

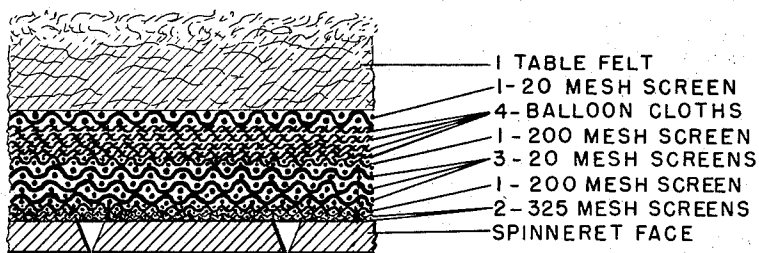
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A. A. WRIGHT

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SPINNERET PACK

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INVENTOR.

ARTHUR ALLISON WRIGHT

BY

C. H. Mortenson

ATTORNEY.

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SPINNERET PACK

Arthur A. Wright, Waynesboro, Va., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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1 Claim. (Cl. 18—8)

This invention relates to the manufacture of artificial textile materials and the like and particularly to the production of filaments from organic esters of cellulose by the dry-spinning process.

In the dry spinning of solutions of organic esters of cellulose and more particularly cellulose acetate, difficulty exists in getting the spinneret to start cleanly and in producing uniform filaments without spinning interruptions. Previous attempts to solve these difficulties have been without marked success. In perfect startability each orifice of the spinneret simultaneously passes an unimpeded stream or jet of spinning solution. Hitherto, uniform filaments have not been attained without serious sacrifice in startability.

It is common practice in dry spinning organic esters of cellulose and particularly cellulose acetate to employ a spinning pack containing multiple layers of cloths of various degrees of porosity. These packs produce a reasonable level of startability, and the reason commonly accepted for this is that the flow of solution through the pack takes place in a small cone immediately over each hole in the spinneret. Interaction between adjacent cones is kept at a minimum by the manner in which the cloth layers compact. In any cone there exists a pressure drop ranging up to several hundred pounds as long as the solution is flowing. When the flow of solution is retarded or stopped by some particle lodged in the spinneret hole, a corresponding increase in static pressure develops in the cone extending down to the spinneret hole. Usually this increased pressure is sufficient to clear the hole, whereupon the flow of solution is resumed and the normal pressure drop returned. This action is equally effective in starting a hole for the first time or in clearing a hole clogged while spinning.

Spinneret packs designed as above, commonly referred to as high pressure packs, operate with a high pressure drop and require many layers of closely-woven fabric. From a filtration standpoint such a pack is inefficient since the bulk of the flow takes place at high rates in the channels of the cones which may comprise less than 10% of the total area available for filtration.

Obviously, there are many disadvantages connected with this pack of the prior art. In addition to the poor filtration and high pressure accompanying it, there is another disadvantage of a serious nature. The individual flow passages through the pack are not identical for each hole. Variations in the weaves or thicknesses of the filter layers, or matting, swelling, and channeling all combine to produce variations in the flow to each hole. The resulting non-uniformity of filament size at the spinneret face, which results from the unequal jet velocities introduced by uneven flow, cannot be corrected because the conditions under which the filaments are withdrawn and solidified in the spinning cell apply uniformly to each filament. Accordingly, the non-uniformities in denier of these filaments are brought out in the spinning cell because filaments of different denier react differently to the withdrawing tension. As a result, there exist differences

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in orientation and strength as well as objectionable loops and broken filaments in the yarns produced.

Previous attempts to overcome these denier differences, which are the chief causes of the above-mentioned quality defects, have been unsuccessful. The provision of packs with distribution spaces directly above the spinnerets has failed to give even a poor level of startability, and further those packs which did start soon suffered from interruption in the flow through one or more of the spinneret holes. Since no intensified pressure could be directed to the holes where the flow was interrupted, there was no way to clear these orifices, and the result was nearly complete inoperability.

