

April 18, 1944.

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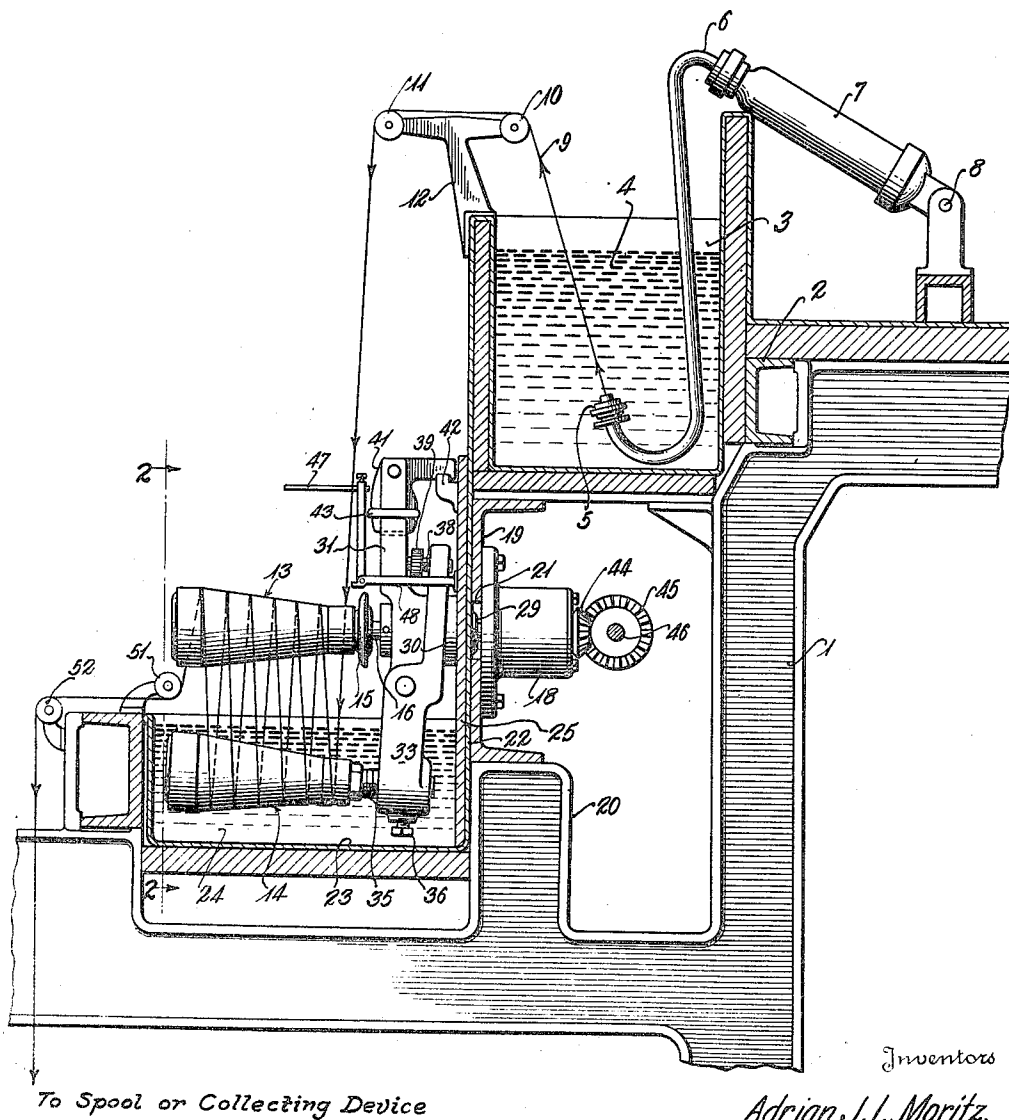
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MANUFACTURE OF RAYON

Filed March 5, 1940

8 Sheets-Sheet 1

Fig. 1.



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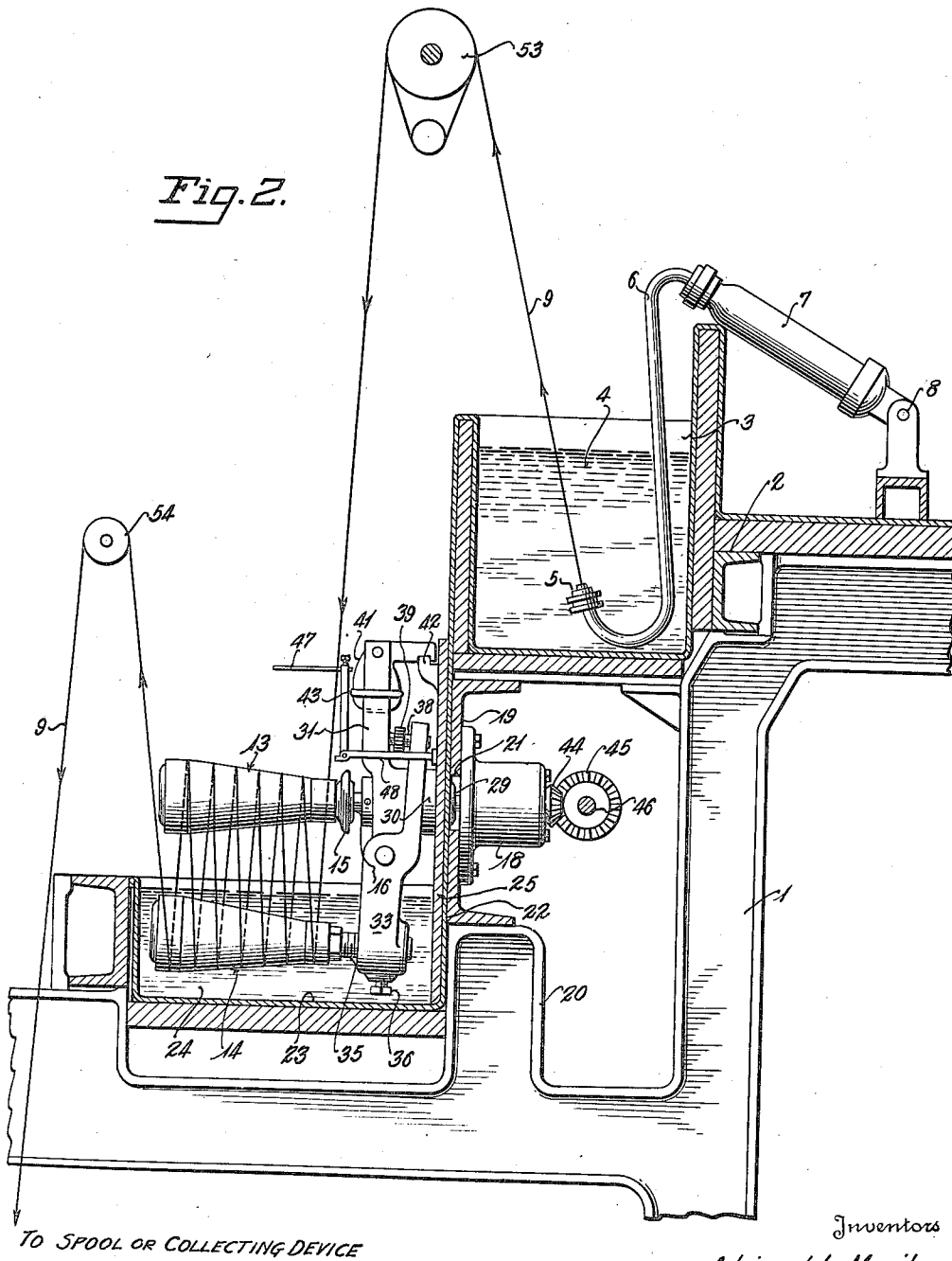
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MANUFACTURE OF RAYON

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8 Sheets-Sheet 2

Fig. 2.



