Dec. 19, 1939. C. A. HUTTINGER 2,184,144

PROCESS OF MANUFACTURING ARTIFICIAL SILK THREAD AND APPARATUS THEREFOR

Filed April 11, 1935 3 Sheets-Sheet 1

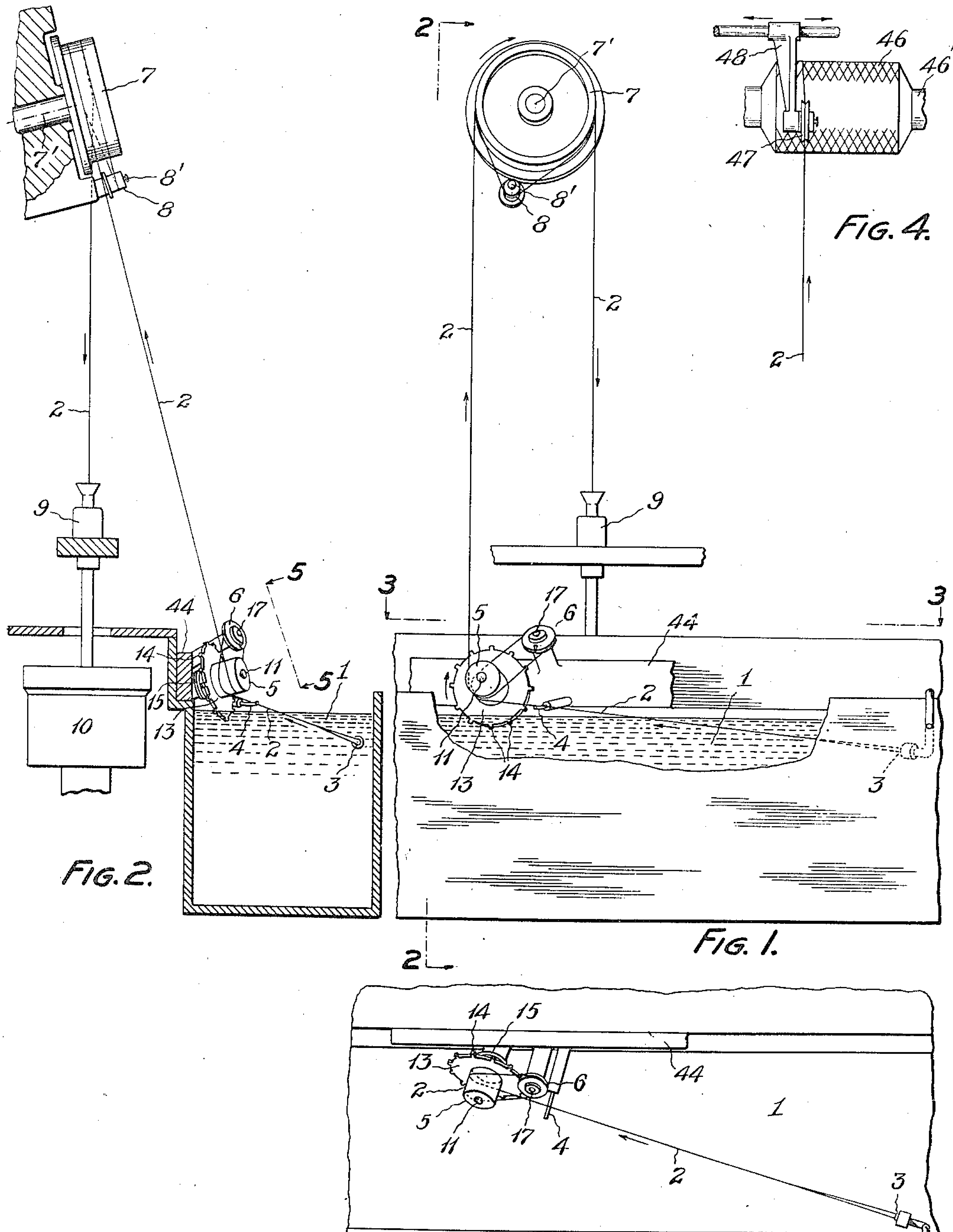

FIG. 1. FIG. 2. FIG. 3. FIG. 4.

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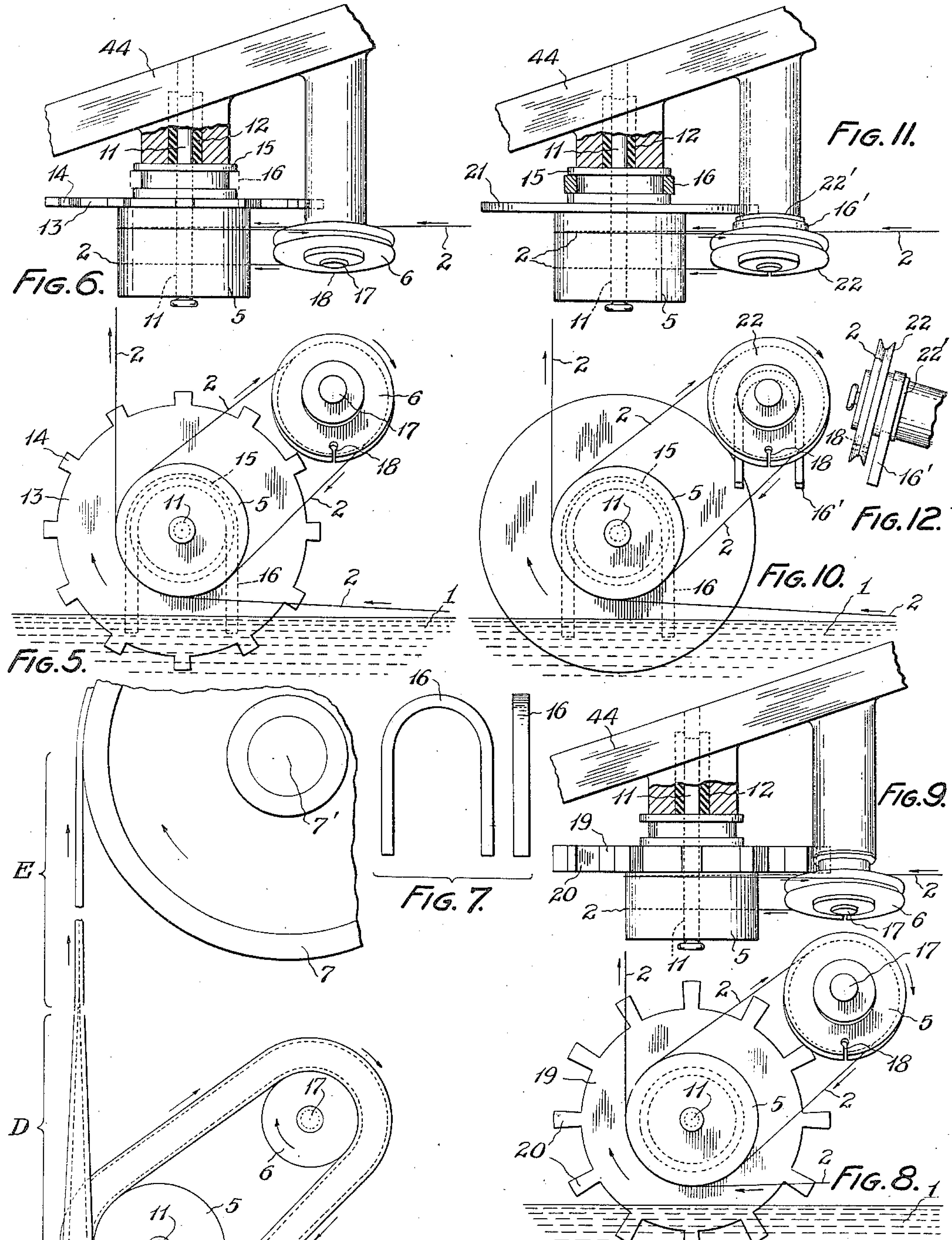
Filed April 11, 1935 3 Sheets-Sheet 2



