April 1, 1969 L. P. VAN BOUWEL ET AL 3,435,539

DRYER FOR A FILM PROCESSING MACHINE

Filed July 20, 1966 Sheet 1 of 3

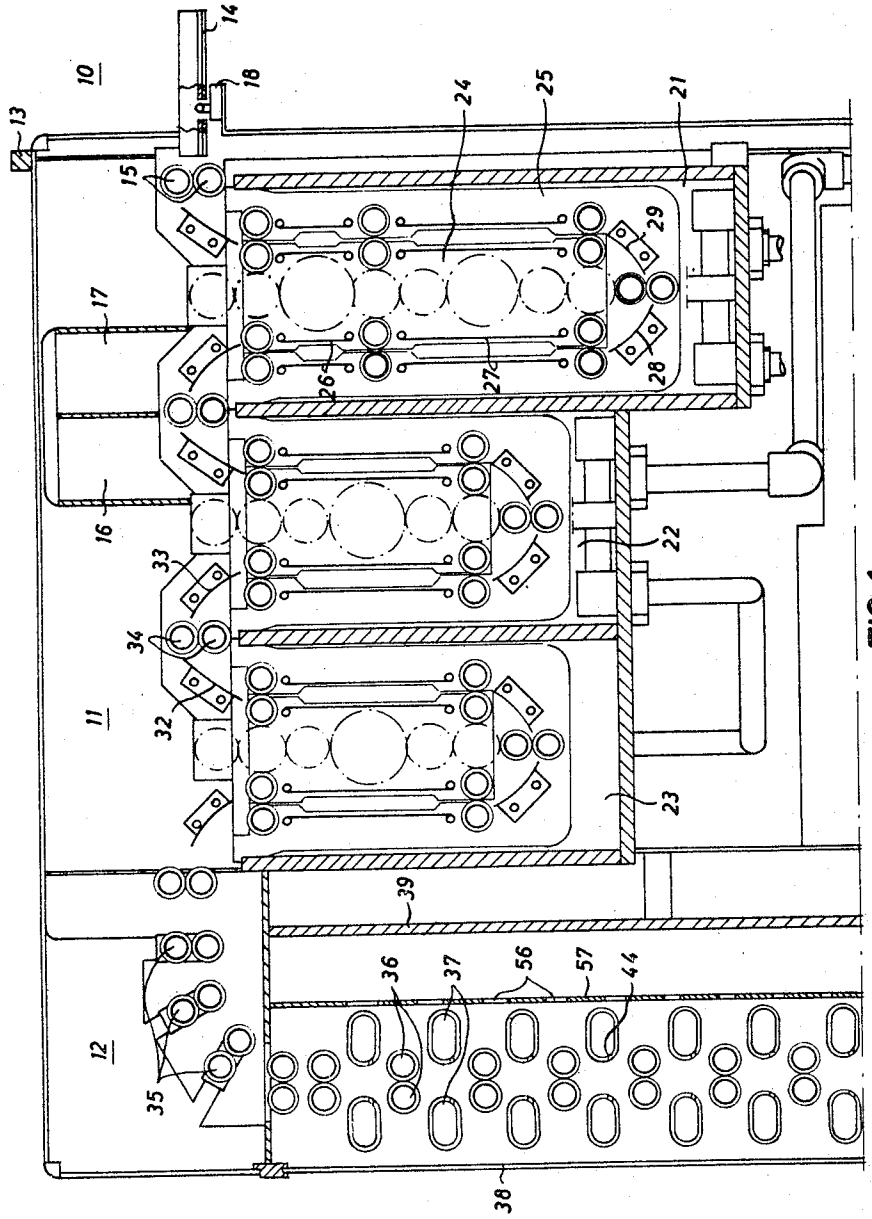

FIG. 1

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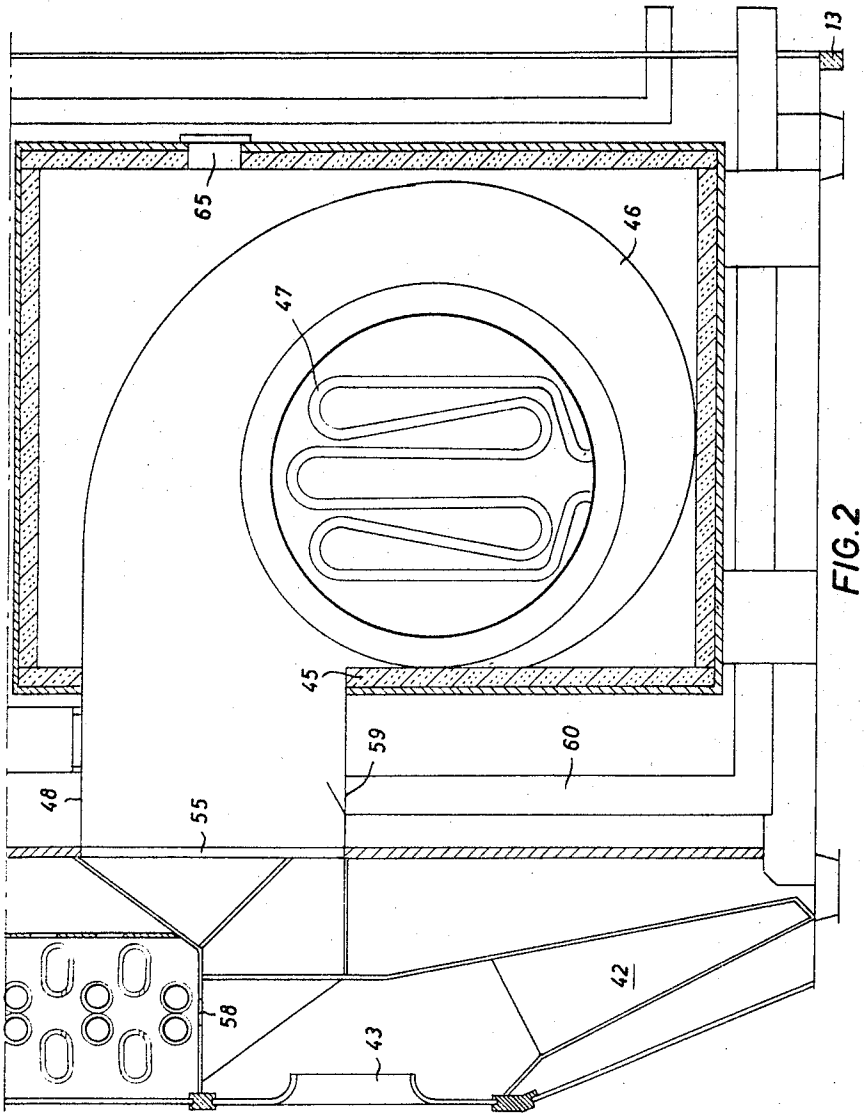

FIG. 2

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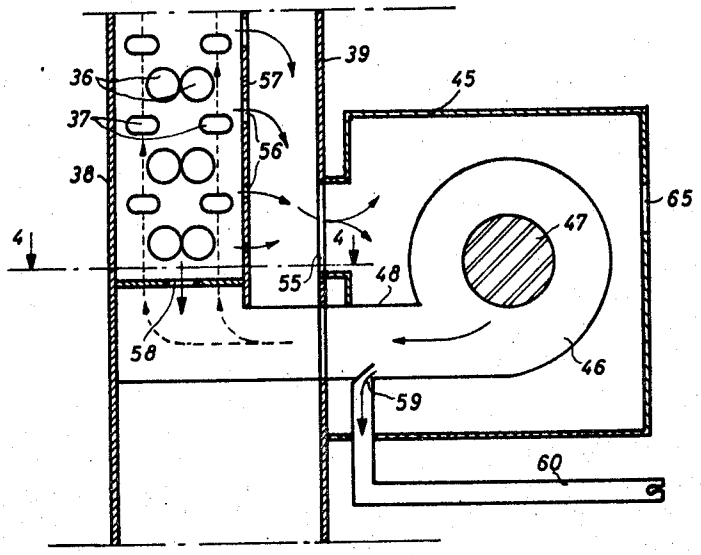

FIG.3

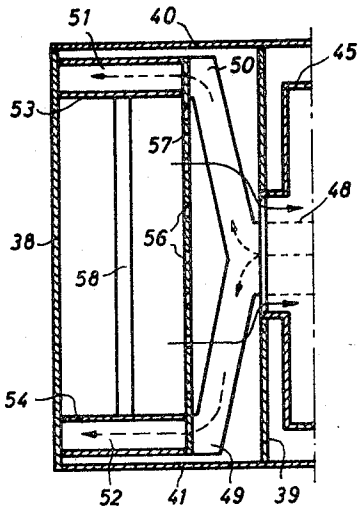

FIG.4

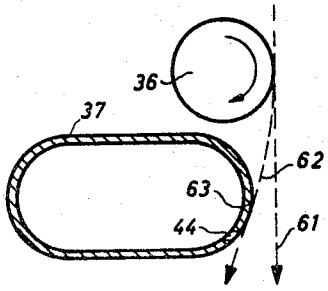

FIG.5

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3,435,539

DRYER FOR A FILM PROCESSING MACHINE

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Int. Cl. F26b 21/02, 13/08, 3/04
U.S. Cl. 34—160 8 Claims

