March 30, 1965 MASAHIDE YAZAWA ETAL 3,175,375

APPARATUS FOR THE CONTINUOUS TREATMENT OF SLIVERS

Filed March 5, 1962

FIG. 1

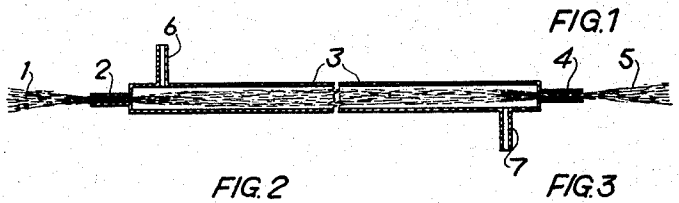


FIG. 2

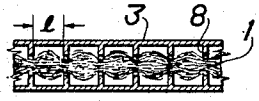


FIG. 3

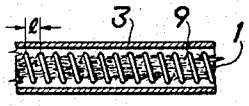


FIG. 4

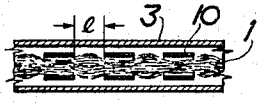


FIG. 5

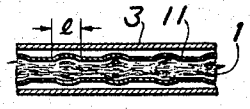


FIG. 6

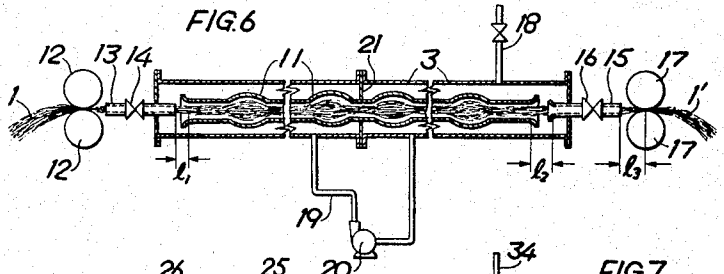
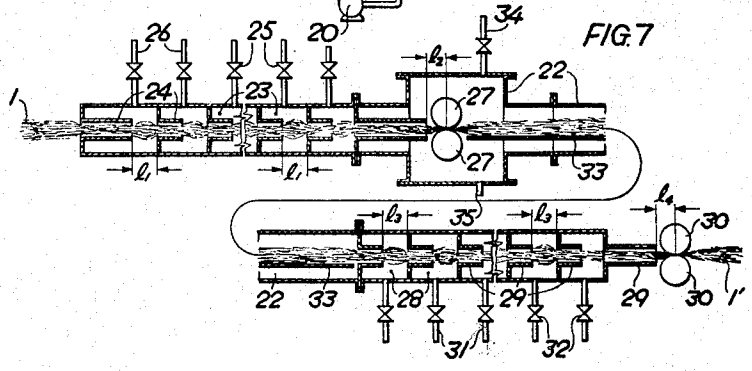


FIG. 7



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APPARATUS FOR THE CONTINUOUS TREATMENT OF SLIVERS

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The present invention relates to an apparatus for continuously and uniformly processing slivers with a treating fluid without additionally applying any twist thereto and yet without causing sliver breakage and disorder in fibre orientation during the treatment.

This invention is particularly applicable when one or more of the so-called short fibre slivers, made of synthetic or chemical fibre material or natural fibre material such as cotton fibres and produced through carding or subsequent drawing and the like known in the art for preparing non-twisted textile slivers, are treated by being passed through a gaseous and/or liquid treating medium, such as for steaming, refining, bleaching, dyeing, chemical treatment, recovery of chemicals, washing, oiling, drying, etc.

It is known that the continuity of yarn thread or the like, or its ability to withstand tension force against breakage is attributable to the fact that the fibres in the yarn or the like, when twisted, adhere closely to or intertwine with each other thereby resulting in high inter-fibre friction proportional to the degree of twist applied thereto.

We have found that fibres in the form of sliver can considerably withstand breakage, without relying upon the twist application, by condensing or squeezing the sliver so as to reduce the cross-sectional dimension thereof.

