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CONTINUOUS FILAMENT FORMATION

Original Filed March 18, 1937

Fig. 1.

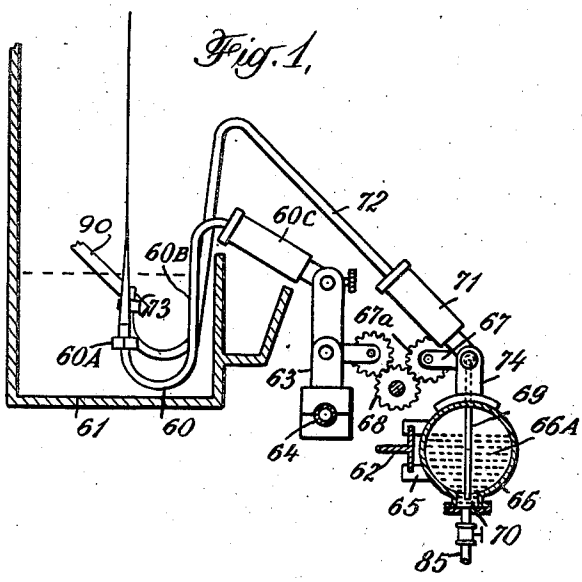
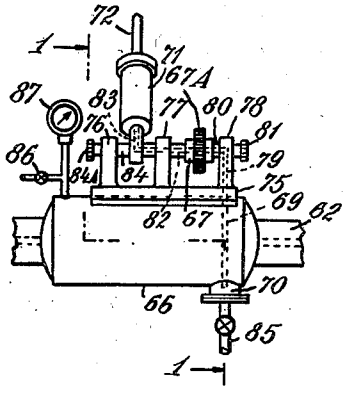


Fig. 2.



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CONTINUOUS FILAMENT FORMATION

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6 Claims. (Cl. 18—8)

This invention relates to spinning of artificial silk and the like and is concerned with operations in which a viscous liquid is extruded through a small orifice in a spinnerette and immediately thereafter solidified to form a filament. The invention contemplates improvements whereby spinnerettes may be withdrawn from service temporarily for cleaning, testing, repairs, exchange, etc., without interrupting the formation of a continuous filament and therefore without interruption to spinning or to the subsequent operations to which the spun filaments are subjected. The invention may be employed to especially great advantage in processes of "continu" spinning, in which a strand of filaments is formed and subjected to all the customary treating operations to put it in marketable condition without interruption of the continuity of the strand.

This application is a division of our copending application Serial No. 131,598, filed March 18, 1937, now Patent No. 2,198,448.

In several of the known processes for making artificial silk a cellulosic spinning solution is forced through orifices in a spinnerette into a setting or solidifying medium, which in the case of dry spinning is an evaporative atmosphere and in wet spinning is a coagulating bath, and is thereby solidified to form one or more filaments. The freshly formed filaments are withdrawn continuously from the zone in which solidification occurs and passed to other operations such as, for example, stretching, washing, desulphurizing, bleaching, drying, lubrication and twisting before the product is completed.

Conventional apparatus employed in the above-mentioned wet spinning operation comprises an open tank to contain the coagulating bath, means for supporting the spinnerette below the surface of the bath, a conduit for supplying spinning solution to the spinnerette, a metering pump adapted to keep the solution flowing through the conduit at a predetermined and preferably uniform rate, and means for continuously withdrawing the freshly formed filaments from the bath. Preferably the conduit to which the spinnerette is affixed is removably mounted so that the spinnerette can be withdrawn from the bath. Thus in one common type of apparatus the spinnerette in spinning position discharges the solution upwardly into the bath, and the conduit to which it is affixed is in the form of an S or a gooseneck which is bent through about 180° at its lower end and extends upwardly to a point above the top of the tank. There it is attached to a candle filter which is mounted swivelly in a hollow arm bracket such that its long axis is perpendicular to the horizontal upper edge of the tank. The spinning solution is forced into the candle filter by the metering pump from a feed line disposed outside of the tank and flows through the hollow arm of the bracket and the candle filter into the gooseneck and thence through the spinnerette. Usually, the inlet end of the candle filter fits into a conical seat cut into the side of one of the hollow bracket arms and is made tight by compressing the candle filter inlet against said seat, but not so tight that the candle filter cannot be moved pivotally. When the spinnerette is to be withdrawn the candle filter and gooseneck assembly are tilted to raise the spinnerette up out of the tank.

