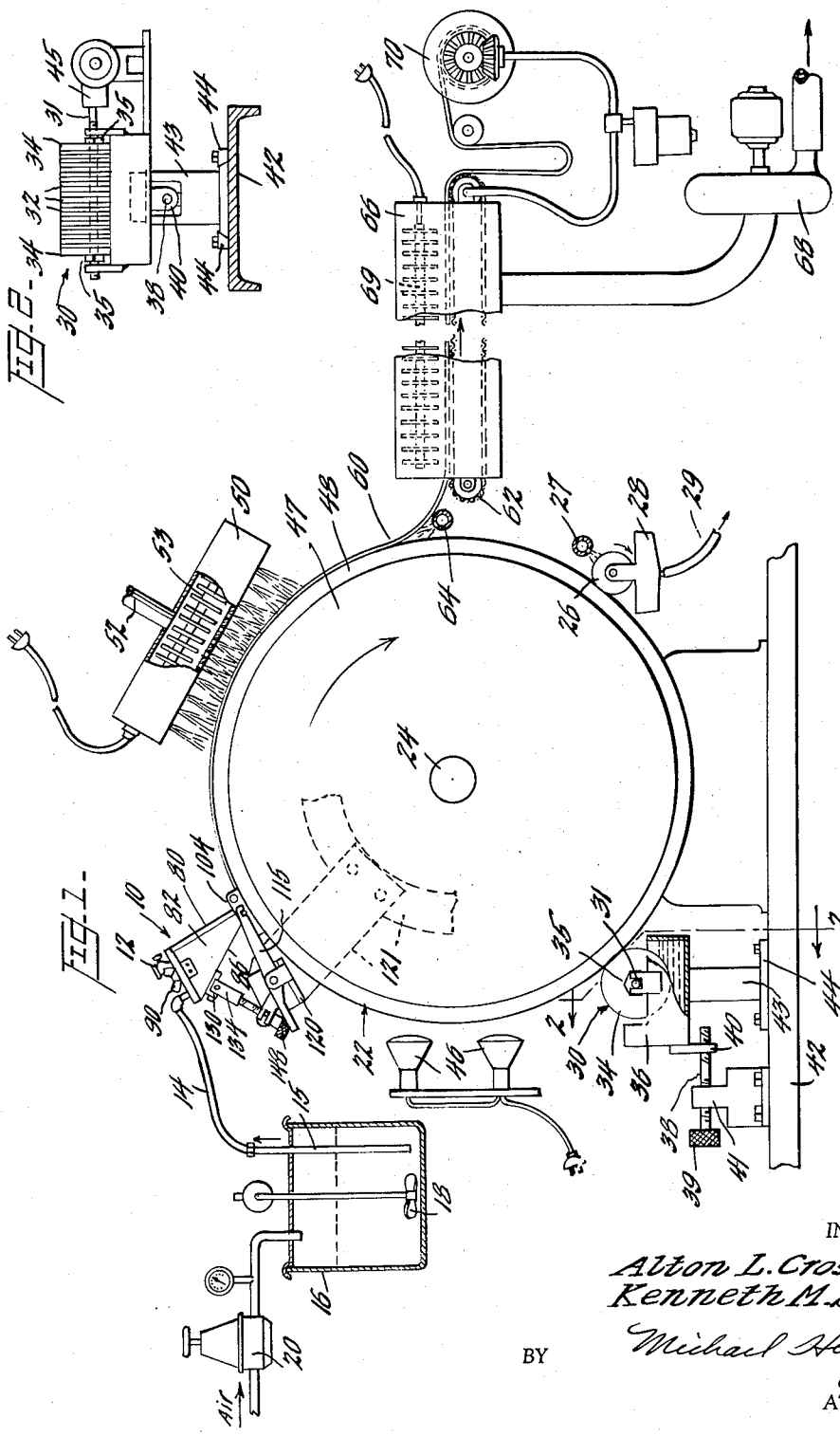
Dec. 27, 1960 A. L. CROSBY ET AL 2,965,927

FILM CASTING APPARATUS

Filed Dec. 30, 1958 3 Sheets-Sheet 1



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FILM CASTING APPARATUS

Filed Dec. 30, 1958 3 Sheets-Sheet 2

FIG. 5.

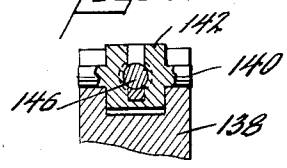


FIG. 3.

