Sept. 6, 1927. 1,641,588

M. HÖLKEN, JR

METHOD OF AND MEANS FOR MANUFACTURING ARTIFICIAL SILK

Filed Jan. 25, 1923 2 Sheets-Sheet 1

Fig. 1

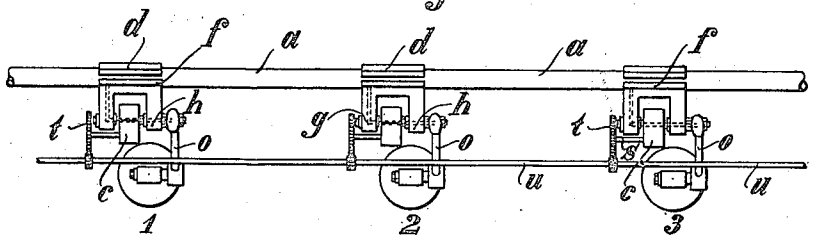

Fig. 3

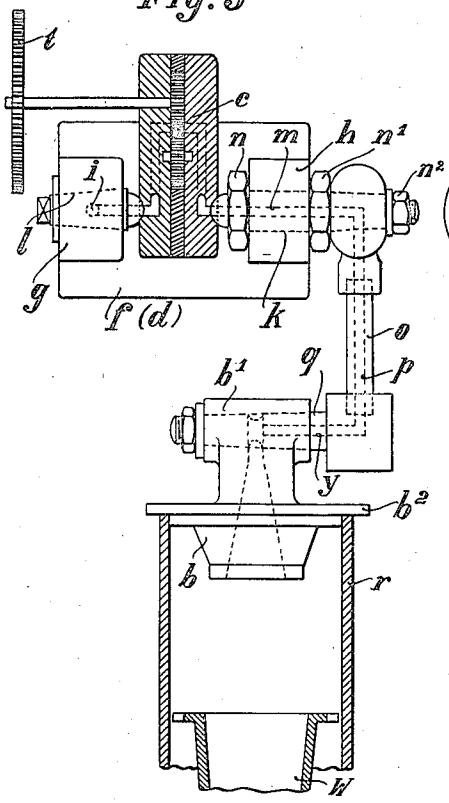

Fig. 4

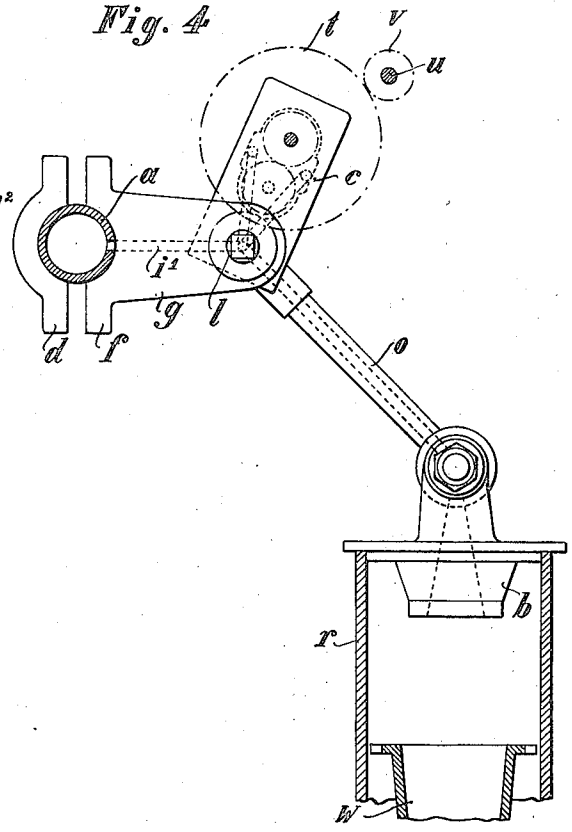

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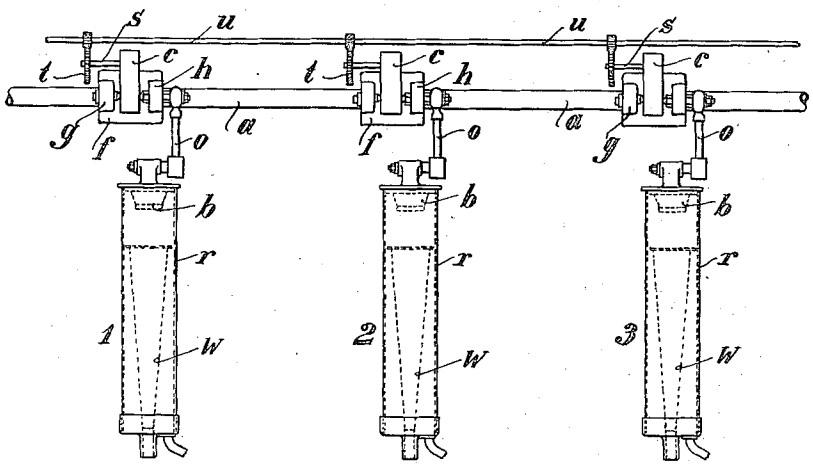
Fig. 2



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UNITED STATES PATENT OFFICE.

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METHOD OF AND MEANS FOR MANUFACTURING ARTIFICIAL SILK.

Application filed January 25, 1923, Serial No. 614,826, and in Germany July 12, 1920.

My invention relates to the so-called stretching spinning method for the manufacture of artificial silk from cellulose solutions, and more especially solutions of cupric oxide ammonia cellulose, in which process the comparatively thick threads issuing from the spinning rose are first conducted through a liquid, the so-called precipitating liquid which flows in the direction of the thread pull and serves to wash out the solvent; the threads are stretched while being conducted through this liquid and, may be, also through an air space forming a continuation of their way through the liquid. In other words, the threads are first drawn out to the desired degree of fineness, and then treated with a hardening liquid for stiffening them.

With the known methods of this kind the spinning solution is conducted directly to the sprinklers from a common conduit which is under pressure and has merely a shut-off cock inserted into it. Generally a plurality of such sprinklers (about 40) are arranged in one machine. In consequence thereof, the thickness of the threads produced in a machine not only varies more or less at different times, but also the threads produced by the individual sprinklers differ greatly. Owing to this, the thickness or fineness of the threads is always more or less a matter of chance, and artificial silk manufactured after the stretching spinning method and being marked for a certain degree of fineness always shows great deviations from this degree of fineness.

I have now ascertained that artificial silk-threads of a uniform fineness, the degree of which may be determined in advance, may be obtained from all spinning heads or sprinklers of a machine, if the sprays which receive the solution from a common supply pipe are fed from this pipe not directly, but by way of apportioning devices, of which one is provided for each spray, for instance a rotary gear or cog-wheel pump which renders the supply independent of the pressure existing in said pipe. By this means not only the desired uniformity of the