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C. J. MALM

2,223,376

YARN

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Fig. 1.

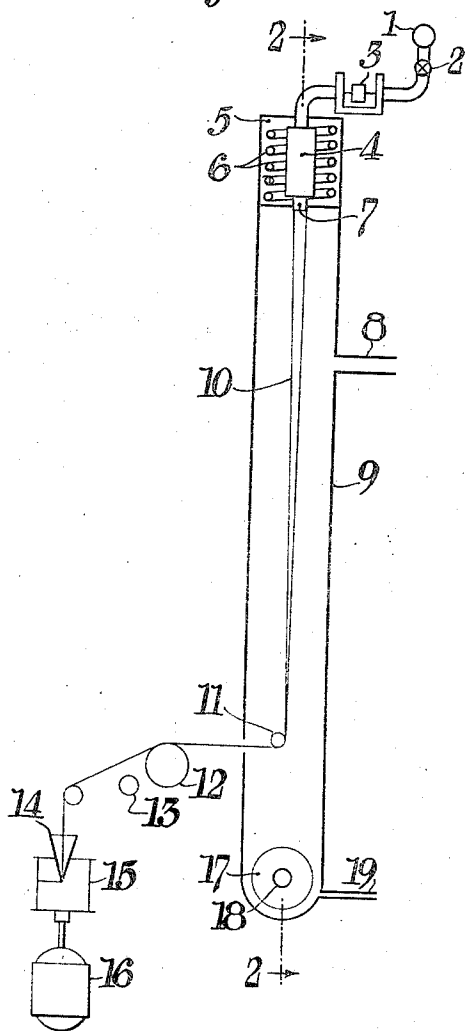


Fig. 2.

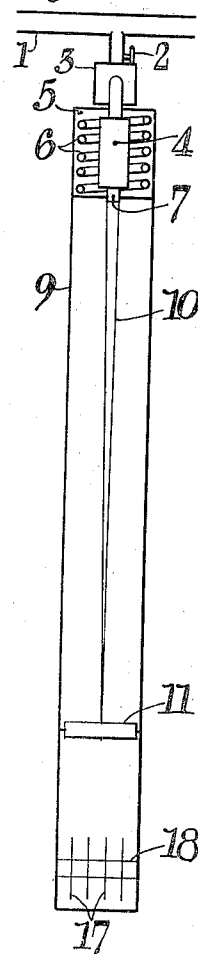
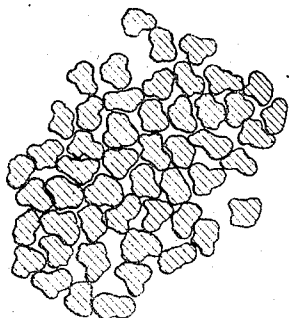


Fig. 3.



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YARN

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5 Claims. (Cl. 28—1)

The present invention relates to the preparation of yarn from a mixed organic acid ester of cellulose containing acetyl and 1-6% of propionyl or butyryl and which has a viscosity of 200-800 seconds. This application is a continuation-in-part of my application Serial No. 18,215, filed April 25, 1935, now U.S. Patent No. 2,097,464.

In the preparation of yarn from cellulose acetate or related cellulose esters, it is desirable to obtain a large proportion of filaments having a cross section which is full rather than flat. It is also desirable to obtain a product having high wet and dry strengths. In the preparation of yarn from cellulose esters, it often occurs that a product giving a high tensile strength has a poor cross section and vice versa. The cross section of silk which is the strongest filament is approximately circular. In the making of artificial yarn, it is desirable that the filaments have a cross section approaching that of silk.

One object of my invention is to prepare a yarn containing a large proportion of filaments having a cross section approaching that of silk. Another object of my invention is to prepare yarn made up of filaments having a full cross section and, at the same time, a high tensile strength, both wet and dry, and which is very resistant to abrasion and deformation. A still further object of my invention is to obtain yarn which because of its high strength and resistance to abrasion and deformation permits faster processing, thus making possible increased production of textiles therefrom without any increase in the amount of apparatus employed.

I have found that by preparing yarn from a cellulose acetate containing 1-6% propionyl or butyryl which ester has a viscosity of 200-800 seconds (4:1 acetone viscosity) filaments are obtained which have a full cross section but which also have high tensile strength. I have found that it is also desirable that the esters employed be high in clarity.

