fig. 1, lie adjacently and parallel to one another on the surface 6 of the drum 5, but rather the scraper knife lifts the air layer on the spinning drum 5 and with it the therein carried glass filaments 4.

The now lifted glass filaments 4 then proceed into a guide assembly 9. In this guide assembly 9, the glass filaments 4 enter a turn-around section 10, wherein their direction of motion is altered somewhat more than 90°. In their rotation about the spinning drum 5, fundamentally, the glass filaments lie in one plane (i.e., a sectional plane always at right angles to the axis of rotation of the drum).

This turn-around takes place within the turn-around section 10, essentially in this plane. The glass filaments in the present invention, are not withdrawn parallel to the axis of rotation of the drum, as this is done in German Offenlegungsschrift No. 3634904 A1.

A small lateral movement is of course unavoidable for the glass filaments. This lateral movement is necessary, in order to consolidate the glass filaments 4 in directions parallel to the axis of rotation 11 of the spinning drum 5. For this purpose, the guide arrangement 9, exhibits a hopper shaped hood 12, the side walls 13, 14 of which converge in the forward direction.

The air which with the aid of the scraper blade of the pick-up device 8 which raises the glass filaments from the surface 6 of the spinning drum 5, flows into the guide arrangement 9. The air is diverted in direction in the turn-around section 10. The air now flows forward through the narrowing, hopper shaped hood 12 and is compressed from the width of the ends of the spinning drum 5. At the same time, an acceleration of the air flow occurs. This altered air flow now has two effects. First, it serves to consolidate the multiplicity of adjacently and parallel running glass filaments 4 and, second, it imparts to the filaments a certain

tensioning. This is especially advantageous in the start-up of the apparatus 1. As soon as a consolidated bundle 18 has become established, it can be led on to the wind-up spool 15, and at that point, be wound using the desired thread tension.

In the turn-around section 10, still another air pillow can be made in the over-run space 16. In this space, a counter pressure forms so that the glass filaments during operation are not pressed against the top walls of the guide assembly 9, but as shown can be drawn down to the underpart of the hopper shaped hood 12, and in many instances practically outside of the guide assembly 9.

After the guide assembly 9, a treatment apparatus 17 is provided. This can be designed as a closure device, or a vortexing apparatus, or a texturing device, or simply as an air nozzle.

By the specified coordination of the drum surface 6 rotary speed to the withdrawal speed of the spool equipment 15, an effect can be exerted on the volume of the strand. If both speeds are equal, then a more compact strand is obtained than if the drum surface 6 rotary speed is greater than the withdrawal speed of the windup spool 15.

In all instances, it is the guide assembly 9 which assures that this consolidated strand is made from filaments which while possibly exhibiting no endless fibers in a true mathematical sense, do possess relatively long fibers. The lengths of the fibers, in any case, greatly exceeds the lengths staple fibers. This comes about from among other matters because the turn-around in the turn-around section 10 of the guide assembly 9 is carried out providing relatively more protection of the filaments than in the past. Besides the relatively small turn-around angle, a turning radius is used which is so large that the danger of strand breakage remains small.

After the treatment device 17, still another apparatus 19 for the application of a sizing composition can be provided. The apparatus 19 can be located either before the treatment device 17 or be combined therein, when the treatment device

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17 comprises an air nozzle. This is, among other considerations dependent on the type of sizing composition that is employed.

As glass, the so-called C-glass can be used, which is relatively inexpensive. E-glass similarly can be utilized. In spite of the use of C-glass, a yarn 2 can be obtained, the strength of which generally corresponds to that of yarns made from E-glass.

With the described apparatus and process, the glass filaments are not vortexed in the guide assembly 9, but are consolidated to a fiber strand or bundle having a filament-like structure. This strand generally performs like a strand of endless glass filaments. A very dense material is formed. Contrary to a roving-manufacturing process, drying is not required. The strand made by the process and apparatus of the present invention can serve as warp yarn in woven or knitted fabrics. A corresponding staple fiber yarn is required to be twisted when warp usage is contemplated which necessitates an additional step in the manufacturing process.