fineness of the threads is obtained, but further striking advantages result from this manner of operation, in that on the one side the fineness of the threads is considerably improved and on the other side the drawing off of the threads proceeds considerably more quickly, whereby the output of thread is greatly increased. Besides, owing to the greater stretching of the threads, also their appearance and their quality is improved so that cupric oxide ammonia silk thus made forms a novel product which is apt to answer the highest requirements as to uniformity, fineness, resemblance to silk, and also as regards washing.

I am aware that providing a pump for each spinning head is already known in connection with such methods of producing artificial silk where the heads or sprinklers have very small apertures and where, therefore, a separate pump is required to force the spinning liquid through the small apertures. Heretofore, however, individual pumps or other force feed devices or controllers for expressing the solution through or governing its flow to the respective spinnarettes have not been employed in the manufacture of cuprammonium silk by the stretch-spinning method, in which the spinnarettes are provided with comparatively large spinning apertures of a well known standard size of 0.8 mm. or 1 mm. In such stretch-spinning method as heretofore carried out, where the use of a force-feed pump is not necessary, because of the large size of the spinnarette apertures, the solution has always been supplied under gravity pressure to the spinnarettes which are connected to a common supply pipe leading from a tank or reservoir, the flow of the solution through the pipe and thence to the spinnarettes being controlled by an ordinary hand valve. As the spinnarettes are located at different distances from the source of supply, the pressure of the solution supplied to the different spinnarettes varies, as a result of which irregularities of expression occur, causing the production of filaments varying in size so that a thread of constantly uniform diameter can not be formed. This condition is aggravated by unavoidable pulsations in the supply pipe caused at times by viscosity differences in the solution, and by the clogging of spinnarette apertures from impurities, by which still further pressure fluctuations are caused. The clogging of spinnarette apertures also results in the breaking or undue attenuation of filaments or the formation of nodules or thickened portions either at times reducing the aggregate dimensions of a group of filaments expressed, so that a thread of irregular diameter will be formed, or the thread will have rough surfaces due to the presence of thick-