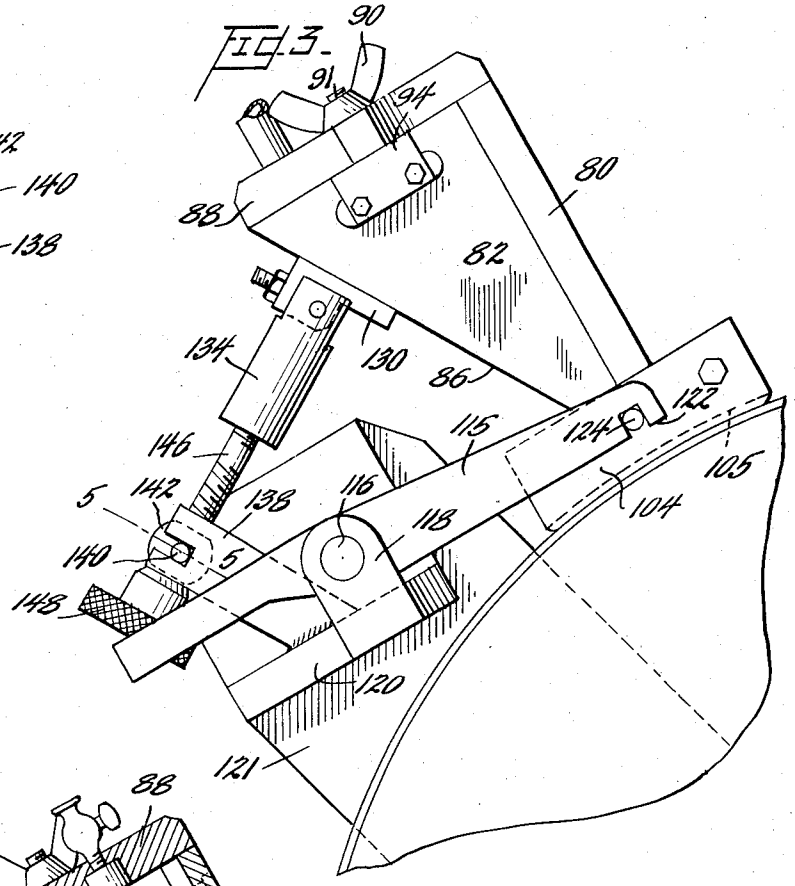
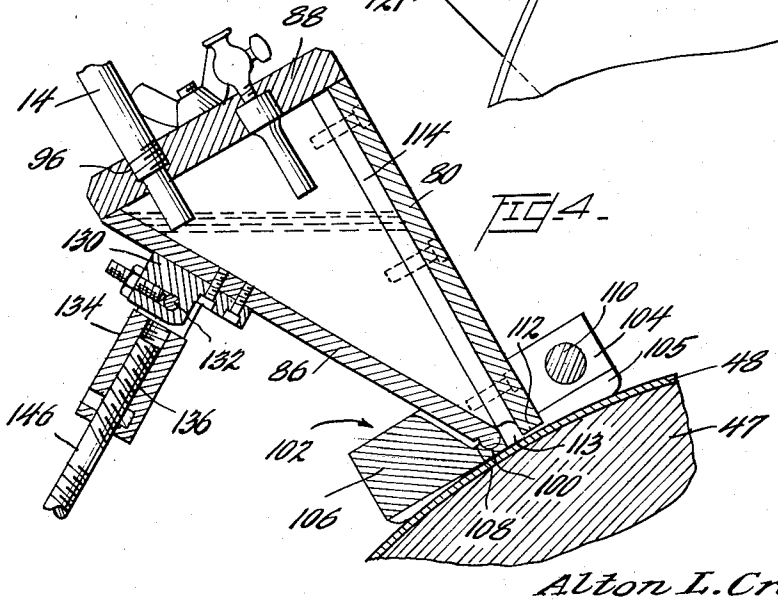


FIG. 4.



