

Jan. 21, 1941.

H. B. KLINE ET AL

2,229,092

METHOD OF AND APPARATUS FOR MANUFACTURING THREAD OR THE LIKE

Filed Sept. 27, 1938

3 Sheets-Sheet 1

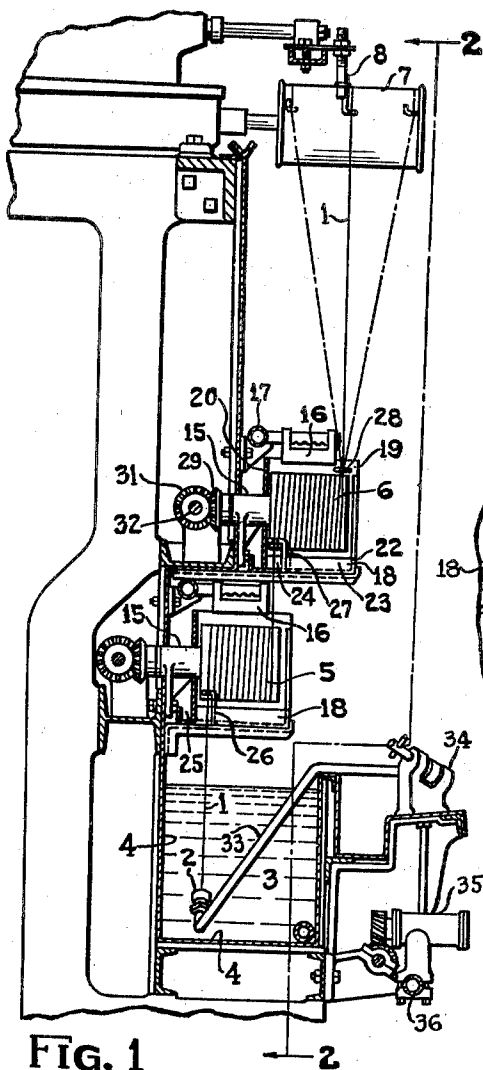


FIG. 1

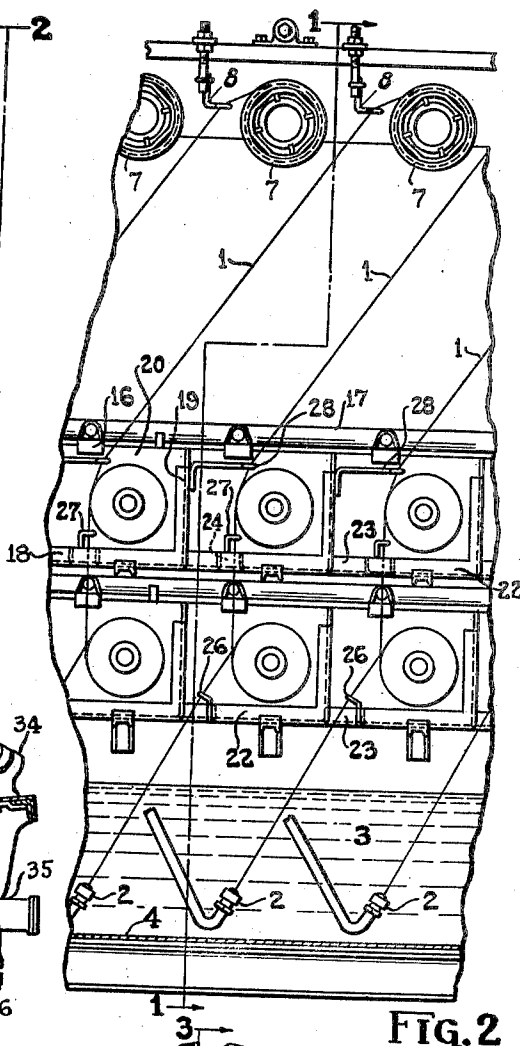


FIG. 2

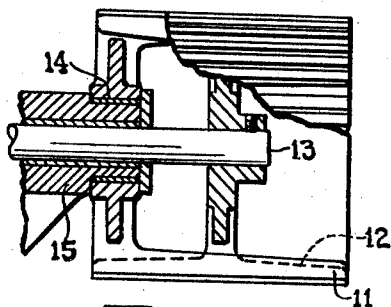


FIG. 3

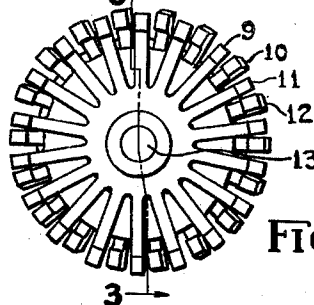


FIG. 4

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3 Sheets-Sheet 2

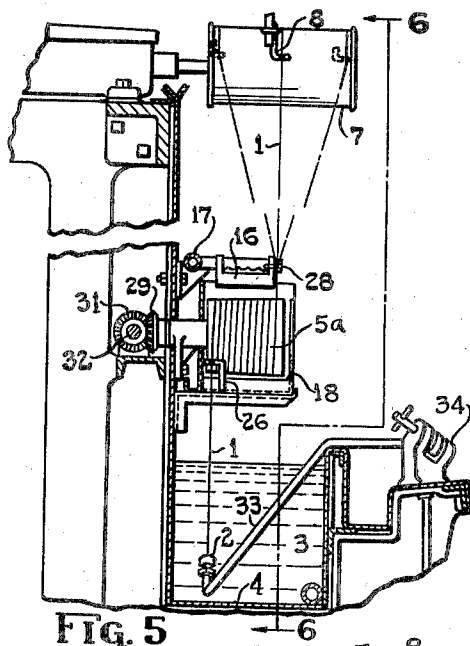


FIG. 5

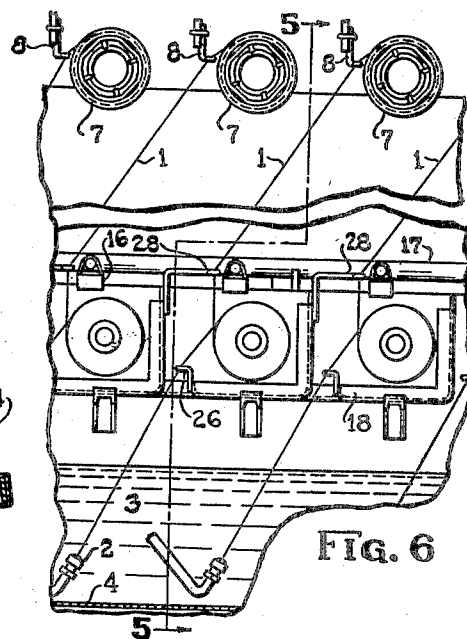


FIG. 6

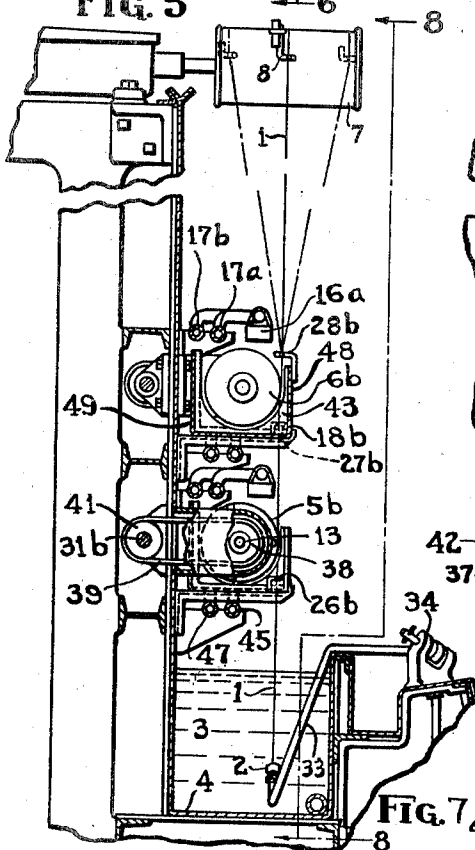


FIG. 7