When the artificial silk industry was in its infancy it was customary to make relatively coarse filaments, and a considerable lack of uniformity in filament size was tolerated. In consequence, orifices in spinnerettes were relatively large and clogging of the orifices and maintenance of constant flow rate through the spinnerettes did not present serious problems. It usually sufficed to clean the spinnerettes or to exchange them for cleaned ones during the weekend general shutdown which was then customary, and it was not necessary, except occasionally, to exchange the spinnerettes at other times.

In more recent years, however, spinnerettes have required more care and attention. Several changed conditions have combined to bring this about. There has been a demand for finer filaments with consequent smaller orifices in spinnerettes and an increase in the tendency for orifices to become clogged. It has become customary to introduce finely divided solid substances, such as pigments, into spinning solutions. Oversize particles or agglomerates of fine particles tend to lodge either in the spinnerette or in the candle filter which precedes it in the spinning assembly. It has become necessary to pay more attention to the rate at which solution is discharged from the spinnerette in order to insure greater uniformity in filament size.

Moreover, the weekly general shutdown which formerly afforded an opportunity to withdraw spinnerettes from service for testing, inspection, cleaning, exchange, etc., is no longer customary. Apparatus in the several operations of artificial silk manufacture has been so far improved that a general shutdown of the entire plant for an

overhauling at fixed intervals is no longer required in commercial practice.

As a result of all these changed conditions, it has become customary to withdraw each spinnerette from its bath at fixed periodic intervals (ranging from a few hours to several days, depending upon the standard of excellence established for the particular artificial silk being made) and to inspect the condition of the orifices in the spinnerette by rubbing away the liquids with the thumb or with a dry soft piece of cloth, paper, or the like. Thus, at relatively frequent intervals each spinning operation is interrupted. The interruptions represent a waste of material in the form of spinning solution and also of time consumed in threading the freshly coagulated filaments through the various godets, guides, rollers, and other guiding, tensioning and conveying mechanisms which are associated with the spinning apparatus. This train of guiding, tensioning, and conveying mechanisms provided for handling the fresh filaments is complicated. Each time that spinning is interrupted and begun again, the filament ends must be threaded through the whole train, so that the time lost is considerable.

"Continu" spinning is conducted in such a way that as a continuous filament is formed by extrusion and solidification of a spinning solution, a portion of the same continuous filament which has been formed earlier is being stretched, while other portions of the same continuous filament which have been formed still earlier are being subjected successively to other finishing operations such as washing, desulphurizing, bleaching, drying and twisting. In principle, "continu" spinning presents many outstanding advantages, among them reduction in labor and increased efficiency of equipment, and there is a tendency at present to adapt "continu" spinning on a large scale. There is, however, a very serious obstacle to such adoption. Freshly spun filaments are extremely delicate and tend to break easily. A broken strand of filaments in a process of "continu" spinning is disastrous, usually necessitating an interruption of the entire train of processes and a laborious and costly operation of starting up again.

From the foregoing, it will be clear that improvements are needed whereby spinning interruptions and the resulting difficulties may be avoided. Moreover, it is highly desirable that the improvements be of such character as not to necessitate the replacement or extensive alteration of present spinning equipment, which represents a large investment. As a result of our investigations we have developed improvements which substantially eliminate spinning interruptions through inexpensive changes to present spinning equipment and in a reliable manner.

In most artificial silk spinning operations, serious difficulties which bring about interruption may be anticipated for the most part by observing the surface conditions of the spinnerette and the character of the extruded material as it leaves the spinnerette. We have found that in wet spinning operations the observation preferably is made through a tube equipped with magnifying means, with one end submerged in the bath and its eye piece outside the coagulating bath. The space in the bath immediately adjacent the spinnerette should be illuminated either with a beam of light entering the tank from outside or by means of a submerged light. When such means are provided, it is relatively easy to anticipate difficulties that may cause spinning interruptions. It is seldom that the orifices in a spinnerette become clogged all at once or that other changes in spinning conditions occur suddenly. Usually there is a gradual change in the size of one or more of the filaments at the point of their formation or some other manifestation which serves as an indication of incipient spinning trouble. With a magnifying and illuminating unit (preferably portable), it is relatively easy to observe the surface condition of the spinnerette and of the filaments at the point of their formation at frequent intervals and thus determine when a spinnerette needs to be exchanged (instead of exchanging all of the spinnerettes at fixed intervals whether or not such exchange is necessary). This has the effect of reducing considerably the frequency of spinnerette replacement.

Freshly spun filaments attach themselves to each other if brought into contact with each other. The greater the length of filaments in contact with each other the firmer is the bond between them. The bonding together of the filaments may be due to the fact that they become entangled or entwined with each other, or to the fact that the filaments are still plastic and stick or cohere to each other, or to both of these causes. In any event, the bonding which results permits the filaments from one of a pair of neighboring parallel spinnerettes to be guided over and attached to the filaments issuing from the other spinnerette. Upon this fact depends that feature of our invention whereby spinnerettes may be withdrawn from a coagulating bath without spinning interruptions. The stream of spinning solution forced through one of a pair of substantially parallel spinnerettes placed close together in a bath is continued while a stream of spinning solution is started through the second or auxiliary spinnerette. The stream from the second spinnerette forms loose-ended filaments which are guided over until they are in contact with the filaments issuing from the first or regular spinnerette. Preferably the contact between the filaments is lengthwise and for a considerable distance and is made while the filaments are still plastic. (A firm bond between the filaments from the two spinnerettes results, however, due to the entangling action alone.) The spinning solution is eventually cut off completely from the first or regular spinnerette so that the spinnerette may be withdrawn from the bath, and the spinning of the filaments is taken up and continued on the second spinnerette. In this way there is no interruption of spinning to require re-threading, when a spinnerette is withdrawn from the bath for inspection, testing, exchange, etc.

The bundle or strand of filaments formed during the period when spinning solution is being extruded from both spinnerettes is described hereinafter as an "interim product."

The foregoing process may be carried out with various types of apparatus as described and claimed in our copending application Serial No. 131,598, filed March 18, 1937. The apparatus described hereinafter is, however, particularly useful, especially when it is desired to produce an easily-identifiable interim product during the change-over period from the regular spinnerette to the auxiliary spinnerette or vice versa and comprises a portable tank, a conduit communicating with the tank, a spinnerette attached to

said conduit, valved means for introducing the spinning solution into the tank and means for forcing the solution from the tank through the conduit and the spinnerette. This apparatus is combined with a regular spinning assembly and is adapted to operate in conjunction therewith. In the preferred form of the apparatus the portable tank is mounted on a horizontal rail or other conveying means for moving the tank and the accompanying auxiliary spinnerette along a battery of spinnerettes, and a metering device, such for example as a spin pump, is interposed in the conduit between the portable tank and the spinnerette. The preferred form of apparatus also has the conduit for spinning solution communicating with a lower portion of the tank and means for forcing gas under pressure into an upper portion of the tank, so that accumulated gas pressure will force the solution into the conduit.

Our invention, therefore, contemplates the combination (in rayon spinning apparatus of the "continu" type wherein a continuous filament may be produced while a spinnerette is temporarily withdrawn from service) which comprises a first spinnerette, means for forcing spinning solution through the first spinnerette, means for coagulating the solution thus ejected from the first spinnerette to form a filament, means for interrupting the flow of spinning solution through the first spinnerette, a portable tank for spinning solution, a second spinnerette disposable adjacent the first spinnerette and in substantial alignment therewith, a conduit connecting the portable tank to the second spinnerette, means for forcing spinning solution from the tank through the second spinnerette and into contact with the coagulating means to form a second filament, means for guiding the first and second filaments into contact with each other, and means for interrupting the flow of spinning solution from the second spinnerette. The foregoing combination preferably also includes a spin pump connected to the first spinnerette, a second spin pump mounted on the portable tank and a common driving means for both spin pumps.

In operating the above-described apparatus, identification of the interim product is facilitated by making it over-size. Over-size filaments may be produced by maintaining a full flow on the first or regular spinnerette for a short time after the auxiliary or second spinnerette comes into operation, and the filaments from both spinnerettes are joined. When changing from the auxiliary spinnerette back to the regular spinnerette a full flow is established on the regular spinnerette and after an appropriate interval, this flow is then cut off. The beginning and end of the interim product are then identifiable by the over-size portions, which may be caught later in any of the subsequent steps of the process, with a knot or slub catcher. If necessary, flow through the auxiliary spinnerette may be such that the entire interim product is over-sized, which permits the slub catcher infallibly to detect and break off the interim product.

