

Aug. 6, 1940.

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2,210,161

PRODUCTION OF FILAMENTARY STRUCTURES

Filed Oct. 23, 1937

2 Sheets-Sheet 1

Fig. 1.

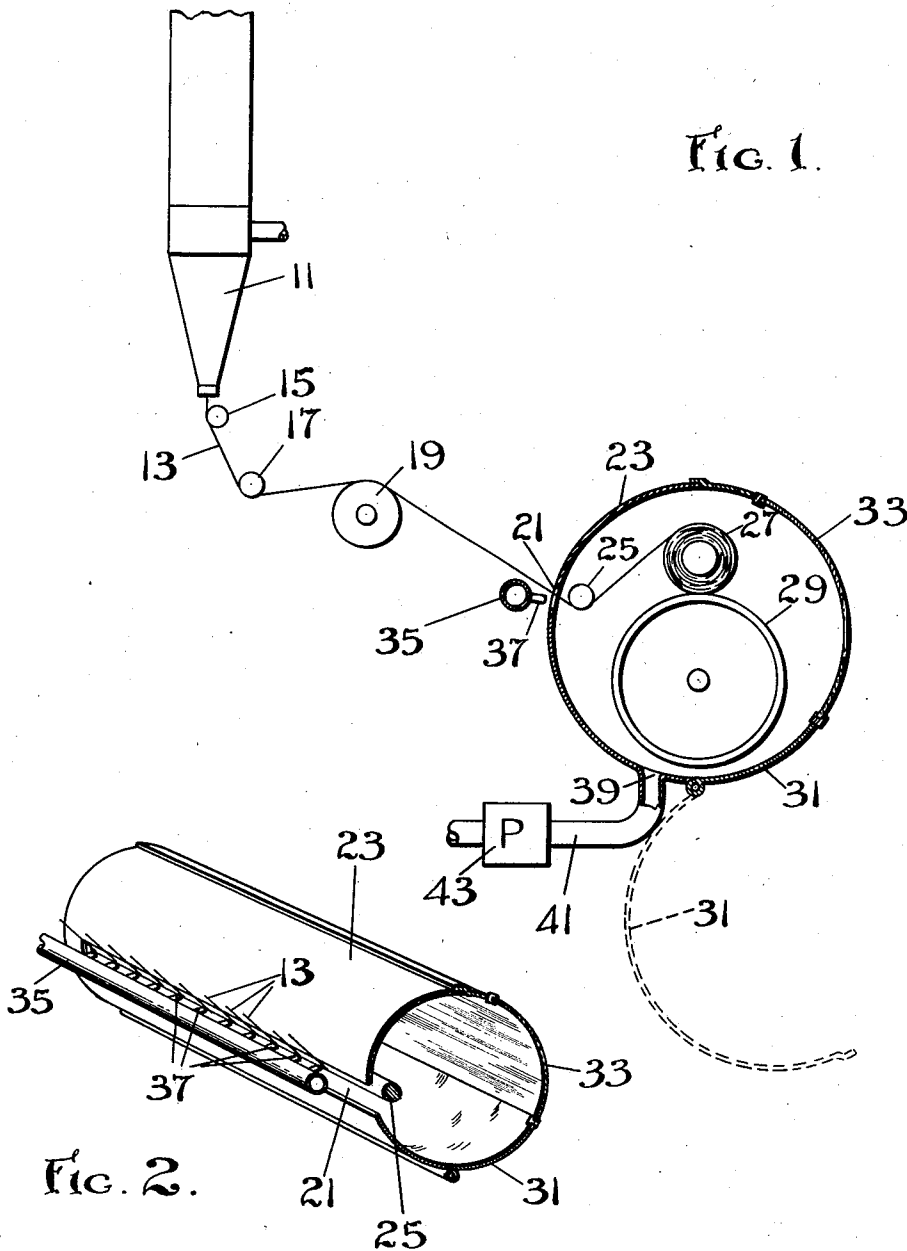


Fig. 2.