Practically, we have found that, in the continuous treatment of a sliver, the desired continuity for the sliver can be maintained without breakage when the sliver is forced to pass through hollow bodies such as pipes, rings or coil springs having a restricted opening with its dimension small enough to reduce the cross-sectional dimension of the sliver and increase the inter-fibre friction in the sliver. It has also been found that if the dimension of a passage through which a sliver is continuously passed during treatment is properly controlled in relation to the sliver so as to obtain the above mentioned break-resistant effect, then it is possible to treat the sliver continuously while maintaining its continuity and without requiring any additional application of twist. Preferably, the narrow passage is formed of a smooth material such as glass, polished metal, and the like. It will be noted that the cross sectional configuration of the passage is not limited to a particular one but any desired configuration may be employed for the purpose stated above. For example, a circle, a rectangle, a triangle and other irregular shapes may be employed.

Our experiments have confirmed that the desired continuity of the sliver obtained by condensing or squeezing the latter by means of hollow body passage means as mentioned above permits the sliver to be processed continuously and uniformly with a treating medium for various purposes as stated hereinbefore without causing any sliver breakage regardless of the presence of movement of the treating medium and moving sliver tension which would, as it is apparent, otherwise make it impossible to process the sliver without breakage under the non-treated condition.

Generally, the feature of the present invention is that a sliver in its natural size or form is passed through a series of restricted or narrow passages for properly condensing or squeezing the sliver to reduce its cross-sectional dimension thereby to keep the continuity of the

sliver to such a degree as to withstand forces caused by the flow of the treating agent and tension caused by the continuous movement of the sliver. The term "natural size or form" of sliver as used herein is intended to include the apparent sectional expansion of the sliver as put in air or water in a relaxed state after removal from the card or like processing machine. Apparently, the size or form of a sliver depends on various factors such as kind of fibre, carding or drawing condition, crimping degree, fibre length. Therefore, even when the sliver counts number is the same, the natural size of sliver will vary according to these factors. The fibre density of a sliver, that is, the weight of fibres contained in a unit volume of the sliver, of course, may vary according to said factors, while it is considered that a sliver density of about 0.03–0.08 is enough to maintain the continuity of sliver in air under relaxed or non-tensioned condition. Therefore, if a sliver in natural state is forced to pass through a narrow passage 2–20 times as large in cross sectional dimension as that of the sliver condensed or pressed to the maximum degree, then the sliver in its natural state is squeezed or condensed in proportion to the cross-sectional size of the passage, so that even non-twisted sliver will maintain its continuity enough to withstand various force and tension to be encountered in the continuous fluid treatment.

The cross sectional dimension of such narrow or restricted passage means must be selected by experience. Generally, the higher the flowing rate of a treating fluid or medium is and the higher the moving sliver speed is, the smaller the cross-sectional dimension of the passage opening.

According to one embodiment of the invention a long cylindrical or tubular treating enclosure or casing constitutes a narrow or restricted passage means of this invention. At opposite ends of this enclosure there are connected a narrower inlet and outlet for a sliver. The enclosure is also provided with an inlet and outlet for a treating fluid.

Alternatively, a series of narrow or restricted passage means may be arranged at intervals along the length of and within a cylindrical or tubular treating enclosure or casing whose diameter is larger than that of a sliver in its natural size or form. Each of the narrow passage means may comprise a short pipe, ring, hollow disc, or the like. If desired a single tube or pipe extending longitudinally of and within the casing body may be employed, said tube or pipe having a series of narrow sections at intervals. Alternatively, a coil spring whose inner diameter is smaller than that of a sliver in its natural size or form may be arranged within a casing. In each case where a series of sliver passage restricting means is provided, the interval must be shorter than the mean length of the fibres comprising the sliver.