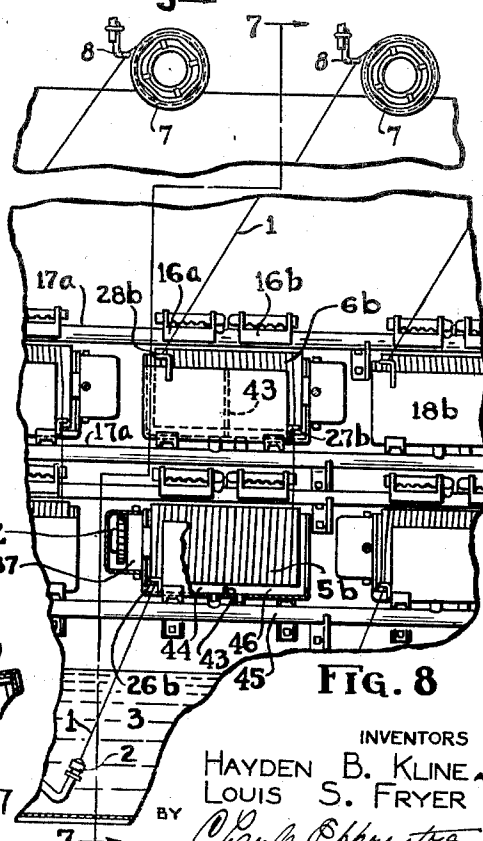


FIG. 8

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3 Sheets-Sheet 3

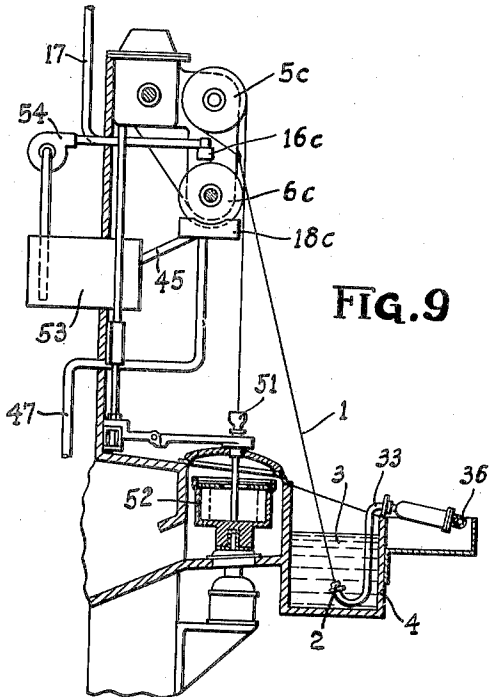


FIG. 9

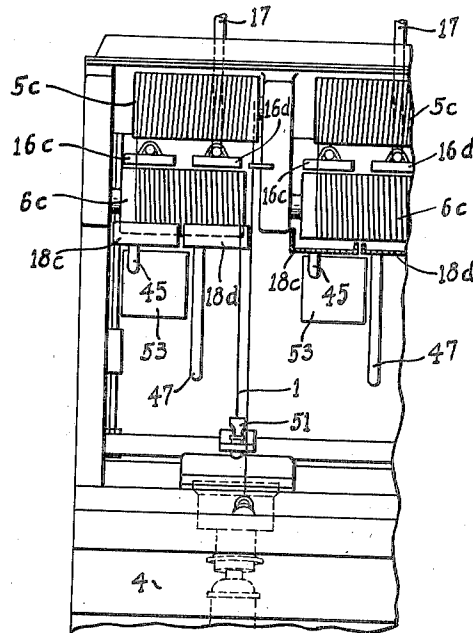


FIG. 10

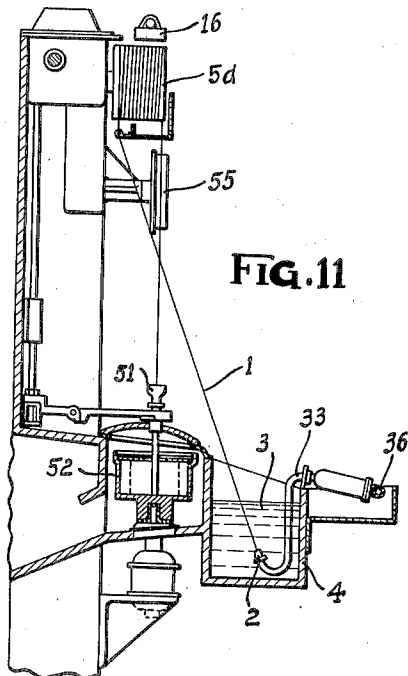


FIG. 11

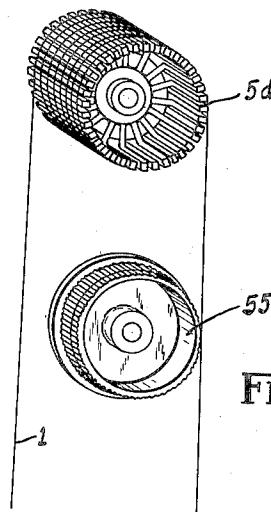


FIG. 12

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UNITED STATES PATENT OFFICE

2,229,092

METHOD OF AND APPARATUS FOR MANUFACTURING THREAD OR THE LIKE

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Application September 27, 1939, Serial No. 296,794

