

Sept. 22, 1959

D. W. GROOMBRIDGE ET AL
MANUFACTURE OF VOLUMINOUS YARNS

2,904,953

Filed Nov. 9, 1955

FIG. 1

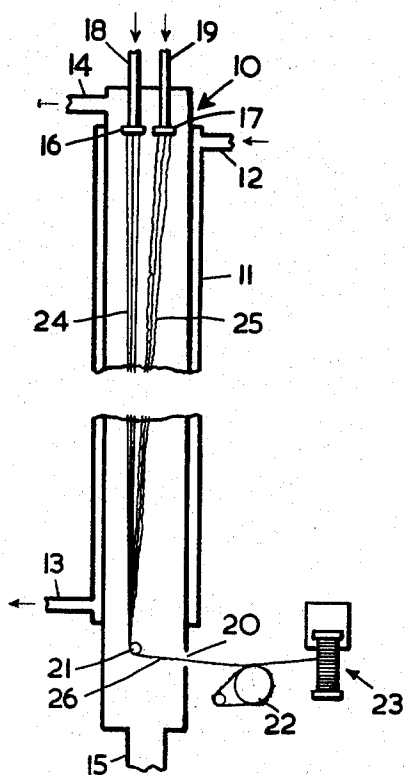
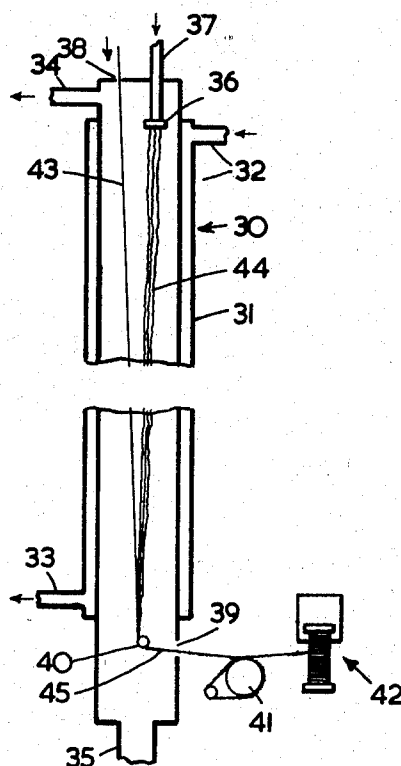


FIG. 2



D. W. GROOMBRIDGE
S. G. HAWTIN
J. DOWNING
INVENTORS

L. B. Groombridge & S. G. Hawtin
ATTORNEYS

1

2,904,953

MANUFACTURE OF VOLUMINOUS YARNS

Denis William Groombridge, Selwyn George Hawtin, and John Downing, Spondon, near Derby, England, assignors to British Celanese Limited, a corporation of Great Britain

Application November 9, 1955, Serial No. 545,905

Claims priority, application Great Britain November 16, 1954

14 Claims. (Cl. 57—157)

This invention relates to the manufacture of voluminous yarns, that is to say, yarns having a high bulk in relation to their weight.

Various methods of making voluminous yarns are known, but for the most part these earlier methods have the disadvantage that, if yarns produced thereby are temporarily subjected to tension, they suffer to some degree a permanent reduction in voluminosity. It is an object of the present invention to provide a method of making voluminous yarns which are free from this disability.

According to the invention voluminous yarns are made by extruding a solution of a filament-forming substance in a volatile solvent (i.e. a solvent from which the said filament-forming substance can be dry spun) into an evaporative atmosphere at a high linear rate such that the filaments formed are crinkled, and doubling the said crinkled filaments with a substantially uncrinkled support thread. Preferably the crinkled filaments are brought into contact with the support thread during their travel from the spinning jet by means of which they are formed and before they are collected or taken up. Thus the crinkled filaments and support thread are advantageously brought into contact in the spinning cell.

The crinkled filaments and the support thread may be chemically similar or different. For example they may both have a basis of a lower fatty acid ester of cellulose, especially an acetone-soluble cellulose acetate or a cellulose triacetate, i.e. a cellulose acetate of acetyl value above 59% reckoned as acetic acid, or of some other material that may be converted into filaments by the dry spinning technique, e.g. a polymer or copolymer of acrylonitrile, vinyl chloride or another vinyl compound. (The term "lower fatty acid" is employed to denote acids containing up to 4 carbon atoms in the molecule.) Alternatively crinkled filaments and the support thread may differ in chemical constitution; for instance crinkled filaments of cellulose acetate may be doubled with a regenerated cellulose support thread made either by the viscose process or, especially when a particularly strong yarn is desired, by the saponification of a cellulose acetate yarn that has been stretched while in a softened condition. Again, the support yarn may be made of a high linear polyamide or polyester, especially a polyamide derived from amino-caproic acid or from adipic acid and hexamethylene diamine, or a polyester derived from ethylene glycol and terephthalic acid. The use of chemically different crinkled filaments and support yarns is of advantage when it is desired to produce differential dyeing or analogous effects.

The voluminosity of the yarn will vary with the ratio of the total denier of the crinkled filaments to the denier of the support thread, and also with the number of the crinkled filaments. High voluminosity results from a denier ratio equal to or greater than unity, and also from the use of a larger number of finer crinkled filaments rather than a smaller number of coarser filaments of similar total denier. Thus by suitably choosing the denier ratio, the number of crinkled filaments, and the natures

2

of the crinkled filaments and support thread, it is possible in accordance with the invention to produce yarns of a wide range of voluminosity and general appearance.

In one method of putting the invention into practice the crinkled filaments and the support thread are formed simultaneously in a single dry spinning cell, and in another the crinkled filaments are doubled with a pre-formed support thread. In both methods the crinkled filaments are preferably brought into contact with the support thread in the spinning cell in which they are made. The first method is of course useful only when the materials of the crinkled filaments and the support thread are either identical or at least may be dry spun under similar evaporative conditions, preferably from the same solvent. The second method is particularly adapted for use when the support thread differs in chemical nature from the crinkled filaments and cannot be formed by dry spinning under similar conditions, though its use is not restricted to such cases.

In describing the invention in more detail, it will be convenient to refer particularly to the production of voluminous yarns in which the crinkled filaments and the support thread both have a basis of acetone-soluble cellulose acetate and are formed simultaneously. Such yarns may be made by extruding an acetone solution of the cellulose acetate into an evaporative atmosphere, e.g. into a current of air passing up a heated spinning cell, through adjacent spinning jets fed by means of different spinning pumps and filters. The two spinning jets may be fed from a common source or from different sources of spinning solution, and the solution fed to either or both jets may if desired contain an effect material, e.g. a finely divided white or coloured pigment or a dyestuff. One of the jets is caused to produce crinkled filaments by forcing the spinning solution through its orifices at a very high linear rate, as explained in more detail below. The other jet is operated under conditions such as are known for the production of substantially uncrinkled filaments of cellulose acetate.

The minimum linear rate at which the spinning solution must be extruded to produce crinkled filaments is substantially higher than the speed at which the solution immediately after extrusion, and the filaments formed from it, will tend to travel under the influence of the various forces acting on them at any point up to and including that at which the filaments come into contact with the support thread. The forces acting on the extruded solution and the filaments include the pull exerted on the filaments by the support thread, friction with the evaporative atmosphere, and gravitation, and the effect of these forces, and the minimum useful linear rate of extrusion, will vary with inter alia the viscosity of the spinning solution and the diameter of the jet orifices. For example when a cellulose acetate of viscosity (in 26% acetone solution at 25° C.) between about 250 and 400 centipoises is to be spun and the concentration of the spinning solution is 20–30%, and especially between 25 and 27% the minimum linear rate of extrusion through orifices of diameter 0.03 mm. is about 150 metres per minute and for orifices of diameter 0.05 mm. is about 650 metres per minute; for orifices of diameter 0.075 mm. and 0.10 mm. the corresponding figures are in the neighbourhood of 850 and 1000 metres per minute. If a cellulose acetate of higher viscosity or a solution of higher concentration is used, so that the viscosity of the spinning solution is increased, the minimum linear extrusion rate will be somewhat lower.

