March 26, 1957 R. H. ROUGHSEDGE 2,786,736

PROCESS AND APPARATUS FOR TREATING FILAMENTARY MATERIAL

Filed Jan. 27, 1953 3 Sheets-Sheet 1

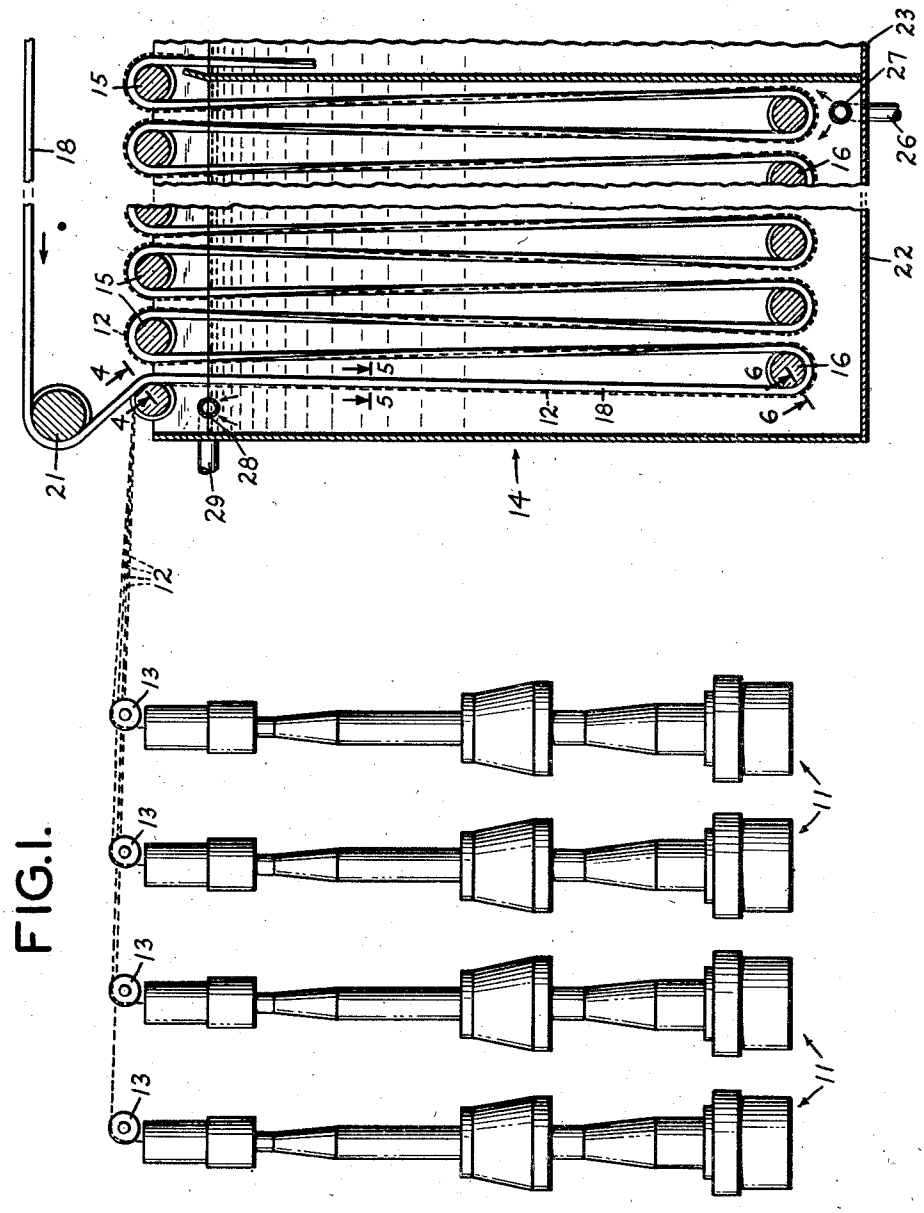



FIG. I.