19 Claims. (Cl. 18-8)

This invention relates to methods of and apparatus for manufacturing thread or the like of synthetic origin; more particularly, to the manufacture of thread or the like of this kind by certain hereinafter described modifications of the recognized discontinuous processes; e. g., the spool-spinning system, the pot-spinning system, etc. For convenience, it will be described with particular reference to the manufacture of multiple filament artificial silk thread, but it should be understood that it is not limited thereto. Among other things, the invention has for its objects to enhance the uniformity of the product, whether or not taking the form of multiple filament artificial silk thread, to reduce the amount of handling, and, by dispensing with certain of the steps heretofore thought to be necessary, to simplify processing operations.

The present application is a continuation in part of applications Serial Nos. 7,115 and 50,306, filed respectively February 18 and November 18, 1935.

According to the conventional method of manufacturing multiple filament artificial silk thread by the spool-spinning system, the solution from which the thread is formed is extruded by means of a spinneret into a suitable coagulating bath from which the thread passes to a rotating spool on which it is collected. The thread is cross-wound on the spool, generally by means of a traverse guide which reciprocates longitudinally of the spool or, less commonly, by axial reciprocation of the spool with respect to the guide. Because of the short time interval during which the thread is subjected to the action of the coagulating bath, the thread is but incompletely coagulated when wound on the spool. Consequently, coagulation of the thread proceeds after the thread is wound on the spool, not infrequently resulting in non-uniformity of coagulation with attendant irregularities in the finished product.

After having been wound on the spool, the thread is given various processing treatments, depending in part on the process by which the thread is produced, such, in the case of thread produced according to the viscose process, as washing, desulfurizing, drying, etc. Since the thread is drawn through the coagulating bath by the spool on which it is being wound, the thread is wound on the spool under considerable tension. The resulting tight winding on the spool makes it difficult for the processing liquids to penetrate the layers of the thread and results in detrimental effects to the thread because of the varying shrinkage of the thread, caused by the wind-

ing, while the thread is being dried on the spool prior to being unwound therefrom.

Because stretch spinning, pursuant to which the thread is stretched before being collected, has certain beneficial effects on the physical properties of the thread; e. g., increased tensile strength, decreased elongation, etc., many attempts have been made in the past to stretch the thread between the spinneret and the collecting spool. These have in general involved drawing the thread over rollers or guides in or above the coagulating bath, meanwhile rotating the collecting spool at peripheral speeds greater than the linear speed of extrusion of the mass from the spinneret. These methods have in general met with but indifferent success, largely because of the excessive tension developed in the thread and because of the varying stretch, resulting in corresponding denier variations, caused by the reciprocating motion of the traverse guide employed to wind the thread on the collecting spool.

As applied to the spool-spinning system, the invention eliminates these disadvantages by performing on the thread before it is collected on the spool one or more processing operations, such as washing. Among other things, it provides means for winding the thread on the spool without, or under very slight, tension. In elaborated form, it contemplates stretching the thread without, however, increasing the tension of the thread during the operation of winding it on the spool. Other features of the invention as applied to the spool-spinning system will be apparent from the detailed description of the first three of the five embodiments hereinafter described, which first three embodiments of the invention involve the employment in the spool-spinning system of one or more thread-advancing thread store devices disposed between the spinneret and the collecting spool.

In the pot-spinning system of manufacturing multiple filament artificial silk thread, uniformity of the product depends among other things upon uniformity of speed of thread travel which, although desirable of attainment, is not usually realized in practice, this because of such factors as slippage of the thread upon the godet wheel even when the latter is especially equipped to minimize slippage. Nor is slippage avoided by the use of a plurality of godet wheels, even when two are used in succession with a higher peripheral velocity characterizing the later wheel as compared with the earlier wheel, as, for example, for the purpose of stretch spinning. Moreover,

the tension on the thread is governed to some extent by the centrifugal force within the spinning pot and is hence not uniform, this because the force continually decreases as a result of the progressive decrease in the internal diameter of the cake. Again, when the thread is wound more than once over a given godet wheel, not only do the turns tend to over-ride each other, but successful operation of the machine becomes more difficult. Further, the additional guides necessary with godet wheels increase friction on the thread and contribute to lack of uniformity in the product in respect of strength, dyeing, and other physical and physico-chemical characteristics.

Again, in the pot-spinning system, with or without stretch, the thread is built up in the spinning pot while still subject to the influence of liquor from the coagulating bath which it carries over with it. It is necessary to maintain the cakes in their wet condition until they are subjected to the later steps of the process; i. e., bleaching, desulfurizing, washing and the like, and to conduct such steps upon the thread while it is still in cake form. Alternatively the thread must be kept wet, wound into skein form while still in the acid condition, and then subjected before drying to any other necessary processing steps, including washing. In some plants, the moist cakes are removed from the spinning pots, washed and desulfurized in cake form, dried as cakes, and subsequently unwound directly into frusto-conical package form or, in some instances, wound first to skeins, then desulfurized, bleached and dried, and finally backwound onto spools for conversion to cone packages.

Attempts have been made to wash out excess coagulating bath, crystallized salts, etc. and even to subject the cakes to the usual later steps of the process while the thread is still in the spinning pot, this being accomplished by flowing wash water or desulfurizing or bleaching liquor through the cakes, but always without success. One drawback to such a procedure resides in the fact that the thread is not completely coagulated when it reaches the spinning pot, due to the relatively short interval of time between the time of extrusion and the time of arrival at the spinning pot. In addition, not only does the thread build up first on the inner surface of the pot wall and then upon itself, layer by layer, with a constantly decreasing radius, but the coagulating liquid is forced outward by centrifugal action to the outer layers, which any wash water or treating liquids must penetrate, with the result that the layers initially wound are not usually fully washed or otherwise treated.

