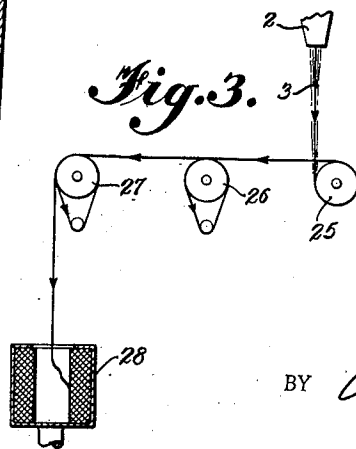
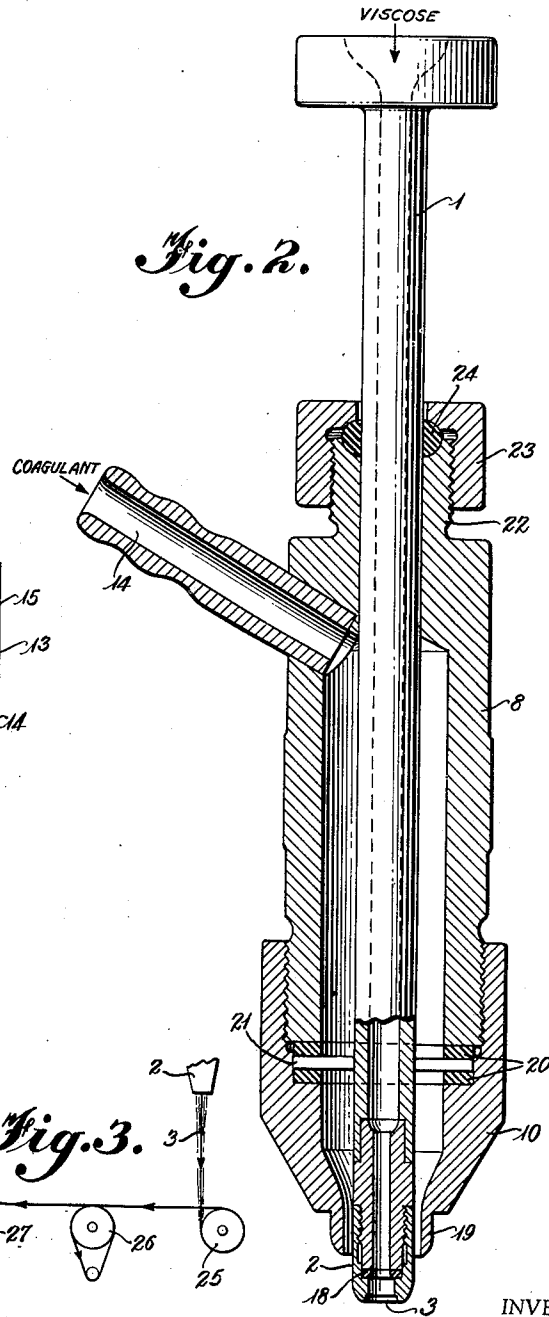
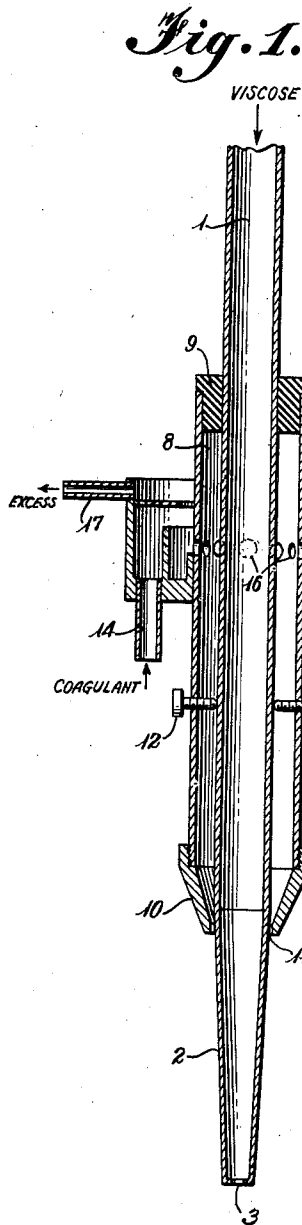


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V. E. GONSALVES
WET SPINNING APPARATUS

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INVENTOR
Victor Emanuel Gonsalves

BY *Allin F. Knight*
ATTORNEY

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WET SPINNING APPARATUS

Victor Emanuel Gonsalves, Arnhem, Netherlands, assignor to American Enka Corporation, Enka, N. C., a corporation of Delaware

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This invention relates to an improved method and apparatus for the jet spinning of viscose rayon.

