Nov. 9, 1937. G. M. KARNS 2,098,628

ARTIFICIAL THREAD AND PROCESS OF PRODUCING SAME

Filed Dec. 18, 1935 3 Sheets-Sheet 1

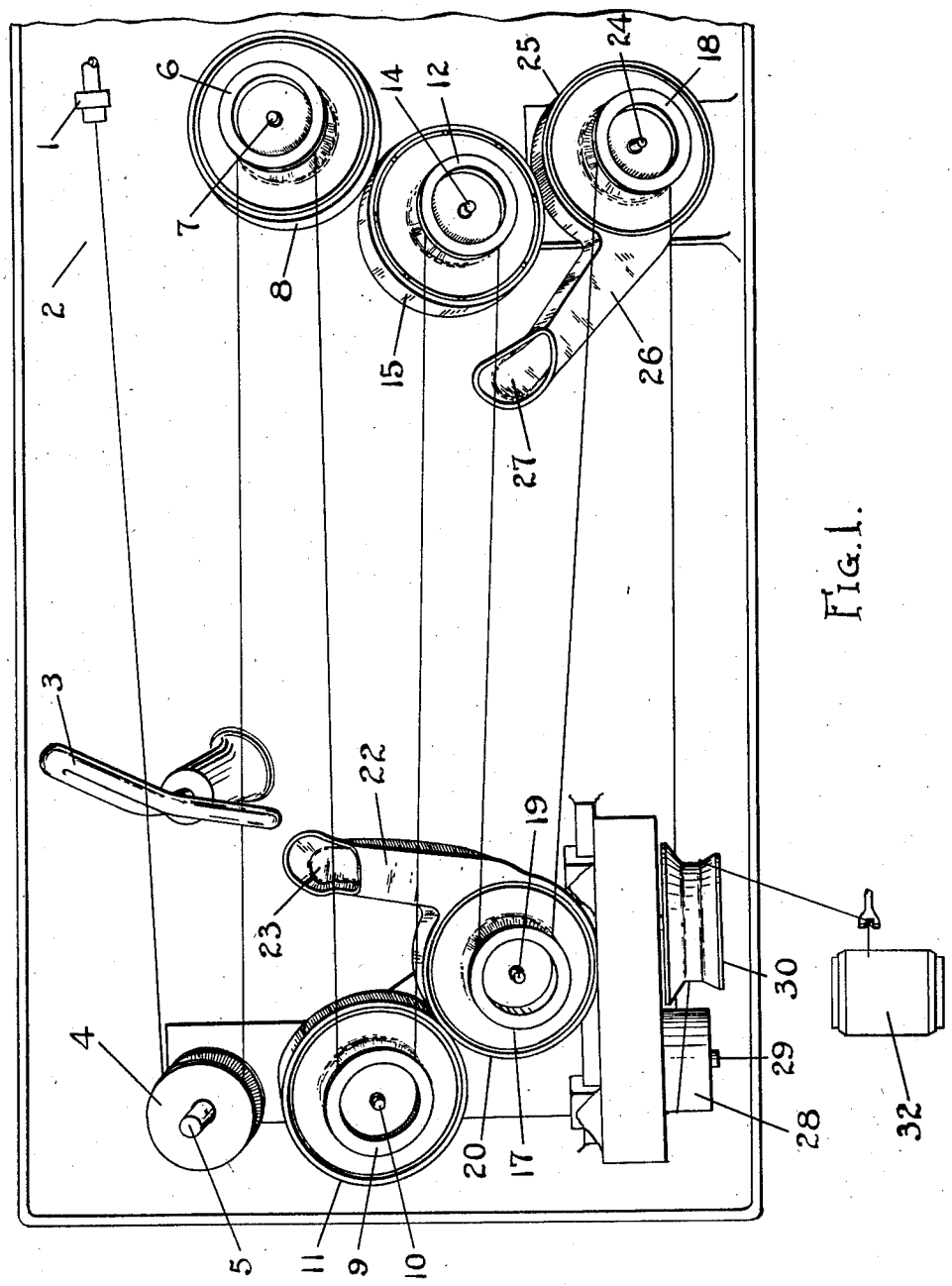



FIG. 1.