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PROCESS OF MANUFACTURING ARTIFICIAL SILK THREAD AND APPARATUS THEREFOR

Filed April 11, 1935 3 Sheets-Sheet 3

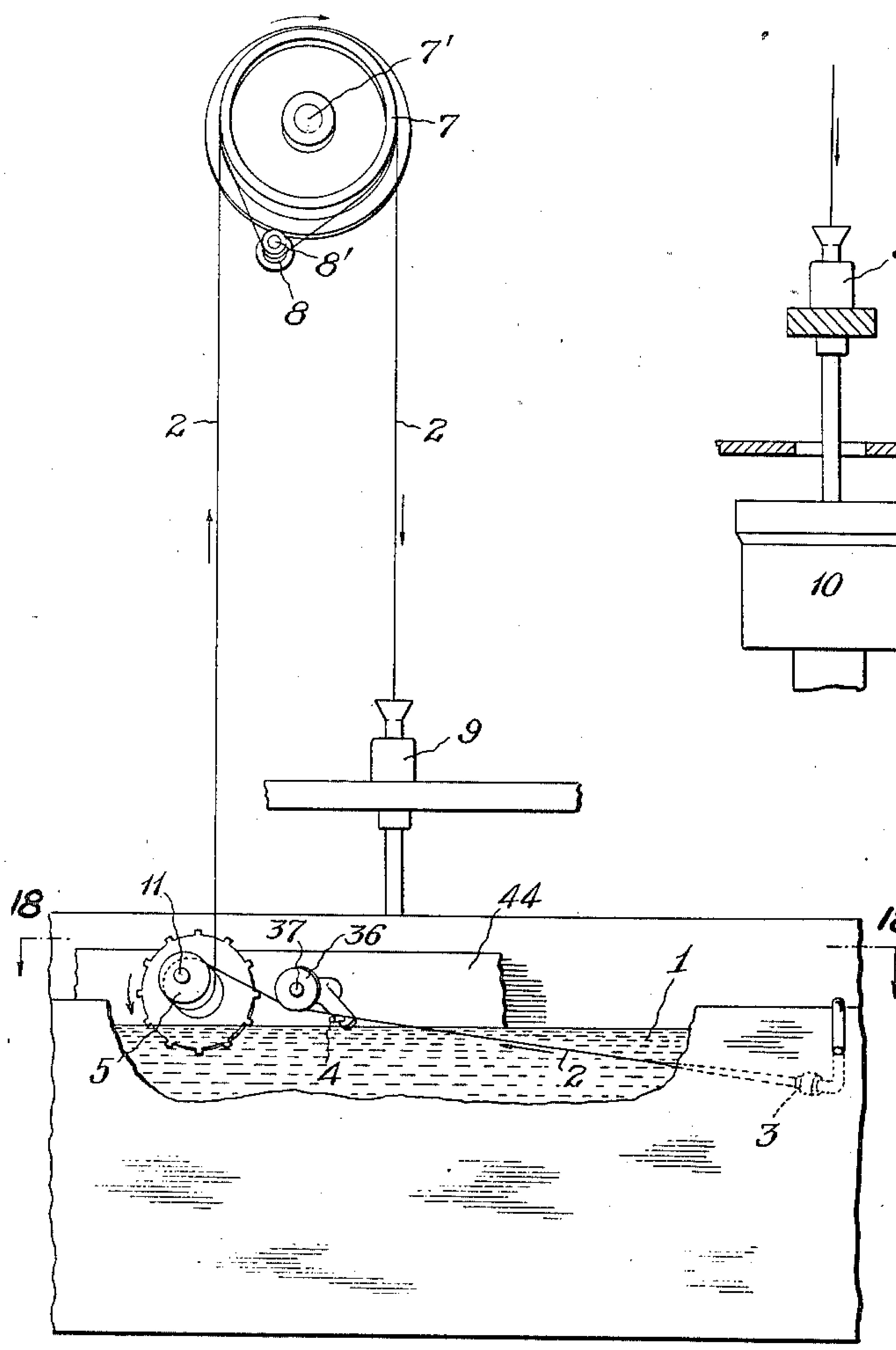

FIG. 13.

