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SPINNERET UNIT AND METHOD FOR THE SPINNING OF CHEMICAL FILAMENTS

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2 Sheets-Sheet 1

Fig. 1

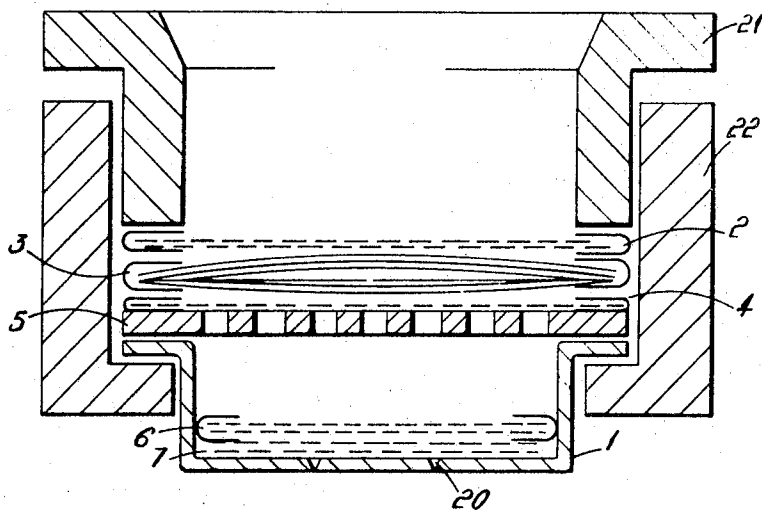
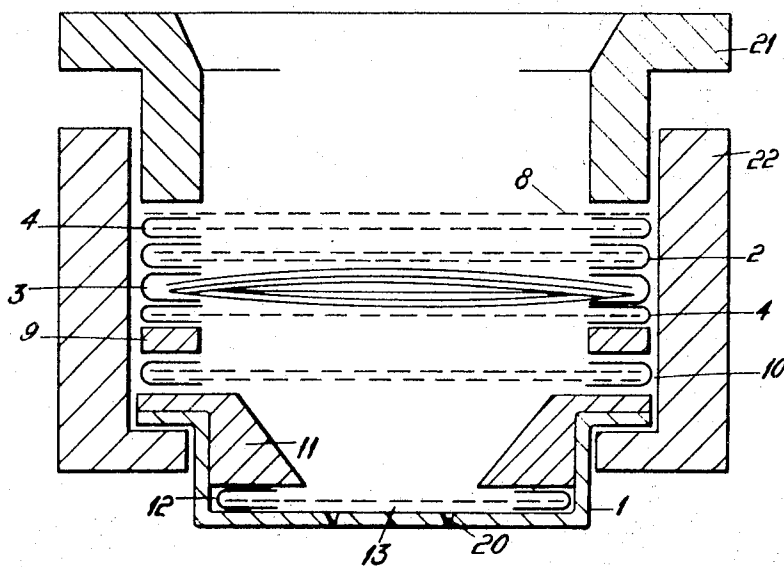


Fig. 2



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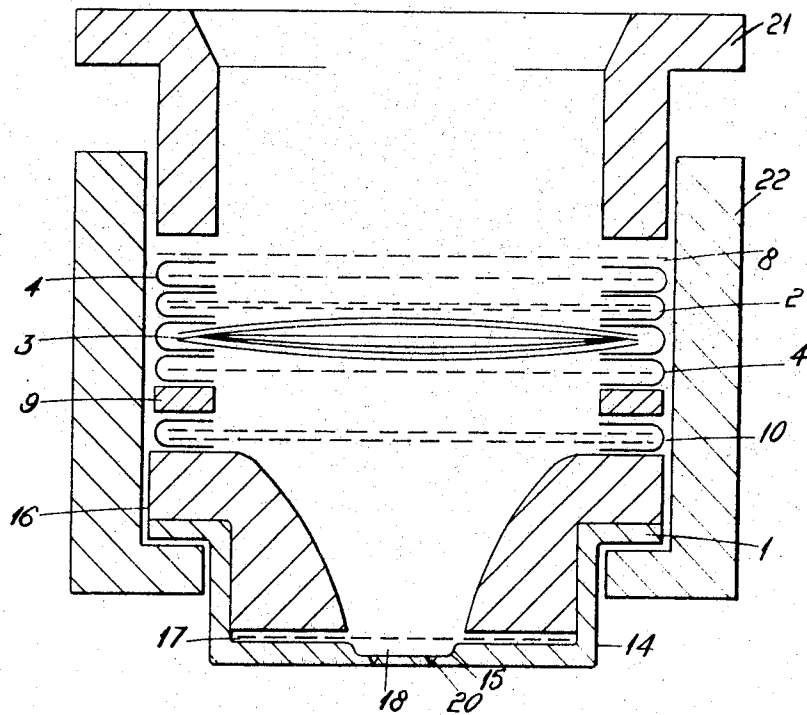
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Fig. 3