ened portions, or both conditions will exist, making such thread difficult to work on textile machines and reducing its commercial value. For these reasons the ordinary stretch-spinning process yields only about sixty percent (60%) of perfect thread. I have discovered that by the employment in a stretch-spinning apparatus of what are known in the viscose and other artificial silk arts as rotary geared pumps, one for each spinnarette, and by the use of such so-called pumps as measuring and flow controlling devices, the operation of the spinning apparatus may be so changed as to overcome the above-noted defects in the ordinary stretch-spinning method, and so as to provide a new and improved method enabling, to a very high degree, thread of a constantly uniform smoothness of surface and predetermined diameter to be produced. By the use of toothed gearing for driving all the flow controllers of a spinning machine from a source of power at a predetermined speed at all times and under all conditions, I also secure a novel and improved expressing action, for the expression with absolute certainty through the apertures of each spinnarette of a fixed volume of the solution per unit of time constantly proportionate for a rate of flow through the spinnarette apertures for continually producing filaments of aggregate dimensions when combined to form a continuously smooth thread of continuously predetermined and unvarying diameter. The flow controllers as employed in my method and apparatus further serve as baffles to protect the volume of solution which is being expressed from fluctuations of pressure in the supply pipe, thereby obtaining a greater uniformity of operation in the expressing action.

To carry this method into practice, the spinning device as hitherto employed in connection with the cupric oxide ammonia method may be used, provided that each spinning head or sprinkler is combined with a feed device or controller which may consist, for instance, of a rotary geared pump as employed in connection with the older method above mentioned. The connection of the spinning spray with the supply pipe is, however, not effected as hitherto, by a piece of rubber hose, but by an articulated double arm permitting of a parallel displacement and, thus, if necessary, of removing the spinning sprinkler from, and putting it again on, the glass cylinder containing the precipitating liquid.

In order to make my invention more clear, I refer to the accompanying drawings which show, by way of example, the principal parts of an apparatus adapted to carry my improved method into practice, parts of minor importance having been omitted. In the drawings

Figure 1 is a front view and

Figure 2 is a plan of three combined devices, the construction of which is fully described hereinafter.

Figure 3 is a front view of one of these devices, the lower portion being partly broken away and shown in vertical section.

Figure 4 is a side view of the parts shown in Figure 3.

1, 2, 3 are three spinning devices arranged side by side and provided each with a spinning head or sprinkler having a sieve-bottom through which the cellulose solution is distributed. Each of the spinning heads *b*, *b* is arranged at the upper end of a glass cylinder *r* containing a rather long glass funnel *w*, the purpose of which is to conduct downwards the threads issuing from the spinning spray, together with the precipitating liquor. This liquor is introduced at the bottom of the cylinder *r* through a pipe *x* and rises in the annular space between the walls of the cylinder and of the funnel until reaching the upper edge of this latter when it flows down into and through it with increasing speed and takes the bundle of threads with it, segregating at the same time the solvent therefrom. The threads issuing from the spinning heads *b*, *b* are comparatively thick, but on their way through the precipitating liquid and, may be, also on an air way forming a continuation thereof are stretched and then rendered solid by being treated with a hardening liquid; finally, they are wound up either already during the treatment with the hardening liquid or thereafter. Stretching the threads is effected in most cases by the pull of the winding-up device and may be assisted, if desired, by the precipitating liquor which flows in the direction of the pull. The means for treating the threads with the hardening liquid and the winding up device, are not illustrated in the drawings, as they do not form part of this invention and may be of any known kind.