ABSTRACT OF THE DISCLOSURE

A drying apparatus for drying discontinuous sheets, especially photographic film, of the type in which spaced pairs of co-operating feed rollers for conveying the sheets are arranged in alternation with pairs of air tubes extending in spaced, generally parallel, relation to the normal path of the sheets, each of the air tubes including a wall section nearest the sheet path which is formed with the curvature bending away from the sheet path in the direction of the sheet movement along such path, each tube having a longitudinally extending air discharge slit therein which is located at a locus on the curved wall section which lies downstream from that locus on the wall section which lies nearest the sheet path, so that the air discharge slit is protected from contact by the leading edge of any sheet which may accidentally deviate from the normal path through the apparatus. Preferably, the air tubes have a cross section approximating the shape of a trapezoid.

This invention relates generally to processing machines and more specifically to an improved drying apparatus for drying gelatin-coated film which is processed in a self-threading machine.

Driers for gelatin-coated film are known in which the film is transported by rollers and is subjected to oppositely disposed uniform and symmetrical air streams extending across the width of the film.

A drawback of the said known driers resides in the deflecting or guide means which must be provided in order to avoid that the film would deviate from its course between the rollers and become damaged in abutting against or striking along some parts of the drier, or even in entering the slits of the air-directing means through which the streams of air are directed towards the film.

The mentioned deviation of the film from its course may be caused by the adhering of the tacky film surface to the roller surfaces, or by the vibration of the front portion of the film which is originated by the air streams impinging irregularly on both its surfaces.

The deflecting or guide means generally consists of a plurality of small fingers, wires or the like, which become bent or distorted easily. They decrease the accessibility of the various parts for cleaning the drier or for occasionally removing a jammed film. They may even be responsible for a non-uniform air distribution.

The present invention provides a drier comprising transport rollers and air-directing tubes arranged to avoid the provision of additional deflecting or guide means.

According to the present invention, drying apparatus suitable for drying photographic film sheets comprises

successive spaced sets of co-operating rollers for conveying sheets through the drier, and comprises between such successive sets of rollers, on opposite sides of and spaced from the intended course of conveyance of sheets by such rollers, air tubes for discharging warm air against opposite sides of said sheets, the shape of each tube and the location thereon of its air discharge opening or openings being such that if the leading end of a sheet should follow, from the nip of the preceding roller set, a course which deviates from the correct course by the minimum angle necessary to bring such sheet into contact with said tube, such leading sheet end will touch said tube before passing its air discharge opening or openings and will then pass such opening or openings at a spacing therefrom.

Preferably each air tube has a single slot-like discharge orifice having a length at least equal to the maximum sheet width to be encountered. However a series of closely spaced slots or other orifices can be used.

Preferred embodiments of the present invention, comprise a self-threading drier for gelatin-coated film, said drier comprising means defining a drying chamber having an inlet at one side and an outlet at the opposite side for unobstructed passage of gelatin-coated film into and out of the chamber, a film transport mechanism disposed in said chamber between the inlet and the outlet comprising two rows of horizontal and parallel rollers having surfaces for engaging the opposite sides of the film so as to transport the film in substantially one direction through the drier, air-directing tubes running parallel to said rollers and located between the rollers of each of said rows of rollers and spaced from the film course between said rows, each of said tubes having at least one longitudinal slit for directing a layer of warm air onto the film and extending across the entire width of each side of the film transported between the rollers, said longitudinal slit being located behind the line of contact between the film and the periphery of the tube, in the direction of film travel, when the film if deviating from its course upon leaving a previous roller surface, strikes along an air-directing tube, a source of pressurized warm air and conducts for feeding the pressurized warm air towards the lateral ends of the air-directing tubes, and an opening for exhausting at least part of the air from the chamber to the inlet of the source of warm air.

The rollers of the film-transport mechanism disposed in the chamber may be in pairs located in horizontal planes so as to perform also the function of squeegeeing the film.