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SPINNERET UNIT AND METHOD FOR THE SPINNING OF CHEMICAL FILAMENTS

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9 Claims

ABSTRACT OF THE DISCLOSURE

The specification describes a spinneret unit for spinning textile filaments, in which the spinneret is mounted at the downstream end of the housing. Within the housing is mounted a first filter, having filter elements having a check threshold which decreases in the downstream direction. The flow rate is increased in a conduit of decreasing cross-section and the material then passes through a second filter located immediately upstream of the spinneret, the second filter having a check threshold no greater than any of the first filter elements.

The present invention relates to a spinneret unit and a method for the spinning of chemical filaments and also to a spinning process utilising the said spinneret unit.

The expression "spinneret unit" is to be understood to mean as assembly which is connected to a feed for a material to be spun and which comprises filtering elements, the spinneret proper and elements providing for the flow of the material from the feed to the spinneret orifices.

According to the present invention there is provided a spinneret unit for spinning textile filaments, such unit comprising, a first filter having a plurality of filter elements each having a check threshold less than the filter element immediately upstream thereof, at least one conduit means downstream of the first filter element, the cross-section of said conduit available for flow being greater at the upstream end thereof than at the downstream end thereof, a second filter downstream of said conduit means, the check threshold of which is no greater than that of the most downstream of said filter elements of said first filter and a spinneret downstream of said second filter.

The invention further provides a method of spinning filaments from a thermoplastic material, such method comprising filtering the material progressively to retain impurities of increasing fineness, increasing the flow velocity of the material, dividing the flow into partial streams, the cross-section of which is no greater than that of the partial streams leaving the filter, and immediately thereafter, extruding the material through spinneret orifices.

With the unit and method of the invention, it is possible to improve the quality of the filaments or yarns obtained, whilst at the same time substantially increasing the spinning velocity.

More specifically, the spinneret unit according to the invention may be considered as comprising in combination:

(1) A first filter, the function of which it is to hold back the particles of foreign matter which might block or disturb the flow of the compound to be spun through the extrusion orifices. The filter consists of filtering elements having a check threshold decreasing in the downstream direction. In proportion with the advance of the compound to be spun, through the filter, first of all the coarser impurities and then the finer impurities are retained by the various filtering elements. The smallest check threshold utilised is, in practice, lower than 60 microns

and ranges preferably between 25 and 40 microns. Advantageously, the filtering element having the smallest check threshold of the filter is spaced slightly apart from the other filtering elements of the filter. The elements constituting the filter may either be fabrics of textile or metallic material, wadding, non-woven webs, paper fabrics, layers of elements of predetermined grain size, optionally agglomerated by sintering. If desired they may be supported by one or more permeable supports. The selection of the above-mentioned elements depends not only on the check threshold which they exhibit but also on the conditions (for example temperature, pressure) under which the filtration is effected, these being conditions which may vary considerably, depending on the nature of the material to be spun.

(2) At least one conduit for the compound to be spun, the downstream end of which is smaller in section than its upstream end and, advantageously, less than a quarter of the section thereof. The shape of the conduit between these two ends is, preferably, of a continuously decreasing nature, thus eliminating any dead zones on the path travelled by the material, and furthermore imparting progressive acceleration thereto. It has been found that a conduit of this kind in the spinneret unit substantially reduces mishaps or defects arising during spinning, such as filament rupture, partial or even complete clogging of the spinning orifices, or poor uniformity in the count of the yarns. This improvement is probably due to the effective reduction in the alterations undergone by the material during its travel through the unit according to the invention, whether what are concerned are physical alterations, for example an increase in viscosity going as far as the formation of gels, or, particularly in the case of spinning of melted polymers, chemical degradation resulting in an excessively long stay at a temperature near the fusion temperature.