The spinning devices, of which a plurality is arranged side by side and which form, in their entirety, the thread producing machine, are fed from a common pipe *a* with the cellulose solution which is apportioned to each device by means of a rotary geared controller such as a rotary gear pump *c* of known construction which is connected on its suction side with the general feed pipe *a* and on the delivery side with the spinning spray *b* of the associate spinning devices 1 or 2 or 3.

The controllers or rotary gear pumps are all of equal size and have equal outputs independent of the pressure in the feed pipe *a*. They are driven by a common shaft *u* with which they are coupled by pairs of cogwheels *t* and *u* having all the same ratio of gearing so that also their numbers of revo-

lution in the unit of time are the same. In consequence thereof all spinning devices 1, 2, 3 forming parts of a machine receive exactly corresponding quantities of the cellulose solution in the unit of time. The quantity of cellulose solution apportioned to the spinning devices may be altered in common for all devices and in exact agreement by changing the number of revolutions of the shaft *u* which may be effected by any suitable means, such, for instance, as geared wheels or friction discs or the like. I have abstained from illustrating such a means in the drawings because it is well known and does not form part of this invention.

In this manner the several spinning devices are simultaneously and uniformly regulated, in the manner necessary to obtain the desired fineness of the threads.

The operation is as follows:

The so-called rotary gear pumps *c*, while generally similar in construction to rotary gear pumps of the type employed in viscose and other artificial silk methods using a force-feed expression, have normally a different action in this apparatus. They serve, under all normal conditions, as measuring devices for feeding the solution in definite volumes to the spinnarettes, and as baffles for protecting the portions of solution fed to the spinnarettes for expression from any variations of pressure in the supply conduit *a*. As each pump or controller is introduced in a flow passage between the conduit *a* and a spinnarette *b*, it divides the flow passage into intake and discharge portions. The solution in the conduit *a* is normally under a predetermined gravity pressure, and the pressure is the same in the intake portion of the passage on the suction side of the pump. This pressure is normally higher than that which exists in the discharge side of the flow passage between the pump and spinnarette, because of the comparatively large size of the spinnarette apertures and the fact that the rapidly flowing precipitating liquid in the chamber *r* and funnel *w* produces a partial vacuum in said chamber on the discharge side of the spinnarette and a combined suction pull on the solution and drawing pull on the expressed filaments. Because of the large size of the spinnarette apertures, the pressure force required for expression is not normally greater than that of the gravity force acting on the solution plus the suction and drawing pulls. The pumps *c* are driven by the gears *t*—*u'* from the drive shaft *u* at such speed as to deliver a measured volume of solution, per unit of time, to each spinnarette. The amount of solution delivered to each spinnarette by each pump in any definite period of time is exactly equal to the maximum amount of solution which may be expressed through the spinnarette apertures under such normal working conditions, in the same period of time, when said apertures are unclogged or unconstricted and fully open. During such action, and at all other times, the volume of solution in such discharge portion of the flow passage will be separated from the solution in the conduit *a* and protected from any variations of pressure occurring in said conduit *a*. The volume of fluid being expressed will therefore have an even and regular flow rate, without jets or pulsations, and consequently will constantly fill the spinnarette apertures for the expression of filaments of a continuously regular and predetermined size. At all times, therefore, when the apertures are unconstricted, filaments of an unvarying and predetermined diameter and free from defects will be formed, which when combined will be constantly of proper aggregate dimensions to form a continuously smooth thread of a continuously predetermined and unvarying diameter. The pressure in the discharge side of the flow passage may vary more or less, however, under normal working conditions of the spinnarette, due to unavoidable changes in the viscosity of the solution, so that in the event of the solution being of higher than normal viscosity, the pump may act with a forcing pressure because of the resistance to flow of the solution, and thereby maintain the rate of maximum expressing capacity of the spinnarette. In the event of the constriction or reduction in size of spinnarette apertures by particles of impurities in the solution, the resistance to flow of the solution thereby induced will cause a back pressure to be thrown upon the pump. In this case, the pump becomes a low pressure force feed expressing device, operating with just sufficient expressing force to dislodge the impurities and clear the spinnarette apertures. Ordinarily this is effected immediately when the expression force is increased by the action of the pump when a resistance is set up, before any apparent variations in the expression action can occur, so that no undesirable change in the size of the filaments or the formation of nodules or other thickened portions will occur. If, however, one or more spinnarette apertures should remain constricted, or be completely clogged, and should not be cleared by the induced low force pressure of the pump before the filaments previously expressed from the clogged openings are broken under the stretching action, then a new expressing action is set up. Under this new expressing action, whereby the back pressure of the solution on the pump is further increased, the pump exerts a higher forcing pressure, with the result that the solution will be slightly condensed and the entire amount of the solution discharged through the clear aper-