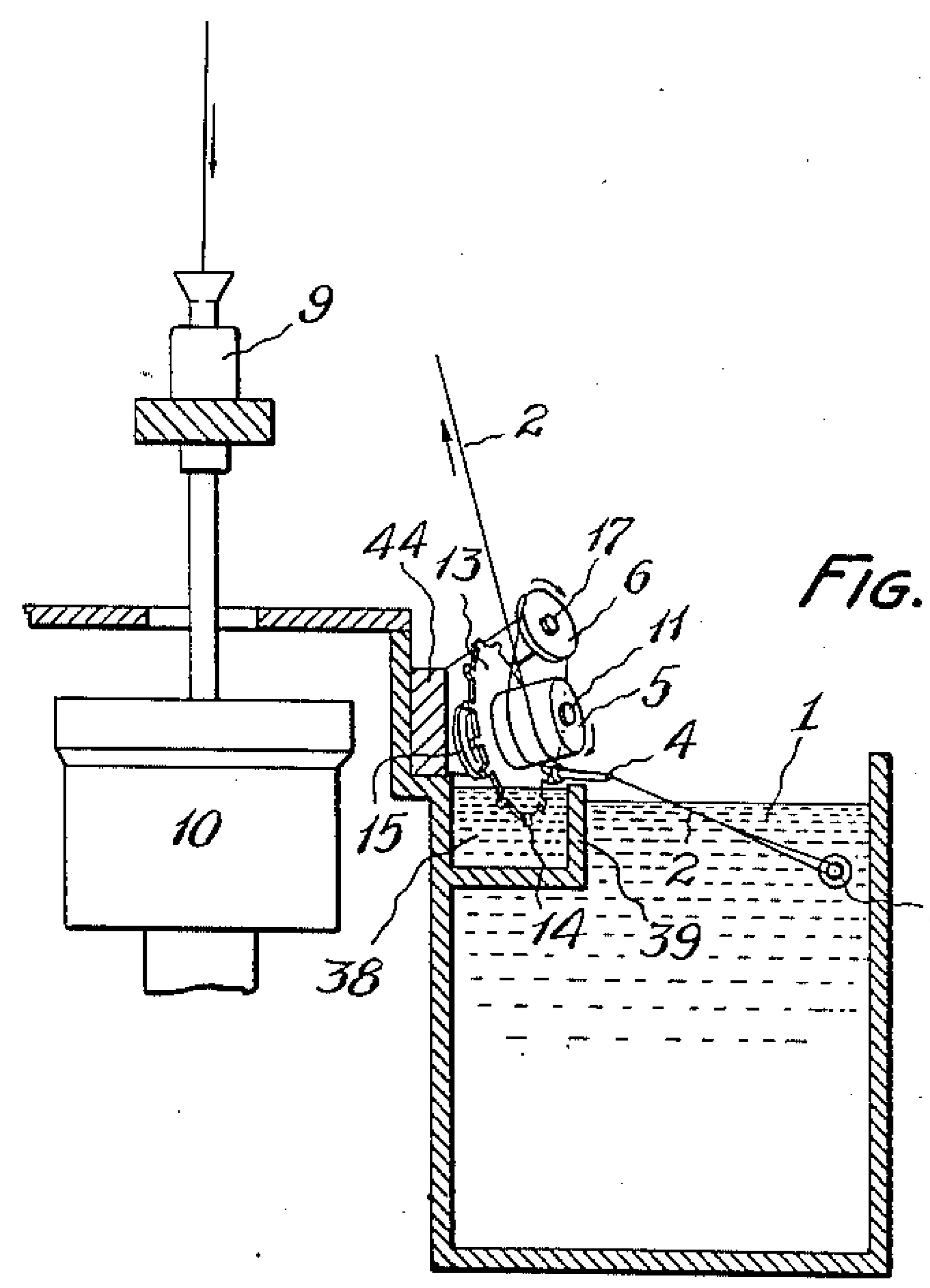

FIG. 15.

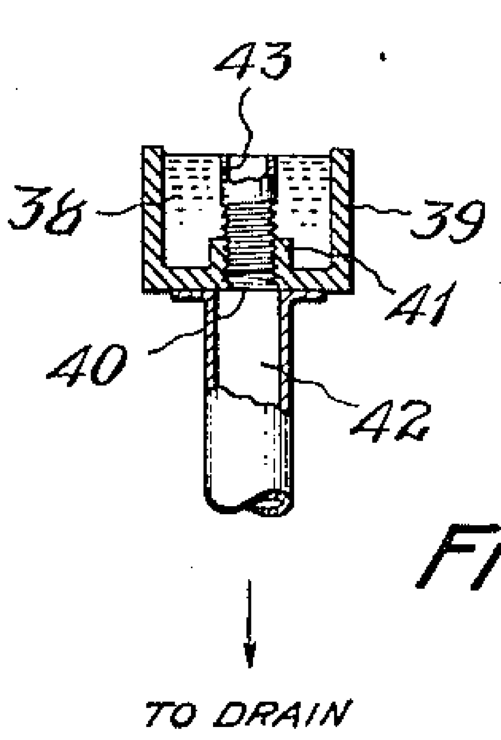

FIG. 16.