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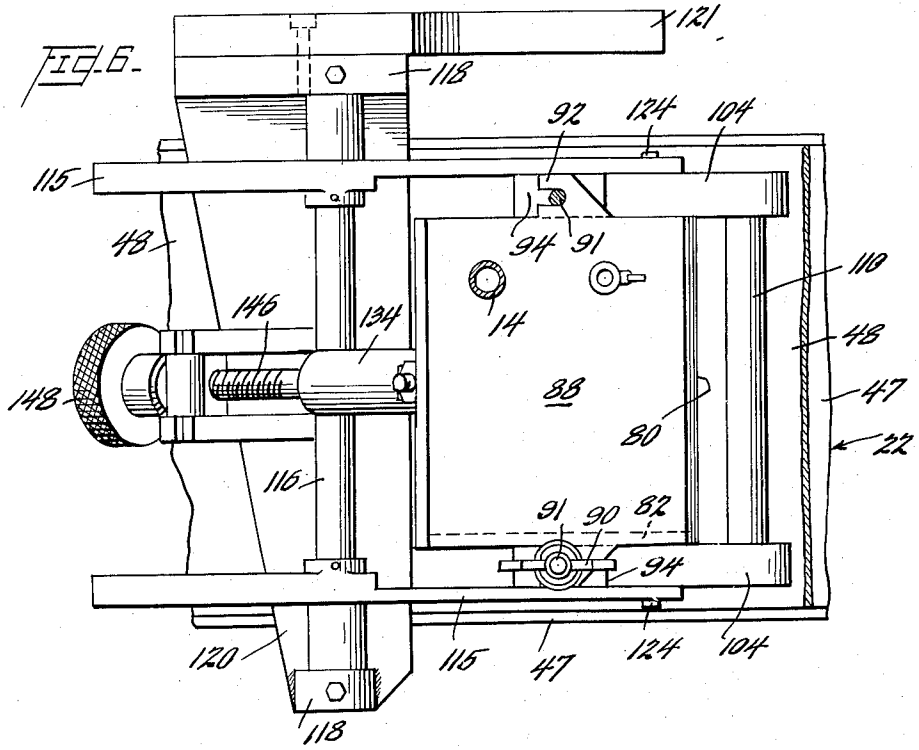
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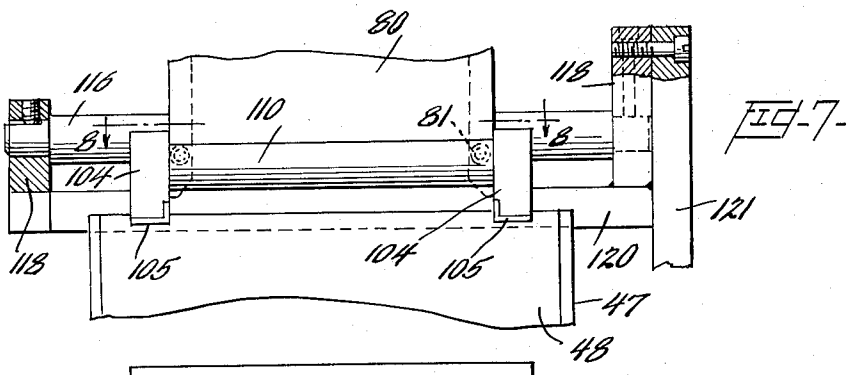
Dec. 27, 1960 A. L. CROSBY ET AL 2,965,927

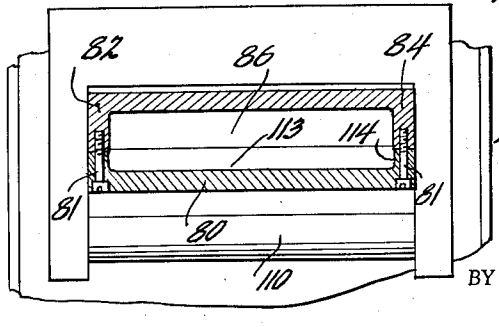
FILM CASTING APPARATUS

Filed Dec. 30, 1958 3 Sheets-Sheet 3

FIG. 6.







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2,965,927

FILM CASTING APPARATUS

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Filed Dec. 30, 1958, Ser. No. 783,788

5 Claims. (Cl. 18—15)

This invention relates to film forming and particularly to the forming of thin films containing the triple carbonates of barium, calcium and strontium in a cellulosic binder and useful as emissive coating material in electron tubes.