Accordingly, it is the object of this invention to provide a spinning pack in a dry spinning assembly which will permit the spinning of filaments having a high degree of denier uniformity. It is a further object of this invention to provide a spinning pack which will permit the continuous spinning of filaments for long periods of time. Another object of this invention is to provide a spinning pack which operates at a relatively low pressure level. It is a still further object of this invention to provide a spinning pack which will produce a high percentage of perfect starts. Another objective is the attainment of uniform filament size along with good startability. Other objects of this invention will appear hereinafter.

The objects of this invention are accomplished by the placement directly above and in contact with the spinneret of a fine filter which may be one or more fine mesh screens or one or more plates having fine holes located co-axially with the spinneret orifice followed by one or more coarse mesh screens which may be in turn followed by one or more somewhat finer screens to support the layer of cloth filtering medium normally used. The ratio of the area of the spinneret orifice at the extrusion point to the area of the individual mesh size in the fine mesh filters directly above the spinneret is greater than 0.8 and preferably greater than 1.0. By the area of the orifice is meant the area of the orifice itself and not the area of the customary counter bore. Thus, by fine filter is meant a screen which preferably has individual openings of smaller area than the area of the orifice in the spinneret below the said openings. The pack of this invention, then, involves, in combination, a fine filter directly above the inner face of the spinneret; followed by a distribution space provided by a flow distributor such as coarse mesh screens, an annular ring, distribution plates or similar means, or combinations thereof; and above the distribution space the usual filter which may be a pack of cloths, felt and the like. The fine filters are chosen so that ratio of the orifice area to the area of the individual mesh size is at least 0.8. Screens of about 200 mesh to about 400 mesh, or finer, may be used in the assemblies of this invention. In choosing a screen one will take into consideration the orifice area so that the desired ratio results and the desired filtering effect is attained.

For purposes of illustration a representative pack of this invention is shown in Figure 1. This pack is shown to contain above the spinneret in the order in which they were added, two 325 mesh screens, one 200 mesh screen, three 20 mesh screens, one 200 mesh screen, four balloon cloths, one 20 mesh screen, and one table felt. This invention, however, is not limited solely to the pack shown in Figure 1, but encompasses those packs which comprise directly above the spinneret one or more fine screens followed by a distribution space and then by means for supporting a filter device. The following examples are given for illustrative purposes and are not to be taken as limitative.

Example I

An acetone solution of cellulose acetate was spun

through the pack described in Figure 1 and through a 120 hole spinneret having 0.055 mm. orifices and was processed in the conventional manner in a dry spinning cell to produce a yarn of 450 denier containing 120 filaments. This pack gave a startability of 77%, a filament denier variation of $\pm\frac{1}{4}$ denier compared to ± 2.5 denier for packs of the prior art, and only $\frac{1}{2}$ as many spinning interruptions as experienced with the packs of the prior art. A further advantage was that the pack life was 20 fold that of the packs of the prior art for the same level of yarn quality.

Example II

Another representative pack of this invention is composed of the following layers above the spinneret in the order in which they were added: one 200 mesh screen, one 20 mesh screen, two 200 mesh screens, fixe balloon cloths, one 20 mesh screen and one table felt.

An acetone solution of cellulose acetate was spun through this pack and through a 32 hole spinneret having 0.09 mm. orifices and was processed in the conventional manner in a dry spinning cell so as to produce a yarn of 300 denier containing 32 filaments. A startability of 65% was obtained and only $\frac{1}{3}$ as many spinning interruptions resulted per day as occurred with packs of the prior art. Pack changes for off denier yarn were reduced 15 fold over that experienced with the packs of the prior art.

Example III

Another representative pack of this invention is composed of the following layers above the spinneret in the order in which they were added: two 325 mesh screens, three 10 mesh screens, one balloon cloth, one table felt, one balloon cloth, and one 20 mesh screen.