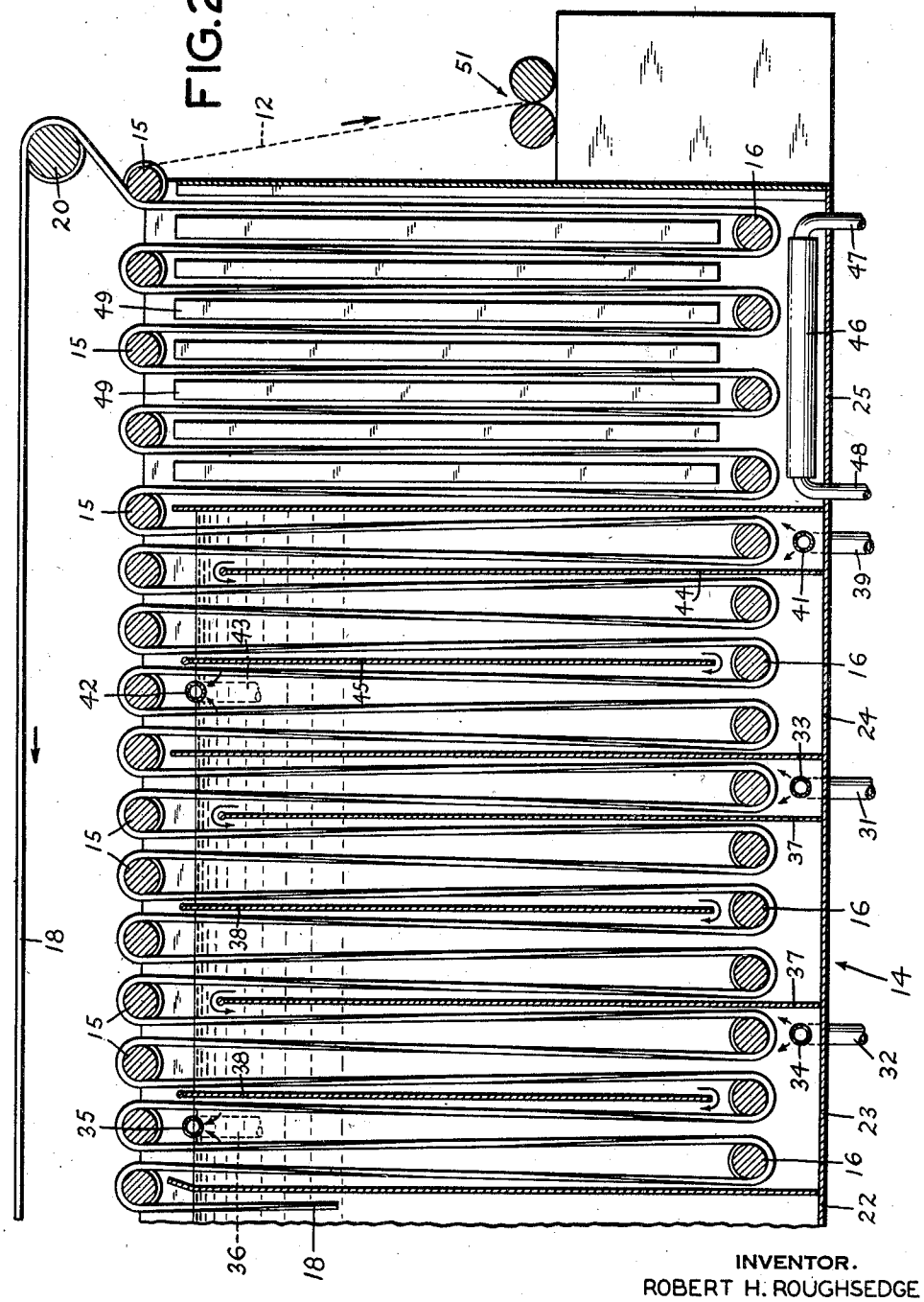
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PROCESS AND APPARATUS FOR TREATING FILAMENTARY MATERIAL

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FIG. 2.




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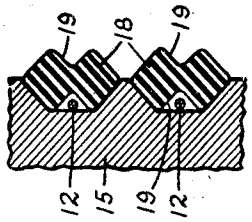



FIG. 4.

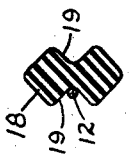



FIG. 5.

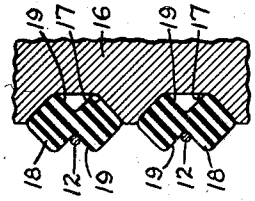



FIG. 6.