According to the fourth and fifth of the hereinafter described embodiments of the invention, the pot-spinning process, and the apparatus for practicing the same, is greatly improved by doing away with the usual godet wheel or one or both of the usual godet wheels drawing the thread from the spinneret by means of a thread-advancing thread store device of such character as to insure complete uniformity of the speed of travel of the thread. Furthermore, such a thread-advancing thread store device not only serves as a convenient member for permitting coagulation desulfurizing and/or bleaching and complete washing of the thread before it is wound into cake form, but also as means for delivering the thread at a uniform speed to the spinning pot. When one such device is used in connection with a godet wheel or two or more such devices are used in

associated relation they permit of the development of almost any desired amount of uniform thread stretch with consequent uniformity of strength, dyeing and other physical and physico-chemical characteristics throughout the length of the thread.

In both of the systems hereinabove mentioned, the thread-advancing thread store device may take any one of a variety of widely different forms, but preferably comprises a unitary thread-advancing reel of cantilever construction.

In the drawings, Figure 1 is a vertical sectional elevation, from line 1—1 of Figure 2, of a spool-spinning machine comprising a plurality of thread-producing units each of which comprises a spinneret, a plurality of thread-advancing reels in stepped arrangement, and a collecting spool. Figure 2 is an elevation of the machine from line 2—2 of Figure 1. Figure 3 is an elevation, partly in section and corresponding generally to section 20 line 3—3 of Figure 4, of one form of thread-advancing reel that may be used to advantage in the practice of the invention. Figure 4 is a corresponding end elevation.

Figure 5 is a vertical sectional elevation from line 5—5 of Figure 6 of another embodiment of the invention in which each thread-producing unit comprises a single unitary thread-advancing reel disposed between the spinneret and the collecting spool. Figure 6 is an elevation, from line 6—6 of Figure 5 of the same machine. Figure 7 is a vertical sectional elevation from line 7—7 of Figure 8 of a third embodiment of the invention in which each thread-producing unit comprises a plurality of thread-advancing reels disposed between the spinneret and collecting spool with their axes extending longitudinally of the machine. Figure 8 is an elevation of the machine of Figure 7 from line 8—8 of Figure 7.

Figure 9 is a sectional elevation of a fourth embodiment of the invention corresponding generally to that of Figure 7, but illustrating how the invention is applied to a pot-spinning machine. Figure 10 is a front elevation of the machine of Figure 9, such elevation corresponding generally to the elevation comprising Figure 8 of the spool-spinning machine shown in Figures 7 and 8. Figure 11 is a sectional elevation of a fifth embodiment of the invention showing a pot-spinning machine in which one of the two godet wheels usually employed has been replaced by a thread-advancing reel. Figure 12 is a detail perspective, somewhat diagrammatical, showing the reel and godet wheel of Figure 11. The pot-spinning machine shown in Figures 11 and 12 is the counterpart of the spool-spinning machine shown in Figures 5 and 6.

In the embodiment of the invention shown in Figures 1 and 2, the thread 1 is formed by extrusion of viscose from spinneret 2 into a dilute sulphuric acid coagulating bath 3 containing approximately 10% sulphuric acid, 20% sodium sulphate and 1% zinc sulphate. The spinneret is supplied with viscose from mass tube 33, pivoted in apron block 34, to which are connected pump 35 and supply line 36. The trough 4 extends longitudinally of the machine and has disposed at spaced intervals along it a plurality of thread-producing units each of which comprises spinneret 2 and its auxiliary apparatus; one or more, in this case two, thread-advancing reels 5, 6 disposed at right angles to the trough; and, positioned above the trough, a spool 7 on which the thread, by reciprocating motion of 75

the traverse guide 8, is crosswound as it is collected.

The thread-advancing reels 5, 6 on which the thread is continuously but temporarily advanced in generally helical form may conveniently be of the kind illustrated in Figures 3 and 4.

The reel shown in Figures 3 and 4 is of much the same type and operates on the same principle as that shown, described and claimed in application Serial No. 652,089, filed January 16, 1933, for "Winding reel." It comprises two reel members 9 and 10 provided, respectively, with longitudinally extending bars 11 and 12, the two sets of bars being in alternating relationship to each other. Each of the reel members is rigid in the sense that all of its parts are immovable relative to each other. The reel as a whole is of generally cylindrical form, its two reel members being of substantially the same diameter. Member 9 is concentric with, is fixed to, and rotates with the driving shaft 13; member 10 is driven by contact of its bars 12 with the bars 11 of member 9 and is rotatably mounted on bearing 14 carried by the stationary frame 15 the central axis of which bearing is slightly offset from and inclined to the axis of shaft 13.

The offset and inclined relationship of reel members 9 and 10 causes the thread to progress in spaced, generally helical turns lengthwise of the reel in the manner more fully explained in application Serial No. 652,089. Reels of this type may, if desired, be rotated by the thread itself as it is drawn off the reel by other means, in which case the reel still performs its thread-advancing function. Since the reel is supported at one end only, the open end is free of a projecting shaft, which feature provides convenience for threading up or starting the thread on the reel. Any reasonable length of thread may be continuously but temporarily stored on a reel of this type.

It is obvious that various other forms of thread-advancing thread store devices, whether or not unitary, may be used in the practice of the invention in lieu of the thread-advancing reel shown in Figures 3 and 4.

Various processing treatments may be applied to the thread while so stored; for instance, in the embodiment of the invention shown in Figures 5 and 6 the reel 5 may be used to provide a period for further coagulation after the thread emerges from the coagulating bath, while reel 6 may be devoted to the washing of the thread. The thread on reel 5 may be allowed to coagulate without the application of reagents thereto or, as in the embodiment shown in Figures 5 and 6, coagulating liquid may be applied to the thread while stored on the reel. If desired, the washing operation may be omitted and the thread subjected on reel 6, after allowing coagulation to occur to a greater or less extent on reel 5, to the action of a more dilute solution of the reagents employed in the coagulating bath. If desired, the thread may be desulfurized or bleached on reel 5 and, on reel 6, washed free of the reagent or reagents so employed.