TO SPOOL OR COLLECTING DEVICE

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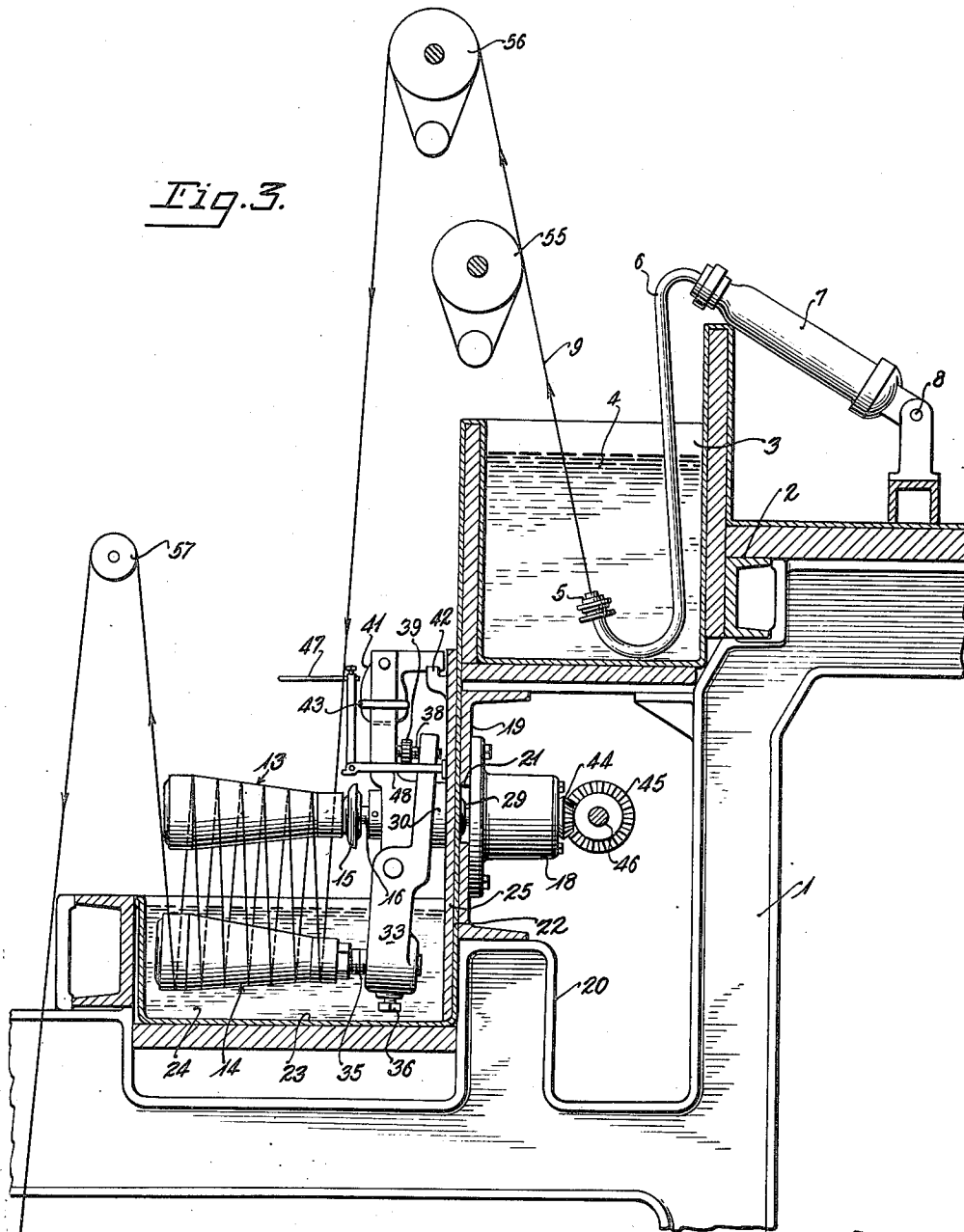
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MANUFACTURE OF RAYON

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8 Sheets-Sheet 3

Fig. 3.



TO SPOOL OR COLLECTING DEVICE

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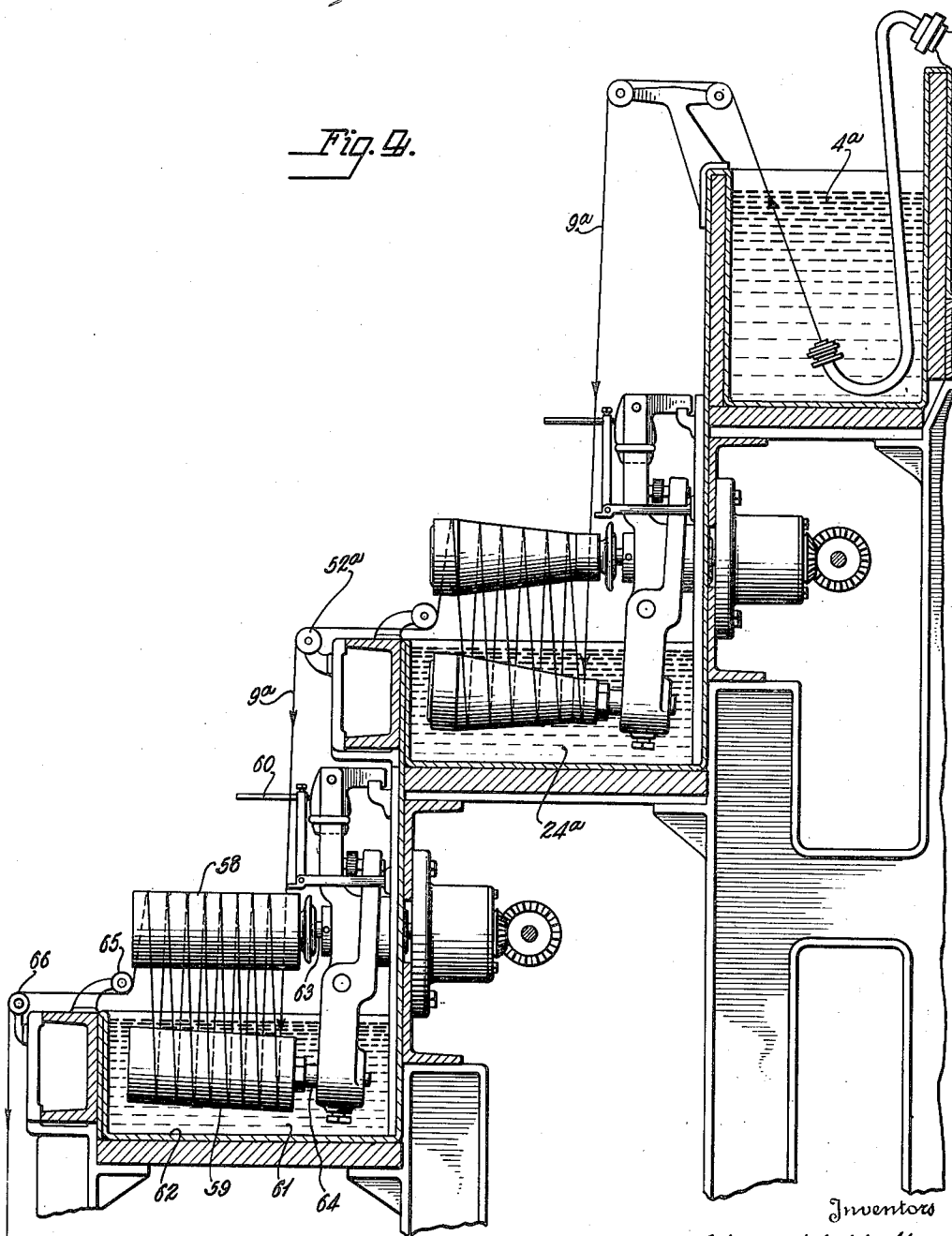
2,346,696

MANUFACTURE OF RAYON

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8 Sheets-Sheet 4

Fig. 4.



To Other Storage
or Processing Rolls

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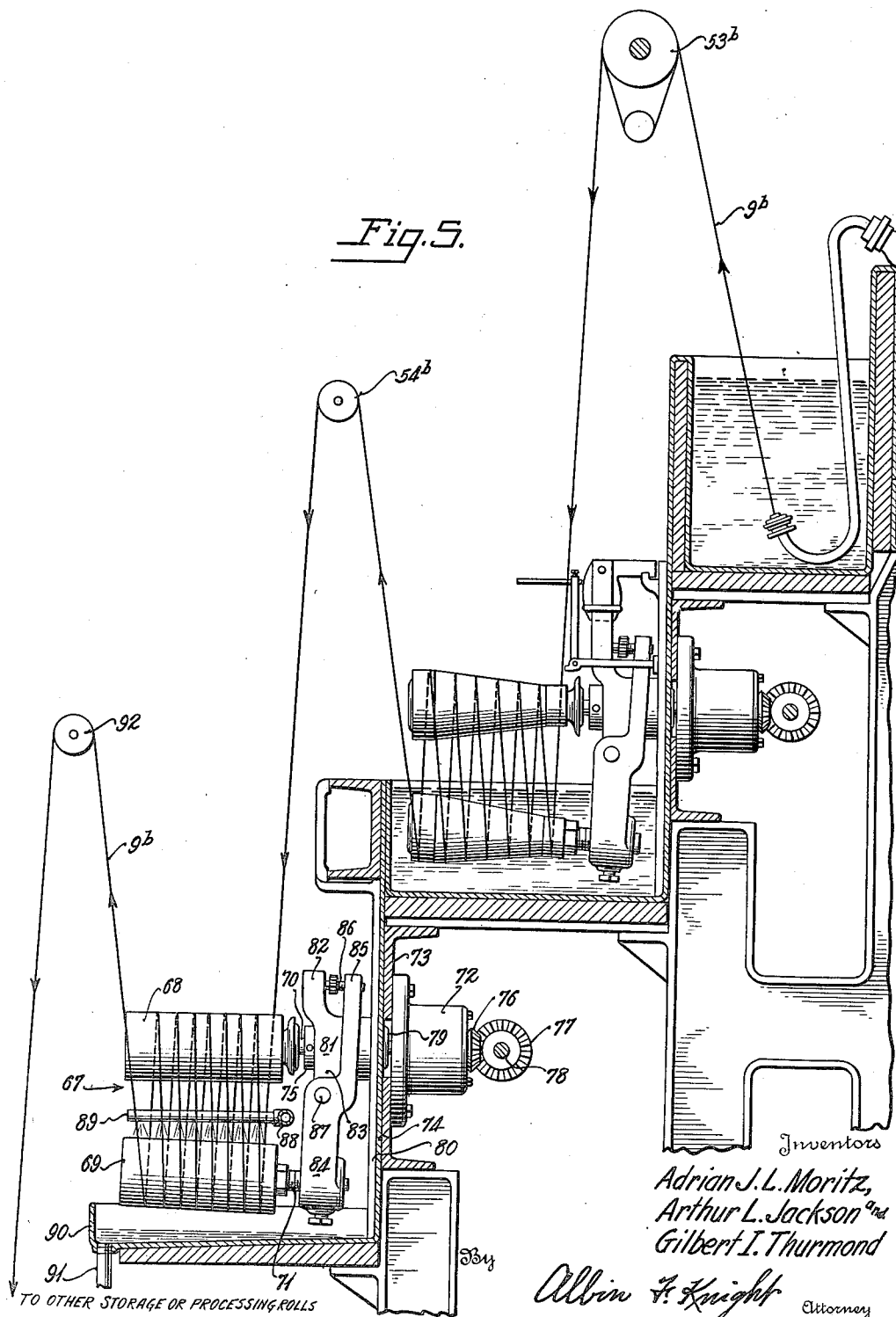
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MANUFACTURE OF RAYON

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Fig. 5.



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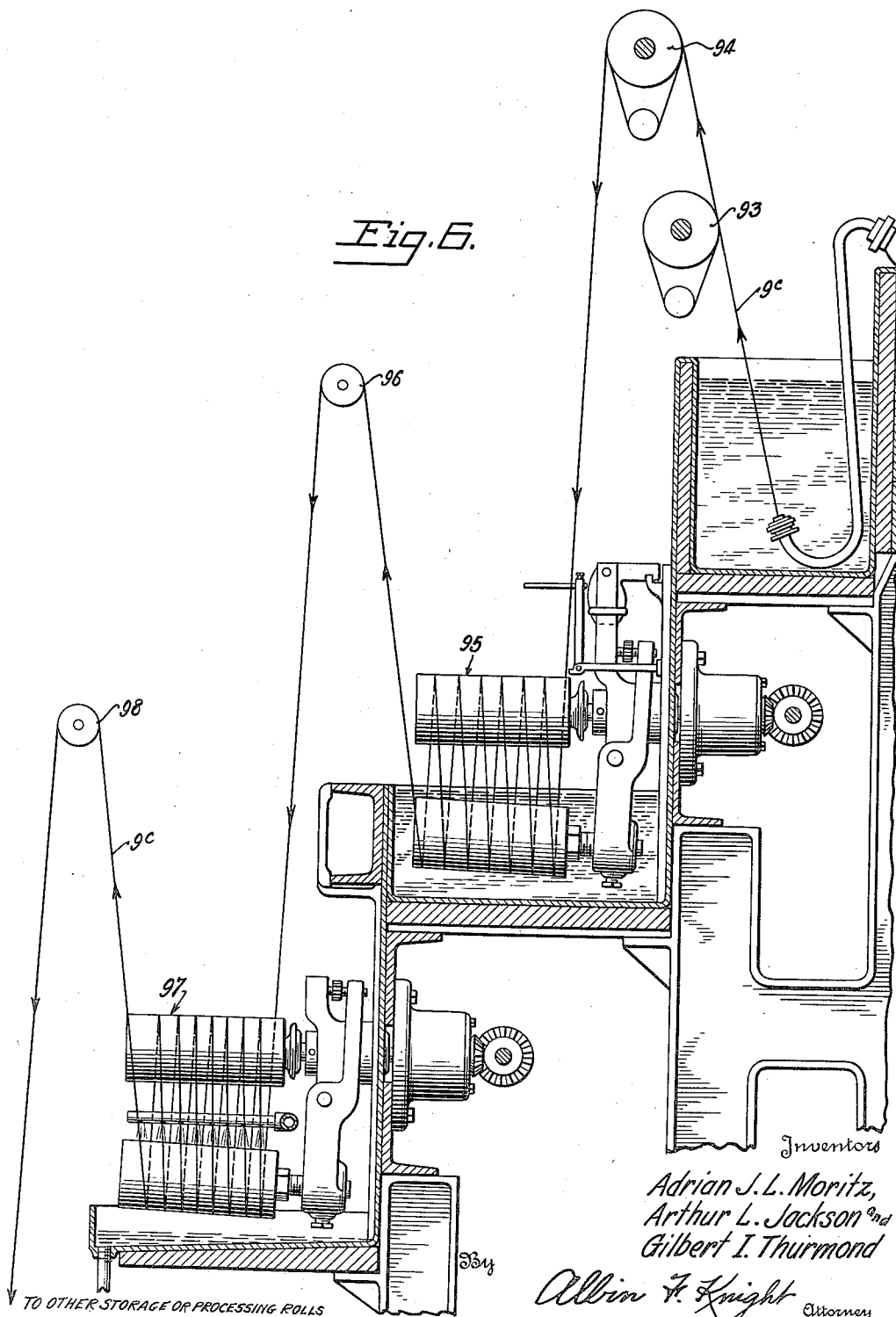
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MANUFACTURE OF RAYON

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Fig. 6.



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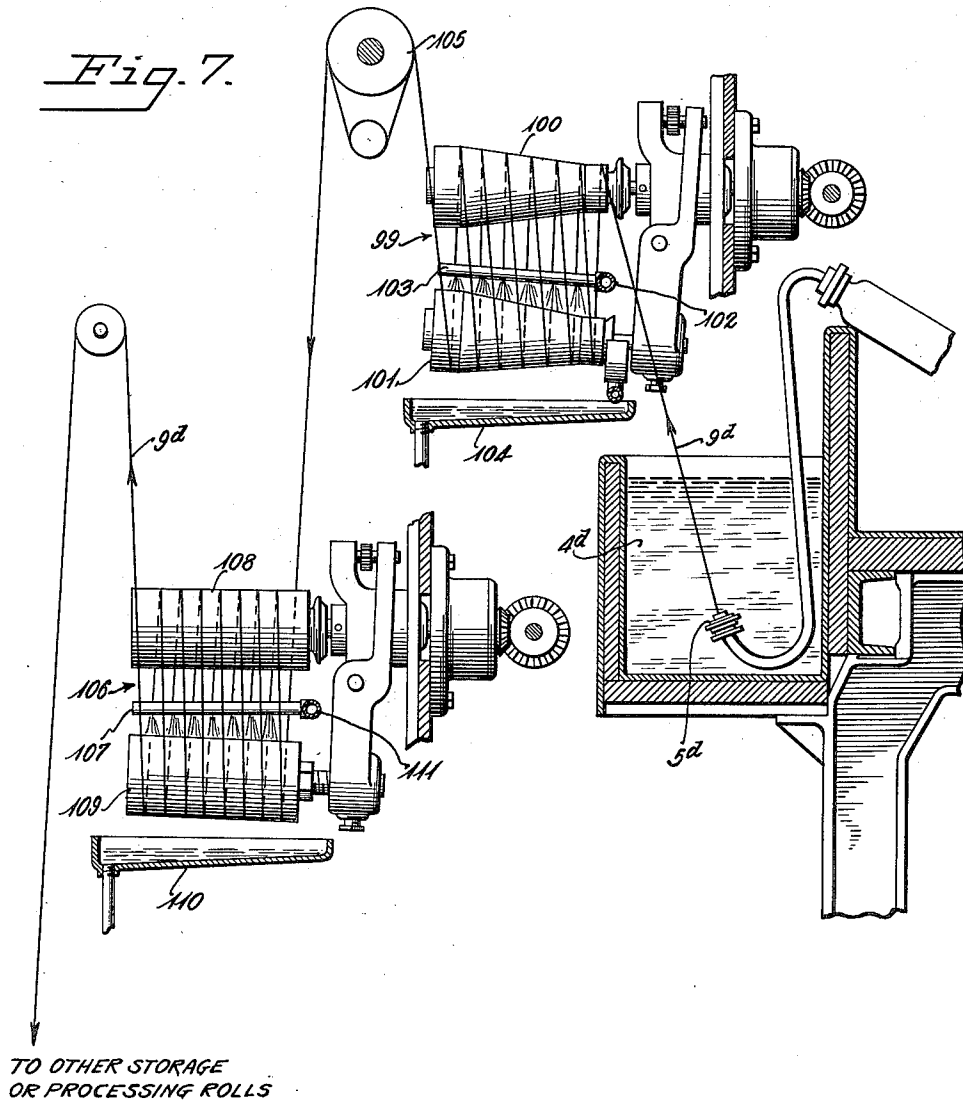
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MANUFACTURE OF RAYON

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Fig. 7.