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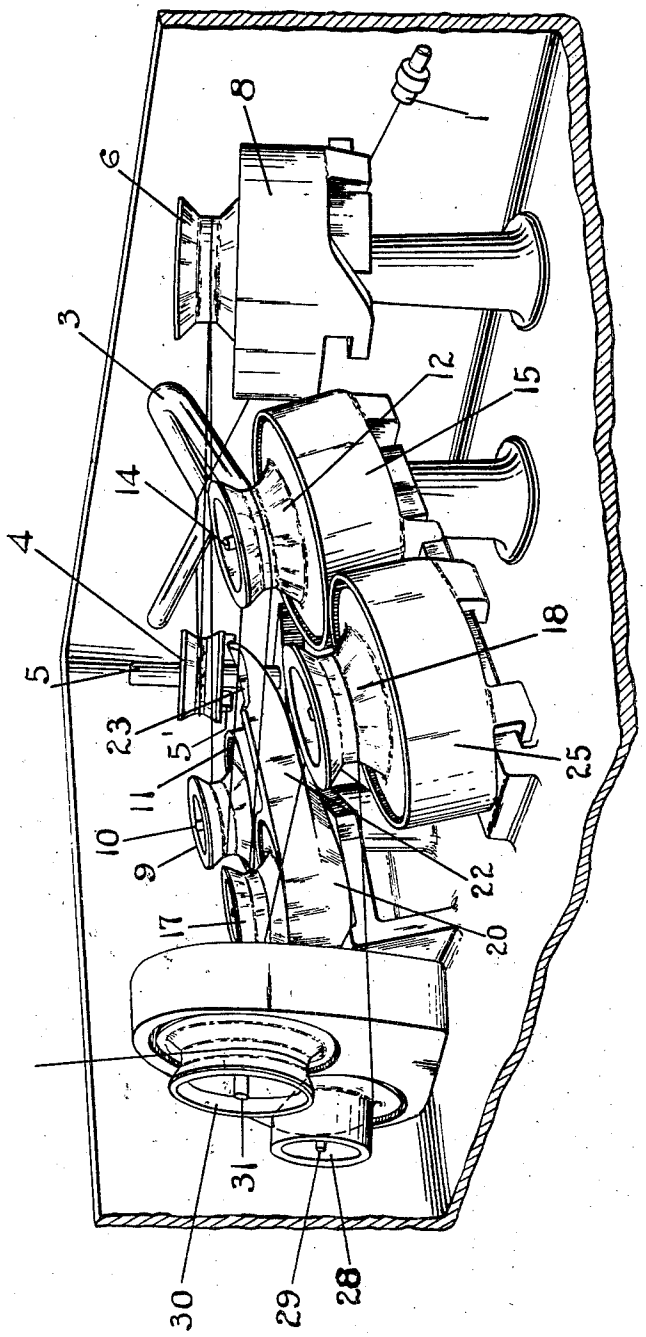



FIG. 2.

