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APPARATUS FOR CASTING FILM

Filed March 29, 1961

FIG. 1

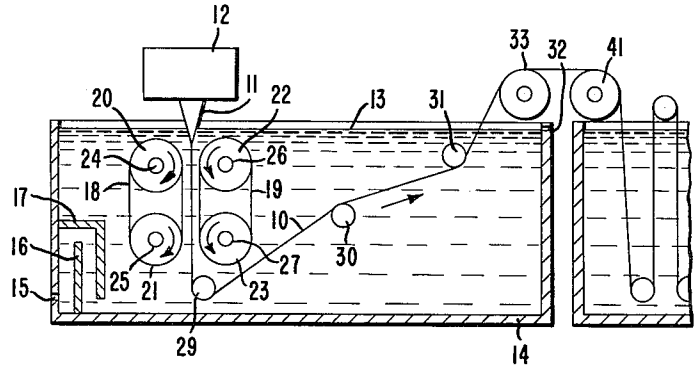
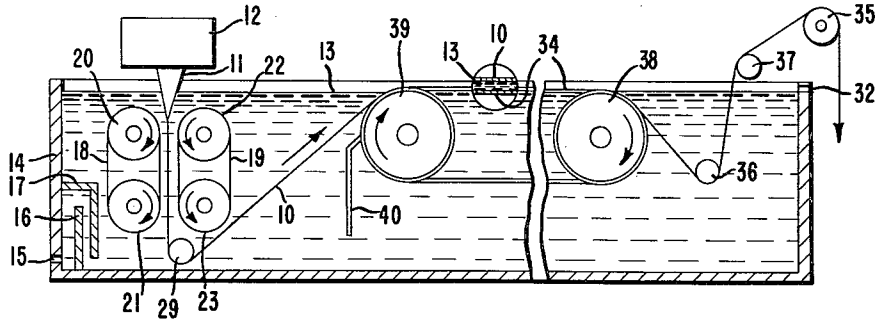


FIG. 2



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APPARATUS FOR CASTING FILM

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This invention relates to the casting of regenerated cellulose film and, more particularly, to an apparatus for casting regenerated cellulose film at relatively high velocities (as high as 200 yards per minute or higher) without adversely affecting the properties of the film.

This application is a continuation-in-part of our co-pending application Seiral No. 689,523, filed October 11, 1957, and now abandoned.

In casting regenerated cellulose film, a viscous film-forming solution is extruded through the lips or orifice of a hopper into an acid-sulfate coagulating liquid. When drawn rapidly through the liquid bath, the film tends to draw liquid along with it causing a rapid flow of bath in the region of the extrusion lips. This flow is augmented by increased circulation of bath in an effort to keep the bath composition and the temperature constant at the higher film rate. The rapid movement of bath in the region of extrustion provides turbulence which tends to affect the quality of the film adversely. The turbulence strains the freshly-formed film, often causing breaks and generally resulting in a streaky, narrowed, physically weakened regenerated cellulose film. Additional strain on the film is provided by the drag of the liquid bath on the film as the film moves through the bath.

The object of the present invention is an apparatus which will minimize the tension on the freshly-extruded film and produce a high quality regenerated cellulose film at relatively high velocities while minimizing turbulence. Other objects will appear hereinafter.

The objects are accomplished by an apparatus comprising means for extruding the film-forming solution below the surface of a liquid coagulant contained in a vessel and between two submerged moving belts adapted to propel coagulating liquid therebetween and in the direction of the extruded film sheet.

While the above-described dual belt system is useful in a conventional extrusion process, maximum benefits are obtained when the apparatus is used in combination with a "moving" flume. The latter is the subject of application U.S. Serial No. 689,735 to Hinkle and Stults now U.S. Patent 2,962,766. The moving flume tends to extend the protection of the gel film to a point where the film is completely coagulated.

The operation and the advantages of the invention will be more readily apparent by referring to the following detailed description in conjunction with the accompanying drawing, in which:

FIGURE 1 is a sectional diagramamtic side elevation of one embodiment of the invention; and

FIGURE 2 is a sectional diagrammatic side elevation of another embodiment of the invention.

In FIGURES 1 and 2 a viscose solution which may contain 4%–15% cellulose and 4%–15% sodium hydroxide is extruded downwardly in the form of a sheet of gel film 10 through the lips 11 of hopper 12 into the coagulating liquid or bath 13 disposed in the vessel 14. The liquid coagulant is usually an acid-sulfate bath containing 4%–15% sulfuric acid and 5%–20% sodium sulfate. The liquid is introduced into the vessel 14 from pipe inlet 15 separated from the hopper section of the vessel by two baffles 16 and 17. The liquid is forced to pass around

the baffles to dissipate turbulence near the region of extrusion. The liquid leaves vessel 14 through outlet 32.

Submerged in the liquid in vessel 14 and immediately below the hopper lips are two endless belts 18 and 19 adapted to rotate in the directions indicated by the arrows in the figures. The belts 18 and 19 are fitted around rolls 20 and 21 and rolls 22 and 23, respectively, the rolls being on drive shafts 24, 25, 26 and 27 mounted between the walls of vessel 14 and driven by conventional variable speed motor means not shown.

The film sheet 10 is passed downwardly between the two endless belts and is then led around a rod 29 disposed below and between the two belts. By means of guide rolls 30 and 31 and drive rolls 33 and 41 in FIGURE 1, the gel film 10 is drawn from the coagulating liquid in vessel 14 to the subsequent purification, bleaching and softening treatments. The endless moving belt 34 in combination with guide rolls 36 and 37 and drive roll 35 serve a similar purpose in FIGURE 2. The driving sources for the power-driven rolls 33, 35 and 41 are not shown but may be conventional variable speed motors.