These films are intended to be cut to size to fit about cathode sleeves employed in electron tubes. For such usage it is highly desirable that the films shall have smooth surfaces and be of uniform thinness so that the coated cathode sleeve can be placed exceedingly close to the next adjacent electrode element, such as a grid, without danger of physical contact of portions of its surface with said element. Also to secure uniformity of emissive quality, the coating should be of uniform thinness throughout. This is particularly true where films of the order of .001 inch are to be formed. To form films of this thinness special forms of film casting apparatus is necessary so that first, such films may be formed on the apparatus and second, that such films may be removed from the apparatus without tearing or breaking of the film or the forming of holes therein.

It is an object of this invention to provide an apparatus which shall form a film of even thinness throughout.

It is a more specific object of the invention to provide a means for ensuring the even feeding of a suspension of the triple carbonates in a plastic binder to a polished moving surface and for the fine adjustment of said means to secure the desired thinness of the cast film.

Another specific object is to ensure the absolute cleanliness of the surface upon which the film is to be cast to prevent unevennesses in the film.

Other objects of the invention will become apparent upon consideration of the following specification when taken in conjunction with the accompanying drawing in which:

Fig. 1 is a schematic presentation of a film forming system embodying the invention.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a side elevation of a portion of the film casting mechanism.

Fig. 4 is a section through the mechanism of Fig. 3 in a plane parallel to the plane of the paper.

Fig. 5 is a section on the line 5—5 of Fig. 3.

Fig. 6 is a plan view of the film casting apparatus, parts being shown in section.

Fig. 7 is a view of the film casting apparatus looking at Fig. 6 from the right, and

Fig. 8 is a section on the line 8—8 of Fig. 7.

Referring to the drawings with greater particularity, at 10, Fig. 1, is disclosed a metallic hopper containing the triple carbonates suspended in a volatile cellulosic solution, for example, ethylcellulose dissolved in a mixture of toluene, ethanol and pentacetate, all as is set forth more in detail in the application of Kerstetter and Wennin Serial No. 453,235, filed August 31, 1954, and assigned to the assignee of this application. The hopper is of course open at its bottom and is air tight at the top except for a valve 12 which may be opened to vent the system. A piping 14, 15, conveys the suspension to the hopper from a mixing tank 16 provided with a motor driven stirrer 18 to maintain the mixture homogeneous, and the surface of the mixture is maintained under air pressure, as through a constant pressure air regulator valve 20. The pipe 15 has its inlet opening below the surface of the mixture in the mixing tank. The mixture in the hopper is fed onto a casting wheel 22 in the form of a narrow cylinder mounted on a horizontal axle 24 driven in any well known manner at a rate to give a peripheral speed of about one and one half feet per second. The surface of the wheel is of highly polished nickel steel and is maintained scrupulously clean by a water soaked sponge 26 with water fed thereto from a water pipe 27, and rotating in an opposite sense to the rotation of the wheel in order to sponge off any dust or dirt on the surface of the wheel; a drain 28 beneath the sponge catches the excess water which is led off through a suitable drain hose 29. The apparatus itself should be installed in a dust free room. There is also provided a liquid applicator in the form of a drum 38 comprised of a shaft 31 on which are strung a very large number of thin discs 32 of polyethylene film held together between end discs 34 of "Lucite" by nuts 35 threaded on the shaft at the ends of the drum. The discs dip into a tank 36 of liquid which will act as a release agent for the carbonate film from the casting wheel 22, as for example, 2,2-aminomethylamino ethanol

$$(NH_2CH_2CH_2NHCH_2CH_2OH)$$

which has a boiling point of about 130° C. at a pressure of twelve millimeters of mercury, and the thinness of the film of liquid can be adjusted very minutely by loosening or tightening the Lucite discs on the shaft or by shifting the axle carrying the polyethylene discs 32 away from or toward the surface of the wheel. This shifting may be accomplished by means of a differential screw 38 having a knurled nut 39, the screw being threaded into a lug 40 extending down from the tank 36 and into a threaded bearing 41 on the base 42 of the machine, the tank 36 being suitably guidedly supported for sliding movement on said base as by its support post 43 sliding between two dovetailed straps 44. The shaft 31 is driven through a motor-driven slow speed gearing 45, the gearing being of the variable character to provide further means to vary the speed of the shaft 31 and therefore the quantity of liquid applied by the applicator to the wheel. Above the applicator is a pair of vertically spaced heating lamps 46 to preliminarily heat the polished surface of the wheel. Thus, the amount of liquid remaining on the wheel depends, in part, on the choice of rotational speed of the wheel and on the heat cast by the lamps 46 onto the wheel. The lamps are intended to leave a small amount of liquid on the wheel to assist in the subsequent peeling of the cast film from off the wheel. The wheel comprises a central drum 47 of iron or the like having a rim 48 of a highly polished metal such as nickel or chrome to afford a smooth highly polished surface, although nickel steel is preferred.