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MANUFACTURE OF RAYON

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Fig. 8.

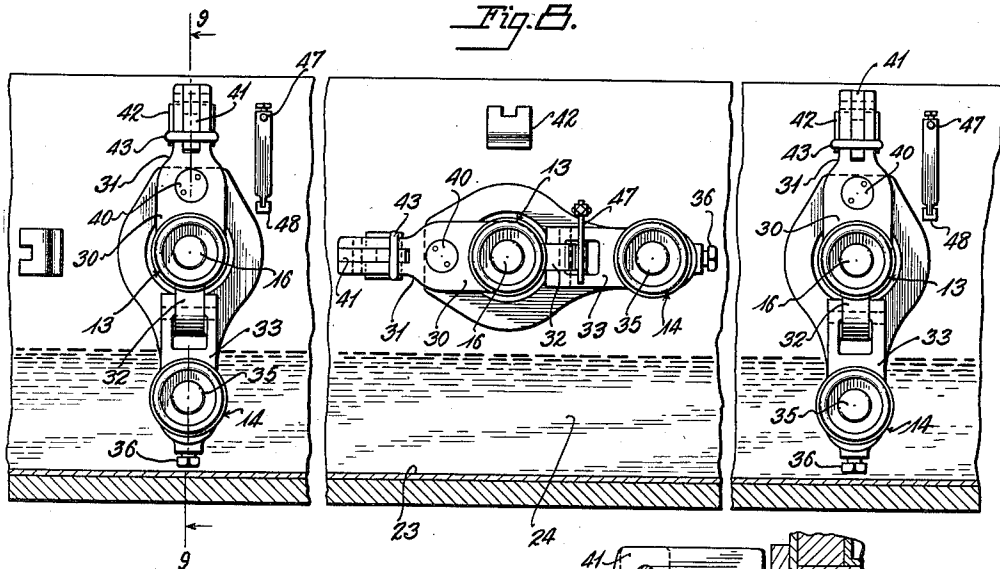
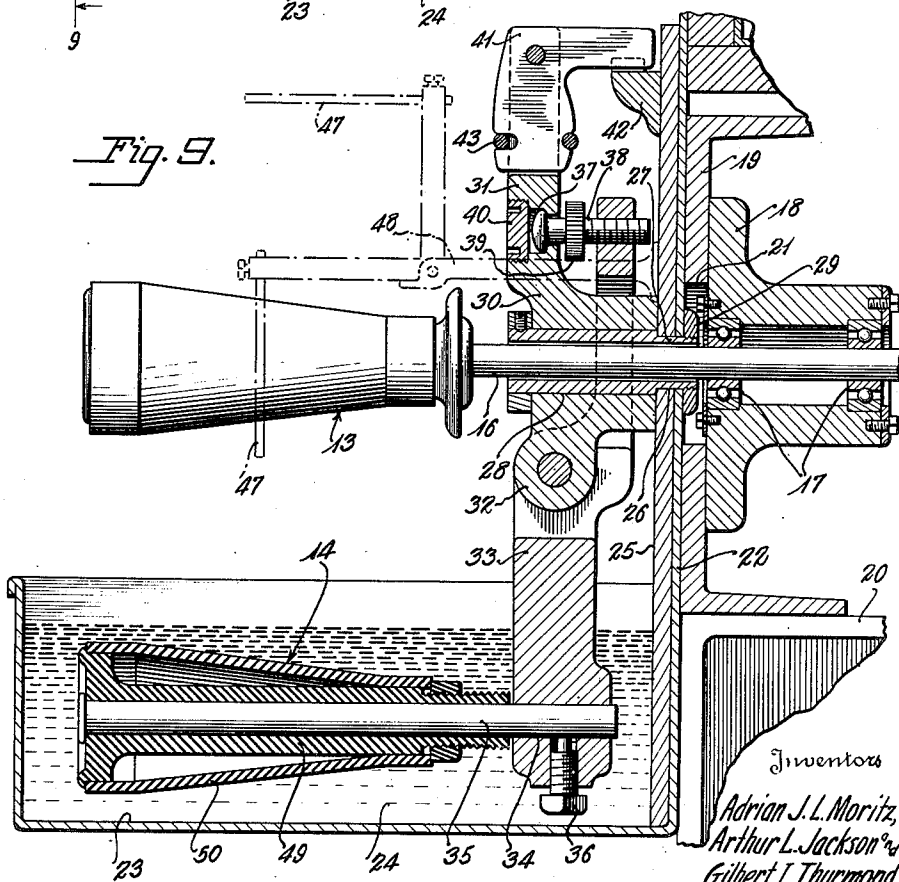


Fig. 9.



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UNITED STATES PATENT OFFICE

2,346,696

MANUFACTURE OF RAYON

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Application March 5, 1940, Serial No. 322,386

10 Claims. (Cl. 18—8)

The present invention relates to the manufac-
ture of rayon and, more particularly, to a process
of and apparatus for extruding solutions to form
artificial filaments, threads, yarns and the like,
and for the subsequent handling and treatment thereof.

In the manufacture of threads of artificial ori-
gin, particularly in the production of viscose
rayon, it is desirable that the threads have uni-
form physical and chemical properties. In fact,
these properties, in some instances, are necessary
in view of the high standards maintained in cer-
tain extremely competitive industries in which
rayon is used. For example, the weaving and
knitting industries are particularly exacting in
requiring the artificial threads to be of a uniform
character.

In the past, cotton has been the standard tex-
tile material used to reinforce certain rubber
products such as cord tire carcasses. Recently,
however, in addition to its wide use in the weav-
ing and knitting industries, rayon has acquired
an ever increasing importance for use as a rein-
forcement for rubber articles such as cord tires,
heavy duty tires and the like, as well as for vari-
ous other rubber products.

The rayon used in the rubber industry, if it is
to give more satisfactory results as a reinforce-
ment than cotton, must have not only certain of
the uniform characteristics required of it in the
weaving and knitting fields but, in addition, it
must have a high strength, a low elongation, a
high flexing life and other desirable character-
istics.

In order to produce rayon having these char-
acteristics required for its satisfactory use in the
rubber industry, it was found necessary to modify
the standard equipment previously used for the
production of artificial threads. These modifica-
tions have necessitated a considerable amount
of time-consuming research with the expense in-
cident thereto.

The standard equipment normally employed in
the manufacture of rayon prior to its utilization
as a reinforcement for rubber involves the use
of a single coagulating or precipitating bath
through which the filaments are passed. After
passing through this bath, the filaments are
stretched to a limited degree by passing them
over a plurality of driven or freely rotatable roll-
ers, stationary friction guides or the like. By this
system, the yarn formed is then collected in pack-
age form, the impurities removed therefrom and
the package dried. The disadvantages in this
type of system is that the regeneration of the

yarns is not complete and consequently the final
threads produced are not sufficiently strong or
uniform in character to be suitable for certain
uses. This is particularly true of rayon which is
to be used as a reinforcement for cord tires, heavy
duty tires and the like.

There are several reasons for the fact that
rayon produced by the standard equipment does
not have the strength and uniformity required
for its satisfactory use as a reinforcement for
rubber. Perhaps the most important reason why
the standard equipment is unsatisfactory in this
respect is the fact that it is not particularly
adapted to stretch the thread in a uniform man-
ner nor does it provide appropriate means for
after-treating the thread prior to collection.
Thus, the desirable qualities in a thread suitable
for reinforcing rubber such as uniformity, high
tensile strength, low elongation, high flexing life
and the like are not attained in a thread produced
by conventional equipment in the usual manner.

It has now been learned that if the rayon spin-
ning system be constructed along lines which de-
part from the conventional type, the above-men-
tioned difficulties are overcome. Probably the
most important change is in the use of a plurality
of treating baths (at least two) containing acids,
salts and/or water, at least one of the baths being
maintained at an elevated temperature, for ex-
ample, from 70° to 90° C. In such a system, it is
believed that the coagulation and regeneration is
so adjusted that the regeneration per se is re-
tarded but it is carried to completion in the sev-
eral treating baths. By using the bath at the
elevated temperature, a tremendously increased
stretch can be effected thereby materially increas-
ing the tensile strength of the individual fila-
ments making up the thread. The arrangement
and specific application of the baths is given
more fully in the copending applications of Thur-
mond, Serial No. 259,261, and Muller, Serial No.
324,727.

Naturally, the use to which the thread is to be
put determines the specific type of system to be
employed. For example, inasmuch as it is nec-
essary to produce a strong thread for use in the
rubber industry, a plurality of specific treating
baths are utilized, whereas in the knitting and
weaving trade since it is of the utmost impor-
tance to provide uniform shrinkage, dyeing and
other properties, specific baths of other types
which are not necessarily designed to impart high
strength to the thread, may be used. It is, of
course, desirable to have uniformity in cord tire
threads.

