Sept. 11, 1956 R. MARKOWITZ 2,762,077

METHOD AND MACHINE FOR CASTING FILM

Filed Feb. 9, 1955 2 Sheets-Sheet 1

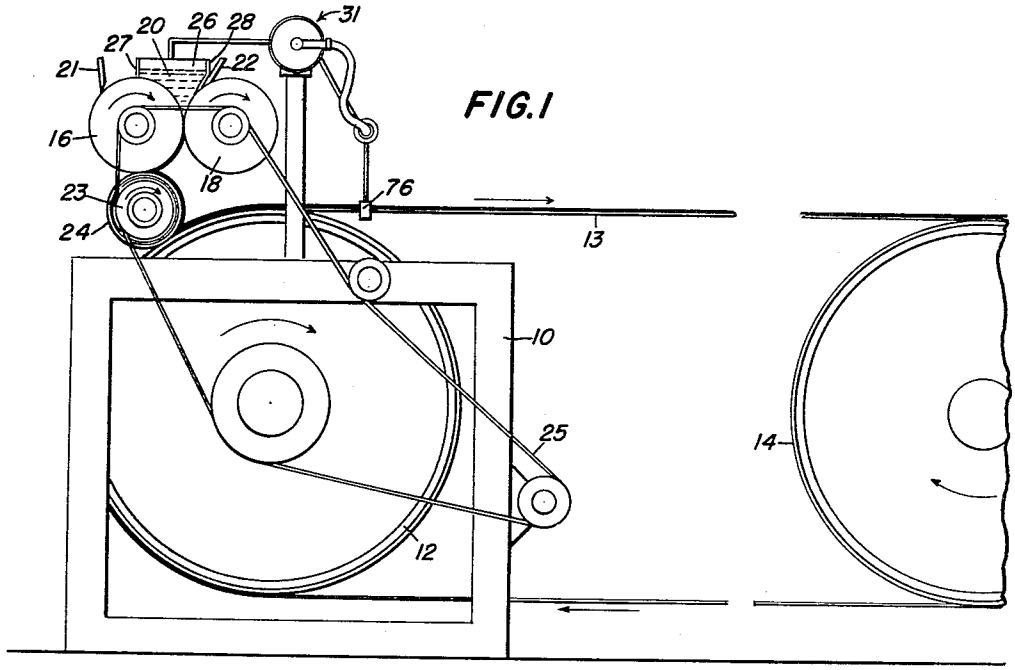


FIG. 1