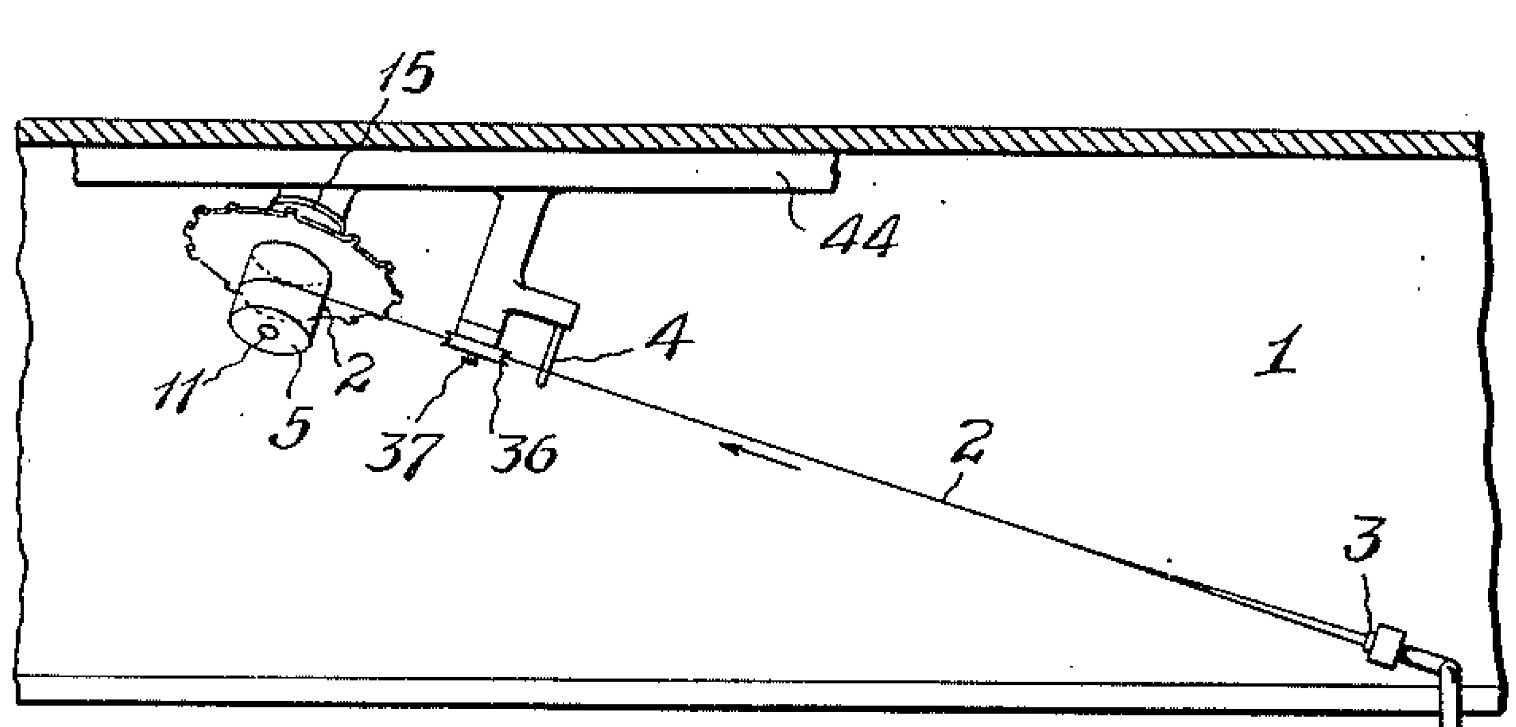

FIG. 14.

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UNITED STATES PATENT OFFICE

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PROCESS OF MANUFACTURING ARTIFICIAL SILK THREAD AND APPARATUS THEREFOR

Charles A. Huttinger, Lakewood, Ohio, assignor to Acme Rayon Corporation, Cleveland, Ohio, a corporation of Ohio

Application April 11, 1935, Serial No. 15,840

4 Claims. (Cl. 18—8)

My invention particularly relates to improvements in processes of manufacturing artificial silk threads whereby the spun product has greater tensile strength and is more uniform than threads obtained by manufacturing processes heretofore used and with which I am acquainted. I secure these advantages by stretching the newly formed threads, to impart uniform properties thereto, in a manner and by mechanism hereinafter fully described. My improved process increases the tensile strength of the spun product without decreasing or, at least, without correspondingly decreasing, the elongation thereof. In other words, whereas heretofore the product of the tensile strength and the elongation has been considered to be necessarily substantially a constant, my improved process increases the value of this constant for a given type of thread. As a result of the improvements in the spun product obtained by my process, this product can be more efficiently processed in preparation for its final use, and in particular can be more uniformly dyed. My invention also includes improved apparatus for the manufacture of artificial silk threads having the desirable characteristics mentioned.

The annexed drawings and the following description set forth in detail certain means and certain process steps embodying my invention and illustrating how the same may be worked, such means and steps, however, constituting, respectively, but a few of the various forms in which the principle of the improved apparatus may be embodied and only a few of the various series of steps by which the improved process may be worked.

In said annexed drawings:

Figure 1 is a front elevation of a thread-stretching device for increasing the tensile strength of freshly precipitated artificial silk threads, this device forming part of my invention and being shown in association with a setting bath and devices for centrifugally spinning the precipitated and stretched thread into cakes;

Figure 2 is a partial side elevation and partial vertical transverse section of the apparatus shown in Figure 1, taken from the plane indicated by the line 2—2, Figure 1;

Figure 3 is a plan view, taken from the plane indicated by the line 3—3, Figure 1;

Figure 4 is a fragmentary elevation showing the substitution of a bobbin winder for gathering the thread into packages, in lieu of the centrifugal cake-gathering device shown in Figure 2, the bobbin winder being designed for association with the improved form of thread-stretching device shown in Figures 1, 2, and 3;

Figure 5 is an elevation, upon an enlarged scale, of a lower pulley set, forming part of the thread-stretching device shown in Figures 1, 2, and 3, the view being taken from the plane indicated by the line 5—5, Figure 2;

Figure 6 is a plan view of the elements shown in Figure 5, partially in horizontal section;

Figure 6*a* is a broken fragmentary diagrammatic view of the thread-stretching device shown in Figures 1, 2, and 3, one newly formed filament of the multiple filaments which form the thread being shown as moving from the spinning jet to the upper drawing mechanism, the forces playing upon the filament, and the reactions of the filament, at different stages of the stretching operation, being indicated in this figure;

Figure 7 includes two views of a form of weight applicable to grooved pulleys to increase the rotation-resistance of the pulleys, thus to increase the drag upon the thread-movement during the stretching operation, as hereinafter fully explained;

Figure 8 is a view similar to Figure 5 but showing a paddle-disk, forming part of the lower pulley set of the stretching device, of a design different than that shown in Figure 5;

Figure 9 is a plan view of the elements shown in Figure 8, partially in horizontal section;

Figure 10 is a view similar to Figure 5 but showing a smooth-edged rotation-resistance disk, and also showing weight grooves formed on both elements of the lower pulley set;

Figure 11 is a plan view of the elements shown in Figure 10, partially in horizontal section;

Figure 12 is a side elevation of the small pulley of the pulley set, shown in Figures 10 and 11;

Figure 13 is a front elevation, similar to Figure 1, but showing a form of my improved thread-stretching device in which the thread drawn from the setting bath makes only a single lap on the tensioning pulley of a lower pulley set;

Figure 14 is a plan section, taken in the plane indicated by the line 14—14, Figure 13;

Figure 15 is a broken vertical transverse section, similar to Figure 2, but showing the paddle-wheel which is secured to one of the pulleys of the lower pulley set dipping into liquid in a trough separate from the chamber containing the setting bath; and

Figure 16 is a fragmentary section of means for adjusting the level of the liquid in the separate trough shown in Figure 15.

