March 11, 1941. L. S. FRYER 2,234,540

MANUFACTURE OF STAPLE FIBER YARN

Filed May 25, 1937 4 Sheets-Sheet 1

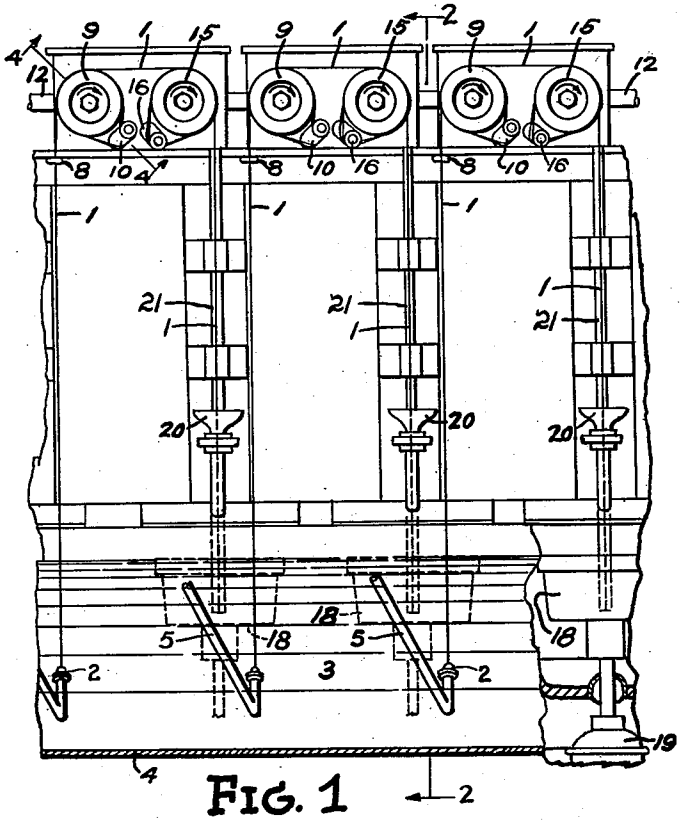

FIG. 1

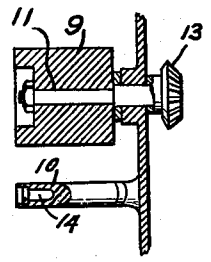

FIG. 4

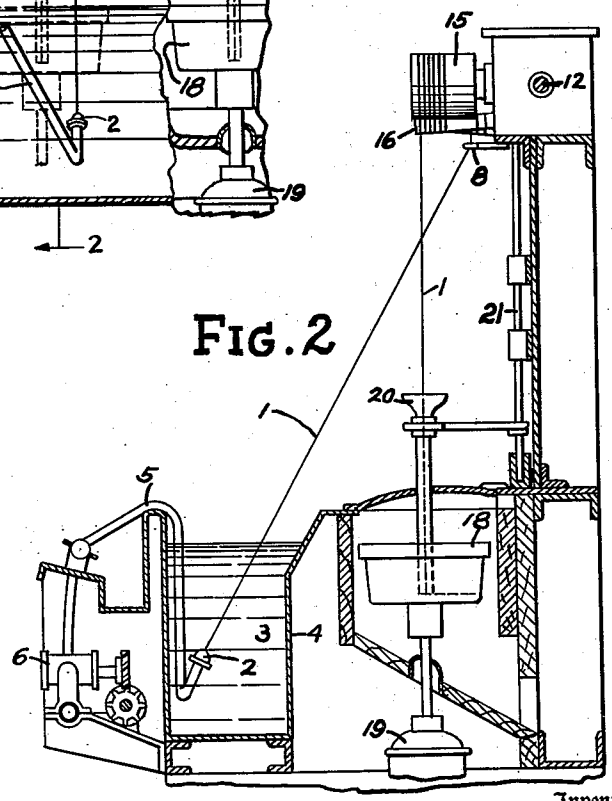

FIG. 2

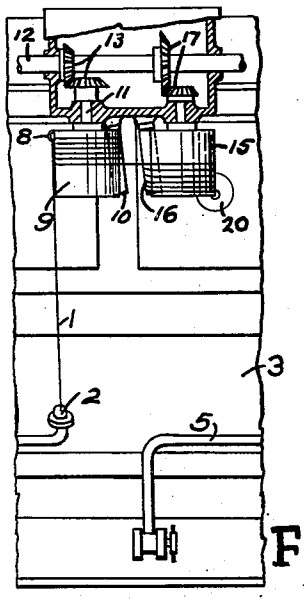

FIG. 3

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MANUFACTURE OF STAPLE FIBER YARN