Various methods of applying the processing liquid to the thread stored on the reel may be used; in that illustrated, the processing liquid is showered down on the thread from a reagent distributor 16 positioned above the reel and supplied from line 17. The liquid is collected in a suitable trough 18 below the reel. If the spool-spinning machine embodying the invention is constructed in the manner shown; that is, with a plurality of

thread-producing units each of which comprises a spinneret, one or more reels, and a collecting spool, all of the reels in the same position with relation to the trough 4 may be devoted to the same processing treatment. Consequently, the construction of the supplying and collecting apparatus for the processing liquids may be much simplified. Thus, all the reagent distributors for the reels in a horizontal series may be supplied from a common line 17 extending longitudinally of the machine, and the collecting trough 18 may be common to all such reels.

If desired, the reels may be arranged to dip into or rotate in baths of the particular processing liquid or liquids employed.

Any suitable arrangement of reels may be employed. With reels of cantilever construction, the stepped arrangement shown in Figure 1 can be employed advantageously, since it provides great convenience of manipulation while threading up or starting the thread on the reel. With this arrangement, the thread starts on a reel at the rear and progresses in closely spaced, generally helical turns toward the front, where it leaves the reel. It then proceeds to the next reel, starting at the rear and proceeding toward the front in a similar manner. While any desired arrangement may be employed, it will in general be preferred to have the reels so disposed with respect to each other that the receiving end of each reel other than the first is in apposition to the discharge end of the reel immediately preceding it in the series.

Trough 18 for each horizontal series of reels may be of the construction shown, which is designed to provide for the conservation of processing liquids, accessibility to the reels, and maximum convenience for the operator. Each trough 18 is provided with partitions 19 between adjacent reels and a back partition 20 to prevent loss of the liquids through splashing. The troughs are formed with a pan portion 22 beneath each reel. Between the reels the troughs are provided with notched portions 23 extending rearward and terminating in a laterally extending notch 24 through which the thread passes on its way to the reel disposed thereabove.

A channel 25 extends across the rear of the trough 18 and communicates in series with all of the pan portions 22, thus providing a common drain for all. Each longitudinal trough 18 may be provided with one or more drains, which may, if desired, communicate with the sewer or, in conjunction with its corresponding supply pipe 17, with makeup and/or recirculating systems, as preferred. Suitable guides 26, 27 serve to guide the thread as it starts onto the reels and a guide 28 is provided to prevent tangling of the thread, which may tend to be caused by reciprocation of the traverse guide 8.

The reels may be operated in any suitable manner, but in the drawings bevel gear 29 mounted on shaft 13 of each reel is rotated by a bevel gear 31 mounted on drive shaft 32, from which are driven all reels in a given horizontal series.

When starting an apparatus of this type, the operator seizes the end of thread 1 as it issues from the spinneret, leads it through guide 26 and to the rear of the first reel 5, around which he winds the thread once or twice. By action of the elements of the reel 5, the thread forms closely spaced, generally helical turns which are positively advanced toward the front of the reel until they are discharged from the open end or

taken off by the operator, who then passes the thread through guide 27, utilizing the notches 23 and 24 which are provided for convenience in manipulation of the thread, and starts the thread on the next reel 6. After leaving the last reel of the series, in this case reel 6, the thread is led through guide 28, through traverse guide 8, and to the spool 7, on which it is crosswound.

In the embodiment of the invention shown in Figures 5 and 6, a single thread-advancing reel 5a is positioned between the spinneret 2 and the collecting spool 7. The apparatus may be otherwise exactly the same as that of Figures 1 and 2. The thread 1, formed by extrusion of a suitable solution of cellulose from spinneret 2 into a coagulating bath 3 contained in trough 4, passes through guide 26 to reel 5a, on which, by the action of the elements thereof, spaced helical turns of thread are formed and progressed axially along the reel until the thread is caused to leave the reel by the guide 28 which may be provided, as before, to prevent tangling of the thread on the reel caused by the reciprocating motion of the traverse guide 8. If desired, the reel may be constructed so its diameter increases progressively from one end of the reel to the other, as shown, in which case a limited amount of stretch may be imparted to the thread as it travels across the reel; similarly, shrinkage of the thread may be permitted if the reel is constructed so that its diameter decreases as the thread travels across the reel.

The reel 5a may be devoted to coagulation of the thread stored thereon, either with or without application of a coagulating liquid, or it may be devoted to other processing treatments such as washing. In any case, the processing liquid may be applied to the thread by apparatus similar to that of the embodiment of Figures 1 and 2, comprising, for example, a reagent distributor 16 positioned above the reel supplied from a feed line 17 extending longitudinally of the machine. The collecting trough 18, which also may be common to all reels, may be of substantially the same design as that previously described. If desired, a portion of the reel may be devoted to coagulation of the thread, either with or without the application of coagulating liquid, and another portion of the reel devoted to washing or other processing treatment.

Another arrangement is shown in Figures 7 and 8 in which the reels are disposed with their axes extending longitudinally of the spinning machine. As in the embodiments of the invention previously described, each thread-producing unit comprises a spinneret 2, a collecting spool 7 and one or more thread-advancing reels on each of which one or more processing treatments is applied to a thread. For purposes of illustration, the apparatus of Figures 7 and 8 is shown as comprising two open-ended reels similar to those previously described with means for applying two processing treatments to the thread on each reel, each reel being so constructed that it is long enough axially to accommodate more than one processing treatment. Thread 1, which is formed in the usual manner by extrusion of viscose from the spinneret 2 into a coagulating bath 3, passes upward through guide 26b to the reel 5b, on which two processing operations are performed on the thread; for example, coagulation and washing.

The thread then proceeds through guide 27b to the next reel 6b, on which two or more processing operations, such as desulfurizing and

washing, are performed. If desired, the thread, rather than being desulfurized and washed, may be bleached and washed on reel 6b, although by suitably arranging the various treatment stages all of these several operations may be performed on the thread before it is collected on the spool 7. On leaving the reel immediately preceding collecting spool 7, in this case reel 6b, the thread passes through guide 28b provided to prevent tangling of the thread due to reciprocation of traverse guide 8 as the thread is crosswound on spool 7.