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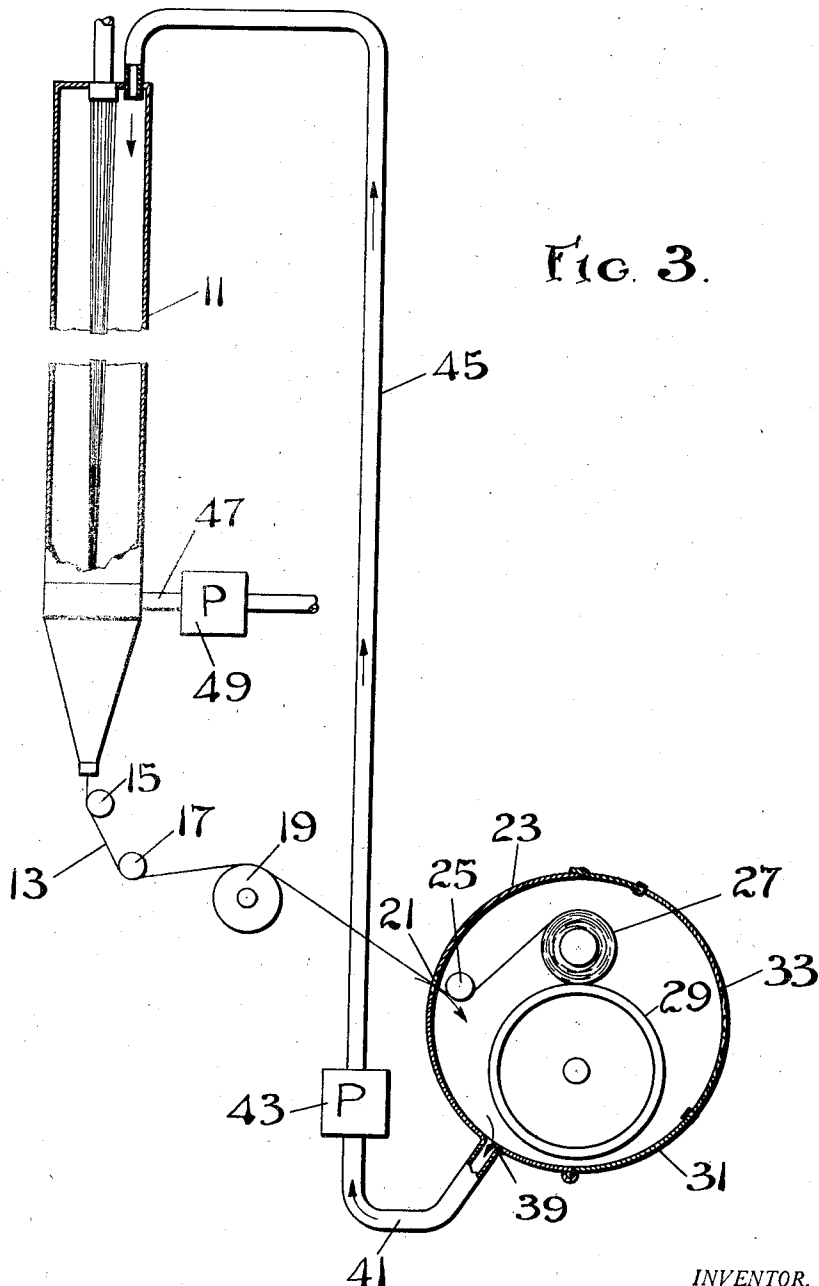
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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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PRODUCTION OF FILAMENTARY  
STRUCTURES

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2 Claims. (Cl. 18—54)

The present invention relates to the production of filamentary structures from filament-forming materials dissolved in volatile solvents. More particularly, the invention relates to the spinning of threads from filament-forming materials dissolved in volatile solvents and more completely and efficiently recovering the volatile solvents used in forming the solutions.

In the conventional method for spinning threads from filament-forming material dissolved in volatile solvents, such as cellulose esters and ethers, the solution is extruded into a heated enclosure generally referred to in the art as a "spinning cell." An evaporative gaseous medium, for example, air, is passed through the spinning cell either concurrently or countercurrently, to remove volatile solvents from the formed filaments and thereby cause the same to set up or coagulate into a finished thread which may be wound onto a collecting device such as a bobbin or cop.

In the first known spinning cells, the spinning solution was extruded into a cell containing an evaporative medium, and the yarn resulting from evaporation of the solvent from the filaments was wound on a collecting device positioned within the spinning cell. This construction was, however, quite unsatisfactory since the collecting device, consisting generally of a rotating bobbin or the like, set up eddy currents within the spinning cell, and the operation of supervising and doffing of the bobbin was also quite difficult to perform.

These difficulties were overcome by the use of apparatus in which the thread wind-up was positioned outside the spinning cell. As the spinning speeds were gradually increased in the industry, it was found convenient to space the wind-up device from the spinning cell a distance of at least 2 feet or more. It has been discovered that when the wind-up device is spaced from the spinning cell a distance of 2 feet or more and the speeds of spinning the thread are comparatively high, there is a considerable loss of residual solvent which remains in the thread as it passes from the spinning cell. In some cases, it is found that the yarn as it passes from the spinning cell contains as much as 10 to 15 per cent solvent based on the weight of the dry thread.