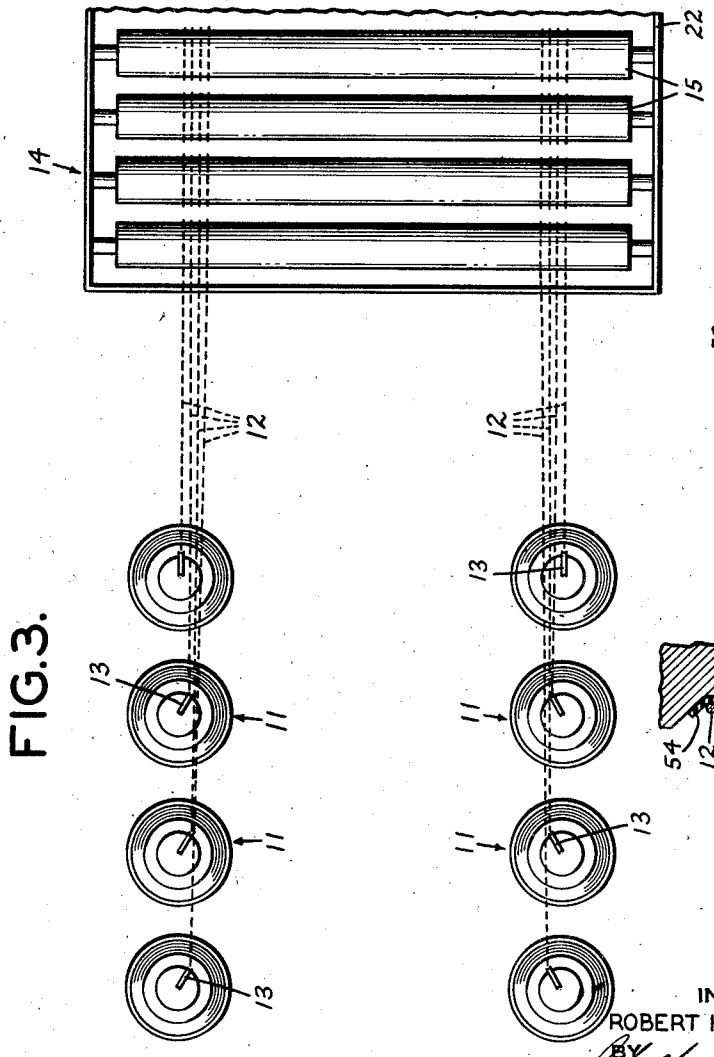



FIG. 3.

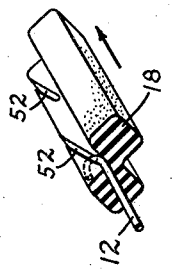



FIG. 7.

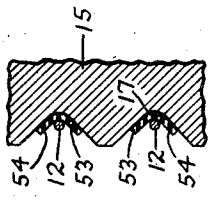



FIG. 8.

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2,786,736

# PROCESS AND APPARATUS FOR TREATING FILAMENTARY MATERIAL

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Application January 27, 1953, Serial No. 333,411
11 Claims. (Cl. 8—151.2)

This invention relates to filamentary material and relates more particularly to an improved process and apparatus for the treatment of filamentary material.

In the production and processing of filamentary material of indefinite length, such as filaments, yarns, threads and the like, it is necessary to treat the said material with various media. For example, in the production of high tenacity regenerated cellulose filamentary material, a solution or dope of cellulose acetate or other organic acid ester of cellulose is extruded into a liquid coagulating medium. As the filamentary material passes through the coagulating medium, it is placed under tension to increase its length by from 200, 400 or 600 up to 1,000 or 2,000 percent, or more. The stretched filamentary material may, if desired, be washed to remove the coagulating medium therefrom, and is then saponified to convert the cellulose ester to cellulose, washed and dried. To carry out this process in the most economical manner, the successive treatments should be applied to the filamentary material as it moves continuously through the processing apparatus so as to avoid the necessity of winding and rewinding the filamentary material into package form and to avoid the necessity of handling such packages, which would increase the expense of such treatments and increase the danger of damaging the filamentary materials. When it is attempted to carry out the treatments of the filamentary materials in a continuous manner, it is found that the properties of the products produced are less desirable than those produced on a batch basis and, in addition, show a higher degree of variability. In addition, the apparatus previously suggested for such continuous treatment has been relatively complex and expensive to build and operate.