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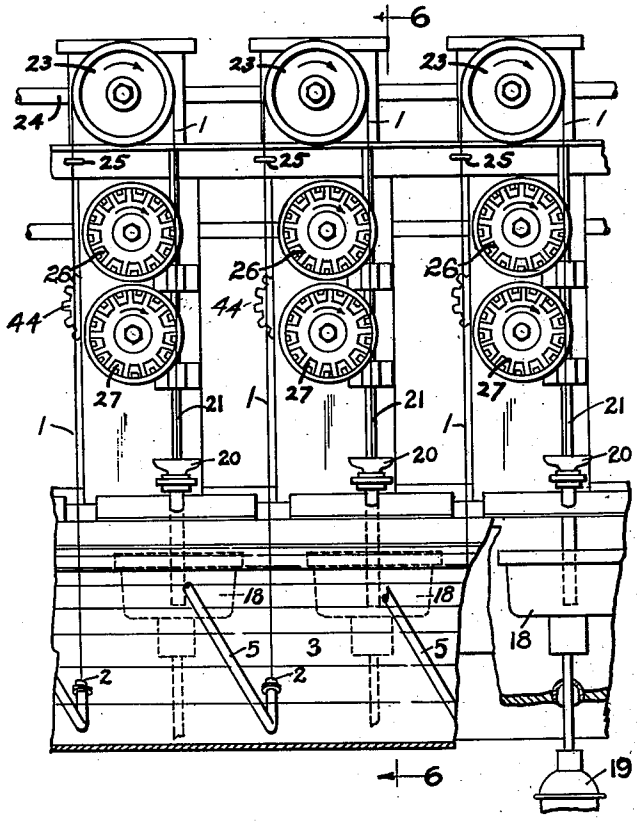

FIG. 5

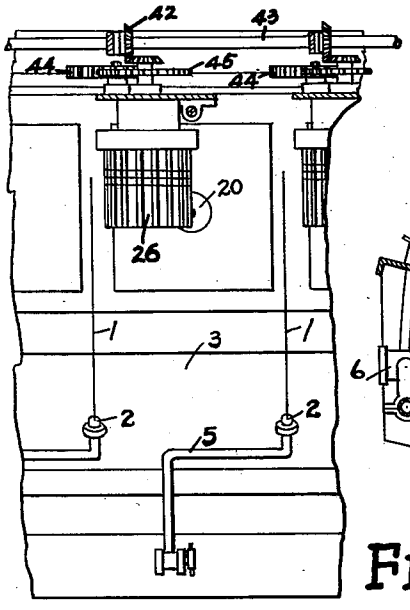

FIG. 7

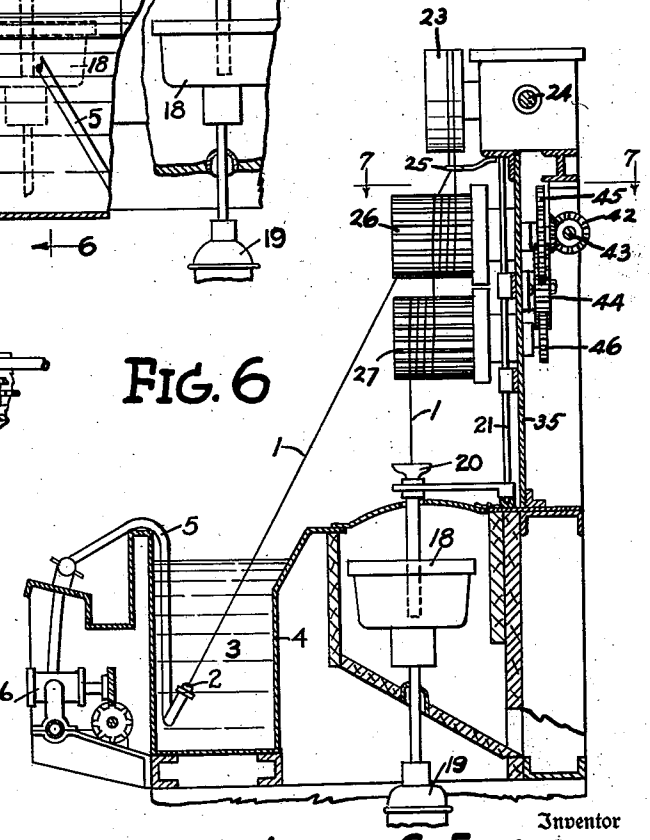

FIG. 6

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MANUFACTURE OF STAPLE FIBER YARN

