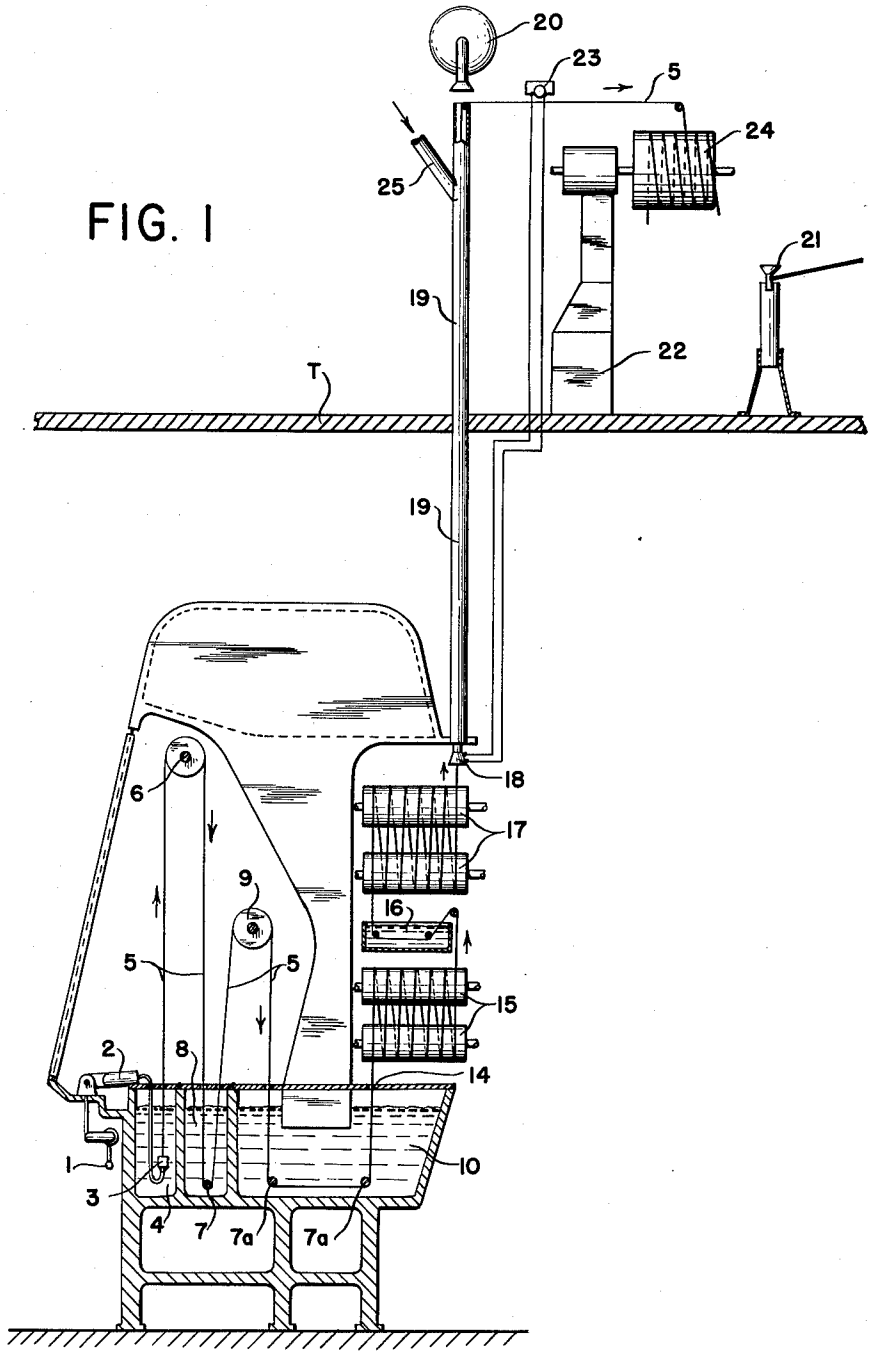
March 14, 1961 H. MEYER 2,974,363

METHOD OF AND APPARATUS FOR THE CONTINUOUS PRODUCTION OF SYNTHETIC FIBERS

Filed July 2, 1954 2 Sheets-Sheet 1

FIG. 1



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METHOD OF AND APPARATUS FOR THE CONTINUOUS PRODUCTION OF SYNTHETIC FIBERS