tures. Necessarily in such operation, with apertures fully clogged or partly clogged, or both, the number of the filaments expressed will be reduced, and some or all of the filaments may be of greater than predetermined size, and others of less than predetermined size, but the amount of material expressed will be the same and the filaments will be of the same aggregate dimensions when combined to form a thread as a full number of filaments of the regular size, and consequently there will be no variation in the diameter of the thread produced. In the normal working of the apparatus complete clogging of spinnarette apertures rarely occurs, because an established low working pressure of the pump generally results in an instantaneous clearance of the apertures, but, even under conditions of partial or complete clogging of some of the apertures of a spinnarette, the same amount of solution will be continuously expressed and a thread of continuously uniform diameter produced. Where for an infinitesimal period of time cessation of flow of solution through a constricted aperture occurs, causing a slight thickening in the filament expressed, the thickened portion will be reduced by the stretching action and, as such thickened portion of a filament will be enveloped in the other filaments no undue irregularity of surface or material increase of thickness of the formed thread will appear. It will be apparent that, as each pump is immutably driven by toothed gearing from the drive shaft, no slippage and change of action of the pump can occur when back pressure is thrown upon the pump, consequently the same amount of solution will and must always be expressed through the apertures of a spinnarette. By so gearing up each pump, and all pumps of the series, all the pumps operate to invariably supply the same amount of solution to the different spinnarettes fed thereby, and as a result no difference in expressing ratio between the different spinnarettes of the machine, or between the spinnarettes and the stretching and winding devices, can occur. The regularity of action of the spinnarettes, as a result of such measuring and flow controlling and compensating force feed actions of the pumps is such that, in actual working practice, ninety percent (90%) of the amount of thread produced is thread of perfectly uniform diameter and of high quality which brings the highest market price. Losses due to amount of imperfect thread produced are also greatly reduced. As before described, the construction is such that any spinnarette and its feed controller may be thrown into and out of action at will independently of the other spinnarettes and controllers and without affecting the operation of the spinnarettes and controllers kept in service. Consequently the throwing of one or more spinnarettes out of action for cleaning or other purposes will not cause the solution supplied to the working spinnarettes to be influenced or affected in any way by resulting pressure changes in the supply conduit *a*. A very valuable and important advantage of the invention, due to this novel flow control and expressing action is that spinnarettes with discharge apertures of much greater than normal diameter may be used. I have in practice used spinnarette apertures of as large a size as 3 mm. with perfect success. As a result, the volume of production of a machine may be greatly increased without increased working costs.

Each of the rotary geared pumps *c c* may be turned around an axle lying in parallel to the driving shaft *u* in order to disengage the respective cog-wheels and bring the respective pump to a standstill. Each pump is, for the purpose in question, provided with two pivots *l* and *k* supported in two bearings *g* and *h* forming projecting parts of the front half *f* of a bipartite clip *d f* clamped to the feed pipe *a* in immediate proximity to the respective spinning device. The pivots *l* and *k* are arranged co-axially with the suction aperture and the delivery aperture of the respective pump and are provided with channels connecting the pump on the one side with the pipe *a* and on the other side with the spinning device. The journal *l* which lies in the direction of flow of the cellulose solution before the pump is constructed to form at the same time a shut-off cock and is provided for this purpose with an angular bore *i*, the radial leg of which is connected, at a certain position of this journal, with a longitudinal bore i^1 provided in the bearing *g*. The journal *l* is of conical shape and is rotatable in the correspondingly shaped transverse bore of the bearing *g*, and its outer end is provided with a square projection which is designed to receive a wrench by which the journal may be turned in order to disconnect the bores *i* and i^1. The other journal *k* is also provided with an angular bore *m* and is made stationary in the transverse bore of the associate bearing by means of two nuts *n* n^1, but it may for the loosening of the inner nut *n* be axially drawn away from the pump and even be entirely removed from the bearing to permit of the pump being dismounted and examined and cleansed.