Yarn from filaments having a flat cross section are more sensitive to textile processes thus requiring slower processing of the yarn obtained therefrom. This yarn also gives uneven qualities in the resulting fabrics, possible due to the twisting of the yarn causing an uneven surface thereon.

Yarn from filaments having a low tensile strength and particularly a low wet strength obviously are sensitive to processing especially where washing is involved and the amount of wear obtained with such filaments does not compare with that obtained from films with higher

tensile strength. By the present invention yarn is obtained which is superior either as to cross section or tensile strength or both to yarn prepared from other types of cellulose esters.

The accompanying drawing illustrates a suitable method for preparing yarn in accordance with the present invention. Fig. 1 is a side elevation of a unit of a spinning machine which may be employed in producing artificial yarn according to my process.

Figure 2 is a section at right angles to Figure 1 taken through the line 2-2 of Figure 1.

Figure 3 is a cross section of a filament prepared in accordance with my invention.

1 represents the pipe or manifold through which the cellulose ester solution or dope may be supplied by means of valve 2 and pump 3 to the filamenting apparatus. The dope or solution passes through a candle filter 4 which is enclosed in a chamber 5 heated by means of hot water coils 6 or other well known heating means as described and claimed in Stone Patent No. 2,000,047. This chamber 5 is separated from the spinning cabinet 9 by a partition which may be well insulated if desired. In fact it is preferred to insulate the entire chamber 5.

If the temperature at which it is desired to keep the candle filter should be considered unimportant, obviously the hot water coils may be omitted and if some heat is desired around the candle filter, the heated air from below may be allowed to surround it. It is, however, desirable as described in the above Stone patent to maintain the candle filter at a temperature somewhat above that of the air of the spinning chamber. The candle filter 4 is connected with a spinnerette 7 to form the dope as it comes through the candle filter into filaments of a desired size and deliver them into the heated air present in the spinning cabinet 9. The cabinet 9 is provided with an air inlet 19 at its lower end in which is located a steam pipe 18 with heat dissipating fins 17, which heats the incoming air. Obviously other means of heating the incoming air than that shown may be employed. The steam pipe with heat dissipating means located in the bottom of the cabinet is shown merely as an example of one means which may be employed to heat the incoming air. The solvent laden air in the upper portion of the cabinet may be removed through the outlet 8 which leads to a solvent recovery apparatus, the outlet 8 being preferably located a little below the top of the spinning cabinet.

After the dope is forced through the spin-

nerette 7, into the heated air, the solvent evaporates from the formed filaments, forming threads. The thread passes over the guide roll 11 (or if desired a fixed guide may be employed) and out of a small aperture in the cabinet to the draw roll 12 from whence it is conducted to the spinning pot or bobbin 15, through the guide 14, to assure uniform winding of the thread. The spinning pot or bobbin is rotated by means of a motor, a tape or a belt drive or any other suitable device which may also be employed for operating the guide 14 in any suitable manner desired. A waste roll 13 is provided below the draw roll 12 to collect any threads which might drop from the draw roll.

It is to be understood that instead of a spinning pot and roll winding, any other method such as cap spinning, may be employed to collect the thread after its formation.

The dope which may be employed in preparing yarn in accordance with my invention may be prepared by dissolving the cellulose ester in acetone to form approximately a 20-25% solution of the ester. A small amount of non-solvent may be embodied in the dope, for instance the solvent may consist of approximately 97% acetone and 3% water. If some other non-solvent is desired, such as methyl alcohol, the solvent used may consist of 85% acetone and 15% methyl alcohol. If it is desired to use ethyl alcohol, a suitable solvent mixture would be one containing 90% acetone and 10% of ethyl alcohol. These proportions are merely illustrative of the concentration of non-solvent in the solvent mixture and may be varied over quite a wide range. Obviously, other well known solvents may be employed instead of acetone.

It is desirable that the cellulose ester used in the preparation of yarn in accordance with my invention have a turbidity in its esterification mixture of not more than 35 parts per million. This turbidity is determined by comparison with a turbidity solution which has been standardized by the U. S. Bureau of Standards. The preparation of esters which are suitable for use in the present invention is described in my co-pending application Serial No. 18,215, filed April 25, 1935 now U. S. Patent No. 2,097,464 of which this is a continuation-in-part. I have found that the tensile strength of filaments formed by the dry spinning method is affected by haze or lack of clarity of the cellulose ester when dissolved in the spinning solvent. Therefore, the use of esters of high clarity and of the indicated viscosity is desirable to obtain optimum strengths. Figure 3 of the drawing represents examples of cross sections of the filaments of the yarn prepared in accordance with the present invention. It will be noted that filaments having a full cross section are present in large proportion in the yarn.