It is usually preferable that the linear extrusion rate actually employed for a given spinning solution using orifices of a given diameter should not greatly exceed the minimum rate at which crinkled filaments are formed under these conditions, since considerably higher

rates not only involve the use of spinning pressures that may be inconveniently high, but may also give a less satisfactory product.

It is important that any tension applied to the crinkled filaments before they are combined with the support thread should be very low, and it has been found advisable that the rate of travel of the support thread, when the crinkled filaments first make contact with it and begin to be carried along by it, should be less than about 0.8, and especially between 0.35 and 0.75 times the linear rate of extrusion of the crinkled filaments. Still lower speeds may be used if desired, but higher speeds may result in the crinkled filaments being pulled out to some extent, and the voluminosity of the product then suffers.

When a pre-formed support thread is to be used, as in the second of the methods of working referred to above, the spinning cell need contain only the jet used for forming the crinkled filaments, and the support thread may be led into the cell at any convenient point and caused to pass close to the jet and travel in the same general direction as the crinkled filaments, preferably at a speed below 0.8, and especially between 0.35 and 0.75, times the linear rate of extrusion of the crinkled filaments. The pre-formed support thread is preferably of low or zero twist, e.g. of a degree of twist below 5, and preferably below 3, turns per inch.

If desired two or more ends of voluminous yarn may be made using a single spinning cell containing a plurality of spinning jets for making crinkled filaments, and either an equal number of jets for making support threads, or means for leading an equal number of pre-formed support threads through the cell.

The combined yarn is preferably simultaneously twisted and wound up outside the spinning cell, for example by means of a cap spinner or a ring spinner. Advantageously the degree of twist inserted is quite low, e.g. between 1 and 5 turns per inch and especially between 2 and 3.5 turns per inch. When a pre-formed support thread of low twist has been used in making the combined yarn, the twist inserted by the winding device may be in the opposite sense, and may if desired also be equal or nearly equal in degree, so producing a voluminous yarn of which the support thread itself is free or nearly free from twist.

The appearance of yarns produced in accordance with the invention may, if desired, be modified by passing them under tension more or less sharply round one or more guides to cause some or all of the crinkled filaments to break at intervals. The effect of this is to give the yarn something of the appearance of yarn spun from staple fibre.

Apparatus which may be used for making voluminous yarns by the methods described above is illustrated diagrammatically in the accompanying drawing, in which

Figure 1 is a cross-section from front to back of a spinning device in which the crinkled filaments and the support thread are formed simultaneously, and

Figure 2 is a cross-section from front to back of a spinning device in which the crinkled filaments are doubled with a pre-formed support thread.

Referring now to Figure 1 of the drawing, the apparatus illustrated comprises a dry spinning cell generally indicated by the reference numeral 10 and provided with a heating jacket 11 having an inlet 12 and an outlet 13 for a heating fluid. At the upper end of the cell is an air outlet 14 communicating with suction means (not shown), by means of which air may be drawn from the cell, and at the lower end an opening 15 through which air can enter the cell. At its upper end the cell contains two downwardly facing spinning jets 16 and 17 for forming a support thread and crinkled filaments respectively, fed by pipes 18 and 19 communicating with the same or different sources of spinning solution (not shown). In one side of the cell near its lower end is a

lateral opening 20, and approximately on the axis of the cell at about the same level a yarn guide 21. A feed roller 22 is positioned outside the cell opposite the lateral opening 20, and a cap spinning device 23 is positioned beyond the feed roller 22.

In operation air is drawn through the cell 10 from the opening 15 at its lower end to the outlet 14 at the top, and a heating fluid is passed through the jacket 11. The spinning jets 16 and 17 may be similar or may be different, as explained above, and the rates at which the spinning solution or solutions are fed to the two jets are of such absolute values and so related to the rate at which the feed roller 22 is driven that filaments 24 produced by the jet 16 are drawn through the cell 10 under a degree of tension, while filaments 25 produced by the jet 17 are not only substantially free from tension but also become highly crinkled. The jets 16 and 17 are so positioned that at some point in the cell above the yarn guide 21, e.g. a short distance above it, the straight filaments 24 and the crinkled filaments 25 come together to form a unitary voluminous yarn 26, which is drawn through the lateral opening 20 by the feed roller 22 and passes thence to the cap spinner 23 where it is given a low degree of twist and wound up.