It is an important object of this invention to provide a process and apparatus for the treatment of filamentary material which will be free from the foregoing and other difficulties, and which will be especially simple in construction and efficient in operation.

A further object of this invention is to provide a process and apparatus for the treatment of filamentary material wherein the filamentary material is supported substantially continuously during its treatment.

Other objects of this invention, together with certain details of construction and combinations of parts, will be apparent from the following detailed description and claims.

It has been found that the less desirable physical properties of the filamentary materials produced by previous continuous processes and the higher degree of variability of such products, as, for example, in the elongation and tenacity thereof, is due, at least in part, to the tensions to which said products are subjected during the saponification, washing and drying steps. The tensions applied to the filamentary materials to carry them through the apparatus in which these steps are carried out have the effect of lowering the physical properties of the final products. Variations in these tensions, which result, for example, from slight variations in the shrinkage and elongation of the filamentary materials during treatment, introduce a high degree of variability into the properties of the final product.



According to the present invention, the foregoing difficulties are overcome by providing, in the apparatus, means for supporting the filamentary materials as they are led through the saponification, washing and drying zones of the apparatus and means for driving said supporting means. By the use of said supporting means, the application of tension on the filamentary materials while they are moved through the treating apparatus is substantially avoided. The filamentary materials produced in accordance with this invention have much improved physical properties. In addition, they exhibit a much smaller degree of variability in their properties.

In one form of apparatus for carrying out this invention, there is provided an endless, flexible belt, which may be made of any suitable material such as rubber or the like, which is trained around a series of rolls, at least some of which are positively driven to move the belt through the apparatus. The belt is contoured to provide a channel for receiving and supporting the filamentary materials in their passage through the apparatus. The channel may be formed in the belt during its manufacture so that it will be permanent, or the belt may be flat or of other configuration and be contoured into the form of a channel by the use of suitable shaping means. For example, the rolls over which the belt is trained may have grooves of generally semicircular cross-section extending around the periphery thereof, which grooves will act to hold said belt in the form of a cup-shaped channel to support the filamentary materials.

Advantageously, the rolls are arranged to form a lower set and an upper set and the belt is trained alternately over the upper and under the lower rolls from one end of the apparatus to the other. If the belt were to be placed in the apparatus without twist, the filamentary material would drop off said belt and lie against half the rolls as the belt moved through the apparatus. In this event, at least part of the force needed to move the filamentary materials through the apparatus would be applied directly to said materials, imposing undesirable tensions thereon. To keep the filamentary materials from dropping off the belt and contacting the rolls, the belt is given an effective twist of 180 degrees as it passes from one roll to the next so that the filamentary materials will lie on the outside of the belt as it passes around the rolls. In twisting the belt through an angle of 180 degrees, the twisting may comprise simply 180 degrees or any integral multiple of 360 degrees plus 180 degrees.

While the apparatus of this invention may include only a single belt and be adapted for the treatment of only a single end of filamentary material, it is most advantageously employed for the simultaneous treatment of a plurality of ends of the said filamentary materials. To permit such simultaneous treatment of a plurality of ends, there is provided in the apparatus a plurality of belts which are passed through the apparatus in parallel side-by-side relation. To keep the belts parallel and properly spaced, and, in addition, to provide a more effective driving contact for the belts, at least some of the rolls are preferably provided with grooves extending around the periphery thereof, in which grooves the belts ride.

To start a new end of filamentary material through the apparatus, means are provided for temporarily securing the end of filamentary material to the belt so that the belt will thread said end around the rolls. Such means may comprise a clamp of suitable design which will hold the end of filamentary material to the belt. Preferably, however, such means comprises a slit in the belt in which the end of filamentary material may be secured so that the belt will carry the said end through the apparatus from the entrance to the exit thereof.

The process and apparatus of this invention will now be described specifically in connection with the produc-

tion of a high-tenacity regenerated cellulose yarn by the saponification, washing and drying of stretched filamentary materials of cellulose acetate or other organic derivative of cellulose to which it is specially adapted. It may, however, also be employed generally for the treatment of filamentary materials of all types with various media.