Each of the rollers can be uniform of diameter and extend fully or for the greater part over the width of the film course in the drying chamber. Alternatively all the rollers or some of them may be composed of several sections mounted side by side on a common shaft for making contact with the film at spaced positions.

According to a preferred embodiment of the invention, which provides a compact and reliable drier, the drying chamber is located vertically with the inlet at the top and the outlet near the bottom, one wall of the drying chamber runs closely parallel to the film transporting rollers and to the air-directing tubes situated at one side of the film course, the opposite wall of the drying chamber is located at a distance from the corresponding rollers and tubes which distance is a multiple of the distance over which the said one wall is spaced from the corresponding

rollers and tubes, a baffle is vertically provided in the drying chamber at the side of said opposite wall which separates a substantial part of the space extending between the said opposite wall and the corresponding rollers and tubes. The baffle is provided with a plurality of openings the area of which increases from the bottom upwardly, and the exhaust opening through which at least part of the air of the chamber is exhausted, is provided near the lower part of the chamber at the side of said opposite wall and communicates at least partly with the space comprised between the baffle and the said opposite wall.

Although in the further description the apparatus will be described in connection with the processing of radiographic film sheets, it is clear that the apparatus according to the invention is as well suited for treating other films such as graphic films for halftone or line reproduction, etc.

An embodiment of the invention, selected by way of example, will now be described with reference to the accompanying drawings, in which:

FIG. 1 is the upper half of a longitudinal sectional view of a photographic processing apparatus embodying the invention, and

FIG. 2 is the lower half of the view according to FIG. 1.

FIG. 3 is a diagrammatic longitudinal sectional view showing the air paths in the drier.

FIG. 4 is a horizontal sectional view on line 4—4 of FIG. 3.

FIG. 5 is a cross-sectional view of an air-directing tube.

As shown in FIGURES 1 and 2, the apparatus for processing X-ray film comprises a film loading section **10**, a wet processing section **11** and a drying section **12**. The film loading section **10** is the only portion of the processing apparatus that is situated in a darkroom set off by wall partition **13**. The loading section **10** has a platform **14** upon which a sheet of exposed film is placed for feeding to the driven inlet pressure roller pair **15**.

A microswitch **18** which is provided at the entrance of the apparatus and the contact lever of which protrudes through the supporting platform **14**, is actuated by each film sheet which is introduced into the apparatus, and this microswitch controls the regeneration of the developing and the fixing solutions of the apparatus by means of the regeneration solutions contained in the small tanks **16** and **17**.

As the operation of regenerating the processing solutions is unessential for the understanding of the present apparatus, no further details will be given hereinafter in connection with this point. Further details about a suitable regenerating system may be found in the pending United States patent application Ser. No. 419,727.

The wet processing section **11** is light-tight enclosed and it has three tanks disposed in side-by-side relation, viz. the tank **21** containing a developing solution, the tank **22** containing a fixing solution, and the tank **23** containing the rinsing water.

The developing solution may be of any known type such as the commercially available Gevaert G125 developer for X-ray film.

The fixing bath is a relatively low pH formula such as the Gevaert G334 acid fixer for rapid fixing and for hardening to some extent the gelatin coating of the film. Thereby the tackiness of the film is sufficiently reduced to avoid damaging of the film sheet when it is conveyed between the roller pairs and when it is deflected by the guide plates for reversing the direction of travel of the sheets through an angle of 180°.

Each of the tanks **21**, **22**, **23** of the wet processing section **11** is provided with two roller sections **24** and **25** which are removably insertable in the tank. When inserted in the tank, the rollers constitute a plurality of cooperating driven pressure roller pairs for transporting the film downwardly and upwardly within each tank. Between the different roller pairs of each section are provided guide plates such as **26** and **27** for preventing the film sheet, conveyed by the different roller pairs, from diverging from its course. Further deflecting plates such as **28** and **29** are provided for turning the film through an angle of 180° so as to change the downward movement of the film in an upward movement.

A similar function of turning the film through 180° is performed by the cross-over roller transport sections which are located at the top of the tanks and interposed between adjacent tanks to transport the film from one tank through an angle of 180° into the adjacent tank and to remove the surface liquid from the film. A cross-over roller transport section comprises two arcuate guide plates **32**, **33** with a driven pressure roller pair **34** therebetween.

The rollers and roller pairs of the wet processsing section **11** described hereinbefore and the rollers and the roller pairs of the drying section **12** which will be described hereinafter, are drivingly connected by means of gears, wormwheels and worms, chainwheels and chains, or the like, for rotation at equal peripheral speed.