On the other end of the journal *k* there is provided a rotatable arm *o* held in place by a nut n^2 and carrying at its free end a pivot *q* extending in parallel to the pivot *k* and having rotatably attached to it the spinning head *b* by means of the hub-shaped head b^1. The arm *o* and the pivot *q* are also provided with channels *p* and *y* which connect the bore of the pivot *k* with the interior of the spinning head *b*.

Owing to the articulated fastening of the spinning heads at the arm *o* which in its turn is rotatably supported upon the pivot *k*, the head may, if necessary, be lifted off the cylinder *r* of the spinning device after which it is automatically held in raised position by the friction of the conical transverse bore of the arm *o* upon the conical end of the pivot *k*.

The provision of the double joint *k q* warrants a good support for, as well as a reliable tightening of, the flange b^2 of the spinning head upon the upper rim of the cylinder when re-mounting the head upon it.

If the pump is to be dismounted in order to be inspected, the supply of cellulose solution is interrupted first by turning the pivot *l* which forms a kind of cock-plug. Thereafter the inner nut *n* is loosened and the pivot *k* shoved to the right so that the pump is free to be removed. If the nut is completely unscrewed, the pivot *k* may be drawn out of the bearing *h* and may be removed from the device together with the arm *o* and the head *b* in order to permit of cleansing these parts.

A special advantage of the bored articulated arms *o* consists in that owing to the supply of the cellulose solution through unelastic pipes the variations are obviated which are experienced with the known spinning devices and which are due to the use of rubber hoses between the supply pipe and the heads, that is to say, to the expansion of the walls of these hoses, whereby the quantity fed is varied.

In lieu of the rotary geared pumps shown and described, pumps of some other suitable kind may be employed, provided that their output be adjustable exactly and independently of the pressure of the solution supplied, so that the supply of exactly determinable quantities of the cellulose solution is permanently warranted.

I claim:—

1. The stretch-spinning method of manufacturing artificial silk from cuprammonium cellulose solutions by expression of the solution through spinnarette apertures of at least 0.8 mm., which consists in constantly taking from a source of supply of the solution and expressing through the spinnarette apertures a fixed volume of the solution per unit of time constantly proportionate for a rate of flow through the spinnarette apertures for continually producing filaments of aggregate dimensions when combined to form a thread of continuously predetermined and unvarying diameter, while protecting such volume of solution from pressure variations of the source, and then subjecting the filaments to stretch reduction.

2. The stretch-spinning method of manufacturing artificial silk from cuprammonium cellulose solutions by expression of the solution through a plurality of spinnarettes each having a plurality of apertures of at least 0.8 mm., which consists in constantly taking from a source of supply of the solution and supplying to each spinnarette a fixed volume of the solution per unit of time constantly proportionate for a rate of flow through the spinnarette apertures for continually producing filaments of aggregate dimensions when combined to form a thread of continuously predetermined and unvarying diameter, while protecting the volume of solution supplied to each spinnarette from pressure variations of the source, governing the amount of the solution supplied to each spinnarette throughout the series so as to apportion like amounts of the solution at all times to the spinnarettes, and then subjecting the filaments expressed by each spinnarette to stretch reduction.