The belt 34 in FIGURE 2 is adapted to convey liquid at a velocity substantially equal to the velocity of liquid between belts 18 and 19. The belt 34 must be at least as wide as the film and should be constructed of a suitable, flexible, non-corrosive material. A preferred material is a neoprene-covered fabric approximately one-quarter of an inch thick. The belt 34 is fitted around rolls 38 and 39, which rolls are driven by a variable speed drive not shown. The belt is placed so that it picks up bath liquid 13. A squeegee-type baffle 40 serves to adjust the amount of liquid on the belt and to minimize any turbulence that might be cause by the pumping action of the belt. The level of the bath in vessel 14 is preferably about one inch below the top section of the belt 34. However, the height of the bath in vessel 14 is adjustable and may vary anywhere from slightly above to three inches below the level of the belt. The important consideration is that the bath level be adjusted so that the belt will remove only enough coagulating liquid from the bath to substantially complete coagulation of the film and partially regenerate the cellulosic film by the time the film leaves vessel 14. Thereafter, regeneration of the cellulosic film is completed; the film is washed, desulfured, bleached and softened in the conventional manner.

It should be noted that the speed of belts 18 and 19 can be varied to control the velocity of the liquid coagulant therebetween. It should also be noted that the film is drawn independently of the liquid and the film velocity depends substantially on the speed of the drive rolls 33 and 41. It is preferred that the bath liquid move at a slightly lower speed than the speed of the film. It has been found that in this way the motion of the weak gel film is stabilized to an even greater degree than when liquid and film travel at the same speed. However, for optimum results, the process may be operated so that the speed of the liquid between the dual belts and, in the embodiment shown in FIGURE 2, both between the dual belts and on the moving endless belt, is from 80% to 125% of the film speed.

In the following example, a viscose containing 8.6% cellulose and 5.4% sodium hydroxide was cast in the apparatus shown in FIGURE 2 using a liquid coagulant containing 12% sulfuric acid and 18% sodium sulfate. The clearance between the dual belts was ½ inch. The speed of the dual belts 18 and 19 and the moving belt 34 were adjusted to move the liquid coagulant at approximately the same speed that drive roll 35 moved the gel film, a speed of 100 yards per minute.

As a control, the identical viscose was extruded into the identical liquid coagulant using the conventional ap-

paratus, a disclosure of which may be found in U.S. Patent 1,548,864 to Brandenberger.

The film produced by the present invention was wider, stronger and less oriented than that produced in the control.

While the invention has been described for the casting of viscose vertically downward into an acid-sulfate bath to form regenerated cellulose film, the invention is applicable to any system, horizontal, vertical or oblique, wherein a film may be produced from a coagulable film-forming dispersion or solution by extrusion into a solution of a chemical coagulant. In the case of cellulose film, the invention is applicable to the extrusion of viscose, cuprammonium solutions or solutions of cellulose in inorganic salts and organic acids and organic solvents into known chemical coagulants. The apparatus of the invention is particularly useful for high speed casting. However, the apparatus may be used for casting film at velocities from 40 yards per minute to 200 yards per minute or higher.

Having fully disclosed the invention, what is claimed is:

1. In an apparatus composed of a vessel adapted to contain a liquid coagulant; means for extruding a film-forming solution in the form of a sheet disposed above said vessel and adapted to extrude the film-forming solution downwardly into and below the surface of the liquid in said vessel; the improvement which comprises two endless belts mounted in said vessel immediately below said extrusion means, disposed on either side of the extruded film sheet and adapted upon movement thereof to propel liquid coagulant therebetween; means for maintaining the belts out of contact with the extruded film sheet; and means for drawing said film sheet from said vessel.

2. An apparatus as in claim 1 wherein the two endless belts are adapted to propel liquid coagulant at a lower velocity than the speed at which the film sheet is drawn.

3. An apparatus as in claim 1 wherein the two endless belts are adapted to propel liquid coagulant at a velocity equal to 80%–125% of the speed at which the film sheet is drawn.

4. In an apparatus composed of a vessel adapted to contain a liquid coagulant; means for extruding a film-forming solution in the form of a sheet disposed above said vessel and adapted to extrude the film-forming solution downwardly into and below the surface of the liquid in said vessel; the improvement which comprises two endless belts mounted in said vessel immediately below said extrusion means, disposed on either side of the extruded film sheet and adapted upon movement thereof to propel liquid coagulant therebetween; means for maintaining said two endless belts out of contact with the extruded film sheet; an endless belt disposed partially in said vessel adapted upon movement thereof to convey liquid coagulant in a horizontal direction thereon; and means independent of said belt to draw said sheet of film over an in contact with said liquid on said belt to complete coagulation of the film.

5. An apparatus as in claim 4 wherein the two endless belts mounted below the extrusion means and the endless belt disposed partially in the vessel are adapted to propel and adapted to convey, respectively, liquid coagulant at a lower velocity than the speed at which the film sheet is drawn.

6. An apparatus as in claim 4 wherein the two endless belts mounted below the extrusion means and the endless belt disposed partially in the vessel are adapted to propel and adapted to convey, respectively, liquid coagulant at a velocity equal to 80%–125% of the speed at which the film sheet is drawn.

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