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FIG. 3

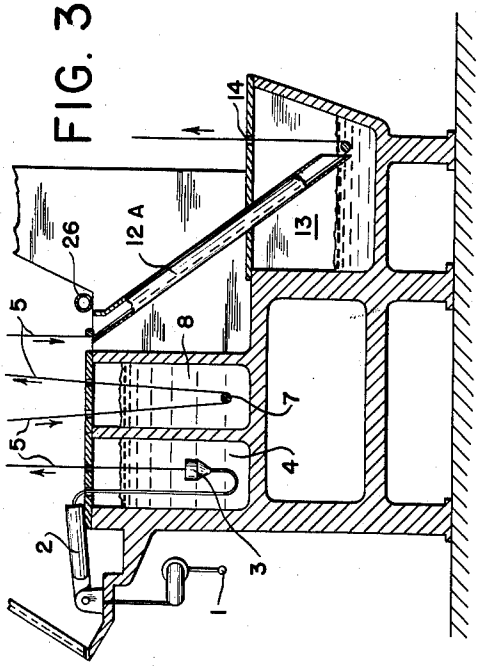
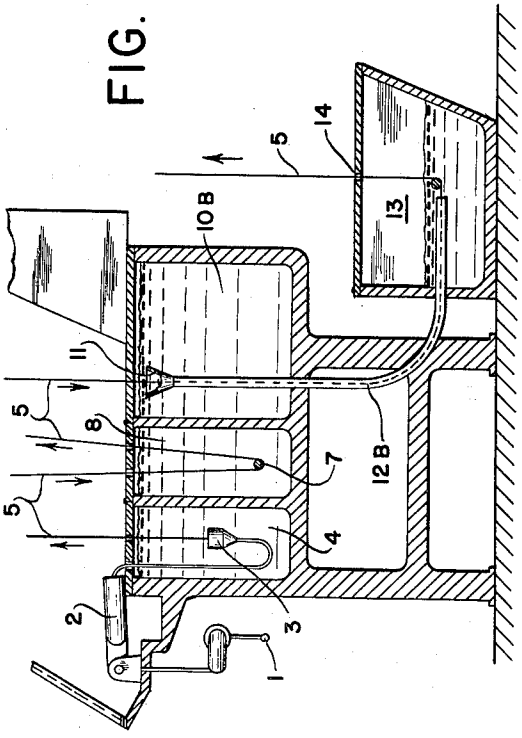


FIG. 4



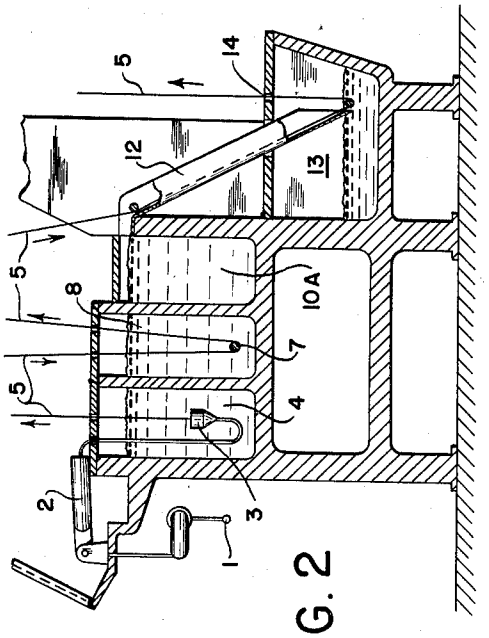


FIG. 2

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METHOD OF AND APPARATUS FOR THE CONTINUOUS PRODUCTION OF SYNTHETIC FIBERS

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5 Claims. (Cl. 18—8)

The invention relates to a method of and means for the continuous production of synthetic fibers, and more particularly, endless threads of the so-called cord thread type.

In recent years, numerous means have been proposed for the purpose of accomplishing such ends, but such proposals have not proven entirely satisfactory in many respects. In general, such prior equipment has been unsatisfactory either as to the starting of the spinning process, the inadequacy of certain of the working parts of the equipment, or the likelihood of the thread being damaged during any of the stages of the process.

One particular objection is that the formed thread or filaments, on running onto the receiving member, or in the case of continuous spinning and after treatment, onto the after treatment member is not fully "coagulated through." Also, the regeneration is performed in a most complicated and impractical fashion, and the "stretching" of the thread at the improper time has been present.

Thus, the attendant results have been to provide a thread having too great a swelling property, and, too low a shrinking factor. Such characteristics have a detrimental effect upon the utility of the thread, especially as cord material.