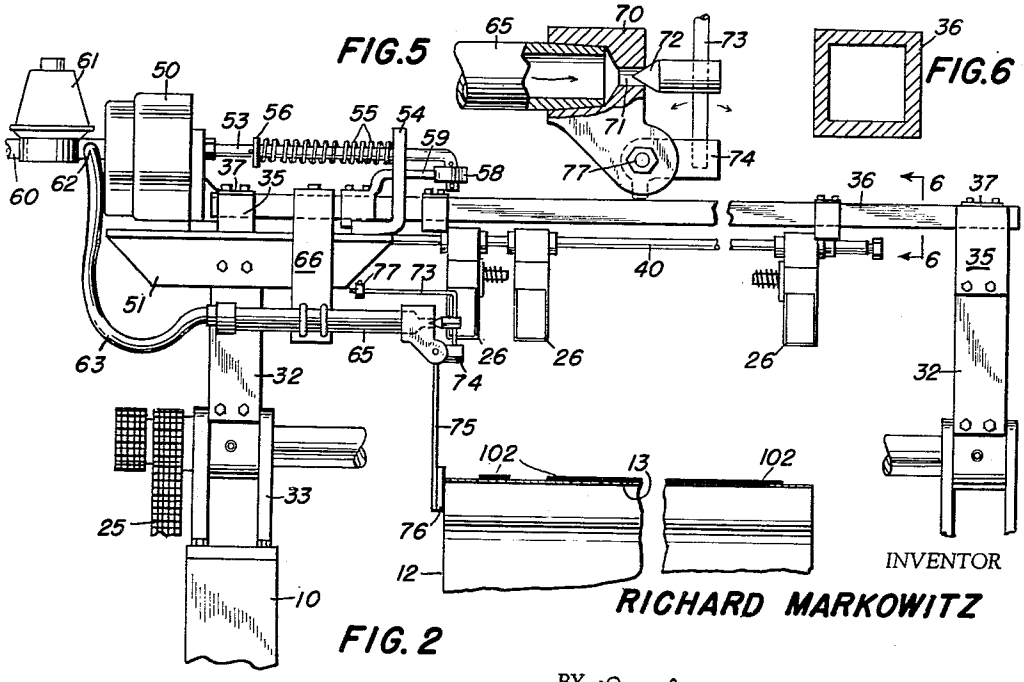


FIG. 2

FIG. 5

FIG. 6

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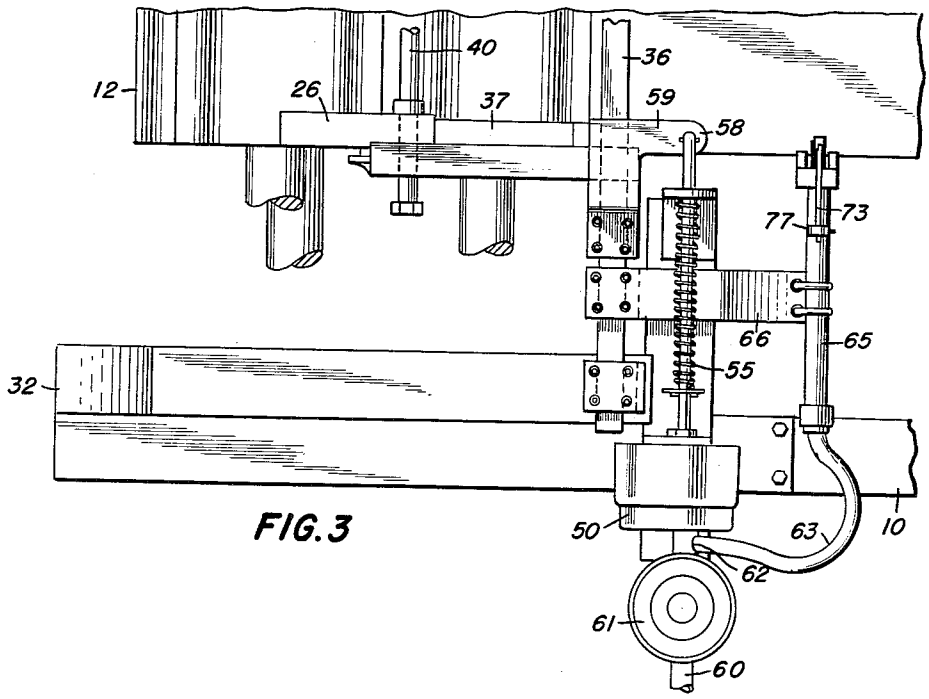


FIG. 3

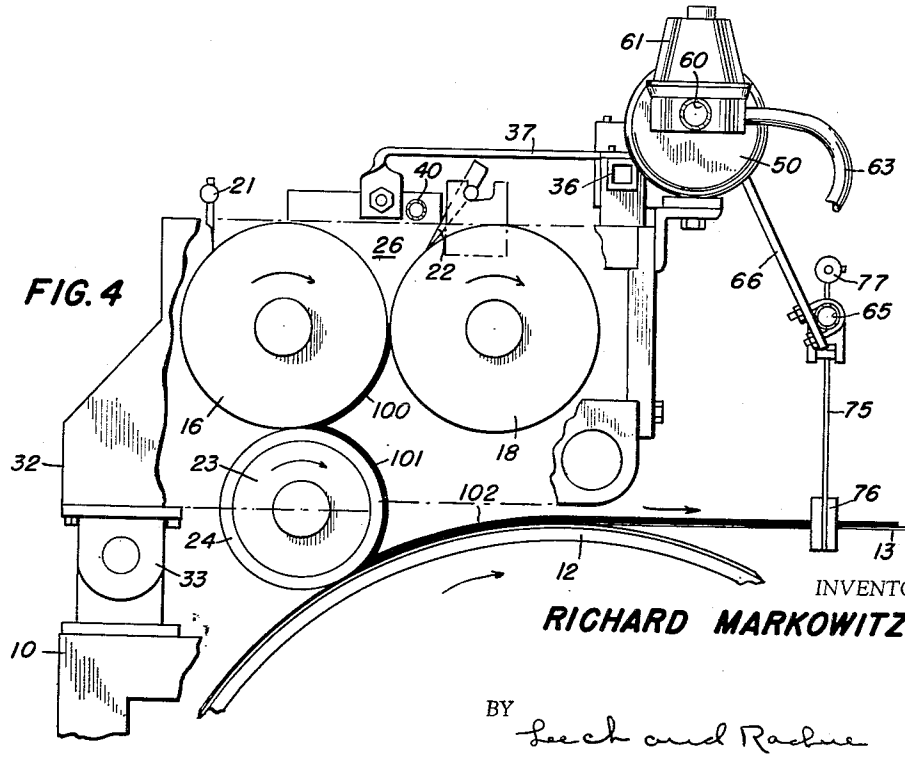


FIG. 4

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METHOD AND MACHINE FOR CASTING FILM

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13 Claims. (Cl. 18—15)

This invention relates to methods of and apparatus for film casting, especially adapted to the application of a liquid onto a flexible belt or apron adapted to carry it through processing machinery for converting it to a film capable of being stripped from the apron.

It is a general object of the present invention to provide novel methods and apparatus for film casting.

A specific object of the invention is to provide a method of and apparatus for the application of a coating of uniform thickness to an apron having thickness variations and minor undulations of surface.

Another specific object of the invention is to provide a method of and apparatus for the automatic application of a limited width coating to an endless apron or belt, which coating remains parallel to the apron edges despite substantial deviations in the path of the apron.

An important object of the invention resides in the detection of the position of the apron edge and the use of this information to adjust the lateral positioning of the application of the coating.

Another important object of the invention resides in the application of the coating material through transfer from its spreading and metering apparatus, to the surface of the apron where rigidly supported, by means of a relatively soft offset roll to insure transfer of all of the metered material to the apron surface.

Among the important features of the invention as directed to the apparatus may be enumerated the following:

Use of follow-up mechanism to move the apron edge position detecting means in unison with the coating edge determining means.

Arrangement of the reverse roll coating means to provide a coating material fountain between rolls and end dams and the movement of the end dams to determine the positions of the coating edges longitudinally of the rolls.

Arrangement of a plurality of controlled coating material dams to provide a number of spaced films of predetermined width on the apron all parallel to each other.

Use of a relatively soft transfer or offset roll in combination with a stainless steel or similar apron to provide film of uniform thickness in spite of inequalities in the apron surface.

Use of an apron having an engraved or etched surface to configurate the under side of the film.

Other and further objects and features of the invention will be more apparent to those skilled in the art upon a consideration of the following specification and accompanying drawings wherein is disclosed a single exemplary embodiment of the invention, with the understanding that such changes and modifications may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawings:

Fig. 1 is a diagrammatic and schematic showing of a film casting machine constructed in accordance with the present invention;

Fig. 2 is a front elevation of the film casting machine omitting the liquid film material transfer, metering and offset rolls better to illustrate the adjusting mechanism for the film edge defining dams;

Fig. 3 is a fragmentary top plan view of the machine showing the arrangement of the dam adjusting mechanism;

Fig. 4 is a fragmentary end elevation of the machine, portions of the adjacent secondary frame being cut away for clarity of illustration;

Fig. 5 is an enlarged fragmentary view of the valve controlled by apron edge position; and

Fig. 6 is a section on line 6—6 of Fig. 2 showing the dam control tube.

The operation known as continuous film casting is distinguishable from coating primarily in the use of a surface from which the coating may be stripped resulting, if it has adequate cohesiveness, in a film whose thickness depends primarily on the thickness of coating applied to the basic supporting surface. Where quick drying materials or those where drying may be accelerated by the application of heat, catalyst or the like, are to be cast, the surface providing the initial support may take various forms as simple as a polished rotating drum or web of paper. In some cases, however, a long, slow, drying operation is required to produce the desired film and in accordance with the present invention the coating is applied to a long, highly polished belt or apron, preferably of stainless steel or similar material, which may be passed through suitable driers, ovens or the like, to finally harden the film to its desired condition whereby it may be stripped from the apron and coiled for shipment or subsequent use.

When using such apron several problems arise. It is impossible to provide an apron which will run absolutely true on its driving and idling drums, and it is, moreover, extremely difficult and cumbersome to provide corrective measures continuously to maintain the apron edges at a uniform spacing from the drum edges. If, therefore, a coating of a predetermined width is desired, effected by one of the more common expedients of limiting the coating width by side dams on the coating fountain, the lateral travelling of the apron, even though controlled, prevents the production of a film whose edges are parallel to the edge of the apron, or one having straight edges itself. This is detrimental since it at least interferes with winding or coiling and may require trimming or other waste in eventual use. The apron cannot be controlled to run absolutely straight and uniformly spaced from the drum edge since correction is dependent on detection of lateral movement, and, moreover, fine correction is difficult and costly.

This invention therefore contemplates a means for maintaining the edge of the film uniformly spaced from the apron edge and therefore straight. This is achieved by detecting the position of the apron edge and moving the coating fountain end-dams longitudinally of their drums coincidentally with the lateral movement of the apron.

A further difficulty arises in the maintaining of a uniform coating thickness due to variations in apron thickness and to certain inequalities in the apron surface so that the conventional hard surfaced transfer roll for the coating material, rotating oppositely to the apron travel, does not contact the apron surface all over for complete transfer of the coating material thereto.

In accordance with the present invention this particular problem is solved by interposing a relatively soft resilient roll, or one having a covering of rubber or the like, between the hard surfaced coating transfer roll and the casting apron, where it is supported on its driving drum. This achieves nearly one hundred percent contact between the apron and offset roll surfaces and consequent complete transfer of the coating material, producing a uni-

form film thickness on the apron without skips or thin spots.

The apparatus for carrying out the operations and method defined above appear in the several figures of the drawing. Fig. 1 is wholly schematic and makes no attempt to show bearings, supports and the like for the various parts of the mechanism other than to illustrate diagrammatically a main frame member 10 from which are supported by suitable means and driven at their requisite speeds by a suitable source of power a plurality of rolls and a drum. The principal drum 12 is of large diameter, accurately ground on the surface for uniformity and minimum run out since it carries one end of and drives the endless, stainless steel belt or apron 13 of a thickness of the order of several hundredths of an inch, preferably highly polished on its face and supported at a remote point by an idler drum 14. The distances between the drum centers may be as much as the order of one hundred feet, and obviously intermediate supports must be provided for the belt to prevent sagging, and to eliminate the need for excess tension in the horizontal reaches. The apron, between drums passes through suitable heating and drying ovens, not shown, as dictated by the nature of the materials forming the film.

The coating material, a relatively viscous compound capable of remaining where positioned on the apron, is applied by modification of the well known reverse-roll coater. As seen in Fig. 1 a pair of rolls 16 and 18 are arranged adjacent each other and journalled for rotation in the same direction, as shown by the arrows. These rolls are preferably of somewhat similar diameters and are of chilled iron or steel ground to a high polish and of uniform surface and diameter whereby they may contact closely along a tangential line throughout their lengths. The roll 16 is referred to as a transfer roll, carrying the film material from one or more fountains 20 in the space between the rolls and above them onto the surface of the apron as will be later described. This transfer roll is mounted in fixed bearings and may be provided with a doctor blade 21 on its rear face for removing any vestiges of coating not deposited on the offset roll later to be described.

The second roll of the pair is the metering roll 18 mounted in bearings which are micrometrically adjustable horizontally as indicated so as to permit the formation of a gauging slot between the two rolls through which the coating material from the fountains passes in a film of the same thickness as this slot. Both rolls are rotated in a clockwise direction as viewed, roll 16 carrying the film material downwardly and 18 wiping away the excess and maintaining the coating on 16 of uniform thickness. A second doctor 22 cleans roll 18 and returns the coating material to the fountains.

Substantially directly beneath transfer roll 16 is the offset roll 23 wholly formed of relatively soft rubber or having a metal core with a rubber cover of substantial thickness thereon, as shown at 24. This roll is likewise driven in a clockwise direction, as is the apron drum 12 as schematically shown by the chain 25 connecting a source of power to the sprockets on all rolls and drum. This offset roll has close contact with the surface of roll 16, permitting no gap or slot, and rotates preferably at a similar peripheral speed as 16 so as to remove all of the coating therefrom, transferring it to its own surface in the same thickness, although obviously the thickness here may be changed by varying the relative speeds of these two rolls, the film being either thickened or thinned as desired.