Preferably, the upstream end of the conduit is disposed near the downstream face of the first filter and has the same cross-section available for flow. Similarly, the downstream end of the conduit is advantageously disposed near the filtering element arranged a short distance from the spinneret and consequently near the latter, and has a section corresponding substantially to the zone of perforation of the spinneret.

The conduit may be formed by one or more intermediate members. These members are advantageously constituted by a material which is a poor conductor of heat, so as to diminish non-uniformity of temperature at the level of the spinneret; it is furthermore advantageous that the said material should be slightly deformable, so as to avoid any leakage at the joints between adjacent elements.

(3) A second filter in the form of a filtering element having a check threshold at most equal to that of the last element of the first filter in the direction of passage of the compound to be spun. The check threshold of the element of the second filter is preferably equal at most to 40 microns and advantageously smaller than 25 microns. The filtering element may be composed of one or more layers of filtering materials, as mentioned above, the last layer, in the direction of progress of the material to be spun, being disposed a short distance from the upstream face of the spinneret, in practice advantageously at a distance ranging between a few tenths of a millimetre and 5 mm. It has been found that the arrangement of the second filter downstream of the conduit and a short distance from the upstream face of the spinneret improves the extrusion uniformity whilst at the same time substantially decreasing the pressure necessary for extrusion through extremely fine orifices.

(4) The spinneret utilised may be of any suitable shape, for example it may be a plate or cup having a flat or curved end face. Advantageously, the spinning orifices

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are as close together as is possible, thus making it possible to reduce the section of the jet or stream of the material feeding the said orifices.

The latter are preferably disposed in one or more annular arrangements. Advantageously, the distance between the orifices may be reduced if the latter are formed in a spinneret, the perforation zone of which has been made thinner at least in the vicinity of the orifices.

When material to be spun is introduced into the spinneret unit, the material is filtered and progressively freed from its impurities, commencing with the coarsest, and it is divided into an increasing number of part-flows of progressively finer section. The flow velocity of the compound as a whole is then increased and the flow is once again divided up into partial flows the section of which is at least as small as at the filtration outlet, and then, immediately after, the material to be spun is extruded through the spinning orifices.

The combination of a zone involving division of the flow of the compound into extremely fine part-flows, of a zone for acceleration of the said flow resulting in redistribution of the velocities at each of its points, and re-division of the flow into part-flows which are at least as fine as the preceding flows, such re-division being extremely rapidly followed by extrusion, permits the achievement of excellent homogeneity, free from any deterioration, whether physical or chemical, of the compound to be spun, and substantially improves spinning possibilities using a given spinneret.

This combination, furthermore, makes it possible to spin compositions using spinnerets which have finer orifices, and, in every case, substantially improves the spinning uniformity and also the quality of the filaments or yarns obtained.

The present invention may be applied to the spinning of both artificial and synthetic filaments, obtained by extrusion of spinnable materials as a solution or in the melted state.

In order that the invention may more readily be understood, the following description is given, merely by way of example, reference being made to the accompanying drawings, in which:

FIG. 1 is a longitudinal cross-section through a conventional form of spinneret unit; and

FIGS. 2 and 3 are views similar to FIG. 1 showing two embodiments of spinneret unit according to the invention.

In the various figures of the drawings, like reference numerals have been used for like parts.

Referring firstly to FIG. 1, there is illustrated therein a conventional type of spinneret comprising a housing 22 to which is secured a spinneret 1 having a perforated zone in which perforations 20 are formed. The housing 22 is threaded onto the outlet 21 of an extruder (not shown) and immediately below the lower end of the extruder are two bronze cloths 2 clamped together. Six nylon fibre cloths 3 are fastened together below the bronze cloths 2, and a support grid 4 is placed thereunder. A perforated plate 5 is located immediately below the support grid 4, and two further bronze cloths 6 are mounted immediately above a nylon fibre cloth 7 which is closely adjacent to the spinneret 1.