After the film has been cast on the wheel by flow of material from the hopper 10, either by action of gravity alone, or by the action of gravity assisted by air pressure, the film passes beneath an open or perforated bottom box 50 which has air fed thereto by pipe 52. Any suitable form of heater, as finned electric resistance rods 53, is embodied within the box and the air in passing over and about the heater is heated, is blown out of the open or perforated bottom of the box and onto the freshly cast film of carbonates. The film by the time it reaches the line of stripping off which approximately is at the position indicated by the reference character 60 has sufficient of its volatile solvents driven off so that the film has enough

tenacity to be pulled from off the drum and deposited onto an endless mesh conveyor belt **62** travelling in the direction of the arrow in Fig. 1. The film is stripped off the casting wheel by the pull of the conveyor belt, assisted by the action of an air stripper **64**, which blows air through a series of aligned nozzles against the underside of the film at about the designated line **60**. In practice, the conveyor is of aluminum and has a 14x16 mesh (224 holes to the square inch). It is wider than the width of the film and moves at about twice the lineal speed of the surface of the wheel or about three feet per minute. As it moves, it slips beneath the film as it is being stripped from off the wheel. The film is thoroughly dried by air which is heated within an oven housing **66**, the air being drawn in through the two open ends of the oven by a motor driven pump **68** and discharged at a suitable location. The oven has within it finned electric resistance rods **69**, like those within the box **50**. The conveyor is made of the mesh material so as to be sure to obtain an undersurface on the film which is free of bumps and unevennesses. Also the mesh structure of the conveyor permits free access of the heated air to both surfaces of the film as it is being transported by the conveyor.

The dried film is wound up on a spool **70** in any conventional fashion, care being taken that there always is sufficient slack between the conveyor **62** and the spool **70** to avoid rupture of the film.

The mounting of the hopper with relationship to the casting wheel and its adjustment relative thereto is of extreme importance in attaining a proper consistent thinness of film cast on the wheel.

In the form of invention adopted to secure the best results, the hopper **10**, see Fig. 3, is constructed of a vertical rear end wall **80** fastened, as by bolts **81**, to the substantially triangular side walls **82**, **84** extending laterally from an inclined front wall **86**. The wall **86** inclines downwardly and toward the rear end wall **80** to form a metered orifice or slot at the bottom of the hopper. The hopper is closed at the top by means of a cover plate **88**, removably held to the hopper by a pair of wing nuts **90** threaded onto bolts **91** passing through slotted ears **92** on the cover and held in blocks **94** fastened to the triangular side walls. Additionally the cover is provided with threaded inlet **96** for pipe **14** and with valve **12** to release air pressure, when desired, from within the hopper.

The bottom of the inclined wall **86** is rounded to rest in a groove **100** of a metallic shoe **102** provided with side runners **104** shod with hard highly polished shoes **105** which ride on the periphery of the wheel near the lateral edges thereof. The shoe is, in general, a casting comprised of a thick cross piece **106** whose forward end is of less thickness, as shown at **108** and provided with the previously referred to arcuate groove **100** to provide the seat for the rounded lower end of the front wall **86**. The shoe also comprises the side runners **104** to straddle the formed film and arcuate on their lower faces to conform with the curvature of the peripheral polished surface of the wheel. The rear end of the shoe consists of a round bar **110** joining the runners to provide space, actually much more than needed, for the swing of wall **80** as the hopper is pivoted about the groove **100**. The lower edge of wall **80** has a lip **112** formed thereon to assist in placing an even film on the wheel and to cooperate with the lower thin portion **108** of the shoe to form a casting mouth **113**. At the ends of the mouth, the wall **80** is slightly recessed, as indicated at **114** to enable a wide film to be cast.

The shoe is restrained against movement around with the circumference of the wheel by a pair of reach bars **115** pivoted on a shaft **116** fixed in ears **118** on a bracket **120** fixed to a fixed part **121** of the machine, the bars having hooked ends **122** engaging pins **124** extending laterally from the side runners.