Because of its natural resilience and relatively soft surface, roll 23 which is in closely pressed contact with the apron 13 on drum 12, makes contact with the whole surface of this apron despite minor variations in the latter's thickness and smoothness, so that a film is deposited from 23 onto 13 of uniform thickness throughout and devoid of perforations, weak or thin spots and the like.

Coating material fountains are provided between the rolls 16 and 18 and confined by end dams such as 26, accurately shaped to fit into the nip between the rolls and having a close fit against their surfaces. In order to increase the depth of the material in the fountains suitable side dams 27 and 28 may be provided.

The apparatus may be provided with some means for controlling run-out of the apron 13, but none is shown since many conventional devices are available for the purpose. Even though these do not accurately maintain the position of the apron the film supply thereto is kept parallel to its edges by adjusting the dams 26 longitudinally of their rolls, thus determining the positions of the edges of the films in accordance with the positions of one edge of the apron, which is detected by a feeler 76 acting through mechanism 31 to position the dams, as will be described in detail subsequently.

The arrangement of the dam adjusting mechanism and further features of the coating apparatus are illustrated in greater detail in Figs. 2 to 6, inclusive. These figures show secondary frames 32 supported from the main frame 10 through the journals 33 for a cross shaft accommodating drive chains. These secondary frames provide bearings for rolls 16, 18 and 23, and in some of the figures fragments of the roll drive chains are shown. Each of the secondary frames 32 is provided with a bracket 35 provided with an open top rectangular notch in which is longitudinally slidable and non-rotatively fitted a square tube 36, seen in detail in Fig. 6. This is held in position in its notches by cover plates such as 37, providing for a working sliding fit. As viewed from the top in Fig. 3 a pair of rigid strap members 37 extend rearwardly from and have their forward ends secured firmly to tube 36. These are spaced apart so as to separate the dams 26, to which each is attached as shown, to the proper positions to define the film edges.

In many cases it is desired to cast several narrow strips of film and rather than resort to a narrow apron or slitting of the film cast on a wide apron, intermediate dams 26' (Fig. 2) are provided, thus dividing the fountain into several parts. These dams may be mounted and adjustable on a rod 40 extending through the end dams 26 and clamped therein as shown. The intermediate dams, seen only in Fig. 2, may be longitudinally adjusted to fix the widths of the several independent strips of film cast on the wide apron.

The dams may be of any particular type as found most satisfactory for coating machines of this general character, and no additional details need be given of their construction.

The square tube 36 carrying its dams as just described is adjustable longitudinally by means of a suitable servomotor, such as the pneumatic diaphragm motor 50, seen in the drawing, and mounted on a cross bracket 51 carried by the upper portion of the left secondary frame 32. The horizontally slidable output rod 53 of this servomotor slides through a bearing in bracket 54 remotely secured to part 51 and a helical spring 55 compressed between this bracket and washer 56 mounted on rod 53 urges the rod toward the left. The outer end of the rod is bent downwardly and pivoted in a boss 58 offset both upwardly and forwardly of tube 36 by means of the L-shaped arm 59 clamped about the tube 36, as clearly seen in the figures. It may be adjustable thereon in any simple manner. It will be seen that operation of the rod 53 will adjust the position of the dams longitudinally of the transfer and metering rolls and so change the position of the cast film laterally of the apparatus.

Compressed air is supplied to the motor from a suitable source through pipe 60, the interposed pressure regulator 61 and a T 62. The T attaches to hose 63 leading to control valve mechanism for controlling operation of

motor 50. This valve is mounted on a tube 65 having hose 63 attached to its left end being supported from tube 33 by strap 66 to which it is attached by U-bolts as shown. By this arrangement the valve mechanism moves with the dam adjusting tube and provides the necessary follow-up means to insure adequate operation of the mechanism.

Fig. 5 shows the air valve, comprising a fitting 70 secured on the right end of tube 65 and having a reduced diameter hole 71 therein adapted to be partially or fully closed by means of valve pin 72 having a conical end. This pin is carried on rod 73 extending from the arm 74 of a bell crank lever, the other arm 75 of which depends downwardly and is fitted with pad 76 positioned to engage one edge of the stainless steel apron and indicate its position in respect to that of the dams. The bell crank lever is pivoted at 77 in the valve fitting 70 while the rod 73 is bent over toward the left as seen in Fig. 5 and fitted with an adjustable weight 77 to maintain the pad 76 lightly but firmly and continuously in contact with the edge of the apron.