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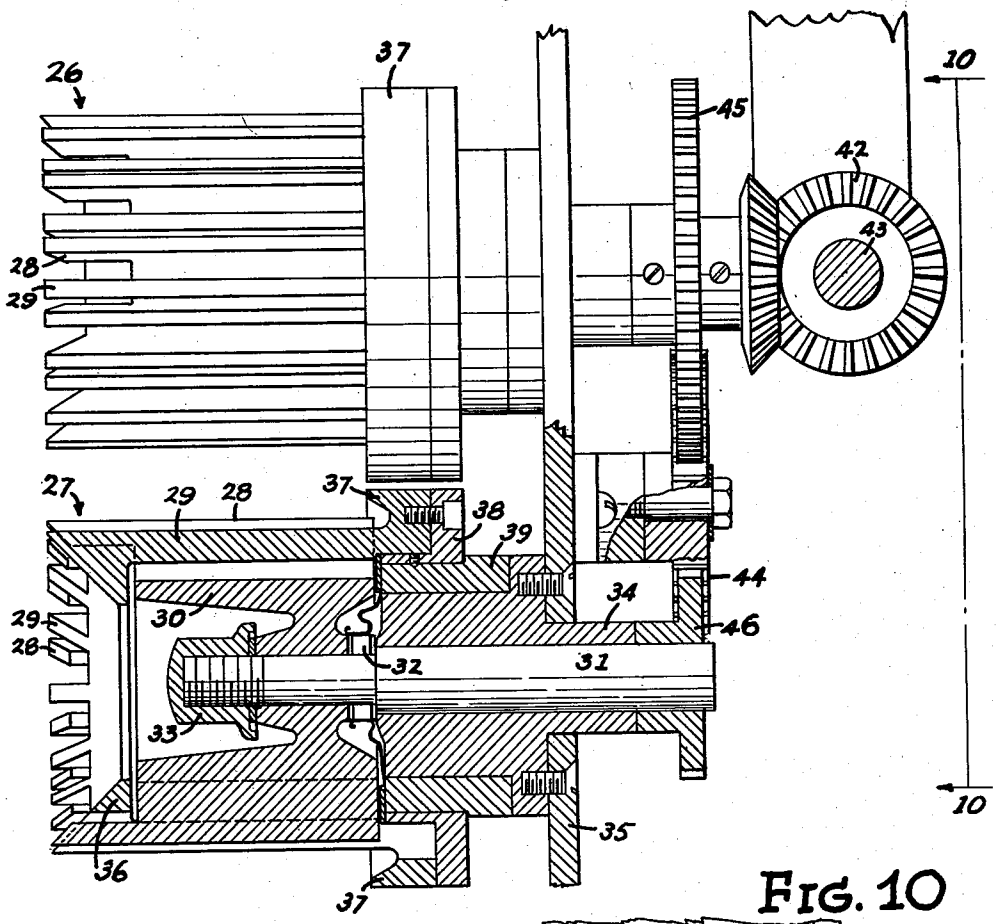

FIG. 8

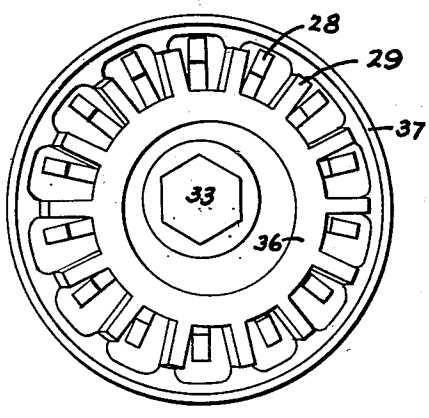

FIG. 9

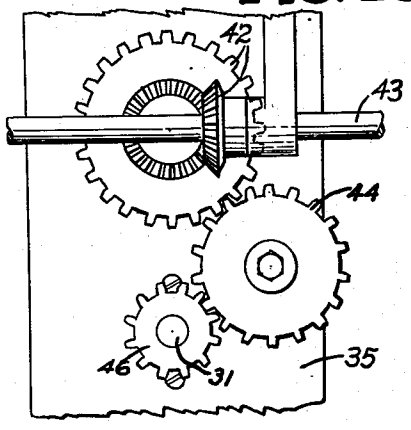

FIG. 10

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MANUFACTURE OF STAPLE FIBER YARN