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FIG. 3

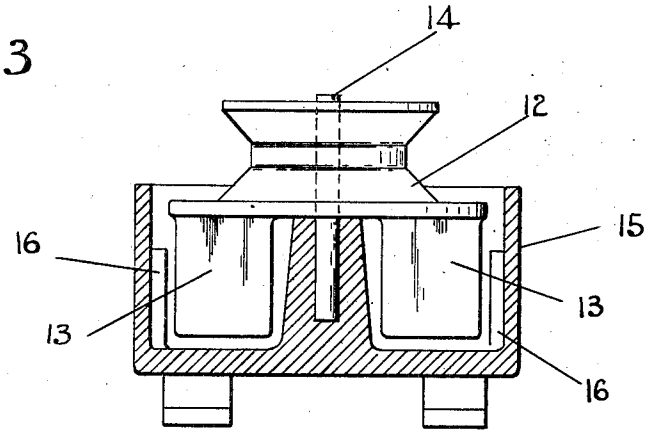
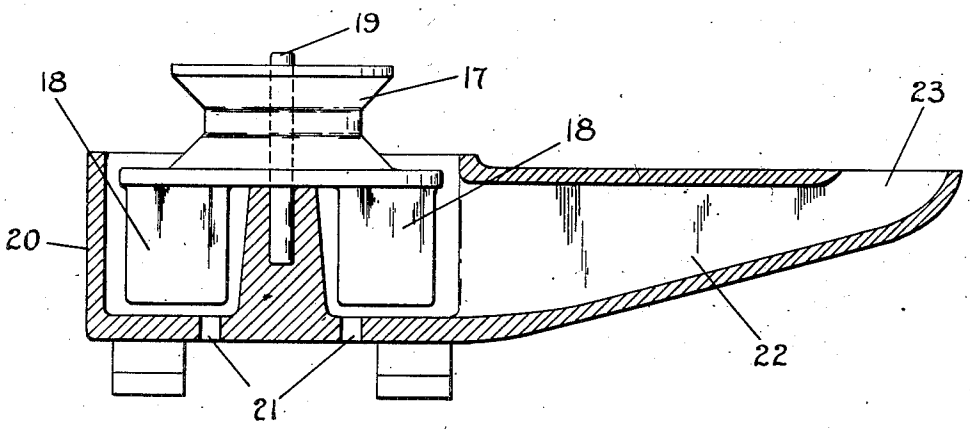



FIG. 4




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# UNITED STATES PATENT OFFICE

2,098,628

## ARTIFICIAL THREAD AND PROCESS OF PRODUCING SAME

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Application December 18, 1935, Serial No. 55,060

6 Claims. (Cl. 18—8)

This invention relates to a process of spinning artificial silk thread and more particularly, it relates to an improved process for the production of heavy denier, continuous, multi-filament thread by the wet spinning process, such as for instance, from viscose.

By "heavy denier thread" I mean a thread which is at least 900 denier, and is preferably greater than 900 denier, e. g., 1,100 denier, 1,500 denier, 1,900 denier, 2,500 denier, or more. The filament size in these large denier threads will in general be from 2 to 3 denier although other filament sizes are contemplated as falling within the scope of this invention.

Producers of continuous, multi-filament thread have generally confined themselves to the spinning of relatively low denier threads, such as threads of no more than 300 or 400 denier. Higher denier, continuous, multi-filament threads have been produced but have not been commonly used by textile manufacturers inasmuch as the threads are not uniform in dyeing qualities or in other physical properties, such as tenacity. Also, very high denier, continuous filament yarn has been spun and cut into short lengths and sold as staple fiber, or in some cases, reeled into skeins of untwisted yarn, processed in that form and sold to the converter who has subjected the continuous bundle of filaments to a drawing operation which tears or breaks the filaments into various short length fibers which are then subsequently twisted together to form a sliver or intermediate product which is further subjected to drawing, tearing and spinning. When large bundles of artificial filaments are to be converted into short lengths, either by cutting or by drawing and breaking, it is not necessary that each and every filament in the bundle be of uniform strength and uniform in other physical characteristics since the strength of the finished thread is due largely to the bonding and intertwining of individual short fibers and any non-uniformity in dyeing is largely obliterated in the formation of the ultimate thread.

In the spinning of high quality high denier yarn, it is essential that each and every filament making up the thread be subjected to the same conditions of coagulation and regeneration during the tensioning period. Otherwise, it is not possible to obtain yarn possessing uniform properties, and numerous filaments that have not been sufficiently regenerated are broken, thus producing low quality yarn which is unsuited for use in continuous filament yarn fabrics. Uniform and complete coagulation becomes a real problem when large denier threads such as 900, 1,500, 1,800, etc. are to be spun under high tension to produce thread of high strength such as 3 grams per denier or more and it becomes increasingly difficult to effect uniform and complete coagulation as the denier and number of filaments making up the yarn increases. It is not only necessary that uniform coagulation and uniform regeneration of the filaments be attained from the standpoint of high tenacity, but it is also essential that uniform coagulation and regeneration be attained in order to effect uniformity of dyeing which is extremely important if the yarn is to be suitable for use in colored textile fabrics.

One object of my invention is to produce heavy denier continuous filamentary yarn by a direct spinning process, which yarn will have uniform physical properties so that it is admirably suited for use in the textile industry as a continuous filament thread.