Any suitable means for mounting and driving the reels may be provided. In the arrangement shown, each reel is supported from one end only, being mounted on a bracket 37 which is supported by the frame of the spinning machine. The driving means consists of a sprocket 38 mounted on the reel drive shaft 13 journaled in the bracket 37 which sprocket is driven by means of a chain 39 driven by a sprocket 41 mounted on a drive shaft 31b extending longitudinally of the machine. All reels in a single horizontal series are driven by the same or similar driving means. Housing 42 may be mounted on bracket 37 to cover the sprocket and chain.

The processing treatment may be applied in any desired manner, as by showering processing liquids on the thread stored on the reel. In the embodiment of the invention shown in Figures 7 and 8, two separate systems for supplying and collecting the processing liquids are required for each reel. The processing liquids are shown as showered down on the thread on each reel in a horizontal series from distributors 16a and 16b, which may be supplied from corresponding supply lines 17a and 17b. The trough 18b below each reel is divided by a partition 43 into separate compartments 44, 46 which compartments may be provided with suitable shields 48, 49 to prevent splashing and loss of the processing liquids.

One compartment 44 communicates with the drain line 45, while compartment 46 communicates with the drain line 47. Each of drain lines 45 and 47 may extend longitudinally of the spinning machine and serve all reels in a horizontal series in the manner shown. These lines may, in conjunction with their corresponding reagent supply lines 17a and 17b, communicate with suitable makeup and/or recirculating systems, or the processing liquids may drain into a sewer, in which case a separate drainage system for each processing liquid applied on a reel may not be required. The collecting trough 18b, which is here shown as individual to each reel, may, if desired, be made common to all reels in a horizontal series.

In the operation of starting the thread on the reels, the thread 1 formed by extrusion from spinneret 2 is led through guide 26b at one end of reel 5b and is wound for a few turns on the reel. The action of the elements of the reel during rotation thereof causes the thread to form and proceed in positive fashion in spaced helical turns to the other end of the reel, where the thread is led upward through guide 27b and started on the next reel. After leaving the last reel, the thread is led through guide 28b and thence through guide 8 to the collecting spool 7. Collecting troughs 18b and shields 48, 49 are so designed as to permit threading up of the reels without interference therefrom.

Advantages other than those derived from applying processing treatments to the thread be-

fore it is crosswound on the collecting spool may readily be obtained in the practice of the invention. Stretching or shrinking of the thread while it is still plastic affects the physical properties of the thread and it is often desired to produce thread under one or the other of these conditions. This can readily be accomplished according to this invention: where, for example, a plurality of reels is used in each thread-producing unit, as in the embodiments of Figures 1 and 2 and Figures 7 and 8, it is possible to impart stretching or shrinkage effects to the thread by introducing suitable differences in the peripheral speeds of at least one reel and a preceding reel.

This may be accomplished by driving the reels at different angular speeds, if the circumferences of the reels are the same; by employing two adjacent reels of different circumferences driven at the same angular speed; or by a combination of both effects. Likewise, if only one reel is used, or on any reel or reels of a plurality of reels in a thread-producing unit, a limited amount of stretching or shrinkage may be imparted to the thread by so constructing the reel or reels that the diameter thereof increases or decreases as the thread progresses along the reel. The thread may be also taken up by the first reel at a peripheral speed greater than or otherwise different from the linear speed at which the thread is formed, in which case certain modifications are brought about in the physical properties of the thread.

Stretching or shrinkage effects may also be provided by introducing suitable differences between the peripheral speeds of the collecting spool 7 and the reel immediately preceding it. An advantage resides in rotating the collecting spool at a somewhat lower peripheral speed than that of the reel immediately preceding it, since in this case the thread 1 is collected on the spool under no tension or a tension much lower than that ordinarily prevailing. Therefore, since the thread is not tightly wound on the collecting spool, ease of penetration of liquid through the thread on the spool is provided, which is advantageous when subsequent processing liquids are applied to the thread while wound on the spool.

In addition, the lower tension at which the thread is wound eliminates or greatly minimizes the uneven shrinkage of the thread which ordinarily occurs when the thread is tightly wound on the spool and consequently diminishes the variations in physical characteristics, such as dyeing qualities, of the thread. Also, when the thread is being wound under a decreased tension, the variation in tension in the thread caused by movement of the traverse guide is eliminated or minimized, with a consequent elimination or reduction of the denier variations of the thread caused by such tension variations.

Stretching or shrinkage of the thread may be obtained by combinations of the above methods. It is possible by suitable combination of the above methods to obtain a stretching of the thread while it is still plastic without an increase in the tension under which the thread is wound on the spool, which is desirable but which has hitherto been impossible in ordinary practice. It is also possible by suitable combination of the above effects to obtain alternate stretching and shrinkage of the thread which, under certain conditions, is desirable because of the enhanced physical properties which result.

Figures 9 and 10 illustrate the application of

the invention to a pot-spinning machine in which the thread 1 is led from the spinning nozzle 2 to and around a plurality of thread-advancing reels 5c, 6c, etc., and thence to the funnel 51 and spinning pot 52. Any number of reels 5c, 6c, may be employed, depending upon what processing operations are to be performed upon the thread, such as desulfurizing, bleaching, oiling, etc., together with any intervening washing steps. One or more of said reels may be of gradually increasing diameter to stretch the thread while traveling on that reel alone; however, stretching of the thread may, if desired, be accomplished by imposing a peripheral speed on one reel which is greater than the peripheral speed of the preceding reel.

Different processing steps may be performed upon any one of the reels in any suitable manner, as indicated at the reel 6c, where distributor 16c supplies treating liquid to the reel, from which it drains to a trough 18c for return through pipe 45 to a make-up reservoir 53 and thence to the pump 54 which supplies the distributor 16c. Upon any one of the reels at least two, if not more, treatments may be performed; for example, on any given reel, a part of the reel, say its first half, may be used for performing a treating operation, such as desulfurizing, bleaching or the like, while the remaining part of the reel, say its second half, may be utilized for a washing operation. This is illustrated in Figure 10, where 17 represents a supply pipe for wash water which is delivered to the distributor 16d, showered upon the reel, and collected in the drain trough 18d, from which it flows to the sewer by pipe 47.

