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[54] **APPARATUS FOR COATING TAPES, SHEETS AND THE LIKE WITH VISCOUS SOLUTIONS USING THE AIR-BRUSH PRINCIPLE**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**.....**B05c 11/06**

[58] **Field of Search**.....118/50, 63, 407

[56] **References Cited**

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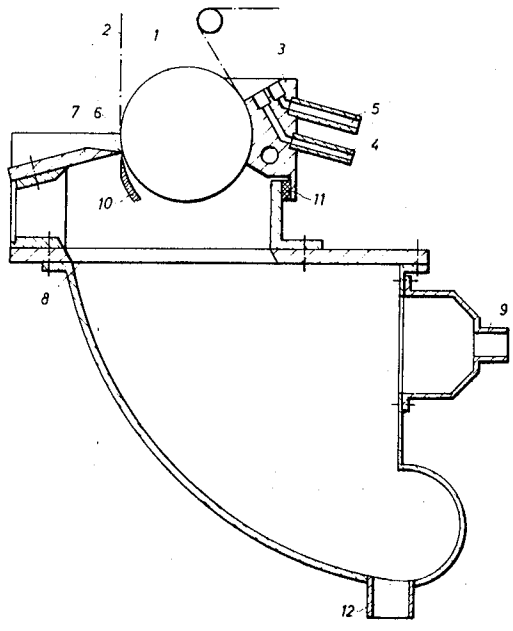
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[57] **ABSTRACT**

In a process for coating tapes or sheets with viscous solutions by the air-brush principle, a steam of air flows in the opposite direction to the movement of the web of material and acts substantially tangentially on the formation of the coating. This steam of air is produced by a vacuum between a bar which has an edge in the form of a ruler edge and the tape which is being coated, which moves past it at a close distance.