The invention will now be more fully described in connection with the accompanying drawings wherein:

FIG. 1 is a longitudinal section of a continuous sliver treating apparatus of this invention;

Each of FIGS. 2, 3, 4 and 5 shows a longitudinal section of a part of a modified apparatus of this invention;

FIG. 6 is a longitudinal section of a double wall type apparatus embodying the present invention;

FIG. 7 is a longitudinal section of a still further embodiment of the invention.

Referring to FIG. 1, the continuous sliver treating apparatus comprises a cylindrical or tubular enclosure or casing 3 provided at its ends with narrow inlet and outlet tubes 2 and 4. A sliver 1 is introduced continuously through the narrow inlet 2 into the casing 3 filled with a treating solution. The inner diameter of each of the tubes 2 and 4 is restricted to such a degree as to allow

the passage of the sliver but prevent the leakage of the treating solution contained in the casing 3. For example, the inner diameter of the tube 2 and tube 4 corresponds to the cross-section of the sliver compressed to a density of 0.2–0.40. The inner diameter of the enclosure or casing 3 is larger than that of the tubes 2 and 4 but is smaller than the natural cross-sectional size of the sliver. It will be understood that the treating solution may be supplied from a pipe 6 and discharged through a pipe 7 or, otherwise, from the pipe 7 and through pipe 6, the former being a parallel flow system while the latter being a counter flow system. During the passage through the casing 3 the sliver is treated with a medium and is then discharged into the atmosphere through the narrow outlet tube 4 as indicated at 5. In case the treating solution flows parallelly at a rate higher than the moving sliver, the resistance to the movement of sliver is decreased since the sliver movement is assisted by the parallel flow of the treating solution.

Referring to FIG. 2, there is shown another embodiment of the invention, wherein the inner diameter of a cylindrical enclosure or casing 3 is larger than the natural cross-sectional size of sliver. The casing 3 is provided internally with a series of spaced walls 8 projected inwardly and radially to form compartments along the longitudinal axis thereof, the distance l between adjacent walls being shorter than the average length of the fibres of the sliver. Each of the walls 8 is formed with a passage opening for squeezing or condensing a sliver 1 passing therethrough. With this structure, the sliver 1, while being treated with a medium in the casing 3, is repeatedly squeezed by said walls 8. Since the length l is shorter than the average fibre length, the squeezing effect, though more or less mitigated, is extended to the sliver portions between the walls.

Referring to FIG. 3, there is shown a modification similar to FIG. 2 except that a coil spring 9 is arranged longitudinally of and within the casing 3 in order to squeeze a sliver 1, the pitch l of said spring 9 being shorter than the average fibre length of the sliver 1. The spring 9 functions similarly to the spaced walls 8 in FIG. 2.

Referring to FIG. 4, there is shown another modification similar to FIGS. 2 and 3 except that a series of spaced narrow and short tubes 10 are provided within the casing 3 in order to squeeze a sliver 1. Here again the distance l between the adjacent tubes is shorter than the average fiber length of the silver 1. The spaced tubes 10 function similarly to the spaced walls 8 and spring 9 in FIGS. 2 and 3, respectively.

Referring to FIG. 5, there is shown still another modification similar to those shown in FIGS. 2–4 except that within the casing is provided a single continuous corrugated squeezing tube 11 having large tube sections and small tube sections alternately arranged as well shown. Each of the large tube sections has an inner diameter larger than the natural cross-sectional size of the sliver, while each of the small tubular sections has an inner diameter smaller than the natural cross-sectional size of the sliver. In this case, the length l of each of the large tubular sections is shorter than the average fibre length of the sliver 1. Therefore, the squeezing effect can be extended to the sliver portions included in the large diameter sections.

In each of the embodiments shown in FIGS. 2–5, it is not while the sliver is being squeezed but while the sliver is passing through the non-restricted zones shown at l that the sliver is actually treated in contact with the treating medium. According to these embodiments, since the squeezing and releasing are alternately effected as the sliver proceeds, uniform and sufficient penetration of the treating medium in the sliver is obtained. In each case, either a parallel flow system or counter-flow system, of course, may be employed as desired.

The system shown in FIG. 6 may conveniently be employed, for example, in high pressure high temperature dyeing operation wherein a treating solution under pressure is circulated through the casing 3. In this apparatus, a sliver 1 is fed, partially assisted by a parallel flow of a treating medium, by a pair of rolls 12 to pass through a narrow inlet pipe 13 and inlet control means 14 (which allows the passage of the sliver but prevents the leakage of the treating medium) into a single corrugated inner tube 11 constructed similarly to that shown in FIG. 5. The inner tube 11 has large tubular sections and small tubular sections alternately arranged, whereby the contact of the sliver with the treating solution is cyclically effected so that the sliver can be treated uniformly, as already described. At the end of the travel in the tube 11 the sliver is delivered by means of a pair of rolls 17, 17 through a narrow outlet tube 15 associated with an outlet control means 16 similar to the means 14. Thereafter the processed sliver 1' may undergo the next operation. The treating solution which has left the outlet end of the inner tube 11 is run through annular fluid passage formed between the inner tube 11 and the casing 3 and is sent back to the upstream part via a pipe 19 by means of a pump 20. The treating solution thus sent back is contacted with newly introduced sliver portion at the inlet end of the inner tube 11 whereby the sliver movement is facilitated by this calculation of pressure solution.

The annular space formed between the casing 3 and the tube 11 is divided by a wall 21, while the inner tube 11 extends through this wall. The portions indicated with l_1, l_2 and l_3 might seem, at first sight, to fail to receive the squeezing action. The continuity of the sliver can be maintained since these lengths l_1, l_2 and l_3 are shorter than the average fibre length so that squeezing effect may be effectively extended to these portions. With the continued operation, the treating solution tends to vary in the composition and decrease in quantity as some portions of the solution are contained in the sliver and carried away from the system, but such tendency may be compensated by the addition of fresh solution as well as recovered solution through a supplying pipe 18 for controlling the concentration and temperature thereof. The casing may be externally warmed or heated with the provision of a jacket (not shown). This type of double wall apparatus enables the use of a glass tube or a glass lined tube as the inner tube 11 with safety free from a pressure damage on the glass even operated at a high pressure.

In FIG. 6, while the inner tube 11 is shown as having its all narrow tube sections made equal in diameter, it is preferable, in respect of the speediness and uniformity of the process, to arrange such that a group of the small tube sections with smaller diameter are employed in the first half of the inner tube in order to increase the velocity of the flowing solution and hence the propelling force of the sliver to balance with the resistance to the movement of the sliver when led into the pressure treating casing. In the second half thereof, the small tube sections with larger diameter are employed in order to decrease the fibre density of the sliver thereby to facilitate the penetration of the treating solution in the sliver.

When a continuous process is carried out under pressure using fluid according to the invention, there will be encountered with a problem how to seal the fluid against leakage. If the fluid is liquid, this may be dissolved, for example, by means described in Japanese Patents Nos. 192,052 and 198,429 or United States Patent No. 2,954,687, and, if it is high pressure gas or steam, means as described in Japanese patent application No. 47,400/60 may be employed. Any other suitable means may be employed for dealing with the problem of fluid leakage.

FIG. 7 schematically shows another embodiment of the present invention wherein a sliver 1 is continuously processed under pressure at a high temperature. As shown a number of pressure gas compartments 23 are provided in series at the inlet side. After passing through