Figures 11 and 12 show a modified form of pot-spinning machine in which the thread 1 is led from the spinneret 2 to reel 5d, thence to the funnel 51 and spinning pot 52. With this arrangement, the reel 5d may be of uniform or substantially uniform diameter from end to end; so that although it carries a sufficient length of thread to enable coagulation to be substantially completed upon this reel, nevertheless on the reel itself no stretch of the thread is produced. Nevertheless, thread slippage on the reel is wholly prevented and the thread is caused to travel at a uniform rate. Stretch of the thread may be accomplished by differential linear thread speeds as between reel 5d and the godet wheel 55.

For example, the godet wheel may be of slightly greater diameter than the diameter of the reel 5d, both rotating at the same angular velocity, or the reel 5d and godet wheel 55 may be of the same or substantially the same diameter with the godet wheel rotating at an increased angular velocity over that of the reel. Alternatively, the thread may be led first to the godet wheel and then to the reel, in which case the peripheral speed of the reel will be greater than that of the godet wheel. In any case, by properly proportioning diameters and angular velocities, any desired increase of peripheral speed may be produced while the thread travels across the space between the godet wheel and the reel, with consequent stretch of the thread. To minimize thread slippage, the thread may be wound more than a complete turn about the godet wheel in accordance with the usual practice.

Various other arrangements of pot-spinning machines suitable for the purpose will readily suggest themselves to those skilled in the art. In all cases, one valuable feature of both the process and apparatus is the possibility of washing the thread before it is twisted and wound into pack-

age form according to the pot-spinning process, making it unnecessary to store the cakes in an atmosphere of high humidity and eliminating the necessity of handling the wet yarn through textile processing steps while it still contains appreciable amounts of sulfuric acid salts and other chemical reagents. Again, not only is the thread twisted in the operation of winding it into a cake, but the entire length of thread is subjected to uniform tension conditions. As a result, the thread has uniform physical and physico-chemical characteristics, and particularly uniform dyeing characteristics, from end to end.

A further example of a discontinuous process to which the invention is applicable is the manufacture by either the spool- or pot-spinning system of viscose thread of high tensile strength made according to the so-called Lillienfeld process, pursuant to which viscose is coagulated in concentrated sulfuric acid of a strength of 45 to 65%. In the use of such concentrated coagulants, the action of the coagulant must be checked before it exercises an injurious effect upon the thread, wherefore it is necessary to wash or neutralize the thread before it is collected. In the production of thread of this type, it is possible to stretch it more than ordinary thread with consequent increase in tensile strength; but the stretching should preferably be done in or immediately after leaving the coagulant. Such thread can be readily produced according to the present invention, since it is conveniently possible to wash it, neutralize it or both; in fact, even to apply the coagulant to the thread before washing while the thread is stored on one or more thread-advancing thread store devices before it is collected. If desired, the thread may be stretched by one or more of the methods above described.

It has also been found that the application of various solutions of an alkaline character, such as various solutions of caustic soda, to thread produced by any process results in certain variations in the physical properties of the thread, such as increased extensibility, etc., especially if the thread is so treated while not under tension. Such treatments are preferably followed by washing or by weak acid and washing treatments. It is apparent that such treatments may be readily applied to the thread according to this invention, since the thread after forming may be subjected to these treatments while stored, without tension if desired, on one or more thread-advancing thread store devices before it is collected. Any suitable processing treatment in lieu of or in addition to those previously mentioned may, according to the invention, be applied to the thread before it is wound into package form.

As has already been mentioned, it is not necessary that the thread-advancing thread store device take the form of a thread-advancing reel of the character described: any form of thread-advancing thread store device, whether or not unitary, may be used upon which, by the action of the elements thereof, the thread is formed into spaced, generally helical turns. Various arrangements of thread-advancing thread store devices with respect to each other and with respect to the machine as a whole other than those shown may be employed. While it is preferable that the apparatus embodying the invention comprise a plurality of thread-producing units, each comprising a spinneret, one or more thread-advancing thread store devices and a collecting spool or spinning pot disposed along a longitudinally extending trough, other forms of apparatus em-

bodimenting the invention may be devised. Various other modifications will readily occur to those skilled in the art.

Processing treatments applied to the thread according to this invention before the thread is wound on the spool or in the spinning pot eliminate the necessity for performing these treatments later and, consequently, reduce the amount of handling of the thread, labor costs, and investment in equipment and plant space heretofore required. All processing treatments thus applied to the thread are highly uniform, wherefore thread produced according to the invention is of high quality and extraordinarily free of variations in such physical characteristics as dyeing qualities, tensile strength, etc. The invention may be applied not only to artificial silk thread but also to the production of artificial horsehair, artificial straw, staple fiber, filaments, bands, tapes, etc., capable of being formed by coagulation and collected while still moist in crosswound form: these and like products are comprehended by the term "thread" as employed in the appended claims.

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

What is claimed is:

1. Apparatus for the manufacture of thread comprising a longitudinally extending coagulating trough having a working face disposed along one side thereof; means in said trough for forming a plurality of separate threads, said means being accessible from the working face of said trough; a plurality of self-threading thread-advancing reels of cantilever construction to the supported end of each of which one of said threads passes after leaving said coagulating trough, said reels being disposed above the level of the liquid in said coagulating trough, having their axes at an angle to a vertical plane parallel to the longitudinal axis of said coagulating trough, and having their unsupported ends presented to and readily accessible from the working face of said coagulating trough; and take-up means to which said threads pass from the unsupported ends of said thread-advancing reels.

2. Improved pot-spinning apparatus of the type employed in the discontinuous manufacture of artificial silk thread which improved pot-spinning apparatus embodies a longitudinally extending trough having a working face along one side thereof, said trough being adapted to contain a coagulating liquid; a number of mutually independent thread-forming means positioned in parallel relation to each other, each of said thread-forming means being disposed in said trough; a number of self-threading thread-advancing reels of cantilever construction supported above and arranged at intervals along the length of said trough with the unsupported ends of the reels disposed in juxtaposition to the working face of said trough so as to permit access to the unsupported ends of said reels from the working face of said trough, each of said reels being adapted to receive one of said threads at its supported end immediately after withdrawal of the thread from said coagulating liquid, to advance the thread toward its unsupported end in a large number of closely spaced, generally helical turns, and to discharge the thread from said unsupported end in a manner such that the thread has no opportunity to wrap itself about obstructions, including the elements

of the reel itself; and, disposed in close proximity to said trough, a number of spinning pots adapted to collect in the form of hollow cakes the threads produced by said thread-forming means.