Many attempts have been made, heretofore, to eliminate this loss of residual solvent. For example, the use of a longer spinning cell has been advocated to more completely remove the solvent from the thread. It has also been suggested to maintain the evaporative medium within the spinning cell at a higher temperature. It has

also been suggested to pass the yarn through steam or other heated evaporative medium to remove the residual solvent. A still further suggestion comprised the passing of the thread through a secondary enclosure after it passes through the spinning cell and before it is passed to the wind-up device. As far as known, none of these previously suggested methods have been entirely satisfactory in reducing the losses of residual solvents from the thread.

It is therefore an object of the present invention to reduce the losses of residual solvent left in the yarn when spinning in an apparatus in which the wind-up device is spaced a substantial distance from the spinning cell.

It is another object of the present invention to reduce the residual solvent left in the yarn in a relatively inexpensive and simple manner without interfering with the convenient operation of the spinning cell.

It is a more specific object of the present invention to reduce the residual solvent in the thread spun in a heated spinning cell from a solution of a fiber-forming material in a volatile solvent, and which thread is then passed to a winding device which is spaced from the spinning cell.

Other objects of the invention will appear hereinafter.

It has now been discovered that when dry-spinning threads at high speeds from solutions of filament-forming materials, in volatile solvents, and in apparatus in which the wind-up device is spaced a material distance from the spinning cell, very little of the residual solvent in the thread after passing from the spinning cell will be lost in its travel from the cell to the wind-up device. This portion of the thread, therefore, can remain uncovered if the wind-up device will be substantially enclosed and an evaporative medium is passed through the enclosure and led to eventual solvent recovery.

According to the present invention, therefore, the yarn is led in the usual manner from the spinning cell through open air for a distance of at least 2 feet to a rotating wind-up device. The rotating wind-up device, however, is enclosed substantially completely so that the evaporative medium surrounding the wind-up may be withdrawn and the volatile liquid recovered therefrom in any suitable manner. The solvent laden evaporative medium withdrawn from the wind-up device enclosure may be introduced, at any appropriate point, in the spinning cell to serve in

whole, or in part as the evaporative medium normally employed in the spinning cell.

The invention will be more easily understood by reference to the following detailed description when taken in connection with the accompanying illustrations in which:

Figure 1 is a diagrammatic side elevational view showing the combination of a spinning cell, a wind-up device, and enclosure surrounding the wind-up device.

Figure 2 is a perspective view showing a plurality of threads passing from a spinning cell (not shown) into the enclosure containing the wind-up device, and showing a conduit for passing of an evaporative medium into the enclosure.

Figure 3 is a diagrammatic side elevational view of a spinning cell and enclosed wind-up device combination in which the passage of the evaporative medium is somewhat modified from that shown in the device in Figure 1.

Referring to Figure 1 of the drawings, reference numeral 11 designates the end of a spinning cell through which the freshly formed thread is drawn. The spinning cell is heated in any desired manner and is provided with means for passing a drying and evaporative medium, such as air, therethrough, for the purpose of removing as much as possible of the volatile solvent from the freshly formed thread. The thread 13 as it leaves the spinning cell passes over guide rollers 15 and 17, feed roller 19 and thence through opening 21 of the enclosure 23. From this point, the thread passes over guide roller 25 and then onto the collecting device 27 shown in Figure 1 as a bobbin. The bobbin may be rotated in any desired manner such as, for example, contact with a surface drive roller 29. One side of the enclosure 23 is provided with a hinged member 31 which will open as shown by dotted lines so that the bobbin may be easily doffed after it has been filled. It is preferred that the pivoted member 31 is provided with a transparent window 33 so that the winding operation may be easily supervised or observed. The evaporative medium which usually comprises air but may consist of nitrogen, carbon dioxide or other gas, may be passed into the enclosure 23, for example, by means of conduit 35 and jets 37. The evaporative medium is withdrawn from the enclosure 23 by means of an outlet opening 39, conduit 41 and a pump or fan 43. The evaporative medium, containing the volatile solvent, may be passed through a solvent recovery apparatus, such as, for example, an activated carbon absorbent tower.

Figure 2 shows the position conduit 35 and the plurality of jets 37 relative to the opening 21 in the enclosure 23. It will be noted that the enclosure 23 is sufficiently long to permit the winding of and solvent recovery from a number of threads.