The viscosity of the cellulose esters to be employed in my invention is determined by dissolving one part of the ester in four parts of acetone and determining the time in seconds necessary for a $\frac{1}{16}$ inch steel ball to drop through 10 inches of the solution in a tube 1 inch in diameter at a temperature of 20° C.

The following example illustrates the preparation of yarn from a cellulose acetate containing 1-6% propionyl and having a viscosity of 200-800 seconds in accordance with my invention. Cellulose acetate containing about 1½% propionyl and which has been hydrolyzed to acetone solubility (about 38% apparent acetyl) was dissolved in acetone containing 2½% of water to form a

25% solution of the ester. The solution was then introduced into a spinning system of the type illustrated by Figures 1 and 2 by means of the valve 2 and pump 3. The dope was passed through the candle filter 4 and the spinnerette 7, the candle filter being kept constantly at a temperature of 65° C. The temperature at the bottom of the cabinet was maintained at 58° C. by incoming heated air. The withdrawal temperature of the solvent-laden air was found to be 48-53° C. Air was passed through the cabinet at the rate of 20 cu. ft. per minute, and a thread of approximately 150 denier was formed. If a spinnerette for forming larger threads is employed, it is advantageous to pass air through the cabinet at a more rapid rate.

The following table illustrates the superiority both as to wet and dry strengths of the yarn of the present invention over that of good quality cellulose acetate yarn. This also shows that the stretch of the product is about the same. The figures given below were obtained with filaments containing 1-6% propionyl.

	Dry		Wet	
	G/D	Stretch	G/D	Stretch
Good quality cellulose acetate yarn.....	1.38	25	.86	35
Yarn of the present invention.....	1.72	23	1.16	32
Do.....	1.65	24	1.14	34
Do.....	1.71	24	1.16	34

G/D indicates the tensile strength, being the number of grams per denier which is necessary to cause breaking of the yarn. The stretch is expressed as the percentage of increase in length before the breaking occurs.

Esters containing 1-6% butyryl also exhibit the desirable properties pointed out above when an ester of 200-800 seconds is employed. For instance, a cellulose acetate containing approximately 1.6% butyryl and having a viscosity of 390 seconds was dissolved, as indicated below and the yarn resulting therefrom gave the following results:

Percent cellulose ester	Percent acetone	Percent water	Percent methyl alcohol	Dry		Wet	
				G/D	Stretch	G/D	Stretch
23.6	58.0	.73	17.72	1.48	22.9	1.02	30.4
23.5	70.8	.73	4.92	1.52	23.1	1.06	31.8

I claim:

1. Yarn made of filaments of full cross section and high wet and dry strengths essentially consisting of a hydrolyzed acetone-soluble cellulose acetate containing 1-6% of saturated fatty acid groups of 3-4 carbon atoms and having a viscosity of 200-800 seconds in 4:1 acetone solution.

2. Yarn made of filaments of full cross section and high wet and dry strengths essentially consisting of a hydrolyzed acetone-soluble cellulose acetate containing 1-6% propionyl and having a viscosity of 200-800 seconds in 4:1 acetone solution.

3. Yarn made of filaments of full cross section and high wet and dry strengths essentially consisting of a hydrolyzed acetone-soluble cellulose acetate containing approximately 1.5% of saturated fatty acid groups of 3-4 carbon atoms and having a viscosity of 200-800 seconds in 4:1 acetone solution.

4. Yarn made of filaments of full cross section

and high wet and dry strengths essentially consisting of a hydrolyzed acetone-soluble cellulose acetate containing 1-6% of saturated fatty acid groups of 3-4 carbon atoms and having a viscosity of 400-600 seconds in 4:1 acetone solution.

5. Yarn made of filaments of full cross section

and high wet and dry strengths essentially consisting of a hydrolyzed acetone-soluble cellulose acetate containing 1-6% butyryl and having a viscosity of 200-300 seconds in 4:1 acetone solution.

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