Another object of this invention is to produce a heavy denier, multi-filament thread of high tenacity.

Another object of this invention is to provide a new process for the spinning of heavy denier, multi-filament thread so that all the filaments contained in the thread are subjected to the same conditions of tensioning, coagulation and regeneration. Other objects will appear from the description which follows.

Figure 1 is a plan view of an apparatus adapted to the use and practice of the present invention, and Figure 2 is a view in perspective of the same apparatus. Figure 3 is a sectional view showing the details of one of the roller thread guides together with its casing. Figure 4 illustrates another one of the roller thread guides together with the details of a pump casing.

The objects of my invention are accomplished in general by extruding a spinning solution into a coagulating bath in such volume as to produce a large denier thread and conducting said thread around a plurality of rotating guides equipped with means for resisting rotation and so arranging the thread travel in the bath that at certain stages in the thread travel, it is subjected to the action of a cross-current of bath which separates and opens up the filaments to effect a more uniform and rapid coagulation and regeneration of the numerous filaments contained in the thread bundle.

To further illustrate the invention and to explain the operation of the apparatus described, I give below the following specific examples in which reference is made to the drawings:

*Example I—Spinning 1,100 denier—480 filament yarn*

Viscose containing 7% cellulose and 6% NaOH is prepared in the usual manner from cotton linters cellulose or from high grade wood pulp cellulose. After ripening to a salt index of about 4.0, the viscose is extruded through a spinneret containing 480 holes into a coagulating bath

2 containing 9% sulfuric acid, 19% sodium sulfate, 4% glucose and 0.7% zinc sulfate. The bath is heated to and maintained at about 45° C. during the spinning operation.

The yarn is drawn around a plurality of guides as is shown in Figures 1 and 2. The thread first passes over a stationary guide 3, (which may be made of glass or other suitable material) disposed 10 inches from the spinneret and serving to spread the filaments out in the form of a ribbon in the plane of roller guide 4 disposed 5 inches from guide 3. Roller guide 4 is a grooved roller rotatably mounted on pin 5 and is free to move up and down along the pin. Roller guide 4 is provided on its under side with two vanes 5' which are ¼ inch wide by ½ inch long, the vanes serving as means to resist rotation and impart a small initial tension to the thread.

The thread passes from guide 3 around roller guide 4 and then travels about 15 inches further to a grooved roller guide 6. Roller guide 6 is rotatably mounted on pin 7 and is provided on its under side with two vanes which are ¾ inch wide by ¾ inch long, guide 6 being mounted to rotate in casing 8 which has a smooth inner surface and an inner diameter somewhat larger than the largest diameter of guide 6, thereby permitting free rotation of the guide and permitting flow of coagulating bath in and within the casing, tension being imparted to the thread by resistance of the vanes to rotation in the bath liquor which is present in casing 8.

From the thread roller guide 6 the yarn travels on about 15 inches farther to a third roller guide 9 mounted on pin 10 and disposed for rotation in casing 11, the roller and casing being substantially identical in design to roller 6 and casing 8. The thread then passes 12 inches through the bath to a fourth roller guide 12 similar in design to roller 6 except that the vanes 13 are ½ inch wide by ¾ inch long, roller guide 12 being mounted on pin 14 and being adapted to rotate in casing 15 which is similar in design to casing 8, except that it is provided with vertical baffles 16 which protrude inwardly from the inner side of the casing wall to interrupt bath flow within the casing, clearance being provided between the baffles and vanes to permit rotation of the vanes. The details of roller 11 and casing 12 are shown in Figure 3. It will be understood that baffles may be provided on any of the other casings if it is desired to supply increased tension on the thread.

The thread travels then about 8 inches to a fifth roller 17 and then passes about 9 inches more through the bath to a sixth roller 18, rollers 17 and 18 being substantially like roller 6, except that the vanes of roller 15 are ½ inch wide by ¾ inch long.