A preferred embodiment of this invention is shown in the accompanying drawings wherein:

Fig. 1 is a side view, partly in section, of the spinning and initial treatment end of the apparatus,

Fig. 2 is a side view, partly in section, of the treatment and delivery end of the apparatus,

Fig. 3 is a plan view of the portion of the apparatus shown in Fig. 1, with certain parts omitted in the interest of clarity,

Fig. 4 is a cross-sectional view, taken on the line 4—4 in Fig. 1, in the direction of the arrows,

Fig. 5 is a cross-sectional view taken on the line 5—5 in Fig. 1, in the direction of the arrows,

Fig. 6 is a cross-sectional view, taken on the line 6—6 in Fig. 1, in the direction of the arrows,

Fig. 7 is a detail perspective view of the belt, and

Fig. 8 is a cross-sectional view of a modified embodiment of the invention.

Like reference numerals indicate like parts throughout the several views of the drawings.

Referring now to the drawings, the reference numeral 11 designates generally a spinning assembly, which may be of the type shown in Bradshaw et al., application S. No. 285,238, filed April 30, 1952, now Patent No. 2,732,586, from which yarns 12 emerge over guide rolls 13. From the spinning assembly 11, the yarns 12 enter a treating section, indicated generally by reference numeral 14, comprising a plurality of upper rolls 15, driven by any suitable means, not shown, and a series of lower idler rolls 16. The rolls 15 and 16 are all provided with a series of grooves 17 extending around the periphery thereof, which grooves are closely spaced and parallel to one another. A series of endless flexible belts 18, having channels 19 in both faces thereof, are trained alternately over the upper rolls 15 and under the lower rolls 16 from the inlet to the outlet of the treating section 14. The belts 18 are guided back to the inlet of the said treating section by idler rolls 20 and 21, which are grooved in the same manner as the rolls 15 and 16. Between the upper rolls 15 and the lower rolls 16, a 180-degree twist is inserted in the belts 18, except in that portion of said belts which extends between the first of the upper rolls 15 and the first of the lower rolls 16. As shown in Figures 4 to 6, the belts 18 are contoured to fit closely into the grooves 17 in the rolls 15 and 16 so that said grooves will hold said belts closely spaced and parallel to one another as they move through the treating section 14.

As the yarns 12 emerge from the spinning assembly 11 over the guide rolls 13, they are led to the first of the upper rolls 15 in the treating section 14 and will lie in the grooves 17 of said upper roll as shown in Fig. 4 of the drawings. The yarn 12 and the belt 18 will move away together from said upper roll 15, with the yarn 12 lying in the channel 19, as shown in Fig. 5 of the drawings, being supported and carried along by said belt. The yarn 12 is then carried under the first of the lower rolls 16 by the belt 18, with the yarn 12 lying in the channel 19 of said belt and out of contact with said lower roll, as shown in Fig. 6 of the drawings. As the belt 18 moves up from the first of the lower rolls 16, it is twisted through an angle of 180 degrees so that the yarn 12, carried along therewith, will lie in the channel 19 of said belt when it reaches the upper roll 15. The belt 18 will carry the yarn 12 through the remainder of the treating section 14 in like manner without permitting the said yarn to contact the rolls 15 or 16. The belt 18 will provide a substantially continuous support for the yarn 12 so that it will not be necessary to impose any substantial tension on the said yarn to move it through the treating section 14.

The treating section 14 also comprises a plurality of compartments 22, 23, 24 and 25 through which the belt 18 moves and wherein the yarn 12 is subjected to the desired treatments. The compartment 22 contains a saponifying medium which is supplied thereto through a conduit 26 and a header 27 and which overflows therefrom through a header 28 and a conduit 29. In the compartment 22, the saponifying medium converts the cellulose acetate of the yarn 12 to cellulose. From the compartment 22, the belt 18 carries the yarn 12 into the compartment 23 to which wash water is supplied at spaced points through conduits 31 and 32 and headers 33 and 34 and from which the wash water overflows through a header 35 and a conduit 36. The compartment 23 is provided with a pair of baffles 37 that extend upwardly from the floor of said compartment to a point below the level of the wash water therein, and a pair of baffles 38 which extend downwardly from a point above the level of the wash water to a point above the lower rolls 16 and spaced from the floor of the compartment 23. The baffles 37 and 38 force the wash water to flow through a circuitous path, as shown by the arrows in Fig. 2 of the drawings, so as to increase the efficiency with which the washing is carried out. The introduction of additional wash water into the compartment 23 through the conduit 32 and the header 34 acts to keep the concentration of the salts in said wash water at a relatively low level to ensure the proper washing of the yarn 12.