A similar construction is illustrated in FIG. 2 except that this construction is formed according to the invention. It includes in series a cotton cloth 8, a support grid 4, two bronze cloths 2, six nylon cloths 3, a further support grid 4, a packing 9, a stainless steel cloth woven in a repp weave, commonly known as microrepp, this being secured to a further grid. Below this further grid is an intermediate frusto-conical conduit 11 and finally a second filter 12 mounted immediately above the orifices 20 in the spinneret 1, giving a space 13.

EXAMPLE 1

The two spinneret units illustrated in FIGS. 1 and 2 were formed, and a solution of cellulose acetate, having a com-

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bined acetic acid content of 55.5% was prepared at a concentration of 26% by weight in a solvent comprising 95 parts of acetone and 5 parts of water (by weight). This solution was extruded through each of the two spinneret units, the cup spinneret having a height of 7 mm. and being formed with 32 orifices 0.06 mm. in diameter, disposed annularly, the diameter of the annulus being 18 mm. and the distance between each orifice being 1.72 mm. between centres.

In the construction of FIG. 1, the bronze cloths 2 were at a spacing of four hundred wires per inch, the check threshold of the cloths being 40 microns. The nylon cloths 3 had a check threshold of 25 microns, while the support grid 4 had 60 wires per inch, giving a threshold of 28 microns. The perforated plate 5 had 3 mm. diameter apertures, the total free passage cross-section being 25% of the total area.

The bronze cloths 6 had wires at a spacing of 400 wires per inch, giving a check threshold of 40 microns, and the nylon cloth 7 had a check threshold of 25 microns.

The nylon cloths 7 were in contact with the spinneret 1. With this type of spinneret and the solution referred to above, the solution was spun at a temperature of 65° C., and a flow rate of 51.5 grams of solution per minute, corresponding to an extrusion velocity of 612 metres per minute. The pressure at the start of the spinning, measured upstream of the spinneret unit was 40×10^5 Pa. The filaments obtained were dried and wound on in a conventional manner, so as to produce a cellulose acetate yarn.

In the arrangement of FIG. 2, the cotton cloth 8 was a "percal" cloth having a check threshold of 80 microns. The elements 2, 3 and 4 were as in the FIG. 1 construction, and the packing 9 had a thickness of 2 mm. The stainless steel cloth 10, had a check threshold of 20 microns, and a No. 20 grid having a check threshold of approximately 1 mm. was used as the sole mechanical support for the assembly. The frusto-conical conduit 11, had a height of 7 mm., a larger diameter at the upstream end of 40 mm. and a smaller diameter of 20 mm. for the spinneret used.

The microrepp stainless steel second filter 12 had a check threshold of 15 microns. This was mounted directly, via a mounting ring, on the bottom of the spinneret providing a free space 13, the height of which was equal to the thickness of the ring, i.e. 0.5 mm.

This construction was used as before, under the same flow rate and temperature conditions, the spinning pressure being 36×10^5 Pa. Thus it was possible to increase the flow rate up to 68.5 grams of solution per minute, this flow rate corresponding to an extrusion loss of 817 metres per minute. The use of the construction of FIG. 2 according to the invention made it possible to increase the extrusion velocity by 33% and to do so with excellent quality in the yarn obtained.

A further construction according to the invention is illustrated in FIG. 3. This construction is similar to that of FIG. 2, except that instead of the conduit 11 the conduit was formed of polypropylene, the interior of which had the shape of a surface of revolution produced by rotating two semi-parabolas, so that the interior surfaces were generally convex. The second filter 12 of FIG. 2 was replaced by a second filter 13, again of metallic microrepp which rested directly on the bottom 14 of the spinneret 1, a free space 18 being provided in a thinned down portion of the spinneret in which the spinning orifices 20 were formed.