The details of roller guide 17 are shown in Figure 4. Guide 17, which is provided with vanes 18, is mounted on pin 19 in a manner similar to the mounting of roller 6 on pin 7, and is adapted to rotate in casing 20 which is designed similarly to casing 8 except that it is provided with center openings 21 of ¼ inch diameter in its bottom to permit entrance of coagulating bath, the rotation of the guide vanes forcing bath through tangentially disposed tubular member 22, welded to casing 20 and having an exit opening 23. Guide roller 18 is mounted similarly to guide 17 on pin 24 and in casing 25, which is similar in all respects to casing 20 except that its tubular member 26 and its exit port 27 are disposed oppositely to tangential arm 22 as shown in Figure 1.

The exit port 23 is so located as to direct the stream of coagulating bath coming therefrom across the thread as it runs on to the first roller and as it leaves the first roller. This stream of bath has sufficient force of direction as to cause the numerous filaments of the thread to be separated one from the other and thereby to cause more complete and uniform coagulation and/or regeneration. The outlet port 27 of roller 18 is located so as to direct the bath stream across the thread and the cross-current stream of bath is strongest against the thread as it runs onto and away from the fourth roller in the series, but the stream also has considerable effect on the thread as it runs onto and away from the second roller in the series and even very slightly affects the thread as it comes from the spinneret. It is essential that the thread before it passes the stationary guide previously referred to, be subjected to no violent cross-current of bath since the thread at this point is very tender and is incapable of withstanding the strong cross current of bath to which it is subjected later on. The force of the stream from the outlet ports 23 and 27 may be governed by providing baffles similar to baffles 15 within the casings 20 and 25, or by the relative size of inlet and outlet ports, the baffles also serving to impart further tension to the thread.

After leaving roller 18, the thread is next conducted about 14 inches and then under and over roller 28, mounted on pin 29 for rotation in the vertical plane, and then about 5 inches under roller 30 similarly mounted in a vertical plane on pin 31, and then travels about 5 inches through the bath and up to a wind-up device such as a bobbin 32, or to a godet wheel and a bucket if the yarn is to be collected as a centrifugally wound package.

Counting the travel of the yarn while it is in contact with the rollers the total bath travel of the yarn is about 110 inches and the total tension on the 1,100 denier thread is 870 grams, which is equal to about 0.8 gram per denier. In view of the large size of the thread, the spinning time is relatively short, being about 15 minutes if the yarn is wound up on the usual 90 mm. bobbin, or perhaps 30 or 40 minutes if it is collected in the customary 7 inch diameter bucket. This spinning time may be varied of course according to the size of the collecting device. The yarn is washed and otherwise treated, if desired (desulfured and bleached), and then twisted in the known manner. The physical properties of such yarn at room temperature (75° F.) are:

| | |
|---|---|
| Tenacity—Dry | 3.08 g. p. d. |
| Tenacity—Wet | 1.77 g. p. d. |
| Elongation—Dry | 10.2% |
| Elongation—Wet | 16.7% |

*Example II—Spinning 1,900 denier—800 filament yarn*

Viscose such as that described in Example I is extruded through an 800-hole spinneret into the coagulating bath described in Example I and is passed around a plurality of rollers in much the same manner as described in Example I. The viscose flow and draw-off speed are adjusted to give a thread of 1,900 denier, after it has been washed and dried, and if the total tension on the thread as it is spun is from 1,500 to 1,600 grams, the tenacity of the yarn will be substantially the same as in Example I. For instance, I may produce by this procedure a yarn of 1,932 denier,

having the following physical properties at room temperature:

| | |
|---|---|
| Tenacity—Dry | 3.04 g. p. d. |
| Tenacity—Wet | 1.80 g. p. d. |
| Elongation—Dry | 9.5% |
| Elongation—Wet | 16.3% |

By spinning yarn as described above, it is possible to coagulate uniformly and completely very large threads containing a very large number of filaments. It is to be noted that I endeavor to move the filaments through the bath in a diverged condition which enables the individual filaments to be more completely set in a relatively short bath travel. Furthermore, by using bath guides at different levels in the bath as shown, the entire bath becomes active and not the surface layer. In addition, the pumping action of the special guides which are used further stirs up the bath and the jets from the discharge ports of the casings aid in keeping the filaments diverged. The threads are kept diverged by using guide rollers which permit the yarn to spread out as a ribbon rather than using a sharp V-type grooved roller which tends to bundle the filaments together and the stationary guide which was mentioned in Example I is so mounted as to cause the yarn to flatten out as a ribbon as it passes thereover and thus exposes all the filaments more generally to the action of the bath.