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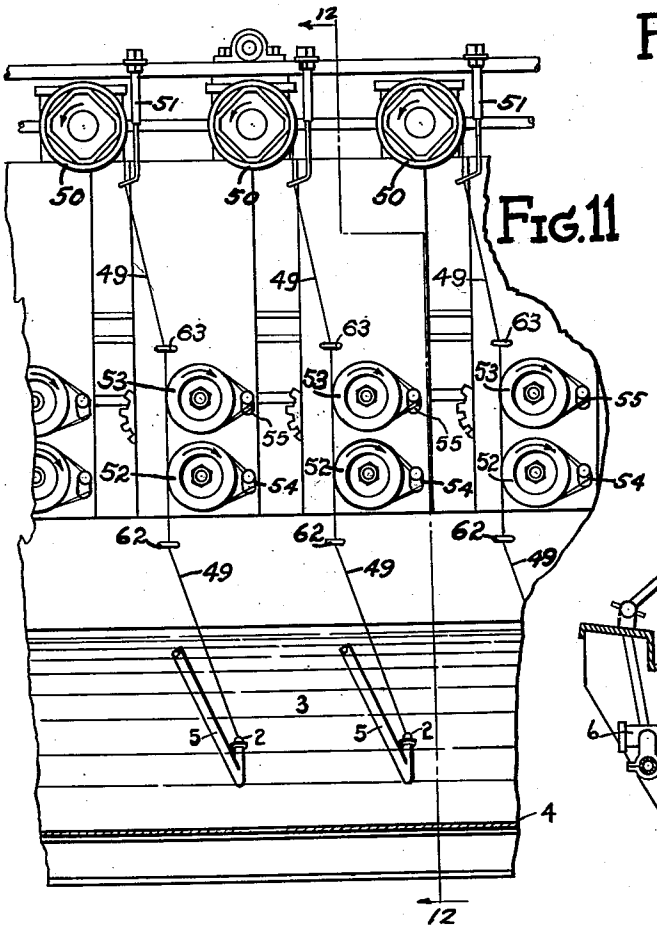
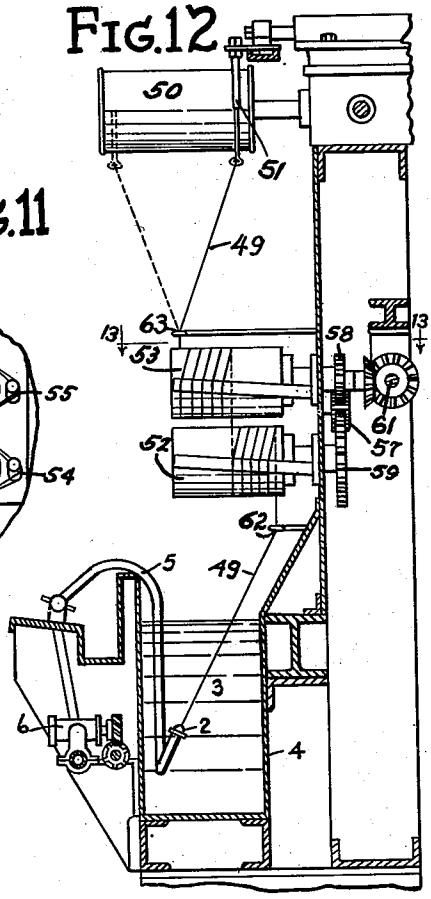


FIG. 11

FIG. 12



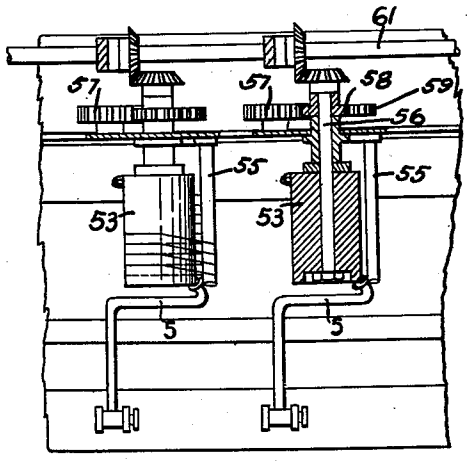


FIG. 13

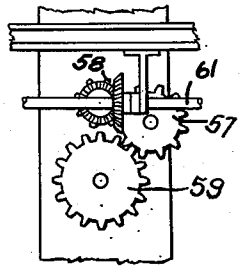


FIG. 14

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Patented Mar. 11, 1941 2,234,540

UNITED STATES PATENT OFFICE

2,234,540

MANUFACTURE OF STAPLE FIBER YARN

Louis S. Fryer, Cleveland, Ohio, assignor to Industrial Rayon Corporation, Cleveland, Ohio, a corporation of Delaware

Application May 25, 1937, Serial No. 144,602

5 Claims. (Cl. 18—54)

This invention relates to methods of manufacturing staple fiber yarn of synthetic origin.