Description of the roller driving system as such is unnecessary for the understanding of the present embodiment and such system has therefore been omitted in the drawings.

After the film has been thoroughly rinsed in the rinsing tank **23**, it is directed into the drying section **12** by a roller system **35** comprising a number of driven squeegee roller pairs.

The drying section is defined by a front wall **38**, a rear wall **39**, and two lateral wall portions **40** and **41**. The front wall **38** consists for the greater part of a glass panel, permitting the observation of the interior of the drying section and the arrival of film sheets. Beneath the drying section is provided a chute **42** wherein the film sheets fall down when they leave the drying section through the opening **58**. Through the opening **43** the film sheets may be removed by the operator.

Along the film path in the drying section **12** are located the vertically aligned horizontally positioned roller pairs **36** and the air-directing tubes **37**.

The rollers are preferably made of a material that minimizes damage to the gelatin coating of the film caused by the rollers adhering to the coating when in contact therewith. Materials of this type are butyl rubber, polyethylene, hard paper, or the like.

The air-directing tubes may consist of aluminium, stainless steel, or the like. In the present embodiment they are made out of aluminium, they have a cross-section as enlargedly seen in FIG. 5 and they are provided with a longitudinal slit **44**. The wall thickness of the tubes is 2 mm. and the width of the slit amounts to 1 mm.

The end of each of the tubes has a portion of reduced outside diameter adapted to be inserted through corresponding openings which are provided in the vertical walls **53**, **54** (FIG. 4). As the tubes have a non-circular cross-section, no means need further be provided for securing them against rotational displacement.

It may be useful to mention here that the FIGURES 3 and 4 are diagrammatic views only wherein the exact geometrical location of some parts of the drying chamber has slightly been changed in order to facilitate the representation and the understanding of the air circulation in the device. For the same reason the direction of the air flow and the exit of the air in the blower casing have been changed in FIG. 3.

The walls **53**, **54** form part of the air plenums **51**, **52**, respectively, which are disposed vertically at either side of the drying section. The upper end of each plenum is closed whereas the lower end is connected to a tangential blower **46** by means of a main duct **48**, forming two branches **49**, **50**. The air paths from the main duct towards the air-directing tubes are indicated in broken lines. The blower **46** is located in a thermically insulated chamber **45** which is located under the wet processing section

11. The heating of the air occurs by means of the heating element 47.

As the air is evacuated from the chamber 45 through the main duct 48, a vacuum develops at its entrance opening 55, so that the air, moistened by the wet film sheets passing between the air-directing tubes, is removed from the drying section along the paths indicated in drawn lines. At it appears from the figure, the removal of the air occurs through the openings 56 provided in a baffle 57. The said baffille runs parallel to the front wall 38 and the rear wall 39 of the drying section, and separates a substantial part of the space comprised between the right vertical row of air-directing tubes 37 (FIG. 3) and the wall 39. Through a plurality of openings 56 in the baffle the spaces at either side of the baffle communicate with each other. In increasing the area of said openings from the bottom upwardly, the underpressure which prevails at the right side of the film course may be substantially equal over the complete height of the drying chamber.

In absence of the described baffle, on the one hand, the underpressure developed near the bottom of the chamber takes relatively great values so that the film sheet may be pulled out between two successive roller pairs and, on the other hand, the underpressure developed near the top of the chamber is too small to still have any significant effect in evacuating moistened air.

The warm air circulates through the drier and becomes still more laden with moisture removed from the film surfaces. In order to avoid the saturation of the drying air, a certain amount of the air is continuously vented and replaced by fresh air. The venting of the air occurs in part through the slot-like opening 58 through which the dried film sheets leave the drying chamber and in part through the adjustable opening 59 in the main duct 48. By means of a duct 60 the said opening 59 may communicate with the open air so that the air laden with moisture does not enter the room where the apparatus is disposed. The introduction of fresh air for replacing the vented air occurs through an opening 65 in the rear wall of chamber 45.

The slits 44 of each pair of air-directing tubes 37 which are in register with one another direct unobstructed symmetrical sheets of warm air normal to and extending across the entire width of the film.

The slightest unbalance between the sheets of air or a given roller pair, any difference in adherence of the tacky surfaces of the film to the roller surfaces will make the front edge of the film diverge from its rectilinear course through the drying chamber. The divergence of the film sheet may be increased by turbulences in the air-streams, by the vibration effect of the front portion of the film, etc. The deviation of the film sheet from its course generally will be greatest towards the side of the blower since at that side of the film course an underpressure exists. In its most extreme deviations, the film may follow a course 62 as is shown in FIG. 5, and touch the air-directing tube 37 in a point 63. In reality a great number of such points extend over the length of the tube and form a line of contact between the film and the tube. The front edge of the film sheet is prevented from entering the slit 44, owing to the location of said slit out of reach of the film sheet.