The maintenance of a full flow at the regular spinnerette during change-over is of advantage when filaments of fine denier are spun in that the interim product is not so fine and delicate as to bring about accidental breakage during change-over with consequent interruption.

It is also of advantage to produce an interim product of different color as well as different size, thus facilitating its identification. The apparatus of our invention is adapted to accomplish this result, although it may be employed conveniently when it is not desired to produce an interim product of different size or color. Our invention will be more thoroughly understood in the light of the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a diagrammatic side elevation (partly in section) of a spinning assembly arranged for the practice of our invention and provided with an auxiliary spinnerette having a separate supply of spinning solution; and

Fig. 2 is a partial end elevation of the apparatus of Fig. 1.

Referring now to Figs. 1 and 2, it will be seen that along a battery of reguluar spin sets **60** operating in a spin bath **61**, there is mounted a horizontal slide rail **62**. There may be a line of 100 or more such regular spin sets in the same or different spin baths, each spin set being provided with a spinnerette **60A**, a gooseneck **60B**, a candle filter **60C** and a regular spin pump **63** and all being fed from a solution main **64** disposed below and parallel to the sets. The slide rail preferably is T shaped with the base of the T pointing toward the regular spin sets and with a longitudinal axis of the rail lying parallel to the main. On the rail, by means of a clip **65**, is mounted a horizontally disposed cylindrical tank **66** for an auxiliary supply **66A** of spinning solution. The tank may be slid along the rail from spin set to spin set, or be removed completely from the rail and carried to any desired position. If desired, other transport means such as a wheeled carriage may be provided for moving the tank from spin set to spin set.

An auxiliary spin pump **67** is mounted on the top of the tank and provided with a gear **67***a* which can be dropped into mesh on a driving gear **68** of the regular spin pump. Spinning solution is moved out of the tank **66** by means of a pipe **69** communicating with the inlet of the spin pump and extending into a well **70** in the bottom of the tank. On the outlet of the auxiliary spin pump is fastened an auxiliary spinning assembly comprising a candle filter **71**, an extra long gooseneck **72** and a spinnerette **73**.

Preferably, the auxiliary spinning assembly and the auxiliary spin pump are mounted pivotally on a swivel bracket **74** fastened to the top of the tank so that the spinning assembly can be tilted up out of the spin bath and the gear of the auxiliary spin pump can be swung up out of contact with the driving gear.

The swivel bracket **74** comprises a base plate **75** which rests on the tank and three uprights **76**, **77**, **78** formed integrally with the base. The pipe **69** extends upwardly to the upright **78** which has a bore **79** through which the spinning solution rises. The bore communicates with a short horizontal pipe **80** which is journalled in the upright **79** and is attached to the spin pump. A horizontal set screw **81** is threaded in the upright **78** and bears against the end of the pipe **80**. The pipe **80** in the upright **78** forms a swivel joint which may be tightened by the set screw, or released to permit the gear **67***a* to be disengaged from the driving gear **68**.

The outlet of the spin pump **67** communicates with a short pipe **82** which passes through a journal in the upright **77** and is seated in the side of a second short pipe **83**, and communicates with this pipe through a channel in the seat. The short pipe **83** is attached to the candle

filter 71. The other side of the short pipe has a blind seat in which an axle 84 is disposed. This axle is journalled in the upright 76 and a set screw 84A is provided for forcing the axle into the seat. This set screw may be employed to regulate the swivel joint formed by the seats in the pipe 83 and the members 82 and 84.

The tank 66 is provided with a valved inlet 85 for spin solution in which may be included a distinguishing dye or other coloring matter. The inlet may be at any convenient point, and for example, may communicate with the tank through the well 70.

The tank has a gas inlet at a point near its top. The gas inlet is provided with a valve 86 and a pressure gauge 87.

The operation of the apparatus of Figs. 1 and 2 is as follows:

The tank 66 is filled with an appropriate spin solution, such as one containing a distinguishing dye, and the apparatus is moved to a convenient position on the rail adjacent a regular spinnerette which is to be taken out of service. Compressed air or other gas is forced into the tank so that the somewhat viscous spinning solution tends to flow up the pipe 69 to the auxiliary spin pump. Air may be admitted either intermittently or continuously, but because of the viscous character of the spinning solution the use of gas pressure to force solution up to the auxiliary spin pump is strongly recommended.