More particularly, it relates to a process for spinning a multiple filament synthetic thread, severing the filaments into fibers before collection of the thread in package form, and, ultimately if not immediately, twisting into an integrated product the severed filaments going to make up the thread. Among other things, the invention contemplates the breaking of the individual filaments into fibres before coagulation is complete, as by stretching the thread soon after spinning beyond the breaking point of the individual filaments, preferably by means of a plurality of rotatable helix-forming devices each of which stores the thread thereon in a traveling spiral characterized by a relatively large number of turns, whereby a firm grip on the thread is provided, and one of which rotates at a peripheral speed sufficiently greater than that of the preceding device to cause the filaments to stretch and break as they pass between them. In certain instances, the invention contemplates the immediate twisting of the thread followed by the usual washing, desulphurizing, bleaching, and drying steps; in others, the performance of analogous steps before the twisting operation.

When synthetically produced filaments are thus stretched beyond their breaking points, preferably before the coagulation of such filaments is complete, it is possible to spin the individual filaments going to make up the thread as a whole through much larger openings in the spinnerets and attenuates the thread to the desired smaller denier in and as a part of the stretching operation. The breaking operation, moreover, by bringing to the surface uncoagulated material from the core of the filament, tends to impart a roughened character to the fibers. The thread may be twisted either before or after processing, depending on the type of spinning apparatus employed.

The apparatus used in practicing the invention may closely resemble the type of equipment employed in manufacturing the corresponding kind of multiple filament synthetic thread, whether from viscose, casein, cuprammonium cellulose solution, cellulose acetate or the like. In general, it will differ therefrom by embodying drafting means taking the form of a pair of helix-forming devices on each of which the thread is stored in a traveling spiral characterized by a relatively large number of turns, whereby a firm grip on the thread is assured. Differences in peripheral speeds of the respective devices effects stretching and breaking of the filaments to form fibers of staple length, without, however, destroying the parallelism of the filaments or the identity of the thread. After the breaking step, the thread is collected in the usual way either with or without a twisting operation.

For convenience, but not in any sense of limitation, the invention will be described hereinafter as applied to the manufacture by the viscose process of staple fiber yarn.

In the accompanying drawings illustrating several arrangements contemplated by the invention, Figure 1 is an elevation, parts being broken away, of a portion of a pot-spinning machine embodying one form of the invention. Figure 2 is a section on the line 2—2 of Figure 1. Figure 3 is a plan of a portion of the device of Figure 1, parts being broken away. Figure 4 is a section on an enlarged scale on line 4—4 of Figure 1. Figure 5 is an elevation, parts being broken away, of a portion of a pot-spinning machine embodying a second form of the invention. Figure 6 is a section on line 6—6 of Figure 5. Figure 7 is a section on line 7—7 of Figure 6. Figure 8 is a side elevation on an enlarged scale of the breaking apparatus of Figure 6, parts being broken away. Figure 9 is a front elevation of one of the reels of Figure 8. Figure 10 is a rear elevation on a reduced scale of the gearing of Figure 8. Figure 11 is an elevation, parts being broken away, of a spool-spinning machine embodying a different form of the invention. Figure 12 is a section on line 12—12 of Figure 11. Figure 13 is a section on line 13—13 of Figure 12. Figure 14 is a side elevation of the gearing appearing in Figure 12.

In the embodiment of the invention shown in Figures 1, 2, 3 and 4, the threads 1, the individual filaments of which are to be broken into fibers of staple length, are formed by extrusion of viscose from spinnerets 2 submerged in coagulating bath 3. The spinnerets 2 are mounted, as shown, upon individual mass tubes 5, each of which is provided with its own pressure pump 6. In the ordinary pot-spinning machine employing the invention, a large number of threads will be formed by spinnerets 2 located at regular intervals along a common trough 4 containing the coagulating bath 3.

From the coagulating bath 3 the thread is drawn upward through a guide eye 8 by a positively driven drum 9. Located adjacent drum 9 is a transfer roller 10, the axis of which is inclined to the axis of drum 9. Due to the in-

clination of the axes of drum 9 and roller 10, the thread 1 will, upon rotation of drum 9, be advanced axially thereof. Drum 9 is secured to a shaft 11 driven from line shaft 12 through a pair of bevel gears 13. Roller 10 is mounted upon a bolt 14 which serves as a shaft, being rotated thereon by the thread passing over drum 9, but if desired may be positively driven from line shaft 12. Line shaft 12 drives all of the various drums 9.

Located a short distance from drum 9 is a second drum 15 to which the thread 1 passes from drum 9. The thread is caused to advance axially of drum 15 by a transfer roller 16 similar to transfer roller 10. As in the case of drum 9, the thread is caused to advance over drum 15 in a relatively large number of closely spaced generally helical turns. Drum 15 is driven from line shaft 12 through a pair of bevel gears 17. The ratio of bevel gears 17 is so related to the ratio of bevel gears 13 that drum 15 is rotated at a considerably greater peripheral speed than drum 9.