From the compartment 23, the belt 18 carries the yarn 12 into the compartment 24 wherein the said yarn is subjected to a further washing to eliminate any final traces of impurities therefrom. Wash water is supplied to the compartment 24 through a conduit 39 and a header 41 and overflows from said compartment through a header 42 and a conduit 43. The compartment 24 is provided with a baffle 44 which extends upwardly from the floor of said compartment to a point below the level of the wash water therein, and a baffle 45 which extends downwardly from a point above the level of the wash water to a point above the lower rolls 16 and spaced from the floor of the compartment 24. The baffles 44 and 45, like the baffles 37 and 38, force the wash water to follow a circuitous path, as shown by the arrows in Fig. 2 of the drawings.

After passing through the compartment 24, the belt 18 carries the yarn 12 into the compartment 25 wherein the yarn is dried. Heat necessary to dry the yarn is supplied by means of a convection heater 46 positioned at the base of the compartment 25, through which steam flows from a conduit 47 and from which condensate is drained through a conduit 48, and a plurality of radiant heaters 49 which are positioned vertically between the successive passes of the belt from the rollers 15 to the rollers 16 and back again. No twist is inserted into the belt 18 as it passes from the last of the lower rolls to the last of the upper rolls 15 so that when said belt carries the yarn 12 to said upper roll, the yarn 12 will lie in the groove 17 extending around the periphery of said roll. The belt 18 is then trained around the idler roll 20 which, with the idler roll 21, will guide the belt 18 back to the entrance of the treating section 14. The yarn 12, which is fully processed and dry, is drawn to a winding apparatus of conventional construction, indicated generally by reference numeral 51, where it is taken up in package form.

To permit the apparatus to be threaded readily at the start of operations, or in the event of a yarn break, the belt 18 is provided with a series of slits 52 therein which are inclined backwardly with respect to the direction in which the belt 18 moves. The end of a yarn 12 is inserted in one of the slits 52, as shown in Fig. 7 of the drawings, and will be carried through the treating section 14 without further attention on the part of the operator. When the end of the yarn 12 reaches the exit of the treating section 14, the yarn 12 is removed from the slit 52 and led to the winding apparatus 51.

In a modified form of the invention, shown in Fig. 8 of the drawings, a flat belt 53 is substituted for the contoured belt 18. As the flat belt 53 rides in the grooves 17 of the rollers 15 and 16 it will be brought to a cup-shaped form so as to provide a channel 54 for carrying the yarn 12 through the treating section 14.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made therein without departing from the spirit of my invention.

Having described my invention, what I desire to secure by Letters Patent is:

1. An apparatus for the treatment of filamentary materials, comprising an endless flexible belt for supporting the filamentary materials during the treatment, a plurality of upper rolls and a plurality of lower rolls parallel to said upper rolls, a container for a liquid treating bath, means for supplying a liquid to said bath, said belt being trained up and down in a zig-zag path through said bath, over said upper rolls and under said lower rolls, said belt being twisted through an angle of 180 degrees in its upward and downward passages between the upper rolls and the lower rolls whereby the filamentary materials will be carried around the upper rolls and the lower rolls on the outside of the belt and will not contact the rolls, said lower rolls being directly beneath said upper rolls thereby providing for a substantially vertical course of travel of the belt and filamentary materials.

