Aug. 28, 1962 R. LEVISON ETAL 3,050,775

SPINNING OF CELLULOSE FILM

Filed March 24, 1960 2 Sheets-Sheet 1

Fig 1

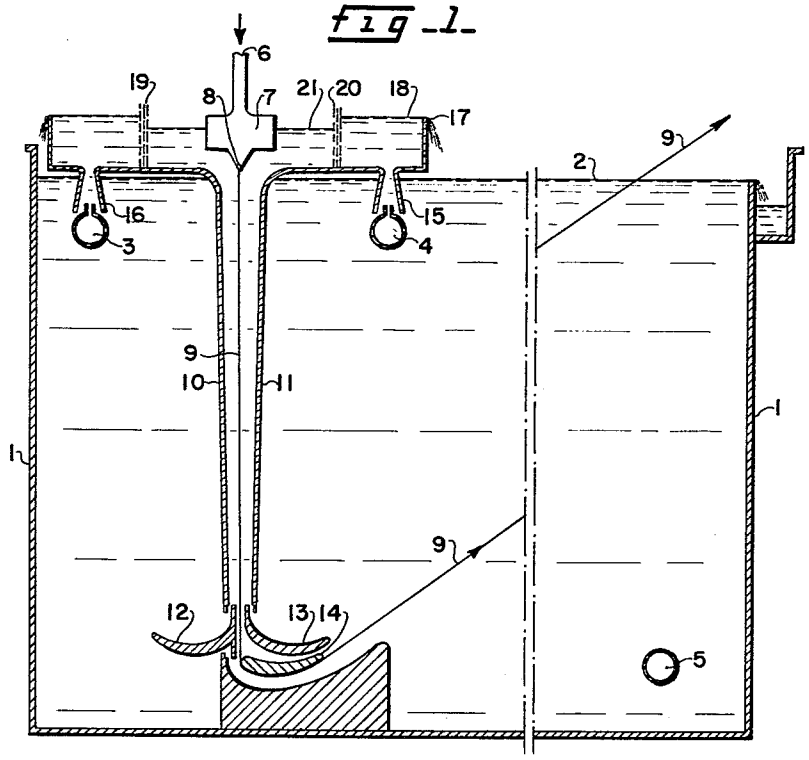


Fig 2

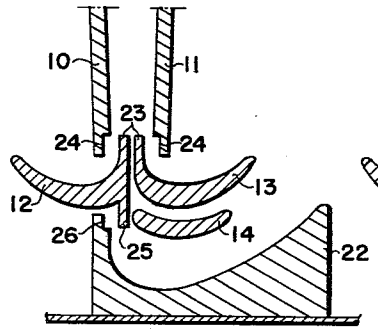
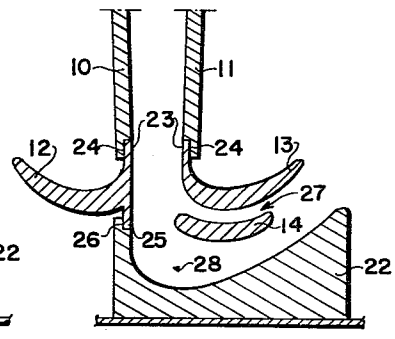


Fig 3



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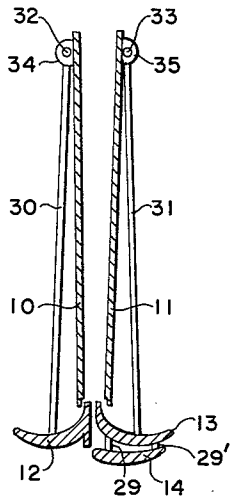
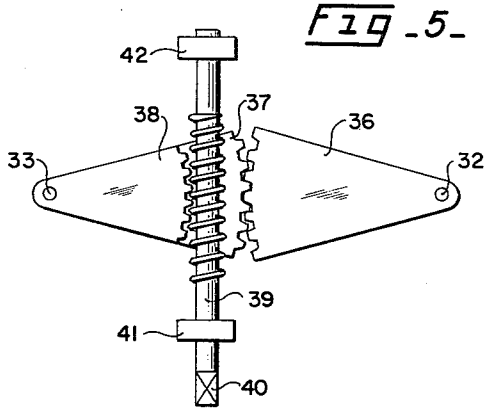


Fig. 4.