In case relatively thin and consequently more flexible film sheets are treated, the distance between the tubes 37 and the rollers 36 may be too considerable for preventing the abutment of the front edge of the film to the upper curved part of the tube when the film deviates considerably from its course. The positioning of the tubes and the rollers, closer to each other preventing the film sheet to deflect exaggerately, may be remedy.

In the operation of the drier according to the invention, an exposed film sheet is removed in the darkroom by the operator or by an automatic cassette unloading mechanism, and fed over the platform 14 to the inlet pressure roller pair 15 which directs the film to the wet processing section 11. The film is transported by the rollers through the developing, fixing and washing tanks, and thence through the squeegee rollers 35 which remove most of the remaining surface liquid from the film. The film is then transported by the rollers 36 through the drying chamber where the gelatin coating or coatings of the film are subjected to oppositely disposed sheets of warm air extending across the width of the film.

The apparatus as shown in FIGURES 1 and 2, and provided with air tubes of a form as represented in FIG. 5, was capable of treating film to a width of 17" at a speed of 6.66 mm./sec. The height of the drying chamber from the upper to the lower roller pair 37 amounted to 55 cm., the warm air supply had a capacity of 1200 $m.^3$ of air per hour at 45° C. The overpressure measured in the main duct 48 amounted to 35 mm. of water.

It has been found that some types of film gave rise to difficulties as to uniform drying in the transverse direction of the apparatus. More particularly slight longitudinal drying strips were noticed on some dried film sheets, at an area, which passed by about the middle of the blower tubes. The phenomenon was attributed to the air currents which were blowing at either side onto the tube and which impinged onto each other in about the middle of the tubes, thus giving rise to turbulencies at said area. In feeding the tubes alternately at one end only and in closing the other end, this difficulty disappeared.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various modifications may be made without departing from the spirit of the invention. Thus the novel sheet conveying apparatus comprising rollers and means for supplying streams of air may be applied otherwise than in drying apparatus for films and the invention includes such conveying apparatus per se.

What we claim is:

1. Drying apparatus suitable for drying photographic film sheets, comprising successive spaced sets of cooperating rollers for conveying sheets through the dryer, and comprising between such successive sets of rollers, on opposite sides of and spaced from the intended path of the sheets through such rollers, air tubes for discharging warm air against opposite sides of said sheets, each of said air tubes including a wall section adjacent said sheet path which bends away from said sheet path in the direction of sheet movement, each such tube having a transversely extending air discharge slit therein, said slit being located at a locus on said bending wall section spaced downstream from the locus on said wall nearest said sheet path, so that if the leading end of a sheet should on emerging from the nip of the preceding set of rollers deviate from the normal sheet path at an angle such that the sheet would collide with one of said tubes, the leading end of such sheet would be obstructed from entering the air discharge slit by the intervening wall section projecting nearer the sheet path.

2. Drying apparatus according to claim 1, wherein said air tubes have an elongate cross-section, the shorter axis of said cross-section being substantially parallel to the direction of film sheet travel between the tubes.

3. Drying apparatus according to claim 1, wherein the air discharge slits extend over at least a distance corresponding to the relevant dimension of the largest sheet to be dried.

4. Drying apparatus according to claim 1, wherein the walls of said slits are substantially perpendicular to the normal path of the sheets.

5. Drying apparatus according to claim 1, wherein said transport rollers and said air tubes are located in a substantially air-tight housing, wherein an underpressure is maintained for discharging the air laden with moisture.

6. Drying apparatus according to claim 5, wherein said underpressure is developed at substantially one side of the film path and closer to one end of the film path than to the other end, and wherein means is provided for controlling the underpressure along the film path so

as to obtain a substantially uniform underpressure at the side of the film path where the underpressure is developed.

7. Drying apparatus according to claim 6, wherein said means consists of a baffle which extends over substantially the length and the width of the film path in the drier, and which is located aside the rollers and the air tubes at the side of the film path where the underpressure is developed, the baffle being provided with a plurality of openings the area of which decreases towards the place where the air is discharged from the housing.

8. Drying apparatus according to claim 1 wherein

the film transport rollers are arranged in pairs opposite to each other.

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