In addition, the known machines of the continuously spinning, after treatment and twisting type wherein the operation is in three stages are objectionable. In such equipment, the uppermost level or story contains the acid spinning bath, the intermediate or middle level, the after treatment requiring various kinds of flowing liquids possessing different chemical characteristics, and the lower level, the twisting machinery. Manifestly, such equipment subjects the finished product to the possibility of damage since it is sensitive to chemicals, and, such chemicals can "drip" or "splash" down into the lower level from the upper levels.

To overcome the above mentioned objections, it has been proposed to permit the thread to pass out of the spinning bath at the top, and, after complete coagulation, to subject the thread to the after treatment on a crossed pair of rollers or the like. Furthermore, the treatment is assisted by a tube operated by water jet pumps for drawing in the threads with the treatment liquids pumped in individual, serially disposed conduits. The thread is twisted directly after passing through a conical drying roller or equivalent unit. This technique is not satisfactory since the stages of the after treatment and the twisting are not sufficiently separated, and, the washing with the after treatment liquids flowing in the same direction is completely inadequate.

A salient object of the invention is to provide a method of and an apparatus for producing the synthetic fibers which overcome the above and other objectionable features now present in the art, and, wherein the apparatus fully meets the requirements as to space occupied, attention necessary on the part of the operators, replaceability of machine parts, the thread movement and the output of the equipment.

Another object of the invention wherein it is possible to produce a perfect rayon, which due to its excellent physical characteristics, is well adapted for use as tire cord, is to provide means by which existing machines can be easily and quickly converted to carry out the present process.

A further object of the invention is to provide a method of producing synthetic fibers including three independent steps or cycles of treatment so that any stoppage or the like which may arise in the twisting or winding cycle will have absolutely no effect upon the preceding steps or cycles.

Broadly, in the first or initial step or cycle, the thread is precipitated, stretched, and the cellulose regenerated with the cycle being performed entirely in an acid medium. Hence, the operator no longer comes into contact with washed goods, and, his task is simple, of short duration, and cannot be affected by interruptions in the subsequent cycles of the process.

The second cycle likewise is of short duration and includes washing, after treatment, stretching (if required), drying under tension to adjust the desired shrinkability of the said thread and the movement of the thread to a higher level. In this step, the operator works with washing water, and rarely comes into contact with the extremely weak acid liquid flowing off the thread making it impossible to contaminate the washed thread with strong acids.

In the third cycle, the required operations are performed at a level above the first and second steps, and, as a consequence, the finished product cannot be adversely affected by the solutions, vapors or gases emanating from the earlier chemical treatments of the fiber.

With the foregoing and other advantageous objects in view, the invention consists in the steps defined, the details of construction, and in the arrangement and combination of parts to be hereinafter more fully set forth and claimed.

In describing the invention in detail, reference will be had to the accompanying drawings forming part of this application, wherein like characters denote corresponding parts in the several views, and in which:

Figures 1 to 4 inclusive represent diagrammatically several forms of apparatus which can be used to carry out the invention, Figs. 2, 3 and 4 being broken, vertical sectional views of modified forms of the apparatus shown in Fig. 1, the parts of the apparatus shown in Fig. 1 and broken away in Figs. 2 through 4 being the same in all forms of the apparatus.

Referring initially to the method, a viscose solution containing approximately 6 to 8% of cellulose and about 6 to 8% of alkali, and having a saline point above 4½ to substantially 8 and a viscosity of over 30 (falling ball method) is spun from multi-apertured spinnerettes with an aperture diameter of from 0.06 to 0.08 mm. into a spinning bath. The spinning bath contains approximately 11 to 13% sulphuric acid and the usual amount of sodium sulphate and is at a temperature of from 45 to 55 degrees C. The bath also preferably contains about 4 to 6% of zinc sulphate or mixtures of equivalent salts, such as magnesium and ammonium sulphate.

The spun thread is drawn off to a length of substantially 20 to 40 cm., or more depending upon the speed of drawing off, through the bath in an upward direction by a draw off roller, and the speed of the drawing off is about 30 to 60 meters per minute. From the first draw off roller, the thread, the interior of which is not yet regenerated, moves downwardly into a second bath, the sulphuric acid content of which can vary between 0.2 and 4% and the temperature of this bath is between 50 and 95 degrees C. As was the case of the first bath,

the second bath also contains additional salts, such as zinc sulphate, and the amounts of the salts can be varied dependent upon the viscosity and age of the viscose.