The theory has been advanced that threads produced in accordance with the more recently developed continuous spinning process are more uniform, although, prior to the present invention, numerous objectionable features have been encountered therein. Regardless of whether the thread is produced by the continuous spinning method or by the "interrupted or non-continuous" method, the present invention in its specific form and modifications thereof overcomes the difficulties heretofore involved. The present invention contemplates several coagulating and/or regenerating baths or treatments immediately after the thread is extruded and prior to subsequent processing operations. To that extent the first parts of the "continuous" and the "non-continuous" systems are the same. After the thread has been initially treated in the foregoing manner it may then be continuously processed and dried prior to its collection or it may be immediately collected after complete regeneration and then given the necessary treating operations which include washing, desulphurizing, bleaching, rewashing and drying.

In practising the present invention it has been discovered that the processing steps subsequent to the passage of the filaments from the coagulating bath may be performed by the utilization of a subsequent bath or baths or by the application of the treating liquid or liquids through the medium of a spray.

It is an object of the present invention to provide a spinning system in which a predetermined amount of high stretch is imparted to the thread during or prior to complete regeneration as a result of a series of gradual stretching operations so that a high degree of uniformity is effected.

This invention further contemplates the provision of spinning apparatus for accomplishing the above referred to results which includes various combinations of godets, conical rollers and cylindrical rollers in their proper sequence, the conical rollers and cylindrical rollers being utilized to convey the thread in a multiplicity of helices and the conical rollers also imparting a gradual stretch to the thread.

Another object of the present invention provides for a series of treatments of the yarn as it is being passed in closely spaced, helical form on the rollers.

This invention contemplates additionally the application of a liquid to the thread being treated which liquid has been preheated or heated by contact with the roller over which the thread is guided, or both of these heating operations may be employed.

It is also an object of the present invention, when the processing steps employed involve the use of a hot bath, to provide a mechanism by which the lower roller of a pair provided for immersing the thread, is mounted for rotary displacement in order to facilitate the "threading-in."

This invention also contemplates the use of a stop to prevent the thread from feeding in spaced helices all the way to the larger ends of cones forming a thread-storage, thread-advancing, thread-stretching device, until after the lower cone has been rotatably displaced into a treating bath.

Other objects and advantages of the invention will be apparent from the following description, when considered in connection with the accompanying drawings, wherein

Figure 1 is a cross-sectional view through a

portion of an interrupted type spinning apparatus constructed in accordance with this invention;

Figure 2 is a cross-sectional view through a portion of the apparatus shown in Figure 1 modified by the inclusion of a driven godet between the spinning bath and the conical stretching rollers;

Figure 3 is a view similar to Figure 1 and illustrates a further modified form of interrupted spinning apparatus, the apparatus including for cooperation with each spinneret a draw-off godet and a driven godet in sequence in the path of travel of the thread to the conical stretching rollers for cooperation therewith;

Figure 4 illustrates a cross-section through a continuous type spinning apparatus formed in accordance with one principle of the present invention wherein the threads are drawn from the spinning bath and over freely rotatable, guiding rollers by means of conical rollers on which they are stretched, and immediately subjected to further treatments on storage devices;

Figure 5 is a sectional view similar to Figure 4 and shows a modified type of apparatus in which a draw-off godet is positioned between the spinning bath and the conical rollers and in which further treatment of the threads is effected on rollers which convey them in helical form while a treating liquid is sprayed thereon;

Figure 6 is also a sectional view through a portion of a continuous spinning apparatus and the apparatus therefor is a modification of the one shown in Figure 5 in that, the conical rollers are replaced by cylindrical rollers and the threads are propelled under the desired degree of tension according to the relative peripheral speeds of a draw-off godet, an adjacent driven godet and the cylinders;

Figure 7 is a schematic view illustrating a spinneret, spinning bath and processing rollers of a continuous spinning apparatus in which conical stretching rollers are mounted above the bath and treating liquid is sprayed on the thread being conducted along the rollers;

Figure 8 illustrates the manner in which the lower rollers of those pairs of rollers which are utilized for immersion in a treating bath, are mounted for rotary displacement to facilitate "threading-in"; and

Figure 9 is an enlarged sectional view taken on the line 9-9 of Figure 8 showing the upper roller in elevation, illustrating the latch means for retaining the lower roller in operative position and means by which the axes of the respective rollers may be adjusted with respect to each other to control the spacing of the convolutions of the threads as they are propelled in helical form.

With reference to the drawings, a frame of a spinning apparatus designated as 1 is provided with a channel bar 2 which extends along the length of the machine. Supported in front of channel bar 2 is a trough 3 which is adapted to contain a coagulating bath 4. A series of spinnerets are spaced lengthwise of the trough 3, one of these spinnerets being designated at 5. The spinnerets 5 are each supported by a spinning solution supply line 6 which is connected to a filter 7. Filters 7 are pivotally supported at 8 in the customary manner to permit removal of the spinnerets from the coagulating bath 4 for changing or cleaning.

After the solution is extruded from the spinneret illustrated, it is conveyed through the coagulating bath 4 in the form of a thread 9, which thread, in the form of apparatus illustrated in Figure 1, is drawn over freely rotatable guides 10

and 11 supported upon a bracket 12. After the thread 9 is passed from the guide 11, it is propelled by roller 13 and then it is passed alternately around roller 13 and a roller 14 a plurality of times in order to stretch the same. Rollers 13 and 14 are mounted so that roller 13 is positively driven while roller 14 is freely rotatable, the rollers being mounted in the manner illustrated in greater detail in Figure 9.

Roller 13 is provided with a splash shield 15 to prevent acid from contacting the metallic parts constituting the housing. Roller 13 is fixed to shaft 16 for rotation therewith and shaft 16 is supported in bearings 17 which are in turn secured in bracket 18 which is attached to a channel bar 19 supported upon an upwardly extending projection 20 on frame 1. An opening 21 is provided in the channel bar 19 for each of the shafts 16 of the series arranged for cooperation with the respective spinnerets 5 and a lining 22 of the trough 3 covers the walls of said trough and then is extended downwardly over the outer face thereof to a point where it overlies the channel bar 19, at which point the lining is formed to provide a covering for a second trough 23 in which roller 14 is arranged to rotate within a bath 24. A plate 25 is clamped over the lining 22 adjacent the face of the channel bar 19 and an opening 26 is provided through the lining and plate 25 for the reception of a boss 27 of a tubular sleeve 28 which loosely encircles shaft 16. Sleeve 28 is maintained in position by means of a nut 29 which engages upon screw threads provided on said boss.

A hub 30, provided with an arm 31 and a short extension 32 diametrically opposite to the arm, is secured lengthwise on the sleeve 28 which sleeve acts as a bearing therefor. Extension 32 is provided with one portion of a pivoted joint and is arranged to have secured thereto a lever 33, the lower portion of which lever is provided with an opening 34 for the reception of a shaft 35 which is fixed in position by a set screw 36. The upper portion of lever 33 encircles hub 30 and lies behind arm 31. Opening 37 is provided in arm 31 and has retained therein a loosely fitting bolt 38 which is provided with a grip 39 which in turn is threaded and pinned to the bolt. The head of the bolt 38 engages upon the inner wall of a shoulder formed by the reduction of the diameter of the opening 37. Bolt 38 is received in a screw threaded opening in the encircling portion of lever 33 and the angle of convergence of shafts 16 and 35 is readily adjusted by the rotation of bolt 38. A screw threaded cap 40 is adapted to be received in an enlarged recess overlying opening 37 in order to prevent longitudinal movement of the bolt 38.

The upper portion of arm 31 is bifurcated and has pivotally mounted therein a latch member 41 which is normally biased to a position to engage within a slot, provided in a stop member 42, by means of an elastic latch member 43. Shaft 16 has fixed to the inner end thereof a bevel gear 44 which engages with a bevel gear 45 in turn keyed to a shaft 46 extending below the trough 3 throughout the length of the machine and which is adapted to be driven from a suitable source not shown.

When the rollers are in the relative position illustrated in Figure 9 and in the positions of the cutter assemblies shown in Figure 8 latch member 41 is engaged within the slot of the stop member 42 and the respective assemblies are secured in this position for operation. However,

during the "threading-in" period, latch member 41 is removed from the slot of member 42 by depressing the outer surface of the latch member below the pivot point and the hub and arm 31 with the latch member and pivoted lever 33 are rotated about sleeve bearing 28 whereupon the latch member 41 is engaged in elastic latch member 43 in the manner illustrated by the central assembly in Figure 8. In this position the attendant receives the thread 9 as it is passed from guide 11 and directs the same first around roller 13 of the assembly which is in line with guide 11 and thence around roller 14. Immediately after "threading-in," roller 14 together with the thread is moved to the position as illustrated in Figure 1.