In operation the apron coating or film casting is carried on as explained above, the liquid being delivered from the fountains 20 through the slot between rolls 16 and 18 and forming the coating 100 (Fig. 4) on transfer of roll 16 maintained of uniform thickness by metering roll 18. The coating is transferred to the resilient surface of the offset roll 23 forming the coating 101 on this latter roll which because of its close contact and opposition rotation to the belt or drum 12 deposits or casts the film 102 on the stainless steel belt where it is carried to subsequent treatment, stripping and winding.

As mentioned above, this cast film may be in several spaced widths dependent on the number and position of the intermediate dams used, it being understood, of course, that the material used to provide the coating or film does not spread substantially as it travels the short distance along the peripheries of the rolls which carry it, nor does it sag or spread on the apron. All this may be controlled by appropriate relative and actual velocities of the several rolls and the apron. A certain amount of lateral travel of the stainless steel belt is inevitable from accumulated inaccuracies in drum diameters throughout their length, from slack apron edges due to faults in the rolling of the sheet, or from use, from inequalities in apron thickness throughout its width, and for many other reasons. While this run-out may be corrected, as previously mentioned, such correction is ponderous and of insufficient accuracy to insure a film whose edge is a continuous straight line.

As the apron 13 moves laterally it is followed by the pad 76 under the action of its weight 77 and dependent on the direction of movement more or less compressed air is permitted to leak out around the conical end of rod 72 through the aperture 71, varying pressure acting on the left face of the diaphragm of motor 50, which responds by moving its operating rod 53 in the proper direction, since this rod is balanced between the pressure on one side of the diaphragm and the spring 55. This adjusts the dams to maintain the film edge uniformly spaced from the control edge of the apron.

As the servomotor operates the tube 36 to carry the dams it also carries the tube 65, the air leakage valve and the apron edge follower pad 76, thus terminating the movement at the proper time in the well known follow-up manner, whereby the edge of the film is maintained parallel to the edge of the apron with a high degree of accuracy at all times. At the same time the operation of the relatively soft, resilient offset roll insures a uniform thickness of coating and hence of film with no opportunity for thin spots, perforations or the like.

I claim:

1. The method of casting film onto a straight edged apron travelling in a path substantially parallel to its edges but subject to lateral deviations therefrom comprising, applying a coating to the apron to be hardened thereon into a strippable film, controlling the width of the coating applied to the apron by positioning the edges of the coating a predetermined distance apart, measuring the deviation of a straight edge of the apron from a predetermined norm and changing said film edge positioning simultaneously in the same direction and to the same degree to maintain the film edges parallel to the apron edges.

2. The method of forming a straight edge film on a longitudinally travelling apron subject to lateral deviations in its path of travel comprising, confining the edges of a liquid coating on a surface, continuously transferring the coating to the apron for hardening thereon into a film and maintaining the coating edges on the apron parallel to the path of deviation of the apron by moving the coating position on the surface laterally in response to apron deviation.

3. Apparatus for casting film having straight edges onto a travelling apron subject to lateral deviations from a straight line path of travel comprising in combination, an endless apron, means supporting said apron for substantially horizontal travel including a metal drum of large diameter relative to apron thickness, a pair of rotatable metal rolls adjustably mounted side by side to provide a coating liquid fountain and a metering slot therebetween, a resilient surfaced rotatable roll beneath one of said rolls of said pair and closely engaging its surface and that of the apron where the latter is drum-supported to transfer the slot metered coating to the apron, means to drive all said rolls and the apron in the same peripheral direction whereby the cooperating surfaces of all rolls and the apron move in opposite directions for complete coating transfer, end dams between said first mentioned rolls to complete the fountain and define the coating edges on said rolls and apron, and means responsive to apron path deviations to adjust said dams laterally to keep the edges of the coating film straight on the apron.

4. The apparatus of claim 3 in which at least one edge of said apron is straight, a feeler biased against said edge and means responsive to changes in position of said feeler to effect a corresponding change in the positions of said dams.