To micrometrically tilt the hopper about the groove **100** in order to bring the lower edge **112** of wall **80** at a desired elevation, the following instrumentalities are employed: Above the surface of the wheel **22**, the front wall **86** of the hopper has screwed thereto a bracket **130** within which is fastened a cross pin **132**. Pivotally mounted on the pin and straddling the bracket is a forked nut **134** interiorly threaded as indicated at **136**. Extending upwardly and in a forwardly inclined direction from the bracket is an arm **138** forked at its upper end and supporting a pair of trunnions **140** of a second nut **142** within slots **144** formed in the upper forked ends of the arm **138**. The threads in the nuts **134** and **142** are pitched slightly differently in the same direction and engage a complementarily threaded screw **146** having a knurled knob **148** on its end. Thus normal rotation of the knob **148** results in micrometric tilting of the hopper about the groove **100** as a center. For some cases it is essential to maintain a distance of .001 inch between the lip **112** and the circumference of the wheel and it has been found that the arrangement just described can make the fine adjustment necessary. Since the shoe rides the wheel directly under lip **112** and the hopper rests on the shoe, the distance between lip and wheel periphery is maintained constant even were the wheel to vary in diameter and not be a perfect cylinder.

The subject matter relating to the stripping of the film from the wheel and subsequent drying thereof is not the invention of the applicants herein and is claimed in an application filed of even date herewith in the names of Robert L. Lambert and William R. McKeirnan, assignors to the assignees of the instant application and bearing Serial Number 783,787.

What is claimed as new is:

1. Mechanism for casting a film onto a continuously moving support comprising a shoe resting on said support, mechanism restraining movement of the shoe along with the support, a hopper having downwardly converging side walls to form a mouth at the lower end of the hopper for feeding material therewithin onto the moving support, means pivotally supporting the lower edge of one of the said walls on said shoe, and means for tilting the hopper about said lower edge to adjust the thickness of material fed from the mouth of the hopper onto the movable support.

2. Mechanism for casting a film onto a continuously moving support comprising a shoe resting on said support, mechanism restraining movement of the shoe along with the support, a hopper having downwardly converging side walls to form a mouth at the lower end of the hopper for feeding material therewithin onto the support, means pivotally supporting the lower edge of one of the said walls on said shoe, an ear on one of inclined walls of the hopper, a nut pivotally mounted in said ear, a base for the mechanism, a second nut pivotally mounted on the base, said nuts being provided with differential threads and a complementary differentially threaded screw traversing the nuts for micrometrically tilting the hopper about said lower edge.

3. Mechanism for casting a film onto a continuously moving support comprising a shoe resting on said support, a base mounting the support, a link pivotally connected to said base and also pivotally connected to said shoe to allow movements thereof in a direction perpendicular to the support but to restrain movements of the shoe along with the continuous movement of the support, a hopper having downwardly converging side walls to form a mouth at the lower end of the hopper for feeding material therewithin onto the moving support, means pivotally supporting the lower edge of one of the side walls on said shoe, and means for tilting the hopper about said lower edge to adjust the thickness of material fed from the mouth of the hopper onto the movable support.

4. Mechanism for casting a film onto a continuously moving support comprising a shoe resting on said support, mechanism restraining movement of the shoe along with the support, a hopper having downwardly converging side walls to form a mouth at the lower end of the hopper

for feeding material therewithin onto the moving support, said shoe having a thinned portion near the mouth, the upper surface of which has an arcuate groove, the lower edge of one of the said side walls being rounded and pivoted in said groove, and means for tilting the hopper about said lower edge to adjust the thickness of material fed from the mouth of the hopper onto the movable support.

5. Mechanism for casting a film onto the cylindrical periphery of a wheel comprising a shoe provided with arcuate runners riding on the arcuate surface near the edge of the wheel, said shoe having a member with a thin portion extending transverse to the arcuate runners, an arcuate groove in the upper surface of the thin portion along the length thereof, a hopper having downwardly converging side walls to form a mouth at the lower end of the hopper for feeding material in the hopper onto the periphery of the wheel between the runners, one of the side walls having a rounded lower edge resting in said groove, and means for tilting the hopper about said lower edge to adjust the thickness of material fed from the mouth of the hopper onto the wheel.

References Cited in the file of this patent

UNITED STATES PATENTS

2,842,797 Scherer ..... July 15, 1958

FOREIGN PATENTS

368,886 Great Britain ..... Mar. 17, 1932