Referring to the annexed drawings in which the same parts are indicated by the same respective numbers in the several views, and referring first particularly to Figures 1-9, inclusive, the multiple filaments of an artificial silk thread 2 are set up in a precipitating bath 1 from a cellulosic solution discharged from the jets 3 of a spinneret, multiple filaments being drawn as a thread from the bath 1 by an upper driven motor 7, the glass pin 4 disposed above the bath and adjacent the area where the thread 2 emerges from the bath 1 serving to drain the thread so drawn. The plastic thread only grazes the pin 4 to enable the latter to drain the surplus liquid clinging to the thread, so that the drainage pin 4 exerts no appreciable drag upon or resistance to the travel of the thread. The rotor 7 is positively driven at a constant peripheral speed which is greater than the rate of linear production of the thread from the spinneret so that the newly formed threads are placed under tension between the bath 1 and the driven rotor 7, resulting in a stretching of the plastic thread. This stretching effects an increase in the tensile strength of the thread, as is well known to those skilled in the art. The positively driven rotor 7 travels at a uniform peripheral speed and, inasmuch as there is no slippage between the thread and the rotor 7, for reasons hereinafter given, the stretched thread is fed from the rotor 7 to the package-making or gathering device at a constant linear rate. Substantially the entire stretching of the thread is effected in the traveling area D, Figure 6*a*, so that the stretched thread remains of substantially constant diameter in the traveling area E, and the newly formed unstretched thread remains of substantially constant diameter in the traveling area between the setting bath 1 and the near end of the traveling area D, as will be hereinafter fully explained, as also conditions under which these results are somewhat varied. There are some variations in the diameter of the thread in the area between the setting bath 1 and the main stretching area D which are due to shrinkage of the newly-formed thread and to progressive setting-up of the cellulosic solution or the increasing thickness of the skin or shell formed on the filaments.

I do not lead the thread 2 to the upper drawing device 7 perfectly vertically but at an angle, such as illustrated in Figure 2, the drawing device 7 being arranged with its axis 7′ at substantially right angles to the path of travel of the thread thereto, whereby the thread may be caused to lap the periphery of the drawing device 7 a plurality of times, without trackage interference, and also without undue friction, when assisted by an adjacent small freely rotatable roller 8 arranged as hereinafter fully described. This multiple lapping of the thread about the rotor 7 provides for a drawing of the thread by the rotor and a discharge of the thread from the rotor without any material slippage between the thread and the rotor.

From the rotor 7 the thread passes to the collection or package-forming device. In the form of apparatus shown in Figures 1 and 2, it passes substantially vertically downwardly through the reciprocating funnel guide 9 and into the box 10 where the filaments thereof are collected in thread packages of cake design by centrifugal spinning. The thread, stretched by my improved process and apparatus, might be spun into other well-known forms of packages, such as bobbin packages.

A spinning system, such as described, is subject to many variations and fluctuations. For instance, the setting bath may vary and/or fluctuate, the viscosity of the cellulosic solution or its composition or its index may vary, or, for other reasons, the homogeneity of the cellulosic solution may not be maintained. Mechanical conditions may vary, such as variations developed by eccentricities in the upper drawing rotor or godet. These variations and fluctuations vary the newly formed and plastic thread to the extent of creating a variation in the resistance thereof to stretching whose amount cannot be accurately and definitely forecast. In other words, the extensibility factor of the thread will vary from that factor which has been set up as suitable for producing the desired stretching of the thread by the pull exerted by the constant-speed driven rotor 7. If this extensibility factor varies, the uniform thread feed will result in a non-uniform stretching, unless some compensation is made whereby comparatively weak thread having a comparatively high extensibility factor is subjected to a proportionately light stretching action, and comparatively strong thread having a comparatively low extensibility factor is subjected to a proportionately heavy stretching action. Without such compensation, a thread which is not of constant diameter will be produced which will not dye uniformly.

Each filament of the thread 2 has an outer shell which has been formed in the setting bath and which is subject to the stretching action. Therefore, the filament is case-hardened by the stretching action. Different amounts of stretching or case-hardening produce varied glosses in the filament shells and the variations in glosses effect non-uniform results when the thread is dyed.

In order to standardize the stretching action to which all portions of the thread 2 are subjected between the bath 1 and the driven rotor 7, and thus result in the production of a uniform thread, having the improved characteristics herein mentioned despite the variations and fluctuations in the spinning system, I subject the thread to those steps of my improved process now to be described and by the use of improved illustrative apparatus shown in the accompanying drawings. After passing the drainage pin 4 the thread 2 engages the periphery of a smooth-surfaced pulley 5 rotatably mounted upon a glass spindle 11, Figure 6, which spindle is mounted in a rubber socket 12 supported by a bracket 44 mounted upon the vat containing the setting bath 1. The thread 2 first engages the lower part of the pulley 5 and laps this pulley, for substantially 180°, more or less, according to the relative sizes and positions of the elements of a lower pulley set of which the pulley 5 is one element. Then the thread 2 passes to the upper part of a pulley 6 which has a peripheral thread groove of smaller diameter than the periphery of the pulley 5, in the form of apparatus shown, which groove is engaged by the thread. The thread laps the groove of the pulley 6 for substantially 180°, more or less, and thence again passes to the lower part of the pulley 5 which it engages for substantially 180°, more or less, and thence passes to the upper driven rotor 7. The grooved pulley 6 is rotatably mounted upon a glass spindle 17 supported by the bracket 44. The rotation of both the pulleys 5 and 6 is effected by engagement of the thread 2 therewith.

The axis of the pulley 6 is set at an angle to the axis of the pulley 5 so that the trackage of the two engagements of the thread with the pulley 5 do not interfere. The small grooved pulley 6 has its edge formed with a transverse slot 18, Figure 5, intersecting the thread groove of said pulley 6 and utilized for cutting tangled and broken filaments of the thread under circumstances hereinafter fully described.