A thread stop 47, arranged to be pivoted in and out of operative position upon a bracket 48, is provided for movement to the operative position during the "threading-in" period. As the thread is initially wound upon the rollers, it tends to advance along the entire length of the rollers 13 and 14, but this is prevented by the stop 47. Such action is necessary in order to avoid damage or perhaps rupture of the thread, because the thread will not normally withstand the stretch which would be imparted thereto by rollers 13 and 14 until the thread is wetted by the hot bath 24. Therefore the stop 47 is maintained in operation until the thread is moved from contact therewith as lower roller 14 is being positioned in the bath. The rollers are each provided with a working surface of an acid-resistant material such as porcelain, glass, lacquered aluminum, Bakelite or other resinous materials. As shown in Figure 9, the lower roller 14 is provided with a rotatable hub 49 upon which is clamped a surface portion 50.

The thread, upon reaching the end of the assembly of conical rollers as described, is then conducted from the roller 13 over freely rotating guides 51 and 52 whereupon, in the form shown in Figure 1, it is conducted to a collecting device.

In Figure 2, a modified form of interrupted spinning apparatus is illustrated, in that, the thread 9, after being propelled through bath 4, is directed to and around a draw-off godet 53. From the draw-off godet, the thread is propelled to a conical roller assembly constructed as described in connection with Figures 1, 8 and 9 and, after being stretched in a series of step-wise operations on the conical rollers 13 and 14, it is drawn over a freely rotating roller 54. The thread 9, after leaving roller 54, is conveyed to a collecting device which may be in the form of a bobbin or a centrifugal pot.

The modified interrupted spinning apparatus illustrated in Figure 3 employs a godet 55 by which the thread is drawn from the spinning bath 4 and the thread is propelled from godet 55 to another driven godet 56 arranged in the path of travel of the thread to the conical roller assembly associated with the second treating bath. Godets 55 and 56 are so arranged in the path of travel that the draw-off speed is maintained constant according to the peripheral speed of godet 55 and, after the thread is sufficiently coagulated, an initial controlled stretch is given the thread between godets 55 and 56 due to the peripheral speed of godet 56 being maintained at a predetermined higher rate than the peripheral speed of godet 55. The thread which has been subjected to the initial stretching operation is then conducted to rollers 13 and 14 and

while being subjected to a second treating liquid it is stretched in a series of operations to the desired extent. The thread is then passed over a freely rotating guide 57 whereupon it is collected in one of the normal collecting devices such as now in common use.

Continuous spinning apparatus are illustrated in Figures 4 to 7, inclusive, Figures 5, 6 and 7 being modifications of the apparatus illustrated in Figure 4.

In the continuous spinning apparatus illustrated in Figure 4, the apparatus is identical with that illustrated in Figure 1 up to the point where the thread 9a is passed over a freely rotating guide 52a, although the compositions of the treating baths 4a and 24a may be modified in accordance with the process hereinafter referred to in discussing the operation of the apparatus. After the thread is propelled from guide 52a, it is "threaded-in" upon rollers 58 and 59 and a stop 60 similar to thread stop 47 is utilized, stop 60 being pivotally mounted upon a bracket. The thread is then continuously passed to the assembly which includes the upper and lower cylindrical rollers 58 and 59, after the lower roller 59 has been submerged within a treating bath 61 contained within a trough 62. The shaft 63 and 64 of rollers 58 and 59, respectively, converge toward the unsupported ends of the rollers in order that the thread will be conducted along the rollers in the form of a series of closely spaced helices. Rollers 58 and 59 and their respective shafts 63 and 64 are mounted for movement in the same manner as rollers 13, 14 and shafts 16 and 35 shown in Figure 9 and described above. Thread 9a is propelled over freely rotating guides 65 and 66 after it is delivered from upper roller 58 whereupon it is directed to and over other processing rollers, the number of assemblies being controlled by the number of processing operations to which the thread is to be subjected. The additional processing of the thread 9a may be conducted on rollers of the type illustrated in Figure 4 or it may be conducted on rollers which are not submerged in a treating bath.

In Figure 5, there is illustrated a modification of a continuous spinning apparatus in which the thread 9b, in being propelled through a coagulating bath, is propelled by means of a draw-off godet 53b. The thread is propelled around godet 53b and is thereafter conducted to a conical roller assembly of the type specifically illustrated in Figures 8 and 9 whereupon it is drawn over a freely rotating guide roller 54b to a cylindrical roller assembly designated generally at 67.

In assembly 67, upper and lower rollers 68 and 69 are mounted upon shafts 70 and 71, respectively, and shaft 70, like shaft 16 as illustrated in Figure 9, is supported in bearings carried in bracket 72. Bracket 72 is supported upon channel bar 73 which is secured to the apparatus frame and a lining 74 extends down over the face of the channel bar. The shaft 70 which has roller 68 keyed thereto extends through a tubular member 75 and then through the channel bar 73 and the supporting bearings. A bevel gear 76 is keyed to the end of the shaft 70 which gear meshes with a bevel gear 77 keyed to shaft 78, and the shaft extends throughout the length of the apparatus and is operated from a source of power not shown.

The tubular member 75 is loosely engaged over the shaft and is secured in position by a nut 79 which passes over a reduced portion of the member where it extends through openings in the lin-

ing 74 and a clamping plate 80. Fixedly secured to member 75 is an annular member 81 which is provided with upper and lower extension 82 and 83. Lever 84 is pivoted to the extension 83 and has a portion 85 which encompasses the annular member 81 and which lies behind extension 82. A bolt 86 is threaded into portion 85 which bolt has its head freely rotatable within extension 82. By adjustment of the bolt 86, lever 84 is caused to move about the pivot 87 in order that the angle of convergence of the shafts 70 and 71 may be modified to control the spacing of the helices of thread 9b upon rollers 68 and 69. A spray pipe 88 extends throughout the length of the apparatus and it is provided with a spray nozzle 89 for each of the lower rollers 69 of the respective assemblies and a drain pan 90 having outlet pipes 91 is arranged to extend longitudinally of the apparatus for the purpose of conducting away or recycling the liquid sprayed from nozzles 89.

The thread 9b when it reaches the free end of the rollers of the assembly 67 is drawn over freely rotating guide roller 92 whereafter the thread is conducted to and over other processing rollers in the manner described in connection with the thread leaving the apparatus illustrated in Figure 4.

Thread 9c as illustrated in Figure 6 is subjected to the same general type of manipulation as is the thread 9b in Figure 5 except that the thread is conducted first to a draw-off godet 93 which acts to withdraw the thread from the coagulating bath at a constant speed. The thread leaving godet 93 is propelled to and around driven godet 94 whereupon a predetermined stretch of the thread is effected. Upon leaving godet 94, thread 9c is propelled to and around a cylindrical roller assembly designated generally as 95 which is identical with the assembly last shown in the path of travel of the thread in Figure 4. The cylindrical rollers of the assembly 95 may be operated at a greater peripheral speed than the peripheral speed of godet 94 whereby an additional stretch is imparted to the thread as it is passed to assembly 95, but otherwise the cylindrical rollers of assembly 95 merely act to effect a prolonged treatment of the thread as it is passed in the form of a series of helices along the cylinders. Thereupon the thread 9c is drawn over freely rotating guide roller 96 and to a cylindrical thread assembly designated generally as 97. Cylindrical roller assembly 97 is identical with the assembly designated as 67 in Figure 5 and the thread may be treated thereon accordingly. Freely rotating guide roller 98 is positioned in the path of the thread as it is conducted from roller assembly 97 and after the thread is passed thereover it is subjected to processing on a series of roller assemblies in the manner suggested above with respect to the thread leaving the apparatus shown in Figure 4.

In Figure 7 there is illustrated a modification of the continuous spinning apparatus described in connection with Figure 6 in that the thread 9d after it is extruded by the spinneret 5d is conducted through the coagulating bath 4d and then immediately to the upper roller of a conical roller assembly designated generally as 99. Assembly 99 is formed with upper and lower conical rollers 100 and 101 and a pipe 102 is arranged to extend longitudinally of the apparatus and to have extending therefrom a spray nozzle 103 for cooperation with each of the assemblies 99, one of which is provided for cooperation with each of

the spinnerets throughout the length of the machine. The treating liquid which is sprayed from nozzle 103 is collected in a pan 104 and may be discharged or recycled for further use. Either roller 100, 101, or both may be provided with means for heating the same and with means for conducting the heating medium therefrom after it has served its heating purpose. Due to the utilization of the spray nozzles and the collecting pan it is unnecessary for the rollers 100 and 101 to be bodily movable with respect to each other for the purpose of "threading-in" and therefore the support and driving means for the rollers of the assembly 99 will be of the same form as utilized in connection with the roller assembly designated at 67 in Figure 5, and others.

The thread discharged from the lower roller 101 of assembly 99 is propelled to and around a driven godet 105 and therefore in addition to the stretch which is imparted to the thread in its passage through assembly 99 a further stretch may be imparted to the thread between roller 101 and driven godet 105 as a result of the driving of the godet at a greater peripheral speed than that of the large end of conical roller 101. After the thread is propelled from driven godet 105 it is conducted to a cylindrical roller assembly designated generally at 106. Roller assembly 106 is provided with a spray nozzle 107 located between upper roller 108 and lower roller 109. The thread conducted to assembly 106 is passed first over roller 108 and then over lower roller 109 after which it is passed alternately around the rollers a number of times in closely spaced helices. A pan 110 is provided below the assembly 106 and a pipe 111 is positioned so that it extends longitudinally of the machine for supplying a treating liquid to the spray nozzle 107, one of which is positioned for cooperation with each unit 106 arranged along the length of the apparatus. The rollers of unit 106 are supported and driven in identically the same manner as the rollers of assembly 67 shown in Figure 5.