Due to the more rapid rotation of drum 15, the individual filaments going to make up the thread 1 will be broken in passing between drums 9 and 15. Slippage of the thread on drums 9 and 15 is prevented by the large number of turns of thread on each of the drums. The necessary difference in the speed of rotation of drums 9 and 15 required to stretch the filaments beyond their breaking points and cause them to break is dependent upon a number of factors, including the size of the individual filaments, one number of filaments in the thread, the composition of the filaments, and the extent of coagulation thereof. In practice, it is readily possible to determine the difference in speeds required to stretch the filaments beyond their breaking points.

Because the filaments break more or less at random; i. e., at various points between drums 9 and 15, the resulting fibers overlap in the thread. This overlap is of importance in that it makes it possible to keep the filaments parallel and to maintain the integrity of the thread. The average length of the fibers into which the individual filaments are broken is determined by the distance between drums 9 and 15. By varying this distance, the average length of the resulting fibers may be modified; for example, if it is desired to obtain fibers of shorter average length, the distance between drums 9 and 15 should be reduced.

Drums 9 and 15, together with their respective transfer rollers 10 and 16, thus serve primarily as drafting means for stretching the thread 1 beyond the breaking points of the individual filaments while the thread is still wet with coagulant. In addition, drum 9 operates to withdraw the thread from coagulating bath 3 at a predetermined rate which may, if desired, be greater than the speed of extrusion of viscose from spinneret 2. Drum 15 serves to supply at a constant speed thread made up of filaments severed into fibers of the desired length. From drum 15 the thread proceeds to whatever thread handling device it may be desired to deliver it. Because of the nature of the thread, it is advantageous to collect it in spinning pot 18.

Pot 18 may be driven by any desired means such as electric motor 19, of which there is one for each spinning pot. To distribute the thread in pot 18, it is passed in the conventional manner through a funnel and tube 20 which is moved in an up-and-down direction by means of a supporting rod 21 reciprocated by any suitable means. In passing into the spinning pot 18, the thread is twisted, thus binding the individual fibers together and maintaining the identity of the thread as a whole. If coagulation has not already proceeded to completion, it may do so in the usual way in spinning pot 18.

Since the thread is delivered at a constant speed by drum 15, the thread will be given a uniform twist as it is collected in pot 18. The thread so collected may be subjected in any convenient manner to the usual processing treatments such as desulphurizing, bleaching, finishing, drying, etc. For example, the thread may, as in ordinary practice, be subjected while in cake form to the desired processing media or it may be unwound from the cake and subjected in thread form to treatment on one or more continuous processing reels. After completion of the processing operations, the product comprises a twisted, completely processed staple fiber yarn.

To place the machine as a whole in operation, the thread end is drawn from coagulating bath 3 and is given the necessary number of turns around drum 9 and transfer roller 10, after which the thread running from coagulating bath 3 to drum 9 is located in guide eye 8. By leading the thread away from drum 9 after it has been wound in a series of turns extending approximately half the length of the drum, it is possible to pass the thread to drum 15, giving it the necessary number of turns about drum 15 and roller 16. In this manner, the thread advances first along the rear half of drum 9 and then along the front half of drum 15, so that the direction of advance of the thread is always toward the front of the machine. From the free end of drum 15 the thread is caused to discharge into spinning pot 18.

In the embodiment of the invention appearing in Figures 5 to 10, inclusive, the thread is formed in the same manner as in the apparatus of Figures 1 to 4, inclusive. A godet wheel 23 draws the thread from the coagulating bath as in known practice. This godet wheel, together with corresponding godet wheels provided for the other threads extruded into the same coagulating bath, may be driven by suitable means from line shaft 24. The thread is guided onto godet wheel 23 by means of guide eye 25. From godet wheel 23, the thread passes to a thread-storage, thread-advancing reel 26. After having passed along a portion of the length of reel 26, the thread is passed to an adjacent thread-storage, thread-advancing reel 27.

The construction and manner of operation of reels 26 and 27 is similar, wherefore an explanation of reel 27 will suffice for both.

As illustrated in Figures 8 and 9, reel 27 comprises two sets of interdigitating bar members 28 and 29. Bar members 28 are carried upon the periphery of a cylindrical body 30 secured to shaft 31 by means of pin 32 and retaining nut 33. Shaft 31 is rotatably mounted in a bearing 34 carried by an upright plate 35. Bar members 29 are supported at the front end by a reinforcing ring 36 and at the rear end by a reinforcing ring 37 which is secured to an annular member 38 which carries within a center opening thereof a bushing 39. Bushing 39 is rotatably carried upon the exterior of bearing 34. The axis of the exterior surface of bearing 34 is offset from and askew to the axis of the inner bore of bearing 34.