2. An apparatus for the treatment of filamentary materials, comprising an endless flexible belt having a channel therein for receiving and supporting the filamentary materials during the treatment, a plurality of upper rolls, a plurality of lower rolls parallel to said upper rolls, a container for a liquid treating bath, means for supplying a liquid to said bath, said belt being trained up and down in a zig-zag path through said bath, over said upper rolls and under said lower rolls, said lower rolls being in said container, and means for driving at least some of said rolls to move the belt through said bath whereby the belt will carry the filamentary material through said bath, said belt being twisted through an angle of 180 degrees in its upward and downward passages between the upper rolls and the lower rolls whereby the filamentary materials will be carried around the upper rolls and the lower rolls on the outside of the belt and will not contact the rolls, said belt passing freely between said rolls, said lower rolls being directly beneath said upper rolls thereby providing for a substantially vertical course of travel of the belt and filamentary materials.

3. An apparatus for the treatment of a plurality of ends of filamentary materials, comprising a plurality of endless flexible belts for supporting the filamentary materials during the treatment, a plurality of upper rolls over which the belts are trained in parallel side-by-side relation, a plurality of lower rolls parallel to said upper rolls under which the belts are trained in parallel side-by-side relation, a container for a liquid treating bath, means for supplying a liquid to said bath, said belts being trained up and down in a zig-zag path through said bath, over said upper rolls and under said lower rolls, and means for driving at least some of said rolls to move the belts through said bath whereby the belts will carry the filamentary materials through said bath, said belts being twisted through an angle of 180 degrees in its upward and downward passages between the upper rolls and the lower rolls whereby the filamentary materials will be carried around the upper rolls and the lower rolls on the outside of the belts and not contact the rolls, said lower rolls being directly beneath said upper rolls thereby providing for a substantially vertical course of travel of the belt and filamentary materials.

4. Apparatus as set forth in claim 3 in which said upper and lower rolls have parallel grooves extending around the periphery thereof for receiving said belts.

5. Apparatus as set forth in claim 3 in which said lower rolls are in said bath and said belts pass freely between said rolls.



6. Apparatus as set forth in claim 3 in which said belts are flat and there are means for contouring said belts to form channels therein for receiving the filamentary materials during the treatment.

7. Apparatus as set forth in claim 3 in which said belts have a contour including a channel for receiving the filamentary materials during the treatment and said belts have slits for releasably engaging the filamentary materials.

8. In a process for the treatment of filamentary materials, the steps which comprise supporting said filamentary materials on an endless flexible belt, which belt is trained zig-zag over a plurality of upper rolls and under a plurality of lower rolls parallel to said upper rolls and which belt travels upwardly and downwardly through a liquid treating bath during its passages between said rolls and is twisted through an angle of 180 degrees in its upward and downward passages between said rolls whereby the filamentary materials will be carried around the upper rolls and the lower rolls on the outside of the belt and will not contact the rolls, and applying a force to drive at least some of said rolls to move the belt through the treatment apparatus whereby the belt will carry the filamentary materials through the treatment apparatus, said lower rolls being directly beneath said upper rolls thereby providing for a substantially vertical course of travel of the belt and filamentary materials.

9. Process as set forth in claim 8 in which said filamentary materials are stretched organic acid ester of cellulose filamentary materials and said liquid bath is a liquid saponification bath for converting said cellulose ester to cellulose.

10. In a process for the simultaneous treatment of a plurality of ends of filamentary materials, the steps which comprise supporting said filamentary materials on a plurality of endless flexible belts, which belts are trained zig-zag over a purality of upper rolls and under a plurality of lower rolls parallel to said upper rolls and which belts travel upwardly and downwardly through a liquid treating bath during their passages between said rolls and are twisted through an angle of 180 degrees in their upward and downward passages betwen said rolls whereby the filamentary materials will be carried around the upper rolls and the lower rolls on the outside of the belts and will not contact the rolls, and applying a force to drive at least some of said rolls to move the belts through the treatment apparatus whereby the belts will carry the filamentary materials through the treatment apparatus, said lower rolls being directly beneath said upper rolls thereby providing for a substantially vertical course of travel of the belt and filamentary materials.

11. Process as set forth in claim 10 in which said filamentary materials are stretched organic acid ester of cellulose filamentary materials, said liquid bath is a liquid saponification bath for converting said cellulose ester to cellulose, said lower rolls are in said bath, said belts pass freely between said rolls, and said belts carrying the resulting cellulose filamentary material pass in the same zig-zag fashion through a water bath for washing the material.


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