The apparatus illustrated in Figure 2 comprises a dry spinning cell generally indicated by the reference numeral 30 and provided with a heating jacket 31 having an inlet 32 and outlet 33 for a heating fluid. At the upper end of the cell is an air outlet 34 communicating with suction means (not shown), and at the lower end an opening 35 through which air can enter the cell. At the upper end of the cell is a downwardly facing spinning jet 36 fed by a pipe 37. There is also provided at the top of the cell a small opening 38 of diameter equal to or a little greater than that of the support thread to be used. At one side of the cell towards its lower end is a lateral opening 39 and at about the same level and about on the axis of the cell a yarn guide 40. A feed roller 41 is situated outside the cell at about the same level as the lateral opening 39, and beyond it is a cap spinner 42.

In operation a current of air is drawn through the cell from the opening 35 at its lower end to the outlet 34 near the top, while a heating fluid is passed through the jacket 31. A pre-formed support thread 43 is passed through the opening 38 in the top of the cell and travels round the yarn guide 40 through the lateral opening 39 to the feed roller 41. At the same time a spinning solution is pumped through the pipe 37 to the jet 36 at a suitably high flow rate so that the filaments 44 produced by the jet have a high degree of crinkle. Before they reach the yarn guide 40 the support thread 43 and the crinkled filaments 44 come together to form a unitary voluminous yarn 45 which is drawn from the cell by the feed roller 41 and given a low degree of twist and wound up on the cap spinner 42.

The invention is also illustrated by the following examples.

Example I

The apparatus employed comprised a dry-spinning cell containing two spinning jets arranged side by side, and provided with a draw roll and a cap spinner to take up the yarn produced, all as illustrated in Figure 1. One of the jets by means of which crinkled filaments were formed, had 26 orifices each of diameter 0.036 mm.; the other, by means of which a support thread was formed, had 42 orifices each of diameter 0.042 mm. The wall of the spinning cell was heated to 67° C.

A 26.2% solution of cellulose acetate in acetone at 60° C. was fed at equal volume rates of flow to the two spinning jets. The crinkled filaments produced by the one jet, and the support thread produced by the other, were drawn out of the cell as a single combined yarn by means of the draw roll at a speed of 85 metres per minute, and then simultaneously wound up and given

5

a twist of 2.5 turns per inch by means of the cap spinner. The product was a voluminous yarn of denier 600, having a very soft handle.

Example II

A similar product could be obtained if, instead of forming the support thread in the cell, a pre-formed 300 denier 42 filament thread of substantially zero twist was drawn from a package through the cell at 85 metres per minute, and combined with crinkled filaments of total denier 300 made as described above, using apparatus as illustrated in Figure 2. A regenerated cellulose support thread, or a support thread consisting of a high linear polyamide made by polymerising caprolactam, could be substituted for the cellulose acetate thread.

Example III

The apparatus described in Example I was again employed, except that the jet to be used to form the crinkled filaments had 26 orifices each of diameter 0.036 mm., while that to be used to form the support thread had 52 orifices each of diameter 0.08 mm. The spinning solution was again a 26.2% solution of cellulose acetate in acetone at 60° C., and was supplied at equal volume rates of flow to the two jets. The combined yarn was drawn from the cell at 100 metres per minute, and then simultaneously wound up and given a twist of 2.5 turns per inch. The product was similar to that of Example I, but of denier 750.

Example IV

The apparatus described in Example I was again employed, except that the jets used to form the crinkled filaments and the support thread were identical, each having 26 orifices each of diameter 0.036 mm., and the spinning solution (again a 26% solution of cellulose acetate in acetone at 60° C.) was fed 4 times as fast to the one jet as to the other, the calculated linear speeds of extrusion from the two jets being about 160 and 40 metres per minute respectively. The crinkled filaments produced by the first jet and the support thread produced by the second were drawn from the cell as a single combined yarn by means of the draw roll at about 85 metres per minute and given a twist of 2.5 turns per inch by means of the cap spinner. The product was a voluminous yarn similar to that produced in Example I.