It will be understood that the size of the vanes on the various roller guides can be varied according to the amount of tension desired, or some of the roller guides may be provided with vanes while other roller guides may be designed without vanes, depending on the total tension desired.

While I have described this invention as a process for spinning viscose into high tenacity yarn, it should be understood that it is applicable to the spinning of any type of cellulosic solution which is spun into thread by the wet or coagulation process, such as for example cuprammonium cellulose, or lowly etherified such as lowly methylated or lowly ethylated cellulose or glycol cellulose, or lowly esterified cellulose such as lowly acetylated cellulose. Also the principles of this invention may be used in connection with the spinning of high denier thread of normal tenacity, in which case, the number of guides will be materially reduced and the length of bath travel shortened. It will be necessary only to keep the filaments spread out in ribbon formation so as to uniformly effect coagulation and regeneration which may be accomplished by a single, well directed stream of bath from the pumping arrangement previously described.

By "high tenacity yarn" or its equivalent as used throughout the specification and claims, it is intended to define rayon having a dry tenacity at room temperature (75° F.) of at least 2.5 grams per denier.

Since the invention is capable of considerable variation, any modification or variation which conforms to the spirit of the invention is intended to be included within the scope of the claims.

**I claim:**

1. In a process for spinning artificial thread according to a wet spinning process, the steps which comprise extruding cellulosic solution into coagulating bath liquor, guiding the formed thread back and forth in the bath, directing a current of bath liquor across several portions of the thread in such a way that the influence of the current is weakest at the weakest portions of the thread, leading the thread out of the bath, then collecting the thread.

2. In a process for producing high denier, multi-filament yarn by a wet spinning process, the steps which comprise extruding cellulosic solution into coagulating bath liquor in such volume and through a sufficient number of orifices to produce a high denier multi-filament yarn, guiding the formed thread back and forth in the bath, directing a current of bath liquor across several portions of the thread in such a way that the influence of the current is weakest at the weakest portions of the thread, leading the thread out of the bath, then collecting the thread.

3. In a process for producing high denier, multi-filament yarn by a wet spinning process, the steps which comprise passing the formed yarn back and forth over a long bath travel through a coagulating bath, and subjecting the thread to a current of coagulating bath directed across the path of travel of the thread in such a way that the influence of the current is weakest at the weakest portions of the thread.

4. Apparatus suitable for use in the production of artificial thread by wet spinning processes which comprises a spinneret, a coagulating bath, means disposed in the bath for guiding the formed thread back and forth through the bath, and means for directing a current of bath liquor across the path of the thread, said last named means being so disposed in the bath that the influence of the said current is weakest at the weakest portions of the thread.

5. Apparatus suitable for the production of artificial thread by wet spinning processes which comprises a spinneret adapted to produce heavy denier, multi-filament yarn, a coagulating bath, a stationary guide disposed in said bath, guide rollers disposed in said bath and adapted to direct the travel of the thread back and forth throughout the bath whereby to obtain a long bath travel, at least one of said rollers being provided on its under side with vanes whereby to resist rotation and to impart tension to the thread, said vanes being disposed in a casing provided with inlet ports and an exhaust port, the inlet port serving to permit the bath liquor to enter the casing, and outlet means on said casing for causing bath liquor to be exhausted across the path of the thread whereby to obtain a more thorough coagulation and regeneration of the thread.

6. Apparatus suitable for use in the production of artificial thread by wet spinning processes which comprises a spinneret, a coagulating bath, means disposed in the bath for guiding the formed threads through the bath, means for directing a current of bath liquor across the path of the thread, said last named means comprising a thread guide over which the thread passes, said guide being provided with means for resisting rotation of the guide means and being associated with a casing having an inlet port through which the bath liquor enters and an outlet port through which the bath liquor is exhausted, said outlet port being disposed so as to direct the said bath liquor across the path of the thread.

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