The strand 2 has a strength which lies between that of staple fiber yarns and true filament yarns. It is possible, to achieve a further strengthening of the strand in treatment device 17. From a visual standpoint, the strand 2 has a similarity to a roving or a textured yarn. The product speed is relatively high. Speeds up to 1600 m/min have been attained.

While this invention has been illustrated and described in accordance with a preferred embodiment, it is recognized that variations and changes may be made therein without departing from the invention as set forth in the claims.

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WE CLAIM:

1. A process for the manufacture of a consolidated strand of glass fibers comprising the steps of:

withdrawing glass filaments from a source with the aid of a rotating pulling surface;

5 causing the glass filaments to dwell on the pulling surface adjacent and parallel to one another;

lifting the glass filaments from the pulling surface after an angle of rotation around said pulling surface and turning the glass filaments at a turn-around in a direction away from the pulling surface;

10 cushioning the glass filaments as they are turned in the direction away from the pulling surface with an air cushion; and

after lifting the glass filaments, consolidating the glass filaments in a direction transverse to a direction of rotation of the pulling surface and drawing the glass filaments in another direction parallel to a direction of a radius extending
15 from an axis of rotation of the pulling surface.

2. A process in accord with Claim 1, wherein the glass filaments are turned at the turn-around through an angle selected with regard to the glass filaments such that, when the glass filaments are turned through the angle, at least a portion of the glass filaments do not break.

3. A process in accord with Claim 1, comprising the further step of subjecting the consolidated glass filaments to a closure procedure.

4. A process in accord with Claim 1, comprising the further step of applying sizing composition to the consolidated glass filaments.

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5. A process in accord with Claims 1, wherein the consolidation step includes consolidating glass filaments with the aid of a guided air stream.

6. A process in accord with Claim 1, wherein the glass filaments are made from C-glass.

7. A process in accord with Claim 1, wherein, except for a movement upon consolidation, after beginning to dwell on the pulling surface, the glass filaments move in a sectional plane at right angles to an axis of rotation of the pulling surface.

8. A process in accord with Claim 2, wherein, except for a movement upon consolidation, after beginning to dwell on the pulling surface, the glass filaments move in a sectional plane at right angles to an axis of rotation of the pulling surface.

9. A process in accord with Claim 3, wherein, except for a movement upon consolidation, after beginning to dwell on the pulling surface, the glass filaments move in a sectional plane at right angles to an axis of rotation of the pulling surface.

10. A process in accord with Claim 5, wherein, except for a movement upon consolidation, after beginning to dwell on the pulling surface, the glass filaments move in a sectional plane at right angles to an axis of rotation of the pulling surface.

11. An apparatus for manufacturing a consolidated strand of glass fibers, comprising:

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- a rotating pulling surface;
- a lifting device disposed on the rotating pulling surface;
- 5 a guide assembly associated with the lifting device and extending downstream of the pulling surface, the guide assembly including a hood and a turn-around section, the turn-around section including an over-run space.

12. An apparatus in accord with Claim 11, wherein the turn-around section is disposed downstream of the lifting device and forms a turn-around angle of less than 120° .

13. An apparatus in accord with Claim 12, wherein a turn-around radius for glass filaments passing through the turn-around section is greater than a buckling radius at which a predetermined portion of the glass filaments break.

14. An apparatus in accord with Claim 11, comprising a supplementary treatment device downstream of the guide assembly.

15. An apparatus in accord with Claim 11, further comprising a source of glass threads made of C-glass.

16. An apparatus in accord with Claim 11, wherein glass filaments contact the pulling surface and are maintained in a sectional plane at right angles to an axis of rotation of the pulling surface.

17. An apparatus in accord with Claim 12, wherein glass filaments contact the pulling surface and are maintained in a sectional plane at right angles to an axis of rotation of the pulling surface.

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18. An apparatus in accord with Claim 13, wherein glass filaments contact the pulling surface and are maintained in a sectional plane at right angles to an axis of rotation of the pulling surface.

19. An apparatus in accord with Claim 14, wherein glass filaments contact the pulling surface and are maintained in a sectional plane at right angles to an axis of rotation of the pulling surface.

20. An apparatus in accord with Claim 11, wherein the hood converges in a downstream direction to consolidate glass filaments extending therethrough.

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Fig.1