After thread 94 is treated as described it is conducted over a plurality of assemblies similar to assembly 99 or assembly 106 and is subjected to different processing steps according to the type of thread being produced. It is thereafter dried, twisted and collected or first collected and then twisted and dried.

In the operation, the initial spinning steps are generally the same in both the continuous system and the non-continuous or interrupted system. However, referring more particularly to the non-continuous system as disclosed in Figures 1 to 3 inclusive, and 7 and 8, the cellulosic solution is extruded into a precipitating or coagulating bath to form a thread or yarn consisting of a number of fine filaments. The composition of the bath is more or less standard, i. e., it contains sulphuric acid, sodium sulphate, zinc sulphate, magnesium sulphate and other salts, depending upon the conditions required for the manufacture of the particular type of thread. The thread is passed through the coagulating bath, over freely rotatable rollers and thence to a pair of conical rollers where it is passed around the said rollers a multiplicity of times in the form of finely spaced helices. These helices are caused to pass to the large end of the rollers by means of the convergence of the axes of the rollers whereby the desired amount of stretch may be imparted by means of a sidewise, step by step, or increment stretching.

As an alternative to giving the thread the re-

quired stretch by means of the conical rollers per se, the thread may be passed from the coagulating bath to one or more driven godets whereby it is initially stretched, whereafter a supplementary stretch may be imparted by means of the conical rollers. As shown in Figures 1, 2, 3 and 9, the lower conical roller is caused to be rotated in a treating bath and owing to the fact that this second bath is preferably maintained at a high temperature, for example, in the range of from 70° C. up to 90° C. or even 100° C., it would normally be impractical or impossible for an operator to initially wrap the thread around the lower roller, as this would necessitate physical contact with the hot bath. Accordingly, when the thread is initially passed around the two rollers, the lower roller is first raised out of the bath. Upon "spinning-in," the thread is prevented from passing more than half the length of the rollers until after the lower roller has been submerged and put into operative position in the bath. Until the thread is actually contacted with the bath, it is impossible to impart the maximum stretch as it would rupture or break.

After the thread passes a sufficient number of times around the rollers in order to impart the required stretching and substantially complete regeneration, it is led by means of freely rotatable rollers to a suitable collecting device such as a bobbin or centrifugal pot. The thread in this condition is properly after-treated. In the case of spinning thread to be used for reinforcement of cord tires or other rubber articles, it is usually only necessary to thoroughly wash the thread and dry the same. The second bath may be comprised of pure hot water or it may contain a very dilute hot solution of acid or equivalent salts wherein a major proportion of the sulphur is removed at the time the thread is completely regenerated. In some cases, it may be desirable to give the thread a treatment while on the conical rollers without immersing the same in a bath. In such instances, spray pipes may be utilized in the same manner as that shown in the continuous process.

The foregoing treatment in the noncontinuous type of spinning imparts to the thread a maximum stretch and complete regeneration, whereby the product obtained is not only uniform in characteristics, but has unusually high strength, low elongation, high flexing and other characteristics that render it particularly adaptable for use in reinforcing rubber articles.

Referring now to the continuous system for manufacturing thread of extremely uniform characteristics suitable for knitting and weaving purposes, the thread is led through a coagulating bath of generally the same composition as that used in the non-continuous system. It is then passed to a pair of conical rollers either directly or by means of freely rotatable rollers or by one or more driven godets, or the thread may even be led to godets, stretched and then passed immediately to a pair of cylindrical rollers acting as storage devices. In this case, it is also readily apparent that the desired stretching can be imparted either by means of the conical rollers or godets or combinations thereof. Although one or more of the treating baths may be heated, it is not essential, as in this type of spinning uniform characteristics are more important and certain uniformity of characteristics may be had by the continuous treatment on pairs of rollers or storage devices in their proper sequence with-

out the use of a hot bath. The fact that the liquids do not have to be heated makes it possible to utilize as an alternative, a series of sprays. These sprays cause the treating liquid to be impinged upon the rollers and the thread contacted therewith. Of course when sprays are used as a substitute for baths it is not necessary to provide means for rotatably displacing the lower roller during the "spinning-in" operation. The location and construction of the spray pipes may be modified to adapt them for the particular specific system used, for example, it may be desirable to locate the said pipes above the top roller or between them, or the spraying may be effected on both rollers. Moreover, a single spray jet for a roller may furnish sufficient liquid on the roller to adequately treat the thread passing transversely across the face of the rollers.

After the thread has been coagulated, stretched and treated it is then passed to a series of cylindrical roller assemblies, the number of which, depends on the number of operations necessary to completely process and finish the thread. In one system after the thread is suitably coagulated, it is washed either by bath or by spray while on a pair of rollers, desulphurized on an immediately succeeding pair of rollers and then successively again washed, bleached, purified, rewashed, dried and finally twisted while being collected in the form of a cop, cone, or the like.

Referring more particularly to Figure 7, the thread is propelled from the coagulating bath by means of the conical rollers on which it is stretched and treated with a dilute acid bath, after which it may be further stretched on godets and led to successive cylindrical rollers for the further processing operations. In this case, one or both of the conical rollers may be internally heated if it is desired to raise the temperature of the treating solution.

It is to be understood that a number of modifications may be made in both systems without departing from the spirit of the invention. In the figures, the lower roller has been shown as freely rotatable, or that is, driven by the thread per se. These lower rollers, if desired, may be driven either by means of a belt connected with their respective upper rollers, or by a separate driving mechanism. In the type of system where sprays are employed instead of baths, sprays on certain of the rollers may be entirely omitted whereby the purpose of that particular pair of rollers is to merely prolong the passage of the thread undergoing regeneration. It has been determined in some instances that the sprays may be omitted from the first pair of conical rollers on which the thread is stretched. In this case, the thread is merely further coagulated during the stretching operation. It is to be also understood that any parts of the system coming into contact with acids or alkali either directly or indirectly, are formed of non-corrosive materials.

While the apparatus employed in the system illustrated in the respective figures of the drawings may be operated in a number of different specific ways so as to materially change the character of the particular threads being produced, for the purpose of exemplification, several specific operations will now be set forth.

Example I

In one operation, the apparatus illustrated in Figure 1 was utilized, and the viscose solution which was extruded contained 7.5% cellulose and 6.7% NaOH. The solution was extruded at the

rate of 70 meters per minute into a spinning bath containing H_2SO_4 , Na_2SO_4 , MgSO_4 and ZnSO_4 . The spinneret utilized produced the 120 filament type thread and the thread was stretched approximately 7% as it was drawn to a conical roller whereupon it was subjected to a second liquid treatment, the said liquid containing about 1.0% H_2SO_4 carried over from the first bath and maintained at a temperature above 70°C . The conical roller was one of a pair over which the thread was conducted in a series of helices due to the axes of the rollers being converged so as to effect a multiplicity of stretching operations in the thread during its progression around the rollers. Due to the shape of the cone and the positioning of the axes thereof, the thread was progressively stretched approximately 65%. In the operation just described, the apparatus was "threaded-in" in the manner hereinbefore discussed. The thread was then conducted to a centrifugal pot collecting device and a cake about one inch in thickness was built up. Thereafter, the cake was subjected to washing, desulphurizing, etc. The thread after drying was tested and found to have 15% elongation and 370 grams tensile strength per denier.

Example II

In one operation conducted with the apparatus illustrated in Figure 2 whereby the yarn was produced, a spinning solution and spin bath of the same composition set forth above with respect to Example I was employed, and the thread was drawn off by a driven godet at a speed of approximately 40 meters per minute, whereupon the thread was stretched to 15% between the driven godet and a conical roller of a pair, the smaller end of which roller was operated at a greater peripheral speed than that of the driven godet. Upon the immersion of the thread in a second bath that was of the same composition as that set forth with respect to Example I, the thread was propelled over the conical rollers in the manner heretofore stated and it was here given an additional stretch which resulted in the thread having a total stretch of 70%. The thread was thereafter subjected to washing, desulphurizing, bleaching and drying in the manner stated with respect to Example I and the thread tested had essentially the same characteristics as in Example I.

Example III

Thread was produced in accordance with either Example I or II, utilizing a similar spinning solution and spin bath. It was stretched approximately 70% on conical rollers and thereafter passed successively around a series of thread-storage, thread-advancing devices while being given the necessary after-treatments. The thread was finally dried, twisted and collected in package form. After testing, the thread was found to have extremely uniform characteristics.

What is claimed is:

1. A process of producing rayon yarn and the like, comprising extruding a viscose spinning solution as a multiplicity of filaments into a coagulating bath to precipitate and partially regenerate the same, withdrawing the filaments from the bath by means of a driven godet, then conducting the same alternately over a driven roller and a freely rotating roller which form a thread-storage thread-advancing device, and contacting the filaments with a regenerating treating liquid in a bath other than the coagulating bath as they travel over one of the rollers, said

filament path being in the form of a series of helices, and so extended that the filaments are substantially completely regenerated when they have advanced to the end of the thread-storage thread-advancing device, imparting a stretch to the filaments between the godet and the thread-storage, thread-advancing device and effecting an additional stretch during further regeneration thereof.

2. A process of producing artificial yarn involving the use of a spinneret, a spin bath, a second bath and a pair of rollers forming a yarn-storage yarn-advancing device of which one roller while being normally adapted for rotation in the second bath, is adjustable to a position for rotation above the bath, comprising the steps of removing the adjustable roller from the bath and directing filaments as they are extruded from the spinneret and then withdrawn from the spin bath alternately around the rotating rollers a plurality of times in the form of a series of helices, immersing the adjustable roller in said second bath, and then continuing the propulsion of the filaments along the pair of rollers, and maintaining the said second bath at a temperature of at least 60° C.

3. A process of producing artificial yarn involving the use of a spinneret, a spin bath, a second bath and a pair of cone rollers forming a yarn-storage, yarn-advancing, yarn-stretching device of which one roller while being normally adapted for rotation in the second bath is adjustable to a position for rotation above the bath, comprising the steps of removing the adjustable roller from the bath and directing filaments as they are extruded from the spinneret and then withdrawn from the spin bath alternately around only the smaller portions of the rotating rollers a plurality of times in the form of a series of helices, immersing the adjustable roller in said second bath, and then continuing the propulsion of the filaments over the pair of rollers while effecting the spacing of the helices along substantially their entirety and maintaining the said second bath at a temperature of at least 60° C., whereby the yarn is subjected to the maximum stretch which is imparted by the cone rollers only after it is contacted with the second bath.

4. In an apparatus for producing artificial yarn which includes a spinneret, a trough for retaining a spin bath, a second trough for retaining a bath, a yarn-storage, yarn-advancing device for propelling yarn in the form of a series of helices while it is in contact with the bath in the second trough, said yarn-storage, yarn-advancing device comprising a pair of rollers over which the filaments are alternately directed, a driving shaft for one of the rollers, a shaft by which the other roller is rotatably mounted, one of said shafts being fixedly located above the bath contained in the second trough while the other shaft is carried by an arm which is pivotally mounted and adapted to have its end carrying the shaft moved through a path for effecting the positioning of the shaft and its roller within the bath during operation of the apparatus and above the bath while the yarn is being threaded thereupon, and means for adjusting the axis of one shaft with respect to the other shaft to thereby cause the yarn to be propelled along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance.

5. In an apparatus for producing artificial

yarn which includes a spinneret, a trough for retaining a spin bath, a second trough for retaining a bath, a yarn-storage, yarn-advancing device for propelling yarn in the form of a series of helices while it is in contact with the bath in the second trough, said yarn-storage, yarn-advancing device comprising a pair of rollers over which the yarn is alternately directed, a driving shaft for one of the rollers fixedly located above the bath contained in the second trough, a sleeve encircling said shaft and acting as a bearing for a rotatably mounted member having an arm radially extended therefrom, a shaft secured to the free end of said arm on which the other roller is rotatably mounted, said shaft carried by the arm due to the rotation of the member from which the arm extends causing the shaft to be moved through a path for the positioning of the shaft and its roller within the bath during operation of the apparatus and above the bath while the yarn is being threaded thereupon, and means for adjusting the axis of one shaft with respect to the other shaft to thereby cause the yarn to be propelled along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance.

6. In an apparatus for producing artificial yarn which includes a spinneret, a trough for retaining a spin bath, a second trough for retaining a bath, a yarn-storage, yarn-advancing device for propelling yarn in the form of a series of helices while it is in contact with the bath in the second trough, said yarn-storage, yarn-advancing device comprising a pair of rollers over which the yarn is alternately directed, a driving shaft for one of the rollers fixedly located above the bath contained in the second trough, a sleeve encircling said shaft and acting as a bearing for a rotatably mounted member having an arm radially extended therefrom, a shaft secured to the free end of said arm on which the other roller is rotatably mounted, said shaft carried by the arm due to the rotation of the member from which the arm extends causing the shaft to be moved through a path for the positioning of the shaft and its roller within the bath during operation of the apparatus and above the bath while the yarn is being threaded thereupon, latching means for securing the rotatable member with its extended arm in the positions of adjustment, and means for adjusting the axis of one shaft with respect to the other shaft to thereby cause the yarn to be propelled along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance.

7. In an apparatus for producing artificial yarn which includes a spinneret, a trough for retaining a spin bath, a second trough for retaining a bath, a yarn-storage, yarn-advancing device for propelling yarn in the form of a series of helices while it is in contact with the bath in the second trough, said yarn-storage, yarn-advancing device comprising a pair of rollers over which the yarn is alternately directed, a driving shaft for one of the rollers fixedly located above the bath contained in the second trough, a sleeve encircling said shaft and acting as a bearing for a rotatably mounted hub member which has an arm radially extended therefrom, a second arm extending from the hub member diametrically opposite to the first mentioned arm, a lever pivotally extending from said first arm, a shaft secured to the free end of the lever on which shaft the other roller

is rotatably mounted, the lever having an extension which overlies the second arm, said shaft carried by the arm due to the rotation of the member from which the arm extends causing the shaft to be moved through a path for the positioning of the shaft and its roller within the bath during operation of the apparatus and above the bath while the yarn is being threaded thereupon, latching means for securing the rotatable member with its extended arm in the positions of adjustment, and means connecting the overlying arm of the hub member and the lever for moving them relative to each other thereby to adjust the axis of one shaft with respect to the other shaft and cause the yarn to be propelled along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance.

8. In an apparatus for producing artificial yarn which includes a spinneret, a trough for retaining a spin bath, a second trough for retaining a bath, a yarn-storage, yarn-advancing, yarn-stretching device for propelling yarn in the form of a series of helices while it is in contact with the bath in the second trough, said yarn-storage, yarn-advancing, yarn-stretching device comprising a pair of cone rollers over which the yarn is alternately directed, a driving shaft for one of the rollers fixedly located above the bath contained in the second trough, a sleeve encircling said shaft and acting as a bearing for a rotatably mounted member having an arm radially extended therefrom, a shaft secured to the free end of said arm with which the other roller is bodily movable and on which it is rotatably mounted, said shaft carried by the arm due to the rotation of the member from which the arm extends causing the shaft to be moved through a path for the positioning of the shaft and its roller within the bath during operation of the apparatus and above the bath while the yarn is being threaded thereupon, a stop for engaging the yarn to prevent its passage entirely along the cone rollers only when the movable roller is positioned above the bath, and means for adjusting the axis of one shaft with respect to the other shaft to thereby cause the yarn to be propelled substantially entirely along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance when the bodily movable roller is positioned in the bath.

9. In an apparatus for producing artificial yarn which includes a spinneret, a trough for retaining a spin bath, a second trough for retaining a bath, a yarn-storage, yarn-advancing, yarn-stretching device for propelling yarn in the form

of a series of helices while it is in contact with the bath in the second trough, said yarn-storage, yarn-advancing, yarn-stretching device comprising a pair of rollers over which the yarn is alternately directed, a driving shaft for one of the rollers fixedly located above the bath contained in the second trough, a sleeve encircling said shaft and acting as a bearing for a rotatably mounted member having an arm radially extended therefrom, a shaft secured to the free end of said arm on which the other roller is bodily movable and on which it is rotatably mounted, said shaft carried by the arm due to the rotation of the member from which the arm extends causing the shaft to be moved through a path for the positioning of the shaft and its roller within the bath during operation of the apparatus and above the bath while the yarn is being threaded thereupon, a stop for engaging the yarn to prevent its passage entirely along the cone rollers only when the movable roller is positioned above the bath, latching means for securing the rotatable member with its extended arm in the position of adjustment, and means for adjusting the axis of one shaft with respect to the other shaft to thereby cause the yarn to be propelled substantially entirely along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance when the bodily movable roller is positioned in the bath.

10. In an apparatus for producing artificial yarn which includes a spinneret, a trough for retaining a spin bath, a trough for a second bath, a yarn-storage, yarn-advancing, yarn-stretching device for propelling the yarn after it is passed from the spin bath in the form of a series of helices, said device comprising a pair of cone rollers over which the yarn is alternately directed, one of which rollers is normally immersed in the second bath while the other rotates thereabove, a driving shaft for one of the cone rollers, a shaft by which the other cone roller is rotatably mounted, and means for adjusting the axis of one shaft with respect to the other shaft to thereby cause the yarn to be propelled along the rollers in a path formed of a series of helices in which the helices are spaced a predetermined distance, the said cone roller above the bath being provided with a splash plate at its inner end to substantially prevent the liquid from the bath from coming into contact with the remainder of the apparatus.

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