The thread is reversed in a thread guide in the second bath, and, drawn in an upward direction, with the largest possible stretching of 50 to 80% or more, and in that condition is already largely regenerated cellulose. To complete the regeneration, the thread is once again moved in a downward direction into a bath, preferably a third one of dilute sulphuric acid with the same or lower acid concentration as the previously mentioned baths. A salt bath or an acid salt bath may be used.

The third mentioned bath is of funnel-shaped structure and the top edge thereof lies slightly below the surface of the liquid in the bath. The thread is led into the funnel, and under the action of a pump jet or injector passes through the conduit adjacent the funnel, the conduit being of such length or shape that when the thread leaves the conduit, the complete regeneration of the viscose has been effected.

In lieu of the funnel conduit, a trough may be located at the edge of the bath and sufficiently below the bath to insure the complete regeneration of the thread under the action of the flowing off liquid.

Also, it is possible to use a single bath through which the thread is guided by suitably disposed guide means, and, it is merely necessary that after stretching, the complete regeneration of the thread is achieved in the bath in the liquid flowing in the same direction without mechanical strain or stretching.

The employment of the injector is advantageous in that the filaments of the thread are open during travel, and, thus it is relatively easy for the liquid to penetrate the thread. Also, the injector can be operated by water vapor thereby dispensing with a separate heating plant for the baths.

Instead of the acid concentration of 11 to 13% of sulphuric acid referred to above, it is possible to use higher concentrations, such as 40 to 70% of sulphuric acid, depending upon the amounts of salts added. With the higher concentrations, the bath is kept at room temperature, and, the length of movement in the bath is adjusted to the degree of regeneration desired for the later stretching. The excess acid is removed by guides, rolls or the like prior to the thread running on the first roller.

In this modified process, the second bath is heated to a higher temperature, such as 40 to 50 degrees C. and kept at an acidity of between 10 and 50% sulphuric acid, a salt content of substantially 20% of sodium sulphate and an addition of zinc sulphate. Lastly, the third bath has a lower acid content, such as 1 to 2% of sulphuric acid, and, the usual addition of salts. The third bath is maintained at a temperature of from 70 to 95 degrees C., and the heat content of the steam which operates the injector may be used for this purpose.

The thread treated according to either of the foregoing techniques is passed into a closed zone having small outlet apertures in the top thereof for each thread and which is partly filled with the flowing after treatment and regeneration liquid. An aspirating effect is created above the surface of the liquid to remove all vapors and gases and at the same time, the thread is "bent over" upwardly and each of the threads passes out through an aperture in the top of the closed zone. The threads are washed completely free of the acid in a countercurrent operation on a pair of crossed rollers located above the closed zone.

Following the washing and the after treatment, the thread passes through a reviving bath disposed at a point above the washing and after treatment rollers. Since the bath is intermediate the washing and drying steps its position renders it impossible for water containing even the slightest trace of acid to be deposited upon the dry thread.

After passing through the reviving bath, the thread is subjected to a heating step and the thread reaches the textile zone in proper condition.

In order to more fully appreciate the invention, reference will be had to Fig. 1 in which the spinning solution is introduced into a spinning bath **4** through a supply pipe **1**, a filter **2** interposed in the line and through a spinneret **3**. A draw-off roller **6** is located above the bath **4**, and, the distance between the bath and the roller is such that the spun filaments of the bundle or thread identified **5** will attain the degree of regeneration most favorable to the subsequent stretching. Of course, this distance is predicated upon the selected draw-off speed.

After leaving the roller **6**, the filament bundle is directed into a second bath **8** disposed therebeneath. The thread passes around a suitable guide **7** within the bath and thence over a draw-off roller **9** positioned above the bath **8** but below the roller **6**, and by means of which the thread can be subjected to severe stretching. Means are provided to adjust the speed of the draw-off roller **9**, and this roller as well as the roller **6** can be designed for each spinning location, or as a continuous surface for the full length of the machine.

The thread **5**, after leaving the roller **9** passes into a third or last bath **10** wherein the thread is completely regenerated while moving about guide elements **7***a* provided within the bath **10**.

The tank or chamber in which the baths **4**, **8** and **10** are located is provided with covers or lids for the respective baths at the upper ends thereof so as to permit the operator to have access to the interior of the baths, and each cover is formed with openings to permit the entry and the exit of the thread to and from the baths. An exhaust means (not disclosed) is located above the bath **10** and operatively connected thereto for exhausting the vapors and gases present in such bath zone.

The thread or bundle **5** leaves the bath **10** through an aperture **14** in the cover in an upward direction, and, passes around a pair of crossed rollers **15** above the bath, the said rollers **15** serving as washing rollers. The speed of rotation of the rollers **15** may be controlled or regulated separately by suitable means.