More particularly, the invention relates to a novel method and apparatus for the manufacture of artificial threads, fibers and similar products by a procedure wherein a bundle of viscose jets or filaments emerging from a spinneret having a multiplicity of holes in the bottom, is coagulated and at least partially decomposed by means of suitable coagulation liquids, such as acid-containing salt baths.

Present day practice in the rayon industry involves for the manufacture of threads, fibers and similar products, a primary drawing-off speed (i. e. the speed at which the freshly formed thread is drawn off from the spinneret) of 60–80 meters per minute. Only after stretching is it possible to increase the speed of travel of the thread.

The method according to the present invention is characterized in that the thread, formed by a multiplicity of filaments, is spun from a spinneret freely suspended with the spinning holes downward. An adjustable amount of coagulation liquid is fed in concentric relation and parallel to the direction of flow of viscose to the face of the spinneret, whereby the coagulation liquid envelopes the multi-filament thread like a sheath, and in this form is carried downwardly by the thread, whereupon the resulting thread is aftertreated or wound, or both, in any well known way.

The coagulation liquid is supplied to the face of the spinneret by means of a jacket surrounding the viscose supply cylinder or tube to which the spinneret is attached so that the flow of coagulant is parallel to the direction of flow of the viscose, and whereby the coagulation liquid is directed near the spinneret face towards the spinning holes. In this way the coagulation liquid is uniformly spread over the surface of the freely suspended spinneret holder, and in this way may be fed to the spinneret face.

As a further improvement of the method according to the invention, the thread is advanced on leaving the spinneret by means of a suitably driven drawing-off roller, and is subsequently stretched.

The apparatus according to the invention, comprising generally a viscose supply cylinder, a spinneret holder with a spinneret provided with many, e. g., several dozen, spinning holes, and a supply device for the coagulation liquid, is characterized in that the viscose supply cylinder is placed vertically, or almost vertically, the spinneret holder is connected with the lower end of the viscose supply cylinder while it is freely suspended, the spinneret is placed with the spinning holes downward, and in that the supply device for the coagulation liquid is so constructed that, during spinning, the coagulation liquid envelopes the thread, consisting of many filaments, like a sheath.

The supply device for the coagulation liquid is preferably so constructed as to provide concentric access of the coagulation liquid at all sides of the spinneret bottom.

A particularly desirable embodiment of the apparatus according to the present invention is characterized in

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that it consists of a vessel for pressurizing the coagulation liquid provided with a supply pipe, which vessel is narrowed at the lower end, and of a vertical supply cylinder for the viscose, going through the vessel just mentioned, which device is connected liquid-tight with the upper end of the vessel for the coagulation liquid, whereby the narrowing at the lower end of the vessel for the coagulation liquid surrounds the supply cylinder for the viscose with an annular gap in such a way that the coagulation liquid can flow to the spinneret bottom over the thus-provided guiding surface. For the proper adjustment of the viscose supply cylinder or the spinneret holder in the aforesaid annular gap, it is preferred that suitable centering members be included in the apparatus.

In order to prevent turbulence in the flow of the coagulation liquid, it is preferred that the surface constituted by the viscose supply cylinder and/or the spinneret holder for guiding the coagulation liquid be smooth and cylindrical before, in and after the aforesaid annular gap. This is brought about by a smooth transition of the spinneret holder into the viscose supply cylinder on which the holder may be screwed, or by the employment of a hat-shaped spinneret of which the cylindrical part is of such a length that the connecting parts communicating with the viscose supply cylinder in the inside of the coagulation liquid vessel are above the annular gap.