3. Apparatus of the character defined in claim 2 in which each of said reels is mounted with its axis at an angle to a vertical plane parallel to the working face of said trough.

4. Apparatus of the character defined in claim 2 which embodies a plurality of reels for each of said threads, said reels being disposed above the level of the coagulating liquid in said trough.

5. Apparatus of the character defined in claim 2 in which the unsupported end of each reel from which the thread passes to a spinning pot is disposed directly above the spinning pot itself.

6. Improved wet-spinning apparatus of the type employed in the discontinuous manufacture of artificial silk thread; e. g., pot- or spool-spinning apparatus, which improved wet-spinning apparatus embodies a longitudinally extending trough having a working face along one side thereof, said trough being adapted to contain a coagulating liquid; a number of mutually independent thread-forming means positioned in parallel relation to each other, each of said thread-forming means being disposed in said trough; a number of self-threading thread-advancing reels of cantilever construction supported above and at intervals along the length of said trough with the unsupported ends of the reels disposed in juxtaposition to the working face of said trough so as to permit access to the unsupported ends of said reels from the working face of said trough, each of said reels being adapted to receive one of said threads at its supported end immediately after withdrawal of the thread from said coagulating liquid, to advance the thread toward its unsupported end in a large number of closely spaced, generally helical turns, and to discharge the thread from said unsupported end in a manner such that the thread has no opportunity to wrap itself about obstructions, including the elements of the reel itself; and, disposed in close proximity to said trough, a number of mutually independent take-up means positioned to collect in the form of cross-wound packages the threads produced by said thread-forming means.

7. Improved spool-spinning apparatus of the type employed in the discontinuous manufacture of artificial silk thread which improved spool-spinning apparatus embodies a longitudinally extending trough having a working face along one side thereof, said trough being adapted to contain a coagulating liquid; a number of mutually independent thread-forming means positioned in parallel relation to each other, each of said thread-forming means being disposed in said trough; a number of self-threading thread-advancing reels of cantilever construction supported above and arranged at intervals along the length of said trough with the unsupported ends of the reels disposed in juxtaposition to the working face of said trough so as to permit access to the unsupported ends of said reels from the working face of said trough, each of said reels being adapted to receive one of said threads at its supported end immediately after withdrawal of the thread from said coagulating liquid, to advance the thread toward its unsupported end in a large number of closely spaced, generally helical turns, and to discharge the thread from said unsupported end in a manner

such that the thread has no opportunity to wrap itself about obstructions, including the elements of the reel itself; and, disposed in close proximity to said trough, a number of collecting spools adapted to collect in package form the threads produced by said thread-forming means.

8. Apparatus of the character defined in claim 7 in which each of said reels is mounted with its axis at an angle to a vertical plane parallel to the working face of said trough.

9. Apparatus of the character defined in claim 7 which embodies a plurality of reels for each of said threads, said reels being disposed above the level of the coagulating liquid in said trough.

10. In the spool-spinning system of manufacturing thread, the steps of forming the thread in a coagulating bath; feeding the thread as it is formed to a thread store device of cantilever construction toward the unsupported end of which the thread is continuously advanced in generally helical form; washing the thread on said thread store device; and, while it is still moist, collecting the thread on a spool.

11. In the spool-spinning system of manufacturing thread, the steps of forming the thread in a coagulating bath; feeding the thread as it is formed to a thread store device on which, by the action of the elements thereof, the thread is continuously advanced in generally helical form; desulfurizing the thread on said thread store device; and, while it is still moist, collecting the thread on a spool.

12. In the spool-spinning system of manufacturing thread, the steps of forming the thread in a coagulating bath; feeding the thread as it is formed to a thread store device on which, by the action of the elements thereof, the thread is continuously advanced in generally helical form; bleaching the thread on said thread store device; and, while it is still moist, collecting the thread on a spool.

13. In the spool-spinning system of manufacturing multiple filament viscose artificial silk thread, the steps of forming the thread in a dilute sulphuric acid coagulating bath; withdrawing the thread from said coagulating bath; continuously but temporarily impressing upon the thread the form of an advancing helix characterized by a large number of turns; subjecting the thread while in helical form to the action of a treating liquid other than that of which the coagulating bath is composed; and, while it is still moist, collecting the thread on a spool.

14. In the pot-spinning system of manufacturing multiple filament viscose artificial silk thread, the steps of forming the thread in a dilute sulphuric acid coagulating bath; withdrawing the thread from said coagulating bath; continuously but temporarily impressing upon the thread the form of an advancing helix characterized by a large number of turns; subjecting the thread while in helical form to the action of a treating liquid other than that of which the coagulating bath is composed; and, while it is still moist, collecting the thread in a spinning pot.

15. In the pot-spinning system of manufacturing thread, the steps of forming the thread in a coagulating bath; feeding the thread as it is formed to a thread store device on which, by the action of the elements thereof, the thread is continuously advanced in generally helical form; desulfurizing the thread on said thread store device; and, while it is still moist, collecting the thread in a spinning pot.

16. In the pot-spinning system of manufactur-

ing thread, the steps of forming the thread in a coagulating bath; feeding the thread as it is formed to a thread store device on which, by the action of the elements thereof, the thread is continuously advanced in generally helical form; 5 bleaching the thread on said thread store device; and, while it is still moist, collecting the thread in a spinning pot.

10 17. In the pot-spinning system of manufacturing thread, the steps of forming the thread in a coagulating bath; feeding the thread as it is formed to a thread store device of cantilever construction toward the unsupported end of which the thread is continuously advanced in generally

helical form; washing the thread on said thread store device; and, while it is still moist, collecting the thread in a spinning pot.

18. Apparatus of the character defined in claim 1 in which the take-up means comprise 5 spinning pots, one spinning pot being employed for each thread.

19. Apparatus of the character defined in claim 1 in which the take-up means comprise collecting spools, one collecting spool being employed 10 for each thread.

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