Although the pulleys 5 and 6 freely rotate upon their respective spindles, except for bearing frictional resistance, the thread 2 does not turn these pulleys freely, since the pulleys, or at least the pulley 5, is subject to a certain external resistance to rotation through the use of different forms of rotation-retarding devices which I shall now describe.

Referring first to Figures 5, 6, and 7, it will be noted that a paddle-wheel 13 formed with peripheral teeth 14 is rotatably mounted upon the spindle 11 and dips into the setting bath 1, this paddle-wheel 13 being secured to the pulley 5. Before the thread 2 can turn the the pulley 5, the drag of the paddle-wheel 13 in the bath 1 must be overcome. Furthermore, there is secured to the paddle-wheel 13 a small grooved pulley 15, also rotatably mounted upon the spindle 11, and within the groove of which may be supported a weight 16, Figure 7, which imposes a further drag upon the rotation of the pulley 5. The pulley 6 which may or may not be weighted with external rotational resistance (both forms being shown and described) serves as means for transferring the thread 2 back to the pulley 5 for its second engagement therewith while preserving the balance that is desired to effect the desired uniform stretching action that is effected in the area D, Figure 6*a*, after the second engagement of the thread 2 with the pulley 5, as herein fully explained. The rotation of the pulley 5 which is effected by the thread 2 is a composite of the rotational effects produced by the two linearly-spaced engagements of the thread 2 with the pulley 5. The action of the thread portion between the two spaced portions thereof engaging the pulley 5 compensates by forces and in a manner herein fully described for the variations induced by the fluctuations of the system in the stretch-resistance of the thread 2.

The effect upon the newly formed plastic thread of the drag imposed by the lower pulley set just described is not only to stretch the thread in the area D, Figure 6*a*, but to effect a stretching pull thereon inversely proportionate to the extensibility factor of the thread. The reason for this result is that, if the variations or fluctuations of the spinning system are such as to increase the extensibility factor of the thread, the resultant easier stretchability of the thread will decrease the pull thereof on the pulley 5, induced by the upper driven constant speed rotor 7, thus resulting in rotating the pulley 5 more slowly, or tending to effect such result. The thread thus travels more slowly, so that the greater stretchability factor of the more slowly moving thread leaving the pulley 5 results in the same stretched-thread speed in the area E, Figure 6*a*, as a stretched thread with the computed desired stretchability factor moving at a greater speed before stretching would have. However, the more slowly rotating pulley 5 receives less external rotational resistance from the paddle-wheel 13 so that, inasmuch as the positively-driven rotor 7 exerts whatever pull is demanded, the pull to stretch the thread is proportionately lighter and the net result is to stretch the comparatively weak thread in the area D by a comparatively weak pull to the same extent that a stronger thread would be stretched by a stronger pull. The necessary adjustment for the weaker thread is made almost instantly, and that portion of the thread between the two portions thereof engaging the pulley 5 serves to effect the result. It will be recognized by those skilled in the art that the thread travel is very rapid, approximately 200 feet per minute being one standard rate of linear thread set-up at the jet 3, so that a thread portion equal to the linear distance between the two engagements by the thread with the pulley 5 travels very quickly through the lower pulley set consisting of the pulleys 5 and 6. It should be noted that the pulley 5 is rotated at a speed which is a composite of two varying thread-rotational impulses at the time of a change in stretch-resistance of the thread, one of which is given by the thread portion coming direct from the setting bath 1 and the other of which is given by the thread portion passing into the stretching area D, these two thread portions having different stretch-resistances. However, inasmuch as both thread portions are engaging the same surface of the pulley 5, the rotational resistance imposed on the pulley 5 by the amount of pull exerted by the thread entering the area D is immediately communicated in effect to the thread portion coming direct from the bath 1, so that the two varying thread-rotation impulses immediately become equalized. As a matter of fact, inasmuch as the thread originates in the bath 1, any changes in the stretch-resistance will be first applied by the portion thereof which first engages the pulley 5 and the necessary pull-adjustment will have been made by the time said portion leaves the pulley 5 after its second engagement therewith, so that the thread will be stretched the desired standard computed amount in the area D. In any event, the portion of thread between the starting point of the first-engaged line of contact on the pulley 5 and the leaving point of the second-engaged line of contact on the pulley 5 absorbs substantially all of whatever adjustment is required to maintain equilibrium of stretch in the area D and constant speed of stretched thread in the area E, although the stretch-resistance of the continuous run of thread as it emerges from the setting bath 1 may change fortuitously. The speeds of the pulleys 5 and 6 are automatically adjusted to the various drawing pulls that are necessary to uniformly stretch threads which vary amongst themselves in extensibility factors.

Figure 6*a* also shows diagrammatically the shell or skin of set-up cellulose which is formed around each filament immediately the cellulosic solution strikes the setting bath 1. Within this shell is solution which has not been acted upon by the bath. More of the solution is constantly acted upon so that the shell becomes thicker as the filament moves but all of the solution is not acted upon, so that the entire cross-section of the filament is coherent, until the filament has traveled a considerable distance, as far as the upper driven rotor 7, for instance. It is this shell which is subjected to the stretching action and the progressive increase in the thickness of this shell correspondingly increases the strength or stretch-resistance of the filament. Therefore, the area D, Figure 6*a*, is a very suitable one within which to effect the stretching action. Also, the diameter of the filament gradually decreases after it leaves the setting bath but this decrease is very slow until the filament nears the stretching area D.

Conversely, if the extensibility factor of the thread 2 decreases, and thus becomes smaller than has been calculated as the normal extensibility, then the thread leaving the roller 5 will rotate the latter at a speed greater than the normal calculated speed, thus increasing the rotational resistance imposed by the paddle-wheel 13, so that the thread of less extensibility but with a tendency to greater speed will be stretched the desired amount in the area D and pass through the area E at the desired uniform speed of the driven rotor 7. The drag upon the pulleys 5 and 6, induced by the paddle-wheel 13 and the weight 16, and the bearing frictional resistance, is not sufficient to cause the thread 2 to slip materially upon the pulleys 5 and 6, when the stretch-resistance of the thread is the computed base amount, so that these pulleys are normally turned by the thread at peripheral speeds substantially equal to the respective speeds of the thread portions in engagement therewith. The thread-dragging means comprised of the pulleys 5 and 6 and their associated elements is a perfectly balanced device in which all parts of the thread-engaging portions travel at the same linear speed. There is no deleterious wear on, nor any cutting of the pulleys which would produce uneven surfaces having different speeds.