After leaving the rollers **15**, the thread or bundle **5** is then guided through a bath **16** above the rollers, and, this bath functions to revive the thread, and, as mentioned above, to positively prevent any washing liquid or acid to contaminate the dried thread. The thread bundle then passes about a pair of drying rollers **17**, the speed of which is separately controlled as was the case of the rollers **15**.

The thread next enters a conveyor pipe or conduit **19** above the rollers **17** which is in communication with the textile conversion room T, and, conditioned air from a supply source passes from conduit **25** into the pipe **19** and flows in a direction opposite to the movement of the thread continuously whereby the thread reaches the room T in a fully conditioned state. The thread leaves the pipe **19** at approximately right angles thereto, and, a relay **23** is disposed in the path of movement of the thread so that in the event of the breakage of the thread, the relay will operate a blower unit **18** provided at the entrance of the conveyor pipe. At the same time, the current of air from the conduit **25** is arrested, and the blower **18** will direct the broken thread upwardly through the pipe **19** where it is removed through a suction pipe **20**, or it can be wound onto the winding member **22** having a spool **24** by means of a movable auxiliary injector **21** operated by gas or air pressure. Otherwise, the thread may be supplied direct to a twisting machine.

When the break occurs at this location, the thread subsequently fed will be aspirated automatically into the pipe **20** until the interruption is eliminated. When the thread tension is reduced for any reason, the relay **23**

operates the blower **18** and the thread is blown through the pipe **19** and drawn into the pipe **20** or passed to the winding means **22** with the assistance of the injector **21**.

It is to be noted that the automatic switching of the injector **21** is connected directly to the pneumatic control circuit of the air conditioning plant with the latter circuit being closed so long as the injector is functioning, but, when the injector is cut off, conditioned air is admitted through the supply pipe **25** into the conveyor pipe **19** for flow in a direction opposite to the movement of the thread **5**. Thus, the thread reaches the receiving member in a conditioned state and at the proper temperature.

In Figs. 2 to 4 inclusive, the same reference characters are applied to corresponding parts for simplicity of description. With reference to Fig. 2, it will be seen that bath **10A** is of lesser capacity than the bath **10** in Fig. 1, and a covered trough or bath **13** is located below the bath **10A** at the exit side of the machine. A trough or chute **12** leads from the bath **10A** to the bath **13**, and the thread or bundle **5** is washed down the chute **12** by the liquid flowing downwardly from the bath **10A**. After leaving the bath **13**, the thread or bundle is subjected to the same steps described in connection with Fig. 1.

In Fig. 3, the thread bundle **5** moves through a pipe **12A** which leads to the bath **13**, and, the discharge end of the pipe terminates immediately above the liquid level of the bath **13**. This arrangement serves as a float passage, and, the length of the pipe **12A** is such that when the thread enters the bath **13** it is completely regenerated into cellulose. In addition, cold or hot water may be supplied through a pipe **26** to the pipe **12A**, and, by disposing the pipe at a slight angle as shown, the machine need not be of excessive height.

Figure 4 is generally along the lines of Fig. 3, but, in this form, the entrance opening of the pipe **12B** is provided with a funnel element **11**, and the upper edge of the funnel element is slightly below the level of the liquid body within the bath **10B**. An injector, not shown, is disposed laterally below and connected with the funnel element for conveying the thread bundle through the pipe **12B**, the injector being driven by cold or hot water although it is preferably operated by hot steam.

The pipe **12B** is curved near its lower end to reduce the overal height of the machine, and, may be provided with restricted portions at spaced intervals to prevent the thread bundle from being driven too strongly.

It will be seen from the foregoing that in each embodiment, the thread follows a predetermined path through a series of three baths with the thread bundle following an upward path from each of the bath zones. After leaving the bath zones, the thread is moved in an upward direction through a washing zone and into a drying zone, and, after leaving the washing zone, there is no danger of water or acids coming into contact with the dried thread to have a deleterious effect thereon.

While it is not essential that the machine be subdivided as described above, into the spinning side and the after treatment side, it has been found expedient to do so in view of the risk involved in impairing the quality of the thread.

Filaments which break off are washed toward one end of the machine by the current maintained in the baths making it unnecessary to remove the spinneret holder and again start spinning. The depths of the baths are such that the moving bundles of filaments are in no sense disturbed by the removal of the broken filaments.