3. In an apparatus for manufacturing cuprammonium silk by the stretch-spinning method, a source of supply of cuprammonium cellulose solution, a spinnarette having a plurality of apertures of at least 0.8 mm., a controller operative for constantly feeding from the source of supply to the spinnarette and expressing through the spinnarette apertures a fixed volume of the solution per unit of time constantly proportionate for a rate of flow through the spinnarette apertures for continually producing filaments of aggregate dimensions when combined to form a thread of continuously predetermined and unvarying diameter, while in such feeding action protecting such volume of solution from pressure variations of the source, and means for subjecting the expressed filaments to stretch reduction.

4. In an apparatus for the manufacture of artificial silk thread by the stretch-spinning method, a supply conduit containing the cuprammonium cellulose solution, a plurality of spinnarettes each having a plurality of apertures of at least 0.8 mm., a rotary controller between the supply conduit and each spinnarette, each controller governing the flow of solution from the conduit to the spinnarette communicating therewith and operative for feeding from the conduit to the spinnarette for expression through the spinnarette apertures a fixed volume of the solution per unit of time constantly proportionate for a rate of flow through the spinnarette apertures for continually producing filaments of aggregate dimensions when combined to form a thread of continuously predetermined and unvarying diameter, and also operative for protecting such volume of solution from pressure variations of the source, means for subjecting the filaments expressed by each spinnarette to stretch reduction, a source of power for driving the controllers, and toothed gearing between said source of

power and the controllers for immutably operating said controllers invariably at the same rate of speed.

5. In an apparatus for the manufacture of artificial silk threads from cellulose solutions after the distending spinning method, a spinning device comprising a spinnarette adapted to produce comparatively thick threads adapted to be drawn out to the required fineness by stretching, a pipe for supplying the cellulose solution, a rotary geared pump adapted to feed the spinnarette from that supply pipe, a driving gearing for said pump, this pump being rockably mounted to permit of throwing the driving gearing into and out of gear, two hollow pivots arranged co-axially with the inlet opening and the delivery opening of the pump and being adapted to serve as journals for the pump, as well as to connect it on the one side with said supply pipe and on the other side with said spinnarette, the pivot connecting the pump with the feed pipe being constructed to form a shut-off cock.

6. In an apparatus for the manufacture of artificial silk from cellulose solutions after the distending spinning method, a spinning device comprising a spinnarette adapted to produce comparatively thick threads adapted to be drawn out to the desired fineness by stretching, a pipe for supplying the cellulose solution, a rotary geared pump for feeding the spinnarette from said pipe, a driving shaft and cog-wheels for driving said pump, this latter being so arranged as to be adapted to be laterally moved on an axle lying in parallel to said driving shaft in order to bring the cog-wheels out of gear, a clip affixed to said supply pipe, two projections extending forth from said clip and forming bearings, two hollow pivots supported in these bearings and lying co-axially with the inlet opening and the discharge opening of the pump and being adapted to connect the latter on the one side with the supply pipe and on the other side with spinnarette, the pivot effecting the first of these connections having an angular channel adapted to communicate with a channel provided in the associate bearing and terminating into the feed pipe and having a conical shape and being rotary arranged in a conical bore of the associate bearing in order to be able to serve as shut-off cock.

7. In an apparatus for the manufacture of artificial silk threads from cellulose solutions after the distending spinning method, a spinning device comprising a cylinder adapted to supply a precipitating liquid, a detachable spinnarette resting upon the upper end of said cylinder and being adapted to produce comparatively thick threads adapted to be drawn out to the required fineness by stretching, and a funnel arranged in said cylinder and being adapted to conduct downwards the threads and said precipitating liquid, a supply pipe for the cellulose solution, a rotary geared pump for feeding the spinnarette from said supply pipe, a driving gearing for said pump, this latter being so rockably mounted so as to permit of throwing said gearing into and out of gear, two hollow pivots arranged, co-axially with the inlet opening and the delivery opening of the pump and forming journals for it and connecting it on the one side with the said supply pipe and on the other side with the said spinnarette, a rotary arm arranged on the pivot effecting the latter of said connections, a turning joint connecting said arm with the spinnarette, said joint and the said arm having channels adapted to connect the channel of said pivot with the interior of the said spinnarette.

In testimony whereof I affix my signature.

MARTIN HÖLKEN, JR.