Fig. 5.



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SPINNING OF CELLULOSE FILM

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9 Claims. (Cl. 18—15)

This invention relates in general to wet spinning of regenerated cellulose, and more particularly to a film or ribbon forming process and apparatus wherein a liquid spinning mass, such as viscose, is spun through a casting device having a casting slit extending into a liquid coagulating spinning bath.

Such a system as that briefly described above is known and usually consists of spinning a liquid mass, in this case viscose, vertically downwardly out of an oblong or elongated casting slit into a spinning bath in order to coagulate the viscose. The casting slit generally is submerged in the bath and the resulting sheet formed by the process is deflected out of the spinning bath, aftertreated, and subsequently wound onto collecting means. The aforesaid deflecting point is located deep in the spinning bath so that the resulting sheet will be strong enough to withstand deflection.

This known system has several disadvantages. It has, for instance, been found necessary at the beginning of the spinning process to pass the forming film by hand under the first deflecting point and then to guide it manually throughout the bath. Thus, the depth of the deflecting point in the spinning bath cannot be greater than the arm length of the operator. In order to obtain a satisfactory coagulation of the viscose in this limited bath length, high acid concentrations must be used, although it is desirable to use lower acid concentrations in order to obtain higher film strength.

It has also been found that in using the known processes, higher spinning rates lead to loss of strength in the film and, additionally, lumps and undulations occur in the surface thereof. These lumps and undulations often seem to be accompanied by an uneven distribution in thickness throughout the film. The latter phenomenon leads to differences in drying speed and shrinkage during further processing. On increasing the spinning rate of the machine, all of these phenomena mentioned make the resulting products commercially unsuitable or the production of films entirely impossible due to an excessive number of film ruptures.

It is an object of this invention to provide a process and apparatus for spinning cellulose film which does not have the disadvantages enumerated above.

Another object of the present invention is to provide a cellulose film spinning system which results in a stronger film and which substantially eliminates undulations and/or lumps heretofore found in the finished product.

An additional object of this invention is to provide a process and apparatus which is particularly suitable for low acid spinning of cellulose film.

Still another object of the present invention is to provide film casting process and apparatus which can be spun in automatically and thereby which can utilize spin baths of unusual depths as well as low acid concentrations.

The foregoing objects may be accomplished, in accordance with this invention, if the freshly spun film is guided between a casting slit and first deflecting point within a substantially vertical shaft-like spinning compartment or spinning case which is open at both the upper and the lower end, and which is entirely filled with spinning bath. The spinning compartment should tightly enclose the spinning product, or film.

There are several advantages of this system of spinning. As the spinning case or compartment is narrow, the freshly spun sheet is guided more efficiently during spinning-in and may be dragged or forced into the compartment as far as the first deflecting point by a bath current. It has now been found that spinning-in is also possible with longer lengths of treatment through the spinning bath between the casting slit and the first deflecting point. Longer treatment lengths of course permits use of lower acid concentrations in the bath and these concentrations are adaptable to the requirements for higher strength of films being spun at a higher speed.

It should be remarked here that this longer bath length also may be realized, theoretically at least, by joining the first deflecting point and the casting slit by means of a coupling system thus making it possible to bring the casting slit and deflecting point close to each other during spinning-in, while permitting subsequent movement of said members apart until the desired length of treatment has been obtained. Such a construction, however, results in considerable technical disadvantages, and does not prevent the forming of lumps, undulation, differences in thickness or weak spots in the sheet or web. These last-mentioned difficulties were not encountered by using a system in accordance with the present invention.

Surprisingly, it has been found that the flow of spinning bath is controlled in such a manner that no lumps, undulations, etc., are pressed into the freshly spun sheet. As a result of this, the uniformity of sheet thickness, as well as strength, are considerably improved, the film as a whole is stronger and the drying thereof also takes place more evenly over the surface. With greater spinning rates film breakages do not occur, and the film is of very high commercial quality. It has also been found that only through use of the vertical spinning compartment or case can these favorable results be obtained.