An acetone solution of cellulose acetate was spun through this pack and through an 80 hole spinneret having 0.050 mm. orifices and was processed in the conventional manner in a dry spinning cell so as to produce a yarn of 300 denier containing 80 filaments. The startability was 58%; the filament denier variation was only ± 0.4 as compared to ± 0.8 denier for packs of the prior art; and there occurred only $\frac{1}{3}$ as many spinning interruptions per day as experienced with packs of the prior art.

Example IV

In another representative pack of this invention the distribution space is composed of a ring and perforated plate instead of the coarse mesh screens given in the other examples. The layers above the spinneret in the order in which they were added: two 325 mesh screens, one $\frac{1}{8}$ " thick ring of a diameter to fit close to the pack wall, one perforated plate (the perforations to be any convenient size and spacing such as $\frac{1}{8}$ " diameter on $\frac{1}{4}$ " centers), one balloon cloth, one table felt, one balloon cloth, and one 20 mesh screen. Similar effective results were obtained with this pack as for the other examples of the packs of this invention.

The remarkable improvements obtained by the packs of this invention can readily be seen from the above examples. The fine screen or filter plate close to the spinneret face apparently serves to filter the solution to remove particles which would clog the spinneret orifices. Further, the added advantage is obtained that the mesh of these screens is not forced apart by small particles which then would flow through to clog the spinneret orifices, nor do these fine screens sag down into the spinneret holes as do the cloth layers of the packs of the prior art. The fine screen is not, as are cloth packs, a source of clogging particles, nor does it mat or swell to alter the flow pattern as do cloth packs. Since one face

or the edge of the screen fits closely inside the spinneret, a maximum filtering effect is assured.

Spinnerets packed with the apparatus of this invention possess a tremendous advantage over spinnerets packed in any usual manner because, once having started, a spinneret containing this cross-flow pack will start again and again after one or more interruptions of the flow of spinning solution to it. It is not even necessary to wipe the face of the spinneret before starting as is standard procedure with spinnerets packed as usual. Spinning interruption of an entire day, or even more, may be tolerated because substantially 100% re-startability of spinnerets packed in accordance with this invention is customary.

The coarse screen on top of the fine screen serves as a distribution means which makes for equal availability of the cellulose acetate or other solution to the various spinneret holes. Likewise, this layer of coarse screen permits the whole surface of the filter-cloth layer above to serve as filter medium without the formation of pressure cones or channels therein. Accordingly, the total pressure on the pack, necessary to produce the startability desired as well as good and continuous performance thereafter is at a much lower pressure level than is necessary with the packs of the prior art, and, further, since the whole area of this filter medium is being used by the flow of viscous material through the pack, a much greater filtering surface is available to retain the particles filtered out with the result that pack pressure build up is relatively slow. Consequently, the packs of this invention can operate continuously for long intervals of time without necessitating any change.

The distinct advantages that the apparatus of this invention affords can be seen in the fact that less pressure is required to start the assemblies of this invention than is required for the old assemblies (275 p. s. i. as compared to 375 p. s. i.), in the fact that the spinning pressure for previous assemblies increases three or four times the increase for the cross-flow assemblies and in the fact that the startability of the cross-flow packs of this invention is on the average 75% to 85% of the high pressure packs. The slight loss in startability over that of the high pressure packs is more than offset by the increase in denier uniformity and in the use of lower pressures.

Although this invention has been described particularly with respect to production of multi-filament yarns of cellulose acetate by the process of dry spinning, it is equally applicable to the production of multi-filament yarns from any polymeric material capable of being dry spun, such as polyacrylonitrile.

Any departure from the above description which conforms to the present invention is intended to be included within the scope of the claim.

I claim:

A filtering and extrusion device for dry-spinning comprising in combination a spinneret having an inner smooth face and a plurality of orifices, the orifices being of uniform shape and size and each orifice having an area between about 0.0019 and 0.0063 sq. mm., a rigid fine screen of several hundred mesh in contact with the inside smooth face of the spinneret, adjacent and upstream of said fine screen a coarse screen of about 20 mesh and adjacent said coarse screen a balloon cloth filter.

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