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METHOD OF PRODUCING THIN THREADS FROM POLYVINYL
ALCOHOL AND ITS WATER-SOLUBLE DERIVATIVES
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Fig. 1.

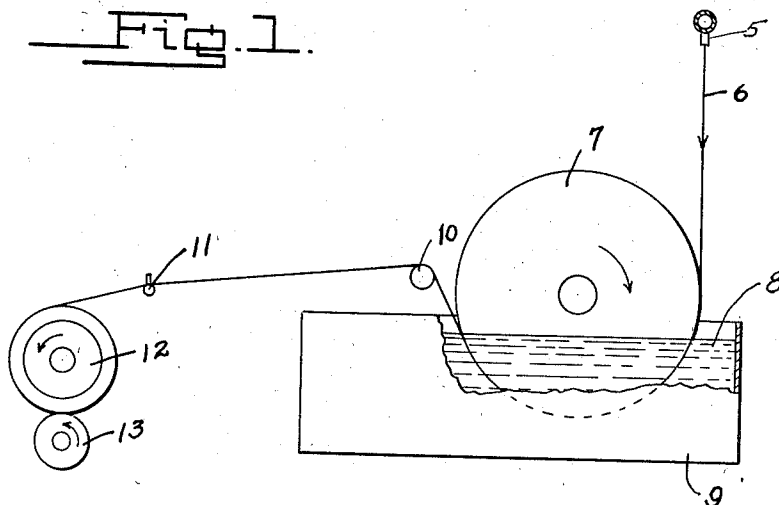
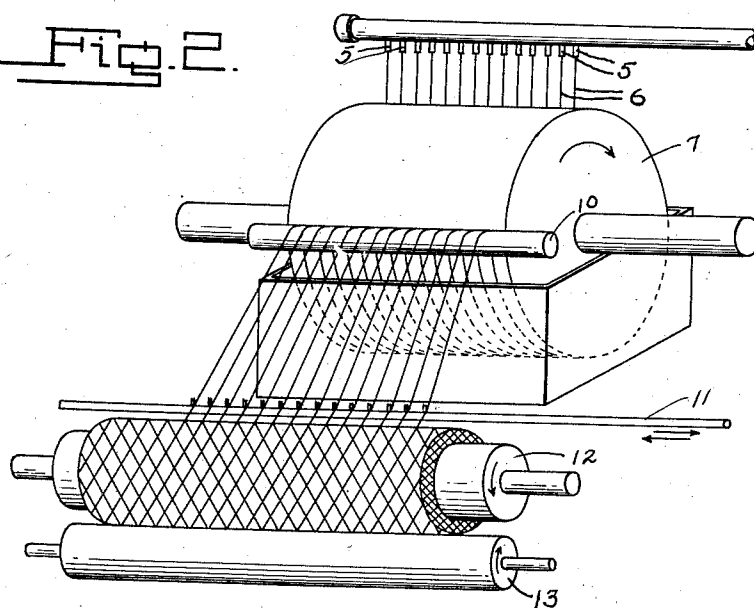


Fig. 2.



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METHOD OF PRODUCING THIN THREADS
FROM POLYVINYL ALCOHOL AND ITS WA-
TER-SOLUBLE DERIVATIVESHilger Peter Schmitz, Munich, Germany; vested
in the Alien Property CustodianApplication October 18, 1940, Serial No. 361,796
In Germany November 3, 1939

5 Claims. (Cl. 18-54)

As is known, it is difficult to produce very thin threads according to the usual spinning processes even if materials are employed well suited for being spun. Even under the most favorable conditions the spinning is difficult because spinning solutions of a considerably high concentration must be applied in order to avoid the non-solidified thread being broken during the removing from the nozzle. Therefore a complicated spinning apparatus, high pressure and in many cases high temperatures must be applied.

The manufacture of very thin threads of polyvinyl alcohol and its water-soluble derivatives—that means of substances of which it was originally not known that they could be spun and which only after 1931 could be worked up into thick threads according to the usual spinning methods—has been an unsolved problem until now. Experiments in this direction have always shown that the thick threads obtained by the usual processes for spinning cannot be extended to considerably thin ones without breaking and that on the other hand diluted solutions cannot be worked up according to the usual spinning processes. These failures are meant to be due to the solvent water which is alone applicable in practice, because polyvinyl alcohol has a high capacity for binding water.

It has now been found that also relatively diluted aqueous solutions of polyvinyl alcohols and their still water soluble derivatives may be worked up into very thin threads very resistant to tear and which may be obtained even thinner than the elementary filament of natural silk if these solutions are conducted in a thin jet through a suitable nozzle upon a support which is in a relative movement against the falling liquid jet. Principally, it is all the same whether the nozzle or the support is moved. The support may consist of a continuous band moving under the nozzle or of a disk rotating under it or a disk over which the nozzle is moving in a circle, and the like. The support in form of a rotating drum is of a technical advantage. The liquid jet falls upon such a drum parallel to the rim of the drum and the forming thread is transported by the rotating drum, provided that a sufficient amount of liquid continuously leaves the nozzle. If the drum is wished to rotate more rapidly a raised pressure may be applied upon the liquid which is to be worked up in order to avoid that the thread breaks.

One modification of the invention is illustrated in the accompanying drawing in which

Figure 1 is a diagrammatic side elevational view

showing an apparatus suitable for use in accordance with the invention.

Figure 2 is a perspective view of the apparatus shown in Figure 1.

Referring to the drawing reference numeral 5 designates the series of parallel nozzles through which the polyvinyl alcohol is extruded. The filaments 6 extruded from the several nozzles pass vertically downward into tangential contact with the drum 7 which rotates in the direction of the arrow. The filaments are carried into contact with the bath 8 in container 9. The filaments 6 then pass over roll 10, and they are then guided by means of traverse bar 11 on to the filament support 12 which may be driven by surface drive roller 13.

This method of producing threads is known but until now it was proposed only for materials easily to be spun and this method has not been proved to be well applicable in the art. On the other hand it could not be recognized that this method is even applicable to diluted solutions and especially to low concentrated aqueous solutions of thread-forming materials. Above all, it is surprising that by this way polyvinyl alcohol—which, as is known, is not well suited for spinning processes—may be worked up into thin threads at all, and it is especially surprising that thereby diluted aqueous solutions of this substance may be spun into thin threads.

The advantages of this method are as follows: it is not only possible to produce thin threads but thereby may be also applied diluted solutions produced and casted at usual temperature, whereby the known undesired hardening-effect of heat upon polyvinyl alcohol can be avoided.

By this method of casting threads, a little stretching and diminishing of the diameter of the free-suspending liquid-thread may be also attained before it reaches the support. On the other hand the pre-stretching of the thread and other influences upon it may be promoted by subjecting the free-suspending thread to methods changing the consistency of the thread, especially the viscosity or solidifying the surface of it in a more or less degree, e. g. removing the solvent by means of a current of gas or heating the thread or cooling the warm casted thread. Also the influence of tanning or condensing gases like aldehydes may be applied.

In every case, however, the selected methods must be applied in such a manner that the liquid-jet reaches the support in a somewhat liquid state. The solidification of the thread is attained upon the rotating drum by one of the above mentioned

methods or by a combination of them. The solidification is preferably effected by drying by means of a current of air or otherwise the under parts of the drum may be passed through a bath which has a precipitating, tanning, vulcanizing or condensing effect upon the thread, whereby the bath-liquid may be removed later on and the thread be dried by a current of air. There are for instance alcohol or solutions of dichromates or solutions of Congo red as described in Patent 2,125,374 which are suitable for this purpose.

If necessary, tanning-, condensation-, and vulcanisation-agents may already be added to the solution to be casted. It is also possible to add liquids promoting the evaporation of water such as acetone, alcohol, suitable amounts of acetic ester and the like.

The efficiency of the solidifying method must be adjusted to the given casting solution, to the desired width of the nozzle and to the velocity with which the solution leaves the nozzle, whereby the size and the rotation-velocity of the drum must be taken into consideration.

Generally it is not necessary that the thread is already solidified completely upon the drum; it is sufficient if an approximate solidification is attained, by which it is possible to remove the thread from the drum when it has passed the largest compass of the drum.

The removing of the thread from the casting support is preferably executed by applying the methods known in the usual processes for spinning, especially by reeling, whereby the thread is drawn off from the drum near the casting device and runs over a roll arranged near the casting device but above the vertex of the drum. Generally the drawing off of the thread is not difficult. In special cases the taking away of the thread may be facilitated by a current of air which is blown against it. Generally a twisting of the thread by torsion and/or a stretching of it which is gradually executed if necessary and which must be adjusted to the material of the thread is combined with the reeling. A spinning and twisting together with other threads may also follow immediately and so on.

The threads drawn off from the drum or from another casting support may be subjected to a suitable after-treatment during or after the drawing off, e. g. to a further drying, heating, tanning, condensation, dyeing, loading, delusterizing, roughening, sizing, and so on. An excessive amount of softeners incorporated to facilitate the stretching of the thread may be subsequently removed more or less by solvents which solve well the softener agents without solving the material of the thread.

The new method allows also the working up of casting solutions containing fillers, pigments, agents for delusterizing, f. i. titanium dioxide or usual loading agents, in a sufficient fine distribution. Softeners, stabilizers, dyestuffs and the already above named agents promoting the solidification and if necessary catalysts promoting the further polymerization may also be added.

According to this method also threads may be produced containing included gas. Even hollow threads may be obtained. The manufacture of the threads upon the moved casting support and their drawing off may even be executed if casting solutions are worked up containing an emulsified amount of gas or if hollow spaces are produced

in the casted threads by solidifying at first only their surfaces and heating the threads subsequently—while they are still upon the drum or after they are drawn off—in such a way that gas spaces are formed inwards the threads before they are completely solidified.

The forming of the thread upon a solid support also allows the blowing up of finely divided fibrous or powdery substances, e. g. textile dust in such a way that the little fibers adhere to the still sticky surface and adhere durably after the solidification of the thread.

The leading of the solidifying threads by a rotating roll is so exact, that upon the roll a series of threads may be casted out of nozzles lying closely adjacent. Several hundred threads may be produced upon a drum of only 1 m. axis-length at the same time.

Following a suitable casting solution:

Example

	Parts by weight
Polyvinyl alcohol (high or low viscous) ---	5
Glycerin or ethylene glycol-----	0.25
Water -----	94.75

By this specially careful production of threads of polyvinyl alcohol and by the now attainable thinnest formation of the elementary threads for twisted yarn, new possibilities are given for promoting the resorption of threads being used for surgical purposes.

I claim:

1. The method of producing thin threads of polyvinyl alcohol which comprises casting a dilute aqueous solution, containing of the order of 5% of polyvinyl alcohol through a nozzle, in the form of a thread, upon a rotating drum, solidifying said thread on said drum, and drawing the solidified thread from the drum.

2. The method of producing thin threads of polyvinyl alcohol which comprises casting a dilute aqueous solution, containing of the order of 5% of polyvinyl alcohol through a nozzle, in the form of a thread, upon a rotating drum, drying and solidifying said thread on said drum, and drawing the dry, solidified thread from the drum.

3. The method of producing thin threads of polyvinyl alcohol which comprises casting a dilute aqueous solution, containing of the order of 5% of polyvinyl alcohol, through a nozzle, in the form of a thread, upon a rotating drum, stretching said thread on said drum, drying and solidifying said stretched thread on said drum, and drawing the dry, solidified thread from the drum.

4. The method of producing thin threads of polyvinyl alcohol which comprises casting a dilute aqueous solution, containing of the order of 5% of polyvinyl alcohol, through a nozzle, in the form of a thread, upon a rotating drum, imparting a sufficient velocity of rotation to said drum to stretch said thread, drying and solidifying said thread on said drum, and drawing the dry, solidified thread from the drum.

5. The method of producing thin threads of polyvinyl alcohol which comprises casting a dilute aqueous solution, containing of the order of 5% of polyvinyl alcohol through a nozzle, in the form of a thread, upon a rotating drum, drying and solidifying said thread on said drum, and drawing said thread from said drum with sufficient tension to stretch said thread.

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