The bath resistance resulting from the compartment or case walls, which resistance is finally transmitted to the film as a tensile stress, may be decreased by providing said walls with perforations, horizontal slits or even by making the same from gauze. A very substantial relieving of the film in the first length of the bath, however, seems to be obtained if the compartment walls are closed and if the spinning bath liquid and film are forced through the compartment at a speed greater than that which corresponds to the dragging action of the film. Thus it appears to be possible to relieve the freshly spun sheet almost entirely from drag due to bath resistance, and in this way to obtain even higher spinning rates.

It is therefore preferred to provide means for insuring uniform flow of the spinning bath liquid at the compartment entrance. For this purpose several gauzes may be placed at the entrance. Especially good results are obtained if the flow of spinning bath through the compartment is accelerated in the direction of the first deflection point. With such an arrangement it is possible to adjust the velocity of the spinning bath stream to the increasing velocity of the film in the first length of the bath, the latter of which results from stretching of the film in this length of bath.

Best results of the described system are obtained if the first vertical length of the bath is longer than that of known systems, for example, if the path of the film through the spining compartment is at least 0.5 m. and preferably about 2 m. in length.

The flow of liquid in the compartment is also influenced by the conditions of flow after the bath leaves the spinning zone. For this purpose special care preferably should be taken for the flow of spinning bath after it leaves the compartment. It has been found that a very quiescent flow is obtained if, after leaving the spinning compartment,

the streams of spinning bath are deflected to either side of the film. By this measure an additional advantage is obtained, i.e., the downwardly directed impulse or force of the spinning bath liquid does not produce a resultant action of force across the film after the first deflecting point. Therefore, the film moves more quietly after this deflecting point and this reacts favorably on the flow within the compartment. Accordingly, a more flat, smooth and even film is obtained. According to this invention it has been found that even without a spinning compartment, better results are obtained merely by deflecting the streams of spinning bath from the film near the first film deflecting point.

It should be noted that a system for spinning films from viscose has already been described wherein film is passed through a compartment shaped space before the first deflecting point. This known system, however, differs in many essential respects from the present invention. The casting slit, for instance, is not submerged in the spinning bath but is arranged thereabove at a rather considerable distance. Therefore, the extruded viscose solution must first be transported through an air gap across this distance before the solution is submerged into the spinning bath. Flow and coagulation phenomena totally different from this invention occur, in the known system, when that film enters the spinning bath. Moreover, in all known processes, it appears that the compartment shaped spinning bath space was intended for nothing more than obtaining a more compact construction of the spinning machine. In this known device a compartment shaped space is provided with a width considerably greater than that characteristic for the spinning compartment used in accordance with the present invention. Finnally, the known compartment shaped spinning bath space extends beyond the first deflecting point whereby undesired raising of the liquid level occurs, especially at the point of deflection.

Besides the described method, this invention also relates to an apparatus, the apparatus including a casting device provided with a casting slit, a spinning bath trough with a spinning bath supply system above the opening of the slit, as well as a first deflecting member at the bottom of the trough, with the improvement comprising a spinning compartment or case having a substantially rectangular cross-section provided between the casting slit and the deflecting member, said case being only slightly wider than the sheet and having a breadth of less than 15 cm., preferably less than 6 cm.

According to a preferred embodiment of the invention, an apparatus is provided which has closed compartment walls and a system for pumping spinning bath liquid through the compartment on either side of the film and in the direction of movement thereof. Hereinabove it has already been explained that a reduction of bath resistance on the coagulating sheet may be obtained by this invention. Therefore, it does not matter in principle how the pumping system operates. The spinning bath liquid may, for example, be circulated by a blade pump while the compartment walls themselves might conceivably do the transporting. In the latter case, these walls should be constructed as endless conveyor belts which are kept moving by a driving device.

In order to obtain a constant flow with very little turbulence, a positive level difference should be maintained between the spinning compartment and bath. In this manner the entire system has a buffering action capable of eliminating disturbances in the bath flow. In order to obtain a satisfactory flow through the compartment during spinning, it is preferred that the compartment walls be parallel at the outlet of the casting slit and form a gradually tapering opening in the direction of the deflecting members. Moreover, it has been found to be very satisfactory if the length of the compartment is a least 0.5 m., and preferably 2 m.