The gear 67A on the auxiliary spin pump is then swung down into engagement with the driving gear 68 so that solution is pumped to the auxiliary spinnerette 73 from the tank. The auxiliary spinnerette is then swung down into the spin bath at a point adjacent the spinnerette which is to be taken out of service. Filaments are formed at the auxiliary spinnerette and these filaments are guided over with a rod 90 or the like until they attach themselves to the filaments issuing from the regular spinnerette. When a sufficient length of filaments has attached the formation of filaments at the regular spinnerette is interrupted, for example, by closing a valve (not shown) between the solution main 64 and the regular spin pump 63, or by withdrawing the regular spinnerette from the trough and swinging the pump 63 out of engagement with the driving gear 68. Repairs to or replacing of the regular spin pump or the regular spinning assembly may then be made. Thereafter, with the regular spinning assembly in good order and back into spinning position, formation of filaments at the regular spinnerette is resumed; these filaments are guided so as to attach themselves to the interim product; a firm bond is permitted to form and then the flow of solution to the auxiliary spinnerette is interrupted by tilting it out of the bath trough and disengaging the gears 67A and 68. The apparatus may then be moved to another regular spinnerette and the process repeated.

As shown in Figs. 1 and 2, the auxiliary spin pump and the auxiliary gooseneck are swivelly mounted in the bracket, solution being supplied to the spin pump and taken from the spin pump to the near end of the auxiliary spinning assembly through the hollow axles or pipes. If desired, the auxiliary spin pump may be omitted, in which case solution is fed from the riser pipe 69 through a hollow axle of the bracket directly into the auxiliary spinning assembly. In such case it is convenient to provide a valve at some point between the pipe 69 and the auxiliary spinnerette so that the flow of solution from the tank 66 can be controlled.

By eliminating the auxiliary spin pump, the apparatus is considerably simplified. However, such elimination makes it difficult to control and to maintain uniform the delivery of spinning solution through the auxiliary spinning assembly and the resulting character of the extruded interim product. We prefer, therefore, to use an auxiliary metering pump in connection with the auxiliary spinning assembly as shown.

We claim:

1. In rayon spinning apparatus of the "continu" type wherein a continuous filament may be produced while a spinnerette is temporarily withdrawn from service, the combination which comprises a first spinnerette, means for forcing a spinning solution to eject through the first spinnerette, means for coagulating the solution thus ejected from the first spinnerette to form a filament, means for interrupting the flow of spinning solution through the first spinnerette, a portable tank for a second supply of spinning solution, a second spinnerette disposable adjacent the first spinnerette and in substantial alignment therewith, a conduit connecting the portable tank to the second spinnerette, means for forcing spinning solution from the tank through the second spinnerette and into contact with the coagulating means to form a second filament, means for guiding the first and second filaments into contact with each other, and means for interrupting the flow of spinning solution from the second spinnerette.

2. Apparatus according to claim 1 in which a battery of first spinnerettes are disposed substantially side by side in contact with the means for coagulating the solution, and means are provided for moving the portable tank and the second spinnerette along said battery.

3. Apparatus according to claim 1 having a spin pump for forcing spin solution through the first spinnerette and a second spin pump for forcing solution through the second spinnerette, a common means for driving both spin pumps, means for disengaging the first spin pump from the driving means, and means for disengaging the second spin pump from the driving means.

4. Apparatus according to claim 1 in which the conduit connecting the second spinnerette and the portable tank is swivelly mounted on the tank and a swivel mounting is provided for the first spinnerette.

5. Apparatus according to claim 1 having a spin pump for forcing spinning solution through the first spinnerette, a second spin pump for forcing solution through the second spinnerette, said second spin pump being mounted on the portable tank, both spinerettes being swivelly mounted.

6. Apparatus according to claim 1 having a spin pump for forcing spinning solution through the first spinerette, a second spin pump mounted on a portable tank for forcing solution through the second spinnerette, a common driving gear for both spin pumps, a gear on the second spin pump adapted to engage the driving gear, and means for disengaging the gear on the second spin pump from the driving gear, both spinnerettes being swivelly mounted so that they may be withdrawn from the coagulating means.

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