By employing suitable spinning jets voluminous yarns of lower denier, for example of denier down to about 150, can readily be made.

Although in the process as described above circular spinning orifices of the usual kind are employed, orifices having other cross-sections, e.g. slot-like or crescent shaped orifices, may be used if desired, especially in the spinning jet by which the crinkled filaments are spun. By this means voluminous yarns of characteristic appearance can be made, and their appearance can be modified by subsequently boiling them in water or aqueous solutions, e.g. soap solutions. Moreover further different effects may be obtained by using more than one support thread; for example a second thread, which may be termed a binding support thread, may come into contact with the yarn already formed from the crinkled filaments and the first support thread, preferably before it is twisted as on the cap spinner referred to in the examples.

Having described our invention what we desire to secure by Letters Patent is:

1. Process for the manufacture of voluminous yarns, which comprises extruding a solution of a filament-forming substance in a volatile solvent into an evaporative atmosphere at such a high linear rate that the filaments formed by evaporation of the said solvent are immediately

6

crinkled, and doubling the said crinkled filaments with a substantially uncrinkled support thread.

2. Process according to claim 1, wherein the crinkled filaments are brought into contact with the support thread during their travel from the spinning jet by means of which they are formed and before they are taken up.

3. Process according to claim 2, wherein the support thread when the crinkled filaments first make contact with it is travelling at a rate between 0.35 and 0.75 times the linear rate of extrusion of the crinkled filaments.

4. Process according to claim 3, wherein the crinkled filaments and the support thread are formed simultaneously in a single dry spinning cell.

5. Process according to claim 3, wherein the crinkled filaments are doubled with a pre-formed support thread.

6. Process according to claim 5, wherein both the crinkled filaments and the support thread consist essentially of cellulose acetate.

7. Process according to claim 4, wherein both the crinkled filaments and the support thread consist essentially of cellulose acetate.

8. Process according to claim 5, wherein the crinkled filaments consist essentially of cellulose acetate and the support thread consists essentially of regenerated cellulose.

9. Process according to claim 5, wherein the crinkled filaments consist essentially of cellulose acetate and the support thread consists essentially of a high linear condensation polymer selected from the group which consists of polyamides and polyesters.

10. Process for the manufacture of voluminous yarns, which comprises extruding a solution of a cellulose acetate in a volatile solvent into an evaporative atmosphere at such a high linear rate that the filaments formed by evaporation of the said solvent are immediately crinkled, and doubling the said crinkled filaments with a substantially uncrinkled cellulose acetate support thread formed simultaneously by extrusion in the same dry spinning cell and travelling at a rate between 0.35 and 0.75 times the linear rate of extrusion of the crinkled filaments, the said doubling being effected before the crinkled filaments are taken up, the total denier of the crinkled filaments being greater than that of the support thread, and the doubled yarn being given a twist between 1 and 5 turns per inch.

11. Process according to claim 1, wherein the total denier of the crinkled filaments is greater than the denier of the support thread.

12. Process according to claim 1, wherein the doubled yarn is given a twist of between 1 and 5 turns per inch.

13. Process according to claim 12, wherein the support thread when it first makes contact with the crinkled filaments has a twist of between 1 and 5 turns per inch in the direction opposite to that in which the doubled yarn is to be twisted.

14. Process according to claim 1, wherein at least some of the crinkled filaments in the doubled yarn are broken at intervals by passing the yarn under tension sharply around one or more guides.

References Cited in the file of this patent

UNITED STATES PATENTS

2,234,763	Hoelkeskamp	Mar. 11, 1941
2,262,872	Whitehead	Nov. 18, 1941
2,328,074	Hunter	Aug. 31, 1943
2,369,395	Heymann	Feb. 13, 1945
2,517,946	Von Kohorn	Aug. 8, 1950

FOREIGN PATENTS

471.313	Great Britain	Sept. 1, 1937
---------	---------------	---------------