In an embodiment of the apparatus in which an especially satisfactory flow of spin bath out of the compartment and along the film is obtained, at least one pair of deflecting blades is arranged between the lower edge of the compartment and the deflecting member at either side of the film path in order to deflect the stream of spinning bath in a transverse direction. As mentioned above, these blades produce an improvement even if a spinning compartment is not utilized. In order to increase the effect thereof, and also in order to prevent undesirable turbulences in the bath, the deflecting member according to the invention is arranged in the shape of a deflecting blade for the spinning bath liquid. For easy spinning-in, a system may also be provided for moving the deflecting blades and the deflecting member to and from each other in a horizontal direction. Any suitable linkage means may be provided for affording this movement. With these elements in the remote position the leading end of film may be brought into its proper path for threading in by the stream of liquid.

Other objects and advantages will become apparent upon study of the following detailed disclosure taken in conjunction with the accompanying drawings, wherein

FIGURE 1 represents a longitudinal elevational view, in section, of a part of the apparatus including the casting head and first or spinning bath;

FIGURE 2 is an enlarged sectional view of the deflecting mechanism, shown in normal operating condition;

FIGURE 3 is a sectional view of the device shown in FIGURE 2, but illustrated in a spinning-in position;

FIGURE 4 is a longitudinal elevational view, partly in section, of a portion of the casting apparatus of FIGURE 1 showing a suitable conventional device for controlling the movement of the deflecting blades of this invention; and

FIGURE 5 is an enlarged detail view of a suitable pivoting means for use in the upper section of the controlling device of FIGURE 4.

The container for spinning bath or coagulating medium is indicated at reference numeral 1, see FIGURE 1. The spinning bath fills this container to a level such as shown at 2. Fresh spinning bath is introduced vertically upwardly through a longitudinal slit in the horizontal pipes or conduits 3 and 4, and used or spent spin bath discharges continuously through an outlet opening 5 provided in the container 1. The supply of fresh spinning bath is equal to the discharge of used bath. Moreover, the level 2 of the spinning bath is kept absolutely constant by the presence of an overflow edge on the container 1.

Viscose is pumped into the casting head 7 through the viscose conduit 6 and from there is extruded through the casting slit 8. The viscose then forms a film 9 which is passed vertically downwardly between the walls 10 and 11 of a tapering compartment or case. After leaving this compartment the film passes, as shown in FIGURE 1 of the drawing, between two deflecting blades 12 and 13 located at the bottom of the container, and thereafter, the film is deflected around the wing-shaped deflecting member 14 also located at the bottom of the container 1. From there the film 9 is pulled away in an upwardly sloping direction through the bath by means of a withdrawal system (not shown) and subsequently passed through a series of aftertreatment devices (also not shown).

Some of the spinning bath in the compartment formed by the walls 10 and 11 comes directly from the pipes 3 and 4 in the following manner. From these pipes fresh spinning bath is injected vertically upwardly through a longitudinal slit into the ejectors 15 and 16. These ejectors are positioned in the bottom of container 17, as shown. About twice as much used spinning bath as fresh bath is forced into the container 17 to the level 18 by the fresh bath. From this level the bath flows through a series of gauzes or filters 19 and 20, respectively, to the casting head and the liquid level drops slightly to that shown

at 21. As a result of the level difference between 21 and 2, the spinning bath between the compartment walls 10 and 11 is forced downwardly with a velocity which differs only slightly from the speed of film 9. The level 18 remains constant because of the flow of excess spin bath over the edge of the container 17.

After leaving the spinning case, the spin bath liquid is deflected substantially by deflecting blade 13 in a direction parallel to the film sheet, which moves in an upwardly sloping direction, and by the blade 12 in a direction which is symmetrical relative to the vertical spinning axis. The wing-shaped deflecting member 14 also has a form which is suitable for deflecting the spinning bath parallel to the film sheet.

In FIGURE 2 the situation adjacent to the bottom of the compartment, in the position of normal operation, is shown on an enlarged scale, although the film sheet has been omitted for purposes of clarity. The slit between the deflecting blades 12 and 13 amounts only to a fraction of the total outlet opening of the compartment. In spite of this, some liquid flows through the opening or slit and thereupon escapes partly through the slot between the deflecting blade 13 and the deflecting member 14, and further through apertures between the deflecting blade 12 and a streamline lower supporting member 22.