these compartments, the sliver **1** is led to a pressure steam-heating treating chamber **22**. Each of the compartments **23** is provided with a narrow tube **24**, through which the sliver passes with a decreased cross-sectional dimension. An exhaust pipe **26** having a regulating valve **25** for exhaust gas is provided for each compartment **23**. The regulating valves **25** are so adjusted to allow the steam to escape through the pipe **26** at the foremost end or right hand end but to pass the steam successively from a compartment at higher pressure to the adjacent compartment at lower pressure in the direction counter to that of the sliver travel, thereby to maintain a pressure difference between the adjacent compartments less than 1.5 atmospheres so as to avoid a sliver breakage due to pressure. Thus the pressures in these compartments are so regulated as to be higher toward the pressure steam chamber **22**. The pulling force required for leading the sliver into the pressure steam chamber **22** through the narrow tubes against the steam pressure is obtained by a pair of rolls **27, 27**. The sliver led into the pressure steam chamber **22** is contacted with the treating steam or gas and delivered by a pair of rolls **30, 30** into the atmosphere successively through narrow tubes **29** similar to the tubes **24**. Exhaust pipes **31** and regulating valves **32** which are provided on the compartments **28** are similar in their functions to those provided on the compartments **23**. The length l_1, that is, the distance between the adjacent tubes **24**, the length l_2, that is, the distance between the nip point of the rolls **27** and the adjacent tube, the length l_3, that is, the distance between the adjacent tubes **29**, the length l_4, that is, the distance between the nip point of the rolls **30** and adjacent tube, are all shorter than the average fibre length of the sliver, so as to ensure the continuity of the sliver as already described in connection with FIGS. 2–5.

If it is desired to allow the sliver to contract under pressure steam, then the surface velocity of the rolls **30** is properly selected so as to be lower than that of the rolls **27**. It is possible to so arrange the system so that while passing on a trough **33** the sliver which is led into the pressure steam chamber **22** is allowed to freely contact the steam. It is also possible to provide the pressure steam chamber **22** with means which applies repeated squeezing effect to the sliver as shown in FIGS. 2–5. In addition, the steam is supplied through a pipe **34** and the condensed water is drained through a trap **35**.

The system shown in FIG. 7 is conveniently employed for processing various kinds of slivers. In case that viscose staple fibre sliver is treated with steam for improving the properties, a simply saturated steam may be introduced into the system. When it is desired to treat various kinds of fibres in the form of sliver by padding for refining, bleaching, dyeing, chemical treatments, etc., it is preferable that the sliver is padded with the treating solution and squeezed by means of roller so as to be a pick up of 0.5–2.0 of the solution per one part of the sliver, before passing through the system of the present invention for pressurized high temperature steam treatment.

The operation can be effected continuously within a considerably short time. Moreover, if means for repeatedly squeezing the sliver as shown in FIGS. 2–5 is provided within the pressure steam chamber **22**, the solution impregnated in the sliver is effectively diffused to be uniformly absorbed in the sliver so that a uniform processing effect can be attained.

The system of the present invention is applicable not only to a high temperature dyeing of synthetic fibres but also to pressurized high temperature refining of cotton, pressurized high temperature bleaching by the use of $NaCl_2$, baking for resin treatment, etc. In case of processes under the normal pressure, e.g., impregnation of a treating solution, mercerization of cotton in the form of sliver, chemical treatment, recovery of chemicals, washing, oiling and drying, etc. the method and apparatus illustrated in FIGS. 1–5 are, of course, applicable and suitable to effect economical operations with a minimum quantity of treating solution and without possibilities of sliver disorder and breakage.

While the present invention has been described with reference to particular embodiments, it will be understood that numerous modifications may be made by those skilled in the art without departing from the scope of the invention. Therefore, the appended claim is intended to cover all such equivalent variations as come within the true spirit and scope of the invention.

What we claim is:

An apparatus which comprises an outer cylindrical casing having inner diameter larger than that of the natural size of the sliver and an inner single continuous corrugated tube having alternately large tube sections and small tube sections, the inner diameter of each of said large tube sections being larger than that of the natural size of the sliver, while the inner diameter of each small tube section being smaller than that of the sliver in its natural size, and the axial length of each large tube section being shorter than the average fibre length of the sliver, so that the sliver, as travels in the tube, is repeatedly squeezed at the small tube sections.

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