For a satisfactory flow of the coagulation liquid it is further desirable that the outer diameter of the cylindrical spinneret holder be greater than the spinneret face diameter, and that at the place of the spinneret face there be a smooth bridging over or transition of this difference in diameters.

Preferably the edge of the narrowing at the lower side of the coagulation liquid vessel is formed conically in such a way as to give a sharp inward edge. This promotes the easy release of the liquid on leaving the supply device.

It is therefore an object of this invention to provide a method and apparatus that will make it possible to draw off freshly formed threads of viscose rayon from the spinneret at very high speeds, e. g. over 100 m./min. and even several hundred m./min. Obviously, important advantages are obtained in this way such as a much greater production than was hitherto possible can be achieved with the same number of spinnerets.

Other objects and advantage of this invention will become apparent when considered in conjunction with the accompanying drawings, wherein:

Figure 1 shows a detailed embodiment of the invention in vertical section;

Figure 2 is a modified form also in vertical section; and

Figure 3 shows schematically the path of the thread in the spinning device according to the present invention, from the spinneret to a winding device.

In Figures 1 and 2, 1 denotes a viscose supply cylinder provided at the lower end with a spinneret holder 2 and a flat spinneret 3 provided with a number of spinning holes.

In Figure 1 the spinneret holder 2 is conically narrowed or reduced in cross-section in the direction of viscose flow, whereas in Figure 2 the cross-section is uniform.

In Figure 1 the supply cylinder or tube 1 for the viscose is provided with a conically narrowed spinneret holder 2. Here, the outer surface of the holder 2 serves for guiding the coagulation liquid. Surrounding the tube 1 is a jacket 8 for this coagulation liquid. At the upper end, jacket 8 is closed with a stopper 9 provided with a hole for the tube 1. The lower end of the jacket 8 is a cone 10, which may be affixed to the tube by means of a screw thread. Between the lower end of the cone 10 and the tube 1 there is an annular gap 11, through which the coagulation liquid flows uniformly around the outer surface of the spinneret holder 2 down to the spinneret 3.

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The viscose supply cylinder 1 may be so adjusted by means of set screws 12 that the gap 11 has an equal width at all points. Near the upper end of the tube 8 a reservoir 13 is placed, which surrounds the jacket 8. Through inlets 14 the coagulation liquid is supplied via an overflow cylinder 15 and holes 16 in the jacket 8. The excess liquid is drained off from the cylinder 15 through an overflow pipe 17.

Figure 2 shows an embodiment that is essentially the same as that of Figure 1. Here again the viscose supply tube 1 is cylindrical over its entire length but at its lower end the cylindrical spinneret holder 2 is screwed on to it. Between the lower end of the tube 1 and the spinneret holder 2 is the packing 18. The supply pipe 14 for the coagulation liquid is directly connected with the jacket 8. The cone 10 is screwed onto the tube 8, and ends in a ring 19, which surrounds the spinneret holder 2, but does not reach to its lower end. The ring 19 is so ground at its lower end that it has a sharp edge at the inner side thereof.

For sealing the connection between the jacket 8 and the cone 10 a washer 20 is provided, while centering members 21 are provided therein for correctly centering the tube 1 in the ring 19.

The jacket 8 is reduced in diameter at its upper end 22, and there provided with a screw thread. A stop nut 23 is screwed on the reduced upper end 22, and a washer 24 serves for sealing the tube 1 passing through the reduced upper end 22 of the jacket 8.

As indicated above, a great increase of the working speed in the spinning room may be acquired with the method and apparatus according to the present invention. It has been discovered, moreover, that the viscose rayon threads obtained are of excellent quality, and that in combination with the stretching of the freshly set thread remarkable improvements, of a nature to be described below, are obtained.

The measures heretofore described in connection with the two embodiments of the invention serve the purpose of satisfactorily guiding the coagulation liquid to the spinneret in a uniform manner. A high pressure on the coagulation liquid, or a high squirting velocity, is avoided. The amount of coagulation liquid can be readily adjusted and it is only necessary that such an amount be supplied that all the viscose filaments are enveloped and are adhesively combined into one whole. The coagulation liquid envelopes the whole in the manner of a sheath, and a complete coagulation and at least a partial decomposition are thereby brought about.

The decomposing action of the thus-supplied coagulation liquid need not be sufficient for the complete decomposition of the viscose. In a subsequent part of the spinning path a second bath may be employed to decompose the viscose further, or the thread may be led through a hot stretching bath whereby the partially decomposed viscose is completely converted into cellulose hydrate by means of heat or by the combined action of heat and acid.

According to the present invention, the freshly set thread takes with it so much coagulation liquid as is supplied. No spinning bath proper, relatively stationary, through which the thread must go for whatever definite immersion length, is present.

In addition to the uniformly divided and concentric supply of the coagulation liquid to the spinneret, there is the definite advantage that the guiding path of the liquid is not interrupted. The adhesive and guiding forces, which act between the spinneret holder and the coagulation liquid, may thus have their full and undisturbed effects on the viscose spinning operation.

One of the outstanding advantages obtained with the method and device according to the present invention is more prevalent when the thread, which is drawn off at high speed by means of a driven, primary drawing-off member, is stretched afterwards, or, what is almost the same, when the thread is stretched over a braking mem-

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ber at high drawing-off speed. It has been discovered that the product "strength $\times$ elongation" only slowly decreases with increasing primary drawing-off speed.

It must be assumed that the new thread (in contrast with the present day threads) spun at a very high drawing-off speed, has, during the first part of the spinning path, and at any rate before the after-stretching, a constitution unaffected by premature overstretching, which, as is generally known, is not to be expected when employing spinning baths properly so called, however small their lengths, e. g. a few cm.

According to the method of the present invention, any viscose hitherto considered workable may be spun. The requirements in respect of maturity or temperature or other viscose properties are no different from those met with in the hitherto known methods for the manufacture of viscose rayon. All coagulation baths are suitable, such as the conventional Muller baths as well as those with special compositions adapted to special purposes. In general, high-acid spinning baths allow of a higher primary drawing-off speed than low-acid baths which less rapidly coagulate and decompose the cellulose xanthate. It has been found, however, that according to the method of the present invention low-acid baths, too, may be advantageously employed since they equally allow spinning at a rather considerable increase of primary drawing-off speed, in contrast with the known methods. Normal Muller baths with high zinc sulphate content permit spinning at equally high speed, though it is not possible to attain the highest primary drawing-off speeds. With normal Muller baths containing little or no zinc sulphate, spinning according to the method of this invention may be done at drawing-off speeds of 250 m./min. and higher.

In spinning according to the present invention there is no problem concerning the length of immersion in a coagulation bath bounded by walls, nor about upsetting or constriction of the liquid or particular constriction of the bundle of filaments. The measures described herein are also taken to prevent a harmful formation of turbulence in the coagulation liquid carried along by the thread, or to avoid undue frictional forces on the still-very-sensitive freshly formed thread.

The amount of coagulation liquid is adjusted to conform to the spinning conditions, according to the coagulating and decomposing properties of the coagulation liquid itself, the properties of the viscose, the titre of the thread to be spun, the primary drawing-off speed, etc.

Experiments have shown that one cardinal cause of the highly beneficial effects of the method according to the present invention is that at the face of the spinneret there is never more coagulation liquid than is continuously carried away by the thread. No accumulation of coagulation liquid can take place so that turbulence formation and friction by redundant liquid are avoided.

Surprisingly, it has been found that, with the method and the device according to this invention, the supplied amount of coagulation liquid combines without any disturbance at and after the spinneret with the many viscose filaments. Moreover, the coagulation liquid reaches the innermost jets of spinning liquid in a very short time, so that clot formation, clogging of holes and thread breakage are avoided.

The artificial threads obtained according to the method of the present invention are, in spite of the abnormally high primary drawing-off speed, of excellent quality. Viscose rayon threads of all common types may be spun, e. g. 15-20 denier, 100-120 denier, and finally 1000-1500 denier, which are especially useful in the manufacture of automobile tire fabrics.

The ease of dismantling the spinning device according to this invention has given complete satisfaction in practice, both for inspection of the viscose supply pipe and of the supply device for the coagulation liquid, for changing the spinneret, and for centering the spinneret holder.

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In the devices described according to Figures 1 and 2, the viscose supply line 1 can easily be displaced axially in the jacket 8 and, as a consequence, the distance between the spinneret 3 and the outlet for the coagulation liquid can easily be adjusted at will. The connection between the line 1 and the vessel or jacket 8 is not entirely stiff or rigid, and yet it is still possible to lead the coagulation liquid under pressure into the coagulation liquid vessel.

Spinning-in with the devices according to Figures 1 and 2 may be carried out as follows:

The outlet of the empty coagulation liquid vessel is closed, and the vessel filled with water. Then the viscose supply cylinder is opened so that the viscose passes through the spinning holes and the water in the vessel is gradually replaced by the coagulation liquid proper.

In four experiments described below by way of example, a device according to Figure 2 was used, the procedure being that schematically indicated in Figure 3. There, after emerging from the spinneret 3, the thread was led vertically downwardly and around a primary draw-off godet 25 at a distance of 60 cm. below the spinneret. Then the thread was led several times around a second godet 26 driven at a slightly higher circumferential speed than godet 25. In its further path of travel the thread was laid in several turns around a stretching roller 27 and was then led into the spinning pot 28 disposed below the roller 27.

The godet 26 imparted a small stretch of about 3% to the thread. The stretching roller 27 stretched the thread with respect to the primary draw-off of roller 25 about 30%, so that the final titre of the thread was 110 denier.

The viscose as spun had a cellulose content of 7.3%, an alkali content of 6.8% and a maturity of 11° Hottenroth. A spinneret was used having 40 holes, each of 70 microns. The coagulation liquid contained per litre 110 g. of sulphuric acid, 175 g. of sodium sulphate, 40 g. of magnesium sulphate, and 8 g. of zinc sulphate. The liquid temperature was 70° C. The amount of coagulation liquid taken along with the thread from the spinneret was adjusted to about 225 cm.³/min.

The following table shows the spinning speeds used and the results obtained:

Exp.	Primary drawing-off speed in m./min.	Spinning speed in m./min.	Strength, g./100 denier		Elongation, percent		Product of dry strength X dry elongation
			dry	wet	dry	wet	
1-----	110	140	183	100	28.5	42.6	5,210
2-----	140	180	171	85	27.4	37.9	4,680
3-----	170	220	173	93	24.9	37.8	4,300
4-----	190	250	166	80	26.7	35.2	4,400

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While specific details of preferred embodiments have been set forth above, it will be apparent that many changes and modifications may be made therein without departing from the spirit of the invention. It will therefore be understood that what has been described herein is intended to be illustrative only, and is not intended to limit the scope of the invention.

What is claimed is:

1. Apparatus for the jet spinning of artificial threads from viscose comprising an elongated cylinder through which viscose is supplied, a tubular spinneret holder secured to one end of said cylinder, the outer surface of said spinneret holder forming a smooth extension of the outer surface of said cylinder, a flat spinneret having a plurality of holes mounted in the end of said spinneret holder, an elongated jacket surrounding said cylinder in spaced relationship and extending over a portion thereof, means at one end of said jacket for closing the space between the cylinder and jacket, means secured to and defining the other end of said jacket for restricting the space between the jacket and cylinder and for forming an annular gap through which coagulating liquid uniformly flows at a point remote from the face of the spinneret, means adjacent the closed end of said jacket for supplying coagulating liquid to the space between the jacket and cylinder and adjustable means for spacing the jacket concentrically with respect to the cylinder, whereby the coagulating liquid envelopes the threads formed during spinning in the manner of a sheath.

2. An apparatus for jet spinning as set forth in claim 1 wherein the spinneret holder is cylindrical in shape and is provided with rounded edges in order to enhance the streamline flow of coagulating liquid.

3. An apparatus for jet spinning as set forth in claim 1 wherein the means for supplying coagulating liquid comprises a reservoir which surrounds said jacket.

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