5. The apparatus of claim 3 in which follow-up mechanism moves the feeler in unison with said dams.

6. Apparatus for casting film having straight edges onto a travelling apron subject to lateral deviations from a straight line path of travel comprising in combination, an apron, means supporting said apron for substantially horizontal travel including a metal drum, a pair of rotatable, hard, smooth surfaced rolls adjustably mounted side by side to provide a coating liquid fountain and a metering slot therebetween, a resilient surfaced roll beneath one of said rolls and closely engaging its surface and that of the apron where the latter is drum-supported to transfer the slot metered coating wholly to the apron, means moving the cooperating surfaces of all rolls and the apron in opposite directions for complete coating transfer from fountain to apron, end dams between said first mentioned rolls to complete the fountain and define the coating edges on said rolls and apron, and means responsive to apron path deviations to correspondingly adjust said dams laterally between said rolls to keep the edges of the coating film straight on the apron.

7. The apparatus of claim 6 in which apron path deviation is detected by an edge feeler, a servo-motor, means connecting said servo-motor for control by change in position of the feeler and means connecting the servo-motor to move the dams in unison and consonant with apron deviation.

8. The apparatus of claim 6 in which said servo-motor also moves the feeler in a follow-up operation.

9. Apparatus for casting film having straight edges onto a travelling apron subject to lateral deviations in

its path of travel comprising in combination, an endless polished metal apron, a large diameter metal drum for driving said apron substantially horizontally, a pair of hard smooth surfaced rolls adjustably mounted side by side to provide a coating liquid fountain and a variable metering slot therebetween, a relatively soft resilient roll closely engaging the surface of one of said metal rolls and that of the apron at a position on the drum to transfer the slot metered coating from the engaged metal roll to the apron in a film of uniform thickness in spite of surface irregularities of the apron, means moving the cooperating surfaces of all rolls and the apron in opposite directions for complete coating transfer, end dams between said first mentioned rolls to complete the fountain and relatively adjustable to define the coating edges on said rolls and apron, and means responsive to apron path deviations to simultaneously adjust said dams laterally of said rolls to keep the edges of the coating film straight on the apron.

10. The apparatus as defined in claim 9 in which said last mentioned means includes a servo-motor connected to adjust said dams, a feeler mechanism responsive to and biased against one edge of said apron, means associating the servo-motor and feeler whereby the latter controls the position of the former and means mounting said feeler mechanism for movement by said servo-motor in the same direction and distance as said dams.

11. Apparatus for casting film having straight edges onto a travelling apron subject to lateral deviations in its path of travel comprising in combination, an endless polished metal apron, a large diameter metal drum for driving said apron substantially horizontally, a pair of hard smooth surfaced rolls adjustably mounted side by side to provide a coating liquid fountain and a variable metering slot therebetween, a relatively soft resilient roll closely engaging the surface of one of said metal rolls and that of the apron at a position on the drum to transfer the slot metered coating from the engaged metal roll to the apron in a film of uniform thickness in spite of surface irregularities of the apron, means moving the cooperating surfaces of all rolls and the apron in opposite directions for complete coating transfer, end dams between said first mentioned rolls to complete the fountain and define the coating edges on the rolls and apron, a bar mounted for sliding parallel to the roll surfaces, means connecting said dams for movement by said bar, a fluid actuated servo-motor, means connecting said motor to actuate said rod in either direction, a source of fluid under pressure connected to said servo-motor, a leakage valve connected in shunt to said servo-motor and having a leakage regulating needle, a stem hinged to the valve structure and carrying said needle, a feeler on said stem, means biasing said feeler against one edge of said apron, and means supporting said valve assembly and stem from said rod to move them in a follow up operation simultaneously with said dams.

12. Apparatus for casting a film onto a travelling apron subject to lateral deviations from a straight line path comprising in combination, an apron having a straight edge, means supporting and continuously driving said apron, means for continuously delivering a stripe of coating liquid onto said moving apron to form a film thereon within its margins, and means responsive to lateral movement of said apron edge to produce a corresponding movement of the coating liquid delivery means to maintain the coating edges parallel to said apron edge.

13. Apparatus for casting a film onto a travelling apron subject to lateral deviations from a straight line path comprising in combination, an apron having a straight edge, means supporting and continuously driving said apron, means for continuously delivering a stripe of coating liquid onto said moving apron to form a film thereon within its margins, means defining the edges of said stripe and adjustable laterally, means for detecting lateral movement of the apron edge and means responsive to said detecting means for moving of said edge defining means commensurate with apron edge movement.

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