EXAMPLE 2

The same solution as that employed for Example 1 was extruded through the cup spinneret of FIG. 3, the cup spinneret having a height of 7 mm. and formed with 32 orifices 0.06 mm. in diameter arranged on an annulus 10 mm. in diameter, the distance between each aperture being 0.98 mm. between centres. The thickness of the walls of the spinneret were made thinner down to a thickness of 0.4 mm. over the circular zone 15, having a diameter of

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12 mm. i.e. slightly larger than that of the diameter of the annular perforation array. In the particular constructor of spinneret unit, the components 2, 4, 8, 9 and 10 were identical with those described with reference to FIG. 2 in Example 1. The conduit 16 had a height of 9 mm., its largest diameter being 41 mm., and its smallest diameter being 12 mm., corresponding to the thinned down circular zone 15 provided in the bottom of the spinneret. The second filter 17 was identical with that of the filter 12 of Example 2, except that it did not have a support ring. The solution to be spun was then extruded at a temperature of 65° C. and a flow rate of 77 grams of solution per minute corresponding to an extrusion velocity of 918 mm. per minute, i.e. an increase of 52% relative to the conventional arrangement described in Example 1 using the FIG. 1 construction.

EXAMPLE 3

A solution of cellulose acetate having a combined acetic acid content of 55.5% was prepared having a concentration of 25% by weight, in mixture of 97 parts of acetone and 3 parts of water (by weight) and was extruded through a spinneret having 100 orifices, 0.025 mm. in diameter, and distributed as indicated below:

- 34 orifices over an annular arrangement of diameter 17 mm.
- 28 orifices over an annular arrangement of diameter 14 mm.
- 22 orifices over an annular arrangement of diameter 11 mm.
- 16 orifices over an annular arrangement of diameter 8 mm.

Using the conventional arrangement shown in FIG. 1 with the filter arrangements of Example 1, it was not possible to extrude in a stable manner, whatever this flow rate of the solution, since the extrusion orifices became successively blocked and the pressure upstream of the spinneret increased very rapidly.

Using an arrangement according to the invention, identical with that described with reference to FIG. 2 in Example 1, the solution to be spun was extruded at a temperature of 56° C., at a flow rate of 11.1 g. of solution per minute, corresponding to an extrusion velocity of 245 m./min., so that it was possible to produce, in a conventional dry spinning cell, a 55 decitex/100 ply (i.e. 0.55 decitex per ply) yarn, at a velocity of 500 m./min., this being hitherto impossible to achieve.

The spinning stability was excellent, the yarn obtained being of good quality in every respect.

What I claim is:

1. A spinneret unit for spinning textile filaments, said unit comprising, in combination:

- (a) a housing having an upstream and a downstream end;
- (b) a first filter mounted within said housing downstream of said upstream end;
- (c) a plurality of filter elements to said first filter each having a check threshold less than the filter element immediately upstream thereof;
- (d) at least one conduit means, downstream of said first filter and having an upstream and a downstream

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end, the cross-section of said conduit continuously decreasing whereby said downstream end has a smaller cross-section available for flow than said upstream end of said conduit;

(e) a second filter downstream of said conduit means, having a check threshold at most equal to that of the most downstream of said filter elements of said first filter; and

(f) a spinneret mounted downstream and closely adjacent to said filter.

2. A spinneret unit as claimed in claim 1, wherein said spinneret has a perforation zone in which it is perforated and wherein the cross-section of said conduit means, at said downstream end thereof, corresponds substantially to said perforation zone.

3. A spinneret unit as claimed in claim 1, wherein the cross-section of said conduit means at said upstream end thereof is at least four times that at said downstream end thereof.

4. A spinneret unit as claimed in claim 1, wherein said most downstream filtering element of said first filter is spaced from the element upstream thereof.

5. A spinneret unit as claimed in claim 4, wherein said most downstream filtering element has a check threshold of between 25 and 40 microns.

6. A spinneret unit as claimed in claim 1, wherein said conduit means is formed of a material of poor thermal conductivity.

7. A spinneret unit as claimed in claim 1, wherein said conduit means is formed of a material which is slightly deformable.

8. A spinneret unit as claimed in claim 1, wherein said second filter has a check threshold of 25 microns or less.

9. A method of spinning filaments from a thermoplastic material, comprising the steps of:

- (a) causing a stream of material to flow;
- (b) filtering the material progressively effective to retain impurities of increasing fineness, and to divide said stream into first partial streams;
- (c) progressively increasing the flow velocity of the material;
- (d) re-dividing the stream of material into further partial streams having a cross-section no greater than that of said first partial streams; and
- (e) immediately thereafter extruding said material through spinneret orifices.

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JAY H. WOO, Primary Examiner

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