3 Claims, 3 Drawing Figures



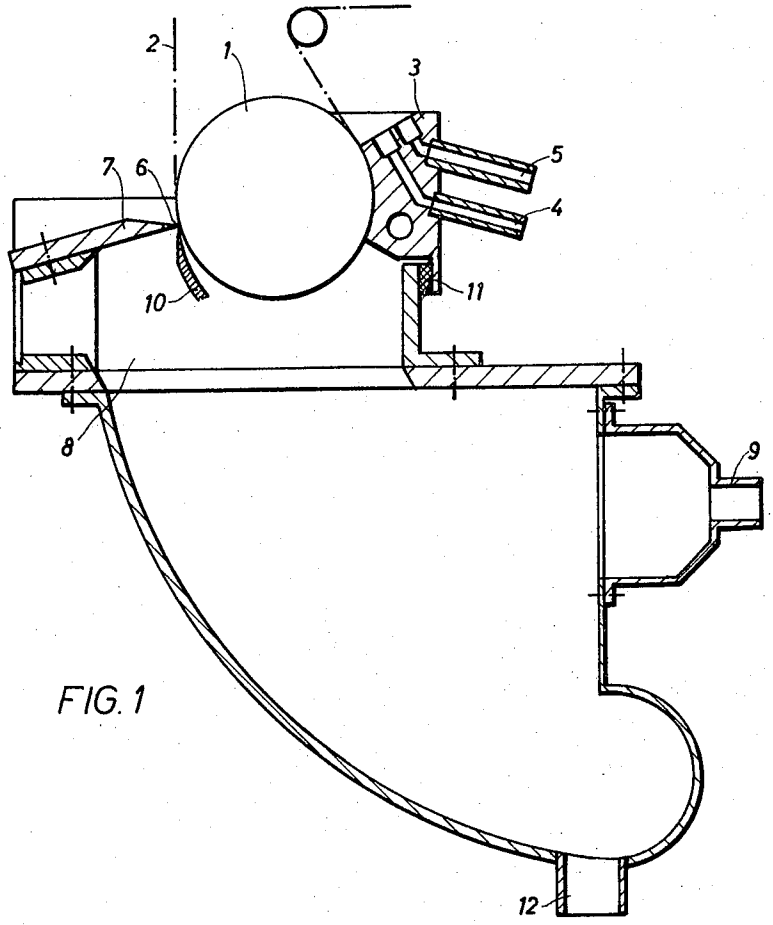


FIG. 1

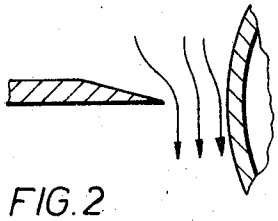


FIG. 2

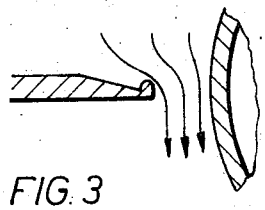


FIG. 3

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APPARATUS FOR COATING TAPES, SHEETS AND THE LIKE WITH VISCOUS SOLUTIONS USING THE AIR-BRUSH PRINCIPLE

It is known to coat sheets, tapes and the like by coating processes such as by dip coating and transporter roller coating. It is particularly important when producing coatings for photographic purposes to obtain very thin layers of a very uniform thickness. For rationalization it is often desirable to use concentrated coating solutions of high viscosity and to apply these at high speeds, but this can not be done by dip coating or transporter roller coating. With this aim in view, various processes have been developed which use, for example,extrusion hoppers with slot dies, which are particularly suitable for the application of substances of high viscosity.

These processes frequently have the disadvantage that the shape and cross-sectional dimensions of the dies, which determine the thickness of the coating, must have the equal dimensions as the coating which is to be produced. This means that the manufacturing tolerances of these parts must be very small particularly as the layer which is to be applied usually becomes thinner as the concentration is increased. Often, however, a more serious problem is that the slot become partly blocked during the operation of the process by solid particles which are present in the coating solution or by particles which adhere to the support, so that a defective coating is obtained. The operational reliability of any particular coating operation can be expressed quite generally in terms of a value obtained from the relationship between the smallest geometrical distance occurring in practice, which determines the formation of the coating, and the thickness of the resulting coating. The higher this value, the greater is the operational reliability, i.e. the freedom of the apparatus from trouble due to the slot becoming blocked.

In this respect, the well known air-brush or air-knife process is very advantageous. Unfortunately is is limited in its applicability as it can only be used for solutions of low viscosity. More viscous solutions require such a high pressure head that the volume of air which has to be discharged on the side of the finished coating is too great, so that the quality of the coating obtained is unsatisfactory. There is, however, a limit to the extent to which the main dimensions of an air brush, e.g. the width of the slot and the distance of the exit of the slot from the film,can be reduced if a sufficiently powerful blow discharge effect is to be obtained even with small pressure heads because the air jet which impinges almost vertically acts as a blockage on the side of the advancing coating solution and produces a wall of liquid which is constantly disturbed by the stream of air and tends to contaminate the edges of the die and hence to prevent a uniform air flow. Manufacturing limitations on the precision obtainable and the fineness of adjustment obtainable also means that an air brush can only be manufactured and adjusted within a certain range in relation to its operating width.

It has now been found that the quality of the finished coating can be substantially improved by the air brush process even when using viscous coating solutions if the coating is formed under the action of a substantially tangential air stream which is produced by a vacuum between a bar of a certain shape and the tape, which is

to be coated, which passes across it at a close distance to it, the tape having been just previously coated with a viscous coating solution and more than enough of this solution having been carried on by adhesion to the tape into the operating region of said air stream.

In contrast to the conventional procedure, the new arrangement has the advantage that formation of the coating takes place in cooperation with the air stream in such a way that the air stream is discharged only on the side of the advancing coating solution. It has also been found that it is very important for the quality of the coating that the bar should be shaped ruler like and very thin in cross-section i.e. it should take up little space, and the diameter of the transporter roller should be as small as possible. Furthermore the radius of the rounded contour of the ruler edge should be correctly proportioned to the width of the gap between the ruler edge and the tape. A ratio of the contour radius of the ruler edge to the width of the gap of 0.25 – 0.75 is particularly advantageous. Shaping of the ruler edge is firstly determined by the width of the gap required. A large gap is preferably used as far as possible. When working with very viscous solutions in order to produce very thin coatings, one would have to use gaps which are too small for practical convenience. