This invention relates to apparatus of the type used to apply a coating of liquid material to flat, substantially monoplanar stock, such as the fibrous or paper stock used in manufacturing milk cartons, food cartons and other packaging cartons. More particularly, but not by way of limitation, this invention relates to improvements in existing curtain coating machines which permit thin paper and fibrous stocks of relatively small area to be more effectively coated in such curtain coating machines than has heretofore been possible.

In conventional curtain coating machines now in use, such as the Steinemann curtain coater, the basic elements of the machine comprise a coating head through which is passed a thin film of a liquid coating composition, which film is allowed to gravitate from the head in a substantially vertical plane so as to form a curtain usually having a width of several feet. The falling coating composition is collected in a trough spaced vertically downwardly from the coating head at which the curtain originates, and is then recirculated from the trough to the head after being passed through suitable heating and degassing equipment.

In such machine, a substantially horizontal plane which extends normal to the falling curtain of the coating composition are a pair of conveyors which serve to feed the stock to be coated through the curtain. In the conventional curtain coating apparatus, the feed conveyor is a broad, belt-type conveyor which terminates adjacent the curtain and feeds the flat stock into the curtain in such manner that the curtain strikes the upper surface of the stock at substantially a right angle. The discharge conveyor, which removes the stock from the curtain also terminates in close proximity to the curtain so that the leading edge of the stock is received by the discharge conveyor, and by frictional engagement, the stock is moved out of the curtain and onto the discharge conveyor for transfer to a point of disposition. The gap which exists between the feed and discharge conveyors, and through which the falling curtain passes, is directly above the trough and is of lesser width than the length of the stock which is to be coated.

In the case of thin, relatively small stocks which are to be coated in the conventional curtain coating machines heretofore utilized, a problem has existed in applying a uniform, blister-free coating to the stock as the stock is passed through the falling curtain. This problem arises from the fact that the dimensions of the stock only permit the stock to barely bridge the gap between the intake and discharge conveyors, and the weight of the unsupported span of the stock, in addition to the impact of the falling curtain on the upper surface of the stock results in a distortion or deflection of the stock from a single plane as it passes through the curtain and over the collecting trough. This bending motion of the stock causes defects in the form of blisters and open spots to occur in the applied coating. The result of these defects is that many of the cartons formed from the stock must be discarded and, for some combinations of coating materials and substrate stocks, the discards reach such a high percentage as to make the curtain coating operation uneconomical.

The present invention provides an improvement in curtain coating machines which enables small, relatively thin stocks to be coated in such machines with a smooth coating of uniform thickness, which coating is free of blisters and open, uncoated spots. In one of its broader aspects, the invention comprises a grate of novel construction which is placed in the trough directly beneath the coating head, and which provides a supporting platform for supporting the stock as it passes through the gravitating curtain. In providing such support, the grate prevents the undesired deflection of the stock hereinafter described, and thereby eliminates the development of the defects in the coatings which require discard of the stock and cartons made therefrom.

The novel grating and curtain coating apparatus which includes such grating in combination therewith which are contemplated by the present invention may assume several forms, but in each embodiment, several common features of the grating are perceptible, and are of substantial importance to the effective functioning of the grating in the attainment of the described ends. First of all, the grating does not present any substantial or considerable obstacle to the free passage of the coating composition through the gap between the conveyors and into the trough below. It is important that the free circulation of the coating composition be uninhibited except for such portion of the composition as is deposited upon the upper surface of the stock which is passed through the gravitating curtain.

A second important consideration in the novel grate construction is that the coating material does not collect in excessive amounts, or adhere for excessive periods of time, on the portion of the grate which is contacted by the stock as it passes thereover. This is an important feature of the invention since otherwise such accumulated coating material will be deposited on the bottom side of the stock as it passes over the grate, thus marring this side of the stock. Such deposition of the coated composition is undesirable in every instance, and is particularly undesirable when the bottom or second side of the stock must subsequently be coated in another operation.

A final important feature of the novel grate of the present invention is that it affords a minimum of resistance to the free passage thereover of the stock to be coated, and does not provide any abrupt edges or points upon which the stock may become impaled or scratched. In each of the embodiments of the invention, this is accomplished by the provision of a minimum grate surface area in contact with the underside of the stock passing thereover, and a proper inclination or curvature of the grate elements to assure that the stock moves easily onto the grate and does not become pierced through, or hung upon some portion of the grate.

From the foregoing general description and summary of the invention, it will be perceived that the present invention provides a valuable improvement in curtain coating machines of the type in which a gravitating curtain of the coating composition to be used falls from a coating head to a receiving trough through a gap defined between conveyors used to feed stock into and through the gravitating curtain of the coating material. The invention permits several important objectives to be achieved which have not heretofore been attainable in conventional curtain coating machines, one of the more important of which is a general improvement in the coating which is applied to the surface of stock passed through the curtain coating apparatus.

A more specific object of the present invention is to provide an improved curtain coating apparatus in which fibrous stocks of relatively small area and thickness may be coated with more uniform and defect-free coatings.

Another object of the invention is to reduce the percentage of coated stock materials which must be discarded after coating such stocks using a curtain coating machine of the type hereinbefore described.
A further object of the present invention is to provide an improvement in curtain coating machines of the type heretofore employed which permits the general appearance of fibrous stocks coated by the use of the machine to be improved, and also improving the overall coating rate which can be attained when using such machines.

An additional object of the invention is to provide an improvement to conventional curtain coating machines, which improvement is readily adaptable to the existing components of such machines, and is inexpensive to construct, to set up, and maintain.

In addition to the foregoing described objects and advantages, additional merits and useful aspects of the present invention will become apparent to the reader as the following detailed description of the invention is read in conjunction with the accompanying drawings which illustrate the invention.

In the drawings:

FIGURE 1 is a schematic isometric view of one embodiment of the invention which may be utilized for improving the coating applied to small, relatively thin stocks utilizing a curtain coating machine.

FIGURE 2 is a modified embodiment of the novel grating which is employed in combination with the conventional elements of a curtain coating machine in substantially the same manner illustrated in FIGURE 1.

FIGURE 3 is an isometric view of a third embodiment of the invention in which the coating is supported in the relative spacing with respect to each other as shown in FIGURE 1 by a pair of elongated, horizontal connecting members 32 and a series of wire support members designated generally by reference character 33. The connecting members 34 include a plurality of horizontally spaced, substantially parallel wires 36 which have their upper surfaces positioned in substantially the same horizontal plane as that occupied by the upper surface of the conveyor 20 and 22, and which are each provided at their ends adjacent to the wire conveyor 20 with a down turned toe portion 38. The wire support members 34 each further includes a pair of wire posts 39 which extend vertically upward from the elongated connecting members 32 and interconnect the wires 36 with the connecting members 32.

The legs 30, connecting members 32 and wire posts 39 of the grate structure illustrated in FIGURE 1 are dimensioned to assure the positioning of the wires 36 in the plane of travel of the lower surface of the stock 28 as it moves through the gravitating curtain of coating material. The wires 36 are each fine and of relatively small diameter, and may conveniently be constructed, for example, of steel piano wire. We have found a 14-gauge piano wire to be useful for most applications. The horizontal distance which is provided between the several wires 36 is governed by the size of the object to be coated, and the down turned toes 38 which are provided on the wires 36 adjacent the feed conveyor 20 assure that the stock to be coated will not be caught or impaled on the wires. With the aid of the grate structure illustrated in FIGURE 1, stock employed for fabricating milk and butter cartons has been successfully coated with hot melt coating compositions comprising blends of a thermoplastic copolymer and a wax. The coatings applied were of high quality and free of blisters and pinholes. Moreover, the grate did not impart any undesirable deposition of the coating material to the underside of the stock passed thereover.

In addition to the grate embodiment illustrated in FIGURE 1 of the drawings, two other embodiments have been successfully utilized in the curtain coating apparatus. The first of these embodiments is illustrated in FIGURE 2 of the drawings. The embodiment of FIGURE 2 comprises two pairs of vertically extending, horizontally spaced legs 30 which are interconnected by elongated connecting members 32. The grate structure used in the embodiment illustrated in FIGURE 1 are replaced by horizontally extending, parallel metallic bars 40 which are tapered at their upper edge to a knife edge 42. The knife edges 42 of the bars 40 occupy the horizontal plane common to the upper surfaces of the conveyors 20 and 22 so that the stock is moved smoothly across the bars 40 in traversing the gap between the conveyors 20 and 22 in passing through the curtain 18. In order to prevent grooving of the carton stock or impalement on the bars 40, the corners 44 of the bars adjacent the feed conveyor 20 are radium so that the leading edge of the stock slips easily onto the knife edge 42 of the bars without undue resistance.

The grate illustrated in FIGURE 2 of the drawings is positioned in the trough 12 in substantially the same manner as is illustrated in FIGURE 1 with the lower ends of the legs 30 resting on the bottom of the trough, and the stock supporting portion of the grate positioned in the gap between the conveyors 20 and 22.

The third grate embodiment which may be used in the combination is illustrated in FIGURE 3 of the drawings. This embodiment comprises two pairs of vertically extending legs 30 for supporting the grate in the trough 12 in the manner hereinbefore described. Each of the pairs of legs 30 is retained in its spatial relationship by a horizontal cross member 48. Interconnecting the horizontal cross members 48 are a plurality of elongated parallel, connecting members 50 which extend normal to the path of travel of the stock and are each provided with a plu-
rality of upwardly extending spikes 52 which terminate at their free upper ends in points. The points of the spikes 52 are all position in a common plane which corresponds to the plane of movement of the stock 28. The spikes 52 are preferably inclined slightly with respect to the vertical and in a direction of inclination away from the input conveyor 20. This inclination of the spikes 52 eliminates a tendency of the stock to catch on the spikes as the stock moves across and is supported by the spikes. The spacing of the rows of spikes 52 with respect to each other and with respect to the feed conveyor 20 is of considerable importance relative to the effectivenes with which the grate embodiment illustrated in FIGURE 3 may be used in combination with the other elements of the curtain coating apparatus. Thus, each of the rows of spikes must not be spaced from the next adjacent row of spikes nor must the first row of spikes be spaced from the feed conveyor 20 by a distance sufficient to permit the leading edge of the stock 28 to dip slightly and therefore abut against the sides of the spikes 52 prior to moving smoothly onto the points of the spikes.

From the foregoing description of the invention, it is believed that the operation and function of the invention will have become clearly understandable. To summarize, however, in the operation of the curtain coating apparatus including the improvement of the present invention, relatively thin stock of small area size is moved toward the gravitating curtain of coating material upon the feed conveyor 20. As it reaches the gap between the feed conveyor 20 and the discharge conveyor 32, the leading edge of the stock projects into the gap between the conveyors and will move outwardly upon one of the grate structures hereinbefore described. In each of the grate embodiments, the supporting surface which is provided for the stock as it moves across the gap and through the gravitating curtain 18 is of relatively small area, being either a point contact support as in the case of the embodiment illustrated in FIGURE 3 or essentially a line-type support as in the case of the wire support members 34 in the FIGURE 1 embodiment of the grate or the knife edge structure shown in the FIGURE 2 embodiment. In this way, a minimum of resistance is afforded to the movement of the stock 28 across the gap between the conveyors, and also the supporting structure does not present a large surface upon which undesirable coating material accumulations may occur. The latter aspect of the grate structure in turn avoids the possibility of transfer of coating material to the under surface of the stock as it passes across the supporting structure.

Although the present invention has been described with a certain degree of particularity and detail, it is to be understood that certain minor changes and modifications may be made in the structure described by way of example in the foregoing specification without departure from the basic principles underlying the invention. Changes of this type are therefore intended to be considered within the spirit and scope of the invention except as the same may be necessarily limited by the appended claims or reasonable equivalents thereof.

We claim:

1. In a curtain coating machine of the type used to apply a thin uniform coating to flat stock, the combination which comprises:
   (a) a coating head for developing a gravitating curtain of the coating composition;
   (b) a trough positioned below the coating head for receiving the coating composition;
   (c) a pair of conveyors positioned on opposite sides of the gravitating curtain for moving the flat stock through the gravitating curtain in a plane extending through the curtain between the coating head and the trough; and
   (d) a grate positioned in the trough and providing a perforate supporting surface in coplanar alignment with the plane of movement of the flat stock through the gravitating curtain for supporting the stock as it moves through said gravitating curtain, said grate comprising:
      (1) a substructure resting in said trough, said substructure comprising:
         (a) a pair of vertically extended rigid legs at each end of said trough; and
         (b) horizontal connecting members interconnected with the legs of said pairs and maintaining the spacing of said legs from each other; and
      (2) a plurality of stock-supporting elements secured to said horizontal connecting members and projecting upwardly therefrom, said stock-supporting elements each terminating at its upper extremity in the plane occupied by the lower surface of said stock as it moves through said curtain.

2. The combination claimed in claim 1 wherein said stock supporting elements comprise a plurality of parallel, elongated wires each extending in the direction of travel of the stock through said curtain.

3. The combination claimed in claim 2 wherein each of said elongated wires terminates at its end adjacent the conveyor moving the stock into said curtain in a downwardly turned toe portion.

4. The combination claimed in claim 1 wherein said stock supporting elements comprise a plurality of parallel, elongated bars each extending in the direction of travel of the stock through said curtain, said bars each tapering to a knife edge at its upper edge with said knife edges extending in substantially the same plane as the plane occupied by the lower surface of said stock as said stock moves through said curtain.

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