In order to spin in the film in a simple manner, the members 12, 13 and 14 are movably mounted in any known manner and can be shifted from the FIGURE 2 position into a position shown in FIGURE 3. The blade 13 and the deflecting member 14 are coupled together by suitable linkage, such as 29 and 29^1 shown in FIGURE 4, and therefore move simultaneously. In the opened position, as shown in FIGURE 3, the compartment wall 10, the deflecting blade 12 and the streamline member 22 form one continuous plane. By the same token, the compartment wall 11 and the deflecting blade 13 form another continuous plane. For this purpose the blades are provided with small lips 23 and 25 which fit accurately into recesses of the lips 24 and 26 on the compartment or case walls 10, 11, and on the streamline member 22, respectively.

In the FIGURE 3 or spinning-in position of the spinning case, there are only the channels 27 and 28 between parts 13, and 14, or 14 and 22, respectively. The channel 28 as shown is much wider than the channel 27. The flow resistance through this channel 28 therefore is considerably less than through the channel 27. As a result of this, the stream of spinning bath flowing from the spinning case will travel at a greater velocity through the channel 28 than through channel 27.

A suitable device for controlling the movement of deflecting blades 12, 13 and 14 is shown in FIGURE 4. Blade 14 may be connected to blade 13 by means of connecting members 29 and 29^1 since it is desired that deflecting blade 14 move simultaneously with deflecting blade 13. Movement is transmitted to blades 12 and 13 by means of their attachment to the lower end of bars 30 and 31 respectively. Bars 30 and 31 are connected at their upper ends to pivots 32 and 33, respectively, which in turn may be pivoted in bearings 34 and 35. Bearing 34 is connected to casting compartment wall 10 and bearing 35 is connected to casting compartment wall 11.

Motion will be imparted to deflecting blades 12, 13 and 14, and corresponding bars 30 and 31, by turning pivots 32 and 33 to swing the deflecting blades from the position shown in FIGURE 2 to that shown in FIGURE 3. It is desired that motion be imparted to pivots 32 and 33 from outside the wall of compartment 1 (see FIGURE 1). This expedient will be readily understood by those skilled in the art since it is obvious that the corrosive nature of the coagulating medium will be harmful to any moving parts. Moreover, moving parts may cause contaminants to be deposited in the coagulant.

FIGURE 5 shows an enlarged detail view of a suitable pivoting mechanism for imparting motion to the deflecting

blades 12, 13 and 14. Gear section 36 is mounted on pivot 32 and gear sections 37 and 38 are mounted on pivot 33. Motion will be imparted to bars 30 and 31 and pivots 32 and through worm gear 9 which meshes with gear section 38. Gear section 38 will turn pivot 33 to which it is attached. Since gear section 37 is also attached to pivot 33, motion imparted to gear section 38 will also move gear section 37 which in turn imparts motion to gear section 36 (and pivot 32), due to being intermeshed therewith. Worm gear 39 is prevented from lateral movement and is retained by bearings 41 and 42. Motion is imparted to worm gear 39 by means of key 40. Turning of key 40 will move pivots 32 and 33 simultaneously therewith.

It is to be understood that the apparatus appearing in FIGURES 4 and 5 is shown by way of illustration only and should not be construed in a limiting manner with regard to this invention. It is intended that any suitable means may be employed to impart controlled motion to deflecting blades 12, 13 and 14. For example, use may also be made of toggle linkages, rack-chains, hydraulic pistons, electrical following circuits, and the like.

Spinning-in of the film may be carried out in the following manner. The apparatus is first brought into the position shown by FIGURE 3, or with the blades 12, 13, 14 pushed apart into the widest position by turning a cam or any other suitable linkage (see FIGURES 4 and 5). Thereafter, the circulation of spin bath is begun and bath flows downwardly through the compartment at a high velocity. Because of the difference in resistance, most of the bath will flow through channel 28, although some will also flow through channel 27, and the streams join at the outlet of these channels. The positioning of pipes 3 and 4 and of outlet opening 5 is chosen so that liquid flowing out of the channels 27, 28 is directed in an upwardly sloping direction as far as possible. Subsequently, viscose is extruded or pressed into the bath through the conduit 6, casting head 7, and casting slit 8. The film sheet or web 9 being formed is carried into and through the compartment by the bath stream, after which the sheet is dragged around the deflecting member 14 by the strong flow of bath through channel 28. That is, the fresh coagulating medium flows at a sufficiently high rate of speed to produce movement in the ribbon-shaped product because of frictional resistance existing between the flowing coagulating medium and the freshly-extruded ribbon-shaped product, as is well understood in the art. After leaving this channel, the film is pressed upwardly into the container 1 partly by the impulse of streams coming from channels 27, 28 and partly by specific gravity of the film, which is lower than that of the spinning bath. At this point, the film can be grasped by the operator and guided further over conveying rollers (not shown) outside the container 1.