Referring to Figure 3 of the drawings, the evaporative medium containing the volatile solvent after it has been withdrawn from the enclosure 23, is passed through the conduit 45 to the top of the spinning cell 11 where it is passed concurrently with the movement of the thread through the cell to remove volatile solvent from the freshly formed thread. The gases are removed from the spinning cell through conduit 47 by means of a pump 49, or the like, and thence passed to a solvent recovery apparatus. This particular form of apparatus permits the building up of the volatile solvent in the evaporative medium to the point where it can be more expe-

ditiously extracted in the solvent recovery apparatus.

The present invention has particular utility in removing the residual solvents from threads which are being spun at high speeds. Obviously, the higher the speed of the thread, the greater will be the percentage of volatile solvent remaining therein. The present invention involves a very considerable saving when applied to apparatus in which the thread is spun at a speed of at least 100 yards per minute in the case of heavy filament yarn and at least 200 yards per minute in the case of light filament yarn. In designing the enclosure of the wind-up device, it is preferred that the evaporative medium is withdrawn from the enclosure with a slight vacuum so that the pressure within the enclosure is always less than the pressure of the outer atmosphere and thereby substantially prevents the escape of the evaporative medium into the atmosphere. The aperture in the enclosure through which the rapidly traveling thread is passed to the wind-up should be sufficiently large to admit the ready passage of the thread, and it is also desirable that the evaporative medium be drawn into the enclosure at this point. The evaporative medium is preferably drawn into the enclosure at the rate of at least 10 feet per minute and preferably at the rate of at least 50 feet or more. The volume of evaporative medium passing into the enclosure is preferably at the rate of at least 2,000 liters per hour. This volume can be increased to 12,000 liters per hour or more. The temperature of the evaporative medium which is introduced should be at least 20 degrees centigrade but should not be at a high enough temperature to harm the thermoplastic yarn. It is preferred, that at least a portion of the evaporative medium be introduced as a gas stream directly onto the rotating wind-up. In the spinning of cellulose acetate from an acetone solution, the evaporative medium is preferably air containing not more than 15 grams per cubic meter of acetone, and is introduced by suitable aspiration at a rate of from 2,000 to 12,000 liters per hour per wind-up position. The necessary control of the rate of passage of the evaporative medium may be secured with suitable flow meters or manometers in a known manner.

The enclosure, substantially surrounding the wind-up may, of course, be of any shape best adapted to the given type of rotating wind-up. Generally, whenever otherwise suitable, it is preferred that the enclosure be smoothly curved rather than of angular contour since stagnant corner pockets are thereby avoided to a large extent and any adverse condition, such as eddy currents created by the motion of the rotating wind-up and attendant disadvantages are more readily eliminated. Generally, also it is preferred to have the enclosure small enough in size that the rotating wind-up is surrounded as closely as will be permitted by efficient operation.

The principle of the invention, namely, substantially enclosing the wind-up so as to enable recovery of the vapors of a volatile liquid which accumulates in the immediate vicinity of the wind-up through diffusion of the volatile liquid from the yarn during formation of the yarn cake on the rotating wind-up, is obviously adaptable to any type of rotating wind-up whether the same is a face driven or spindle driven collector, or a cap spinning take-up. With each type of wind-up, suitable adjustment, of course, will be made in the size and shape of the en-

closure, in the position of the inlet and outlet ducts for the evaporative medium, in the aspiration rate, etc., to meet the given set of conditions. Such adjustments, however, may be readily made by a skilled technician in a known manner.

The enclosure of the wind-up may be constructed of metal, glass, or other material not adversely affected by the volatile liquid to be recovered from the thread. Preferably, however, at least the upper portion of the enclosure is built of a transparent material through which the winding operation may be watched and supervised. A flexible, transparent, relatively thick sheet of cellulose acetate or of a polymerized vinyl or acrylic acid compound is especially suitable for such purpose. In order to facilitate easy doffing of the finished yarn cakes from the wind-up positions, the enclosure either is provided with a snug-fitting shutter which may be slid back to provide the necessary opening, or is furnished with an arrangement whereby the upper portion of the enclosure may be laid back or raised away from the wind-up.

Any suitable gas such as nitrogen and carbon dioxide may serve as the evaporative medium. Generally, however, air is used for the purpose. The air may be used as such or it may be purified, humidified, chilled, heated, mixed with steam or otherwise treated before introduction into the enclosure. If acetone is the volatile liquid being recovered, it is also desirable that the air contain initially not more than 15 grams per cubic meter of acetone. A particularly desirable procedure for efficient recovery of the volatile liquid is to position the evaporative medium inlet duct so that a stream of heated air impinges on the rotating yarn cake during formation. The inlet air in such case may advantageously be derived by heating and compressing air taken in whole or in part from the same enclosure.