The set of bar members 28, together with supporting body 30, may be termed the driving or concentric reel member, since it is fixed to and rotates with shaft 31. The set of bar members 29, together with reinforcing elements 36 and 37, may be termed the eccentric or driven reel member, since its axis is offset from and askew to the axis of shaft 31. Due to the inclined and offset disposition of the reel members formed by the sets of bar members 28 and 29, thread carried upon their exterior surfaces will be automatically advanced axially of the reel in a large number of closely spaced, generally helical turns. Because of the unitary character of the device, the reel is in effect self-threading.

The shaft of reel 26 is driven through gears 42 from a line shaft 43 extending longitudinally of the machine. Line shaft 43 is geared to the corresponding shafts of all of the thread-storage, thread-advancing reels 26. Shaft 31 of reel 27 is driven from the shaft of reel 26 through idler gear 44. Idler 44 is driven by a large spur gear 45 secured to the shaft of reel 26 and idler 44 in turn drives a small spur gear 46 fixed to shaft 31. Due to the differences in size of spur gears 45 and 46, reel 27 has a speed of rotation greater than that of reel 26.

As in the case of drums 9 and 15 of the embodiment of Figures 1 to 4, inclusive, the filaments of the thread passing between reels 26 and 27 are broken by the tension imposed by the greater speed of rotation of reel 27. As in the construction previously described, it is desirable that reels 26 and 27 be rotated in such direction that the thread will be advanced from their supported ends toward their free ends. In order to facilitate operation of the machine it is preferable that the thread be advanced over the inner half of reel 26 and then over the outer half of reel 27, in which case sufficient turns will be present on both reels to prevent slippage and to assure breakage of the filaments. After leaving reel 27, the thread may be collected in a spinning pot 48.

Since the thread, before reaching reel 26, must first pass around godet wheel 23, the coagulation of the filaments of the thread will, in the device of Figures 5 to 10, inclusive, have proceeded more nearly to completion than would be expected with the arrangement illustrated in Figures 1 to 4, inclusive. By increasing the number of turns of thread on godet wheel 23, by increasing the distance between the godet wheel and reel 26, or by increasing the number of turns on reel 27, the degree of coagulation of the thread at the time breakage occurs may be increased. As will be more fully explained hereinafter, the character of the product will be correspondingly changed.

The embodiment of the invention illustrated in Figures 11 to 14, inclusive, illustrates the application of the invention to a conventional spool-spinning machine. The thread 49 is extruded as before from the spinneret into the coagulating bath, but is collected upon a rotating spool 50. The thread is laid upon spool 50 in a reversing spiral manner by means of the reciprocating traverse arm 51. Interposed between the spinneret and the spool 50 are drums 52 and 53, which are provided with transfer rollers 54 and 55. Drums 52 and 53, together with their associated transfer rollers 54 and 55, correspond in arrangement and function to drums 9 and 15 and their associated transfer rollers 10 and 16 in the device of Figures 1 to 4, inclusive.

Drums 52 and 53 are connected through an idler gear 57. A small spur gear 58 on shaft 56 and a large spur gear 59 on the shaft of drum 52 mesh with idler gear 57. It is important that the gear 58 be smaller than gear 59, so that drum 53 may be rotated at the required higher peripheral speed than drum 52 and thus effect breakage of the filaments of the thread between drums 52 and 53. To rotate shaft 56, it is geared to a line shaft 61 which extends longitudinally of the machine. All drums 53 are driven from line shaft 61.

To lead the thread 49 upon drum 52 at the proper point, it is caused to pass through guide eye 62. As in the case of drums 9 and 15 of the device of Figures 1 to 4, inclusive, it is desirable that the thread 49 be wound over the rear half of drum 52 and over the forward half of drum 53, since this facilitates operation of the apparatus. After leaving drum 53, the thread 49 passes on its way to spool 50 through a guide eye 63 which prevents movement of the thread imparted by traverse arm 51 from extending back to drum 53. If it has not already done so, coagulation proceeds to completion on spool 50.

As in the case of the like products produced by the devices of Figures 1 to 4, inclusive, and Figures 5 to 10, inclusive, the fibers into which the individual filaments of thread 49 are broken between drums 52 and 53 overlap and remain more or less together; consequently, the identity of the thread as a whole is not impaired. The package of thread accumulated upon spool 50 may, upon removal from the machine, receive the usual processing operations while remaining upon the spool; but if desired the thread may be withdrawn therefrom and subjected to processing in thread form, preferably upon one or more continuous processing reels. After completion of desulphuring, bleaching, drying and other processing operations, the thread is twisted to assure the retention of the broken filaments in thread form. Thus the final product comprises a twisted, completely processed staple fiber yarn.

In addition to being employed as disclosed in connection with pot- and spool-spinning machines, the invention may, if desired, also be incorporated in continuous spinning apparatus.