The further treatment of film is analogous to known methods and will not be described in detail. After the film has been spun in through the first bath the blade elements 12, 13, 14 are moved back into the position shown in FIGURE 2 by turning the previously mentioned cam. The slit between lips 23 of blades 12 and 13 now is only slightly wider than the thickness of the film 9, whereas the slit between lip 25 of blade 12 and the deflecting member 14 is even more narrow. As a result of the latter, the film passes centrally of the slit between the lips, and most of the spinning bath from the compartment is deflected symmetrically on either side of the film by blades 12 and 13, and thereafter is guided away from the film. The mass of bath carried along by the film through the slit is stripped off for the greater part by the deflecting member 14. In this way the downwardly directed pressure of bath flowing from the compartment onto the film is substantially eliminated.

It has been found possible to spin films at higher velocities than heretofore possible with the apparatus and process described hereinabove. Moreover, the resulting

product did not show any undulations or lumps, and was very uniform in thickness. Also, the strength was found to be considerably higher than that of films which had been manufactured by known systems.

Inasmuch as other alternatives will become apparent to those skilled in this art, it is intended that the scope of this invention be limited only to the extent set forth in the following claims.

What is claimed is:

1. A method for wet spinning ribbon-shaped products comprising the steps of extruding a liquid spinning mass vertically downwardly through a casting device having a casting slit extending into a coagulating medium, completely enclosing the freshly-extruded ribbon-shaped product in a body of coagulating medium, guiding the extruded product vertically downwardly by flowing the coagulating medium in the direction of spinning at a sufficiently high rate of speed to produce movement in the ribbon-shaped product by reason of frictional interaction between the coagulating medium and the ribbon-shaped product, and deflecting the coagulating medium away from the ribbon-shaped product while simultaneously accelerating the flow thereof.

2. An apparatus for wet spinning ribbon-shaped products comprising a container filled with a coagulating medium, a casting device having a casting slit for extruding ribbon-shaped products, said casting slit extending into the coagulating medium, a spinning case extending vertically downwardly from said casting device in alignment with said casting slit for receiving said freshly-extruded ribbon-shaped products, said case having walls defining a generally rectangular opening slightly wider than the products being spun and having a breadth of less than 15 cm., means for pumping fresh coagulating medium alongside the freshly-extruded ribbon-shaped products in the direction of spinning, deflecting means at the bottom of said container in alignment with said case and said casting slit and operating to divert coagulating medium transversely away from the ribbon-shaped product, and further means at the bottom of said container for changing the direction of travel of the ribbon-shaped product after the same has been substantially coagulated.

3. An apparatus as set forth in claim 2 wherein the breadth of said spinning case opening is less than 6 cm.

4. An apparatus as set forth in claim 2 wherein said spinning case walls are parallel at the end adjacent the casting slit and form a gradually tapering opening which narrows in the direction of said deflecting member.

5. An apparatus as set forth in claim 4 wherein the length of said spinning case, in the direction of spinning, is at least 0.5 m.

6. An apparatus as set forth in claim 4 wherein said length is about 2 m.

7. An apparatus for wet spinning ribbon-shaped products comprising a container filled with a coagulating medium, a casting device having a casting slit extending into the coagulating medium, a pair of deflecting blades mounted in the bottom of said container and operating to divert coagulating medium transversely away from each side of said ribbon-shaped product, and a deflecting member mounted adjacent said deflecting blades for changing the direction of travel of said ribbon-shaped product after the same has been substantially coagulated.

8. An apparatus as set forth in claim 7 and further comprising means for simultaneously moving one of said deflecting blades and said deflecting member relative to said other deflecting blade for spinning-in said ribbon-shaped product.

9. A method as set forth in claim 1 wherein said last-named step includes deflection of flowing coagulating medium on both sides of the ribbon-shaped product.

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