The volatile liquid, such as acetone and/or ethyl alcohol, contained in the evaporative medium removed from the enclosure may be recovered therefrom in any convenient and suitable fashion. Thus, the evaporative medium may be passed into an activated carbon adsorption tower and the activated carbon may subsequently be heated to recover the volatile liquid in a concentrated form. Or, if desired, the evaporative medium may be passed into a water scrubbing tower, and the aqueous solution so formed heated later to recover the acetone and/or ethyl alcohol in a concentrated form. Or, the heated or chilled evaporative medium removed from the enclosure may be introduced at any suitable point along the length of the spinning cell to form part or all of the regular evaporative medium of the cell.

The process of the invention may obviously be applied to the recovery of a volatile liquid from any artificial yarn consisting of a cellulose ester, of a cellulose ether such as methyl, ethyl, or benzyl cellulose, of a polyvinyl alcohol or acetal and/or derivatives thereof, of rubber hydrochloride, or any other such type of material. The liquid may also be any volatile one, such as acetone, methyl ethyl ketone, methyl alcohol, ethyl alcohol, ethylene glycol, methylene chloride, ethylene chloride, propylene chloride, methyl acetate, ethyl acetate, ethyl lactate, ethyl alpha-hydroxybutyrate, glycol formal, glycerine formal, dioxane, diacetone alcohol, etc. While perhaps of greatest advantage in recovery of volatile liquid residual in a continuously dry spun yarn, still the invention is also broadly of great value in re-

ducing losses wherever volatile liquids are retained in the yarn at the winding stage. Thus, the process may advantageously be employed in various wet spinning operations, in stretch spinning, or in sizing and finishing operations wherein volatile liquid remains in the yarn to be wound.

By the term "yarn," as used throughout the instant specification, it will be understood to include ribbon, straw, thread, cord, and continuously "spun" yarn prepared either by assembling staple lengths of artificial thread or by partial fraying and/or cutting of a continuous thread as well as a thread continuously spun from a dry or wet spinning machine.

The enclosure need not necessarily surround completely the wind-up, but should, however, surround the same to a sufficient extent that substantially all the evaporative medium from the immediate vicinity of the wind-up may be recovered when employing the conditions described above.

The process and apparatus of the invention permits an effectual recovery of volatile liquids which previously represented for the most part a complete economic loss. The recovery, for example, is more complete than by the use of a very long spinning cell even though the yarn is exposed to an open air travel of two feet or more. In fact, by virtue of the invention even in a shorter spinning cell than customarily used, for instance, six feet in length, the volatile solvent may be recovered substantially completely. Possibly, this is due to the volatile liquid being centrifuged from the yarn cake as well as having more time to diffuse from the yarn while on the rotating windup than during travel through a spinning cell. Heretofore, it has not been considered feasible to recover volatile solvent from yarn which has been spun through a heated spinning cell and after the winding operation was begun. The apparatus also has the advantages of being easy to keep clean, of not interfering with spinning, of ready doffing and of easy supervision, particularly when the upper portion of the enclosure is constructed of a transparent material.

Since it is obvious that many changes and modifications can be made in the details of the invention as above described, it is to be understood that the invention is not to be limited by the above-described details except as set forth in the appended claims.

I claim:

1. In the spinning of threads at relatively high speeds from a filament-forming solution containing a volatile solvent, the steps comprising passing freshly spun threads from a spinning cell through the open room atmosphere for a distance of two feet or more to a wind-up position, reducing the solvent content of said threads in said spinning cell by contact with a heated gaseous evaporative medium to such an extent that substantially no solvent is removed during passage of said threads through the open room atmosphere, removing the major portion of residual solvent remaining in said threads by contacting said threads with a heated gaseous evaporative medium as they are being collected in the wind-up position, and recovering the volatile solvent from all of the evaporative medium with which the threads have been contacted.

2. In the spinning of threads at relatively high speeds from a filament-forming solution containing a volatile solvent, the steps comprising passing freshly spun threads from a spinning cell

through the open room atmosphere for a distance of two feet or more to a wind-up position; reducing the solvent content of said threads in said spinning cell by contact with a heated gaseous evaporative medium to such an extent that substantially no solvent is removed during passage of said threads through the open room atmosphere, removing the major portion of residual solvent remaining in said threads by contacting said threads with a heated gaseous evaporative medium as they are being collected in the wind-up position, employing the evaporative medium containing volatile solvent from contact with said threads in the wind-up position as evaporative medium for contacting the freshly spun threads in said spinning cell, and recovering the volatile solvent from all of the evaporative medium with which the threads have been contacted.

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