In each of these embodiments of the invention, the helix-forming devices may be disposed sufficiently close to the spinneret so that the filaments are broken when but incomplete coagulation thereof has occurred, in consequence whereof uncoagulated spinning material extrudes from the thread at the points of rupture. Depending upon the amount of uncoagulated material so extruded, coalescence into a more or less unitary product occurs; but if coagulation has processed to a sufficient extent, there is produced only a thread the individual filaments of which have been reduced to fibers of staple length. In either case, breakage of the thread while still in an incompletely coagulated state tends to impart to the product maximum tensile strength, low potential elongation, and the crinkled appearance characterizing staple fiber cut in a plastic condition.

The preferred location of the helix-forming devices with respect to the coagulating bath may readily be determined by experiment. If, the distance being short, little coagulation of the thread occurs, the individual fibers tend, by coalescing in the manner above described,

to lose their separate identities, thus giving rise to the novel product above described. On the other hand, if coagulation has proceeded too far before the thread is severed, the characteristic roughness distinguishing the staple fiber yarn of the present invention from ordinary staple fiber yarn will not be obtained. Within these limits, the position of the helix-forming devices in the machine may be varied as desired. In general, location of the helix-forming devices in a relation permitting partial but nevertheless nearly complete coagulation will be preferred.

Numerous departures from the constructions herein disclosed may be made without in any way departing from the spirit of the invention. For example, it is possible to employ other thread-storage, thread-advancing devices in place of the helix-forming devices herein illustrated. If desired, the drums or reels, as the case may be, need be only as long as the portions thereof over which thread is to be advanced, in which case it will be desirable to lead the thread from the discharge end of the one drum or reel to the receiving end of the other drum or reel. Other modifications, substitutions and changes may be made as desired.

It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features or patentable novelty reside in the invention.

What is claimed is:

1. A process of making staple fiber yarn comprising the steps of extruding a spinning solution into a coagulating medium to form a multiple filament thread; storing the thread on each of at least two rotating helix-forming devices in a traveling spiral characterized by a relatively large number of closely spaced, generally helical turns; and breaking the filaments of which the thread is composed by stretching them beyond their individual breaking points before completion of the coagulation of the filaments while the thread is passing from one of said helix-forming devices to a succeeding helix-forming device rotating at a higher peripheral speed, the step of breaking the filaments being performed without destroying the identity of the thread as a whole.

2. A process of making staple fiber yarn comprising the steps of extruding a spinning solution into a coagulating medium to form a multiple filament thread; storing the thread on each of at least two rotating helix-forming devices in a traveling spiral characterized by a relatively large number of closely spaced, generally helical turns; breaking the filaments of which the thread is composed by stretching them beyond their individual breaking points before completion of the coagulation of the filaments while the thread is passing from one of said helix-forming devices to a succeeding helix-forming device rotating at a higher peripheral speed, the step of breaking the filaments being performed without destroying the identity of the thread as a whole; and simultaneously twisting and collecting the thread.

3. A process of making staple fiber yarn by the pot spinning system comprising the steps of extruding a spinning solution into a coagulating medium to form a multiple filament thread; storing the thread on each of at least two rotating helix-forming devices in a traveling spiral characterized by a relatively large number of closely spaced, generally helical turns; breaking the filaments of which the thread is composed by stretching them beyond their individual breaking points before completion of the coagulation of the filaments while the thread is passing from one of said helix-forming devices to a succeeding helix-forming device rotating at a higher peripheral speed, the step of breaking the filaments being performed without destroying the identity of the thread as a whole; and collecting the thread in a spinning pot.

4. A process of making staple fiber yarn by the bobbin spinning system comprising the steps of extruding a spinning solution into a coagulating medium to form a multiple filament thread; storing the thread on each of at least two rotating helix-forming devices in a traveling spiral characterized by a relatively large number of closely spaced, generally helical turns; breaking the filaments of which the thread is composed by stretching them beyond their individual breaking points before completion of the coagulation of the filaments while the thread is passing from one of said helix-forming devices to a succeeding helix-forming device rotating at a higher peripheral speed, the step of breaking the filaments being performed without destroying the identity of the thread as a whole; and collecting the thread in package form on a bobbin.

5. A process as in claim 1 in which thread-advancing reels are used as the helix-forming devices.

LOUIS S. FRYER.

CERTIFICATE OF CORRECTION.

Patent No. 2,234,540. March 11, 1941.

LOUIS S. FRYER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 34, for "one" read --the--; page 3, first column, line 25, for the word "differences" read --difference--; same page, second column, line 61, for "processed" read --proceeded--; page 4, first column, line 29, for "or" read --of--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of May, A. D. 1941.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)