Particular attention is directed to the fact that I obtain the benefits of a rotation-resistance drag imposed in part by the liquid of the setting bath 1 without the path of movement of the thread in the area of the lower pulley set, or thereafter in any area, passing through or entering the bath 1. This is a very important operating advantage inasmuch as thereby there is obviated any threading-up of the device in or through the bath, when initially threading-up the spinning apparatus, preliminary to the operation thereof.

I provide a small freely rotatable roller 8 adjacently below the upper driven rotor 7, mounted on a spindle 8′ which is non-parallel with the axis of the rotor 7, the stretched thread 2 lapping this roller 8 and rotating it after the thread coming from the pulley 5 has substantially completely lapped the rotor 7. From the roller 8 the thread again substantially completely laps the driven rotor 7 whence it passes downwardly to the spinning box 10. By the use of the rotor 7 angularly located relatively to the pulley 5, and by the use of the freely rotatable roller 8, arranged with its axis non-parallel with the axis of the rotor 7, the multiple lapping of the thread around the rotor 7 is obtained without trackage interference, and also without undue friction upon the thread or the trackage roller 8.

In Figure 4, I show the thread 2, after being stretched by my improved device, being gathered into a bobbin package 46 on a rotating bobbin 46′, the thread being guided by a grooved freely rotatable roller 47 and wound in the usual manner by a member 48 reciprocated longitudinally of the bobbin 46′. This view is for the purpose of illustrating the gathering of the thread package in bobbin form, after the thread has been subjected to the uniform stretching action illustrated in Figures 1, 2, and 3, which figures illustrate centrifugal spinning.

In Figures 8 and 9, I show a paddle-wheel 19 with teeth 20, the wheel 19 being considerably thicker than the paddle-wheel 13 of Figures 5 and 6, and the teeth 20 longer than the teeth 14 of the paddle-wheel 13. This construction of Figures 8 and 9 produces greater rotational resistance than the device shown in Figures 5 and 6, but with the same depth of paddle-wheel dip into the bath 1.

Referring particularly to Figures 10, 11 and 12, I disclose a plain disk 21 secured to a pulley 5 and dipping into the setting bath 1, the resistance to the rotation of which disk arises from the friction created by the moving of the face of the disk through the bath 1, and from the weight 16, if a weight is used. This form of lower pulley set construction also has a second pulley 22 provided with a thread groove. Secured to the pulley 22 is a smaller grooved pulley 22′ adapted to accommodate a weight 16′, if desired, for the purpose of providing rotational resistance for the pulley 22. In this form of device, as is also true of the form of device shown in Figures 5 and 6, the resistance to the rotation of the pulleys 5 and 22 is not so great as to cause any material slippage of the thread upon the pulleys, when the stretch-resistance of the thread is the computed base amount, so that the pulleys 5 and 22 are normally rotated by the thread at peripheral speeds substantially equal to those of the respective portions of the thread engaged therewith.

Referring particularly to Figures 13 and 14, I show a form of apparatus, similar to that shown in Figure 1, but in which the small grooved pulley 6 of Figure 1 is dispensed with and a small grooved roller 36 freely rotatably mounted on a glass spindle 37 substituted, the roller 36 being located intermediate the drain pin 4 and the pulley 5 so that the thread 2 engages the roller 36 before it laps the pulley 5. In this form of stretching device the thread 2 first grazes the drain pin 4, then passes under the roller 36, lapping the latter for only a comparatively short distance, and then passes over the top of pulley 5, which pulley it substantially completely laps and thence is drawn upwardly over the upper pulley combination. Proper trackage of the thread onto, and off from, the pulley 5 is provided by properly locating and orienting the axes of the pulley 5, the rotor 7, and the roller 36.

Referring particularly to Figure 15, I show a form of stretching device similar to that disclosed in Figure 2 with the exception that a separate bath 38 is provided for accommodating the paddle-wheel 13 by which the rotation of the pulley 5 is retarded. Thus, the paddle-wheel 13 does not dip into the setting bath 1, and any untoward results arising from disturbances created in the setting bath by the rotation of the paddle-wheel are obviated. Furthermore, the extent of dip of the paddle-wheel 13 into the liquid of the separate bath 38 can be conveniently controlled by regulating the depth of the liquid therein.

Referring particularly to Figure 16, I show means for conveniently adjusting the level of the paddle-retarding liquid 38 in the separate trough 39, these means comprising a tapped upstanding annular boss 41 in the bottom of the trough 39 bordering a bottom hole 40 formed in the trough 39, whereby liquid can be permitted to escape from the trough 39 over the top of an externally threaded vertically adjustable tubular member 43 which engages the tapped boss 41, and flow through the member 43 and run off through a discharge outlet 42, the height of the top of the vertically adjustable member 43 determining the level of the liquid in the trough 39.

I direct particular attention to the ease and certainty with which the different forms of apparatus shown and described can be "threaded-up" with the thread 2 at the start of a spinning operation, since none of the parts over which the thread passes after it leaves the setting bath 1 is submerged in the bath 1, although the bath exerts a drag which assists in the stretching operation, by reason of the paddle-wheel arrangement.

I also direct attention to the fact that my improved stretching device has no gears or other equivalent parts which would deteriorate in use. Also, the thread 2 which induces the rotation of the retarded pulleys does not normally slip upon the several pulleys and rollers which it engages, and neither does the thread so tightly engage the pulleys and rollers as to cut into their peripheries. Neither are there developed any eccentricities in the thread-engaging portion of the upper rotor 7 which would cause variations in the desired uniform stretching of the thread.

Any turbulence or surge induced in the setting bath 1 by the plain or toothed paddle-wheels becomes uniform and does not vary the stretching action upon different parts of the thread 2.

Relatively different sizes of the pulleys 5 and 6 of the lower pulley set may be used, differently relatively arranged, to effect different desired normal stretching actions and different compensating effects for changes in the stretch-resistance of the thread. I have shown one suitable combination consisting of the pulley 5 with the pulley 6 having a thread-engaging groove of a diameter smaller than the diameter of the thread-engaging surface of the pulley 5.