It should further be mentioned that the baths **4**, **8**, **10** and **13** are preferably made in such a manner as to extend continuously throughout the entire length of the machine although the dimensions can vary in accordance with the particular problems at hand.

It is also possible that the thread, after complete regeneration to cellulose could be supplied to the after treatment as well as the drying, on the same side of the machine. This would result in an excellent thread if the operators were so well trained and supervised that contact of the washed or dried thread with acids could be avoided. On the other hand, by moving the thread to the other side of the machine, this result is insured even with the employment of less skilled workmen.

By moving the thread below the machine from the spinning side to the after treatment side, all danger of acid contact with the thread through accident or otherwise is positively prevented, and the use of suction prevents damage by vapors or gases.

The speed of the drying rollers relative to the speed of the washing rollers is so adjusted that the drying under tension provides the extensibility suitable for cord thread purposes and the desired shrinkability is accomplished. In other words, the elongation at break in the finished thread amounts to merely some 8 to 12%.

It is to be understood that the principles of the invention can be used with other cellulosic solutions such as cuprammonium cellulose solutions employing proper precipitation baths.

Having thus shown and described the preferred embodiments of the invention, what is claimed as novel is as follows:

1. The method of manufacturing synthetic fibers in a spinning and treating apparatus from viscose solutions containing from 6 to 8% of cellulose and from 6 to 8% of alkali and having a saline point between 4.5 and 8, comprising forcing the viscose solution through a spinneret into a first spinning bath, the spinning bath containing at least 11% and not over 70% of sulphuric acid and from 4 to 6% of zinc sulphate, maintaining the spinning bath at a temperature of from 45 to 55° C., regenerating only the exterior surface of the resulting thread leaving the interior unregenerated, withdrawing the resulting thread of filaments partly regenerated upwardly from the spinning bath at a speed of about 60 meters per minute to a point spaced above said first spinning bath, leading the thread downwardly from said point into a second bath located adjacent the first spinning bath and having a temperature of about 50° to 95° C. and containing about 0.2 to 4% of sulphuric acid, drawing the thread upwardly through and out of the second bath over a roller above the second bath and applying sufficient tension to the thread to effect stretching thereof to the extent of from 50 to 100%, passing the thread downwardly from said roller into a third bath wherein regeneration is completed, the third bath containing dilute sulphuric acid of a concentration not greater than that of the second bath, drawing the regenerated thread upwardly from said third bath, passing a stream of water over the thread to wash it free of acid, passing the washed thread upwardly and over a system of drying rollers, drying the thread on said drying rollers, and then passing the regenerated, washed and dried thread upwardly from the drying rollers through a tube in contact with a stream of air to give the thread a desired moisture content.

2. The method of manufacturing synthetic fibers as claimed in claim 1, in which the solution of the third bath flows downwardly in a confined stream, and in which said thread is passed into and through said confined stream in the direction of flow of the stream, and introducing a stream of hot water into said confined stream, whereby the movement of the thread along the path of said confined stream is facilitated.

3. In an apparatus for regenerating viscose solutions to form regenerated cellulose, including a first bath, a second bath, a third bath, a spinnerette in said first bath, means for supplying viscose solution to said spinnerette, guide means for advancing a spun filament from said first bath to said second bath and guide means for advancing said filament from said second bath to said third bath; the improvement in which said third bath

comprises an elongated tube extending in a generally vertical direction, means for leading said filament into the top of said tube and means for introducing a jet of fluid into the upper end of said tube to convey said filament downwardly through said tube.

4. In an apparatus for manufacturing artificial fibers comprising acid baths, a spinnerette, means for drawing a filament through said baths, means mounted at an elevation above the acid baths for washing said filament with liquid and means positioned above said washing means for drying said filament; the improvement comprising an air conditioning tube extending vertically above said drying means, means positioned above said tube and responsive to the breakage of a filament and means operatively connected to said breakage responsive means for introducing an upwardly-moving stream of air into said tube for carrying a filament upwardly through said tube when said breakage responsive means detects the breakage of said filament.

5. An air conditioning tube for filaments comprising a tube, means mounting said tube in a vertical position, means for drawing a filament upwardly through said tube, means for introducing downwardly-flowing air into said tube, means for introducing upwardly-flowing air into said tube, means positioned above said tube and responsive to the breakage of filaments, means operatively connecting said breakage-responsive means to said air-introducing means to interrupt the downward flow of air through said tube and actuate said upwardly-flowing air-introducing means on the breakage of a filament to introduce upwardly-flowing air into said tube and thereby draw a broken filament upwardly through said tube.

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