Oct. 3, 1939. H. C. FORREST 2,174,576

ARTICLE OF MANUFACTURE AND METHOD OF MAKING SAME

Filed April 9, 1938 2 Sheets-Sheet 1

Fig. 1.

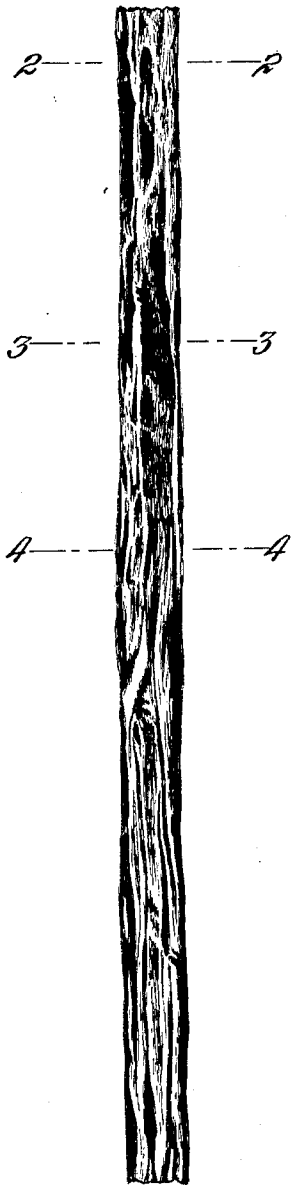



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



INVENTOR
Henry C. Forrest
BY
Robert W. Byrd
ATTORNEY

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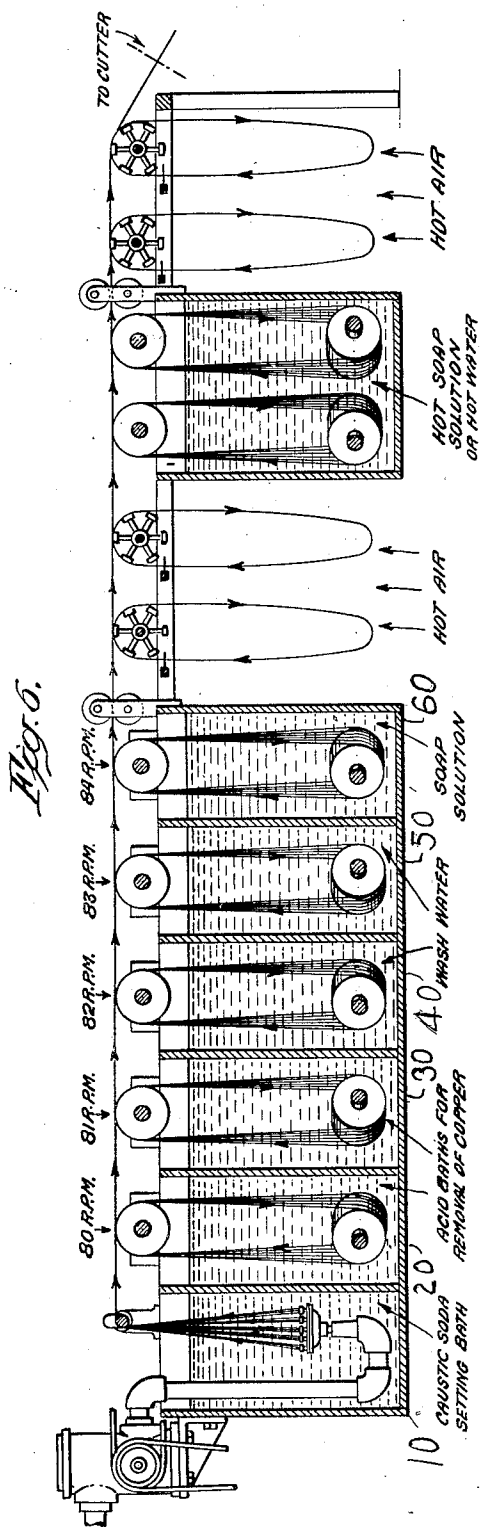



Fig. 6.

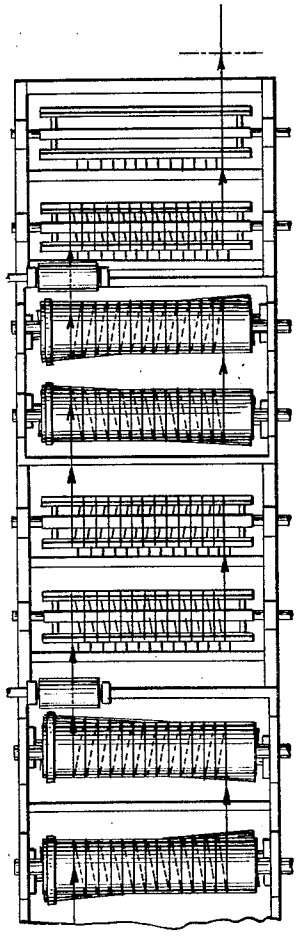


Fig. 7.

INVENTOR
Henry C. Forrest
BY
Robert W Byerly
ATTORNEY

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# UNITED STATES PATENT OFFICE

2,174,576

## ARTICLE OF MANUFACTURE AND METHOD OF MAKING SAME

Henry C. Forrest, Merchantville, N. J.

Application April 9, 1938, Serial No. 201,063

3 Claims. (Cl. 18—54)

This invention relates to a new article of manufacture, namely, a new artificial fibre which may be spun into yarn by ordinary cotton spinning or worsted and woolen spinning machinery, and to a method of making the same.

Rayon yarn is a slightly twisted thread composed of from 50 to 100 extruded regenerated cellulose filaments. The individual fibres have smooth surfaces which give the yarn a shiny appearance resembling silk. The yarn itself and fabric woven from it, while having an appearance resembling silk, have not the softness and pliability of a yarn spun from natural fibres or fabric made therefrom.

Attempts have been made to produce yarn by spinning short or cut filaments of regenerated cellulose in the way in which cotton fibres are spun, and it has been demonstrated that such yarn has not the harshness of rayon yarn. But the smoothness of extruded regenerated cellulose filaments which, when cut to short lengths, are known as rayon staple, has made it in most cases difficult to form them into yarn by cotton spinning machinery unless a considerable proportion of natural fibre is mixed with them. The only spinnable rayon staple which has been produced has consisted of fine denier viscose filaments which have been mechanically treated by crimping or twisting in an attempt to make them kinky and spinnable. Such staple has not been entirely satisfactory, particularly in the large sizes, in which the filaments are stiff and brittle.

The artificial fibre which I have invented provides a readily spinnable rayon staple. The fibre has the following characteristics by which it may readily be identified and distinguished:

(1) It is a cupro-ammonium regenerated cellulose filament of the same composition as the filaments of cupro-ammonium artificial silk yarn.

(2) It is extremely pliable so that, even when made in very large size, for example, 25 deniers, it may be bent sharply without breaking. This characteristic, which is probably a result of the chemical composition of the fibre, distinguishes it from viscose filaments which lack pliability to such an extent that, when made of large size, they are brittle and cannot be bent abruptly without cracking and breaking.

(3) It has a rough and irregular surface by which it may readily be distinguished on microscopic examination from the filaments of cupro-ammonium silk yarn which have smooth cylindrical surfaces.

(4) It has an irregular non-circular cross-section by which it may readily be distinguished under the microscope from the generally circular cross-section of filaments of cupro-ammonium silk yarn.

(5) Its cross-sectional shape varies along its length. This feature is, so far as I am aware, unique in a rayon filament.

(6) It varies slightly and irregularly in denier along its length. This feature is readily observable when it is examined under the microscope by means of polarized light, for, with such light, changes in color occur along the length of the fibre. This characteristic is not, so far as I am aware, found in any other rayon filament.

(7) It is naturally and permanently curved or wavy. Its permanent waviness distinguishes it from other cupro-ammonium filaments, and the permanent character of this waviness distinguishes it from viscose filaments which have in some cases been given a temporary kinky form by mechanical treatment.

(8) When made in small denier, it is readily spinnable into yarn by ordinary cotton spinning machinery without previous mechanical treatment and without admixture of any natural fibre. Yarn spun from it by cotton spinning machinery has the softness and pliability characteristic of cotton yarn.

(9) When made in large denier, it may be spun into yarn by ordinary worsted and woolen spinning machinery. The yarn spun from it has the physical characteristics of worsted yarn and has proved an entirely satisfactory substitute for worsted and woolen yarns, and particularly for the coarse woolen yarns used in carpet making and mohair goods. Such yarn forms the subject-matter of my application Serial No. 121,983, filed January 23, 1937, of which the present application is a continuation in part.

In further explaining the characteristics of the fibre which I have invented and the method which I have invented for making it, I shall refer to the accompanying drawings:

Figs. 1 to 4 are greatly enlarged views of part of a fibre or filament embodying my invention. Fig. 1 is a side view and Figs. 2 to 4 are a series of cross-sections.

Fig. 5 is a slightly enlarged side view of the fibre.

Figs. 6 and 7 are diagrams illustrating a specific method of manufacturing the filament shown in Figs. 1 to 5 with the use of the apparatus shown in my Patent No. 2,108,285, issued February 15, 1938. Fig. 6 is a diagrammatic side elevation with the front walls of the tanks and casings re-

moved and Fig. 7 is a plan view of part of the apparatus shown in Fig. 6.

Many of the characteristics of my new fibre which I have mentioned may be seen in Figs. 1 to 5. The rough surface of the fibre is evident in Fig. 1 which is drawn from an actual magnification of a 25 denier fibre embodying my invention taken at a magnification of 400 diameters. The irregular non-circular cross-section of the fibre and the variation in cross-section and denier along the length of the fibre are apparent from the cross-sectional views Figs. 2 to 4 which are taken from actual microphotographs of the fibre shown in Fig. 1 at the same magnification. The curve or wavy form of the fibre is apparent from Fig. 5 which is a slightly enlarged drawing from a 25 denier fibre embodying my invention. It will be understood that the portion of the fibre shown in Fig. 1 at a magnification of 400 diameters is too short to show the curvature of the fibre.

The specific method which I have found most successful and practical in manufacturing my new spinnable rayon staple consists in first making an untwisted rope or band containing a large number (for example 6000) cupro-ammonium filaments by the method and apparatus described in my Patent No. 2,108,285, issued February 15, 1938. Such apparatus as there explained consists of a series of tanks, the first of which contains an extruding device or spinneret and the others of which have pairs of rollers with their axes set at angles to provide in each tank a continuously winding and unwinding flat coil of the band or rope of filaments extruded in the first tank. Such apparatus is shown in the left-hand part of Fig. 6, wherein it will be seen that the first tank having the extruding device contains a caustic soda setting bath into which copper ammonium cellulose solution is extruded; and the next two tanks, **20** and **30**, contain acid baths for removal of copper from the filament. This completes the chemical treatment used in the making of cupro-ammonium filaments. The next two tanks, **40** and **50**, contain wash water, while the last tank, **60**, contains a soap solution.

An important feature of the method consists in a slight controlled stretching of the filaments after the chemical treatment of the filaments is completed. This is accomplished in the apparatus illustrated by driving each successive pair of rollers slightly more rapidly than the preceding pair. Thus, the pairs of rollers may be driven by gearing (not shown), so that successive pairs are positively driven at the speeds indicated in Fig. 3, namely, 80 R. P. M., 81 R. P. M., 82 R. P. M., 83 R. P. M., and 84 R. P. M. These figures are merely illustrative, and serve to show means for a gradual and controlled stretching of the chemically treated fibres amounting to about 5 per cent.

When the rope of filaments emerges for the last time from the tank **60**, it is taken to a drying chamber **70** and formed into freely suspended loops, so that it is dried without tension and under conditions which permit shrinkage. The dried and shrunk filaments are then rewet with a hot soap solution or hot water either by immersion as indicated at **80** in Fig. 6, or by spraying the solution on the filaments. This causes the filaments to relax or elongate to the extent of about 2 per cent. The filaments are then again dried without tension, as indicated at **90** in Fig. 6. During this drying, a further shrinkage takes place, reducing the filaments to about 90 per cent. of the length which they had on leaving the tank **60**. The filaments are then cut into lengths convenient for spinning. Lengths of from 1 to 2 inches are satisfactory for cotton spinning machinery, while lengths as great as 5 inches may be used in worsted and woolen spinning machinery. The cutting may be done after the second drying of the rope of filaments or at any time after the rope of filaments emerges from the tank **60**, as the drying of the filaments without tension as well as the rewetting of the filaments by the hot soap solution or hot water may, if desired, be accomplished after the filaments have been cut.

The fibres produced by the method which has been described have the characteristics illustrated in Figs. 1 and 2 and described at the beginning of this specification.

While I do not wish to bind myself to any theory as to the operation of my method, a careful microphotographic examination of the new fibre indicates that, after the filaments are set and chemically treated, irregular strains are set up in the filaments, which, in the latter part of the process, are relaxed, so as to cause a permanent deformation of the filaments into the rough and regular form shown in Figs. 2 and 3. I believe that in the setting up of these irregular strains the slight twisting of the rope of filaments first in one direction and then in the other as it passes over the angled rollers may be an important factor.

What I claim is:

1. The method of making a spinnable rayon staple, which comprises extruding a cupro-ammonium cellulose solution into a precipitating bath to produce a wet cupro-ammonium regenerated cellulose filament, subjecting the filament to treatment with liquids while setting up irregular strains in the filament by stretching and then relaxing said strains to deform the filament and drying the filament in slack condition permitting free shrinkage to retain the deformation, and so feeding and guiding the filament during such treatment that it is free from folding.

2. The method of making a spinnable rayon staple, which comprises extruding a cupro-ammonium cellulose solution into a precipitating bath to produce a multiplicity of wet cupro-ammonium regenerated cellulose filaments, continuously feeding the filaments lengthwise, subjecting the filaments during such lengthwise movement to treatment with liquids while setting up irregular strains in them by subjecting them to a plurality of stages of stretching and between each two stages repeatedly slightly twisting and untwisting them, then relaxing said strains to deform the filaments by placing them in slack condition, and drying them in slack condition permitting free shrinkage to retain the deformation.

3. As a new article of manufacture, a spinnable rayon staple consisting of uniformly-extruded cupro-ammonium regenerated cellulose fibres of non-uniform cross-sectional shape and varying irregularly along their lengths in cross-sectional area to an extent sufficient to produce changes in color along their lengths when examined under the microscope by means of polarized light and insufficient to be visible to the naked eye, and having as a result of such variations irregular surfaces and a naturally wavy form.

HENRY C. FORREST.