The small pulley 6 of my lower pulley set is very effective for indicating the existence of any broken thread filaments. This pulley 6, as set in the lower pulley set, picks up any filaments which have been previously broken and retains them so that they repeatedly wrap around the pulley, thus breaking down the following filaments and causing the whole mass to roll up around the pulley 6 and not to be fed to the second lapping of the pulley 5. Thus the broken condition of the filaments is readily indicated, and the deteriorated mass can be removed by cutting the same with a knife inserted in the slot 18, and a fresh unimpaired feed threaded-up for subsequent operation. Certain factors influence the rolling up of the broken filaments upon the pulley 6, such as the fact that a broken filament has no material tension, inasmuch as it is disconnected from the antecedent filament portion being drawn by the rotor 7, so that the broken filament readily adheres to the pulley 6. Furthermore, the broken filaments do not have a sufficient time element to follow the antecedent filament portions and so tend to be wrapped upon the roller 6. Also, the antecedent filament portions, having lost some of their strength by reason of the broken filaments, soon break under the strain induced by the pull of the rotor 7.

My improved process and apparatus increase the tensile strength of the resultant thread to a maximum amount, based on the degree of stretching which is effected, because the stretching is effected in the most favorable part of the path of thread movement for this operation. Furthermore, there is preserved the elongation factor in that portion of the thread which is in the precipitating bath. Thus I am enabled to increase the approximate constant which has heretofore attached to the product of the tensile strength multiplied by the elongation, this increase in the constant amounting to as much as twenty (20) per cent. I preserve the elongation factor by my improved process and apparatus by not unduly straining the filaments of the thread when they are in the precipitating bath, which straining imposed by the stretching operation results in non-uniform skin conditions and thread weakness and lowers the elongation factor. I stretch the thread in an area of the thread movement which is controlled, due to the mechanical set-up, and where the thread is not still so green as to be unsuitable material for an efficient stretching operation, nor set to such an extent as to render it unsuitable for efficient stretching. Also, I obviate the undesirable flame or bloom effect in finished yarns since by my improved process and apparatus green thread is not being operated upon by the time the thread reaches the surfaces of the drawing mechanism.

It will be noted that by my improved process and in my improved stretching device, with the exception of the forms of device shown in Figures 13 and 14, the thread 2 is loaded with the function of driving a dragging rotatable member at least three different times during the travel of the thread from the bath 1 to the drawing mechanism 7, and that the loading upon the thread for the first and last of these driving functions is the same. In other words, the first loading upon the thread is the drag occasioned by the first lapping of the pulley 5, and the last loading upon the thread is occasioned by the second lapping of the thread around the same pulley 5; wherefore, the drag upon the thread is the same composite amount for both the first and last driving functions of the thread. Also, the arrangement of the apparatus is such, and the drag upon the thread so gauged, that no portions of the thread engaging the respective surfaces slip materially relatively to these surfaces, when the stretch-resistance of the thread is the computed base amount, but normally drive the retarding members at substantially the same peripheral speeds at which the respective thread portions engaged therewith move.

What I claim is:

1. In the manufacture of artificial silk threads, an improved structure for imparting uniform properties to the thread during the stretching thereof consisting of a support, a pair of spaced idlers mounted on the support for cooperative action and whose axes are non-parallel, one of the idlers having a smooth thread-engaging surface, and a paddle-wheel secured to said idler and having blades extended outwardly beyond the thread-engaging surface, the other idler being formed with a thread-engaging groove.

2. In the manufacture of artificial silk threads, an improved structure for imparting uniform properties to the thread during the stretching thereof consisting of a support, a pair of spaced idlers mounted on the support for cooperative action and whose axes are non-parallel, one of the idlers having a smooth thread-engaging surface, and a paddle-wheel secured to said idler and having blades extended outwardly beyond the thread-engaging surface, the other idler being formed with a thread-engaging groove, the diameter of said groove being smaller than that of said smooth thread-engaging surface.

3. In the manufacture of artificial thread from cellulosic solutions, the improved process of stretching the thread consisting in drawing the set thread at a constant speed greater than the speed of extrusion from the spinning nozzle into

the setting bath, and causing the thread to traverse a three-part path of movement, between the bath and the drawing mechanism, of which path of movement the intermediate part is a closed circuit in which there is imposed on the thread a series of successive frictional driving functions applied to equal-diameter surfaces of the same rotatable mechanism loaded with resistance automatically variable according to the changes in the stretch resistance of the thread, whereby the fluctuations in the spinning system from calculated conditions which induce variations in the stretch resistance of the thread are compensated for in said closed circuit, the thread being passed through the first part of the path of movement from the bath to said closed circuit substantially without extraneous resistance, whereby substantially all of the stretching of the thread, and a stretching thereof adapted to impart uniform properties thereto, irrespective of fluctuations in the spinning system, is effected in a third part of the path of thread movement between said closed circuit and the drawing mechanism.

4. In the manufacture of artificial thread from cellulosic solutions, the improved process of stretching the thread consisting in drawing the set thread at a constant speed greater than the speed of extrusion from the spinning nozzle into the setting bath, and imposing on the moving thread, between the bath and the drawing mechanism, and in an area substantially spaced from both of the latter, a pair of successive frictional driving functions applied to equal-diameter surfaces of the same rotatable mechanism loaded with resistance automatically variable according to the changes in the stretch resistance of the thread, and providing a path of thread movement, between the two successive thread driving areas, which presents a substantially constant amount of resistance to thread movement, whereby the fluctuations in the spinning system from calculated conditions which induce variations in the stretch resistance of the thread are compensated for in that part of the thread travel comprehended between its two driving functions, the thread being passed from the bath to the area of its first driving function, and from the driven rotatable mechanism to the drawing mechanism, substantially without extraneous resistance, whereby substantially all of the stretching of the thread, and a stretching thereof adapted to impart uniform properties thereto, irrespective of fluctuations in the spinning system, is effected in that part of the path of thread movement immediately beyond the point of its second disengagement from the driven rotatable mechanism.

CHARLES A. HUTTINGER.