

June 16, 1953

TSUKUMO TOMONARI ET AL

2,642,333

METHOD OF SPINNING POLYVINYL ALCOHOL FIBERS

Filed April 8, 1950

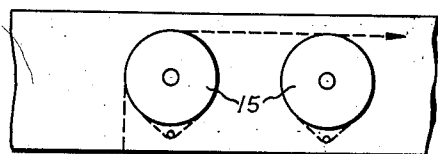


Fig. 1.

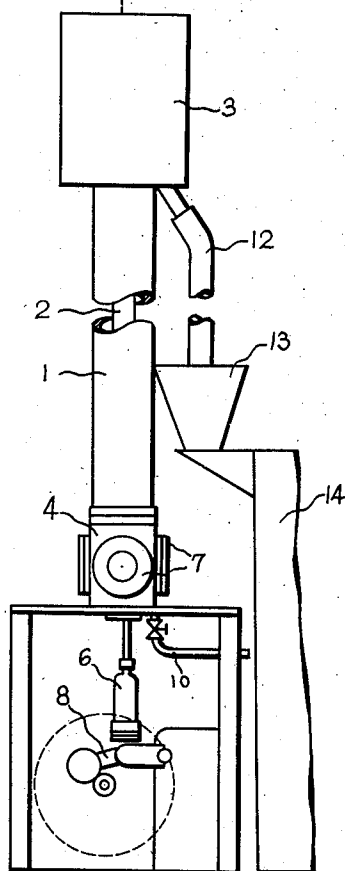
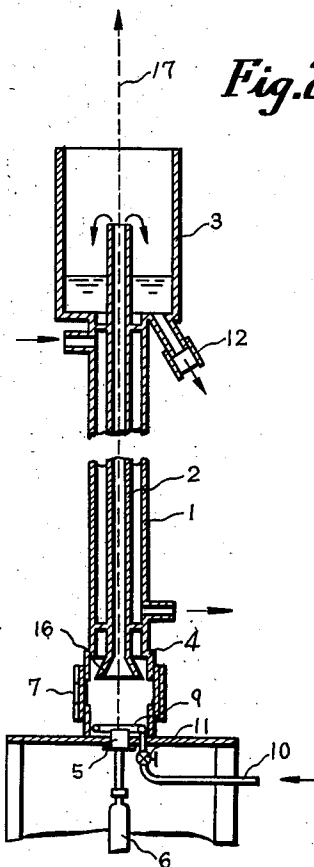


Fig. 2.



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UNITED STATES PATENT OFFICE

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METHOD OF SPINNING POLYVINYL
ALCOHOL FIBERS

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Application April 8, 1950, Serial No. 154,872
In Japan July 26, 1949

1 Claim. (Cl. 18—54)

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The present invention relates to an improvement in or relating to a method of spinning synthetic fibers and the apparatus thereof.

In the spinning of synthetic fibers such as polyvinyl alcohol fibers where the coagulating rate is slow, it is necessary to make the dipping length as long as 500 mm.—1,000 mm. at spinning speeds of about 50 meters per minute. If it is desired to increase the spinning speed (for example, it is possible to use a speed of 90 meters per minute in the viscose method), a longer dipping length is required. For spinning methods where the filaments have to travel through considerable lengths of the coagulating bath, it has been proposed to let the spinning solutions flow upwardly together with the coagulating medium in order to save floor space. This method should be of particular advantage for spinning polyvinyl alcohol and similar filaments where the specific gravity of the spinning solution is considerably lower than the specific gravity of the coagulating bath. This difference in the specific gravities causes the spinning solution to float upwardly in the rising column of the coagulating liquid, and the filaments which are being formed in the coagulating bath are subject to a gentle stretching, which should prevent breakages.

However, when it was attempted to prepare polyvinyl alcohol filaments by the up-spinning process, it was found that the conventional devices were not suitable and that the filaments broke, especially in the zone where the coagulation of the filaments started. Breakages of the filaments became particularly frequent when the same apparatus had to be used under changing conditions of concentration, spinning speed, temperature, etc.

It is a principal object of the invention to provide a method for up-spinning polyvinyl alcohol and similar filaments with a minimum of breakages.

Another object of the invention is to provide an apparatus suitable for carrying out said method.

The present invention provides an improved method and apparatus for producing filaments from polyvinyl alcohol, which method reduces to a minimum the occurrence of breakages by allowing the filaments to take form in an upwardly flowing unturbulent column of the coagulating medium and by applying stretch to the filaments only after they have sufficiently solidified.

An apparatus suitable to carry out the method

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of the invention consists essentially of a reaction chamber in which the spinning solution is brought in contact without turbulence with the coagulating liquid, and of vertical or inclined tubes of much smaller diameter through which the coagulating liquid and the spinning solution pass upwardly for a length of travel sufficient to solidify and stretch the coagulated filaments.

When the rising coagulating liquid enters the narrow tube, the rate of travel of the liquid is increased corresponding to the reduction of the diameter of the rising column, and this increased rate of travel exerts a stretching action on the filaments which are being formed. These filaments will break if they are subjected to a stretching action or to any stress by turbulence before they are sufficiently solidified.

Our invention is illustrated in the accompanying drawings, in which:

Figure 1 is an elevation of the spinning machine embodying the present invention, and

Figure 2 is a sectional elevation showing the essential part of the spinning machine.

Referring now to the drawing, 1 designates a vertical pipe having an inner pipe 2 fixed therein, through which the coagulating bath and the spinning solution are forced upwardly. 3 represents an over-flow tank, through the bottom of which the upper end of the inner pipe 2 is extended. 4 represents the reaction chamber having fitted to its bottom a spinneret 5 which is connected to the filter 6. The chamber 4 is provided with openings which are normally closed by the cover 7. 8 designates a pump such as a gear pump driven by a suitable motor (not shown). Around the spinneret 5, there is arranged a ring-shaped pipe 9 having a number of small nozzles, which is connected to the source of the coagulating bath (not shown) through the pipe 10 and the regulating valve 11. The over-flow tank 3 is provided with an outlet pipe 12 which delivers the excess coagulating bath to a receiver 13, thence the bath is returned to the collecting tank 14. 15 represents godet rollers for transmitting the spun fibers to following machines (not shown).

As shown in Fig. 2, the lower end 16 of the pipe 2 is preferably flared out and the space between the pipes 1 and 2 is used as a heating jacket or a heat insulating chamber.

The operation of the present spinning machine shown in the drawing is explained in the following:

The coagulating liquid is fed from the pipe

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10 slowly and uniformly through the nozzles of the annular pipe 9 into the chamber 4 where-in it flows upwardly without turbulence until it enters the funnel-shaped opening 16. Then it flows upwardly at an increased speed through the narrow tube 2; the liquid overflowing at the upper end of said tube into the tank 3 is recycled through the pipe 12 and the funnel 13 in a reservoir for repeated use.

A certain definite amount of the spinning solution is pumped up by the gear pump 8, through the filter 6, and spinneret 5 into the coagulating bath without turbulence. The spinning solution begins to coagulate and is assembled into the funnel opening 16 together with the coagulating bath. While it flows up through the coagulating tube 2, it completes the coagulation and is transformed into filaments 17 which pass to the following processing stages over the godet roller 15.

The upwardly flowing column of coagulating liquid and spinning solution comprises two sections sharply distinguished by their physical conditions. The lower section is a relatively wide column of undisturbed flow where the spinning solution starts coagulating to filaments. The rate of coagulation depends on the concentrations and compositions of the components, on the polymerization degree of the filament forming material, temperature, etc. If the filaments formed in this section have not sufficiently solidified, they will be broken when entering the pipe 2, i. e., the second section.

In this second section, the rate of upward travel of the column is considerably increased because of the sudden reduction of the diameter of the column, and the filaments are stretched. As stated hereinbefore, the filaments must have a certain strength when entering the pipe 2 to avoid breakages. On the other hand, if the solidification of the filaments has advanced too far, the stretch exerted during the travel through tube 2 will not be sufficient to produce the desired elongation. The jacket formed by the tube 1 around tube 2 allows of passing a heating or cooling medium therethrough; in this way, the temperature of the liquid column in tube 2 may be controlled so as to obtain the desired rate of coagulation and solidification of the filaments therein.

Depending upon the density and quality of the spinning solution, its separation from the spinneret 5 may be sometimes difficult. In such a case, the supply of the liquid may be stopped

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by closing the cock 11 and by opening the window or cover 7 located at a point about 60 mm. above the spinneret, and the free flow of the spinning solution is restored by suitable manipulations. Then the cover 7 is closed and the cock 11 is opened again to feed the coagulating solution. The spinning solution floats on the coagulating solution and flows upwardly therewith, and the filaments are collected at the top of the pipe 2 and then wound up by the godet roller 15.

It will be understood that while a particular embodiment of the invention has been described, the invention is capable of further modification, and the present application is intended to cover such changes or modifications as within the spirit of the invention or scope of the following claim.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

A method of spinning polyvinyl alcohol fibers comprising the steps of extruding a polyvinyl alcohol solution into an up-flowing column of a coagulating liquid having a higher specific gravity than said polyvinyl alcohol solution, imparting to said coagulating column and said polyvinyl alcohol solution a parallel upward direction of flow without turbulence, maintaining said unturbulent parallel flow until the polyvinyl alcohol coagulates to filaments, subsequently reducing the diameter of said column, thereby increasing the rate of flow thereof, and stretching said coagulated filaments by said increased rate of flow and the uplift of the filaments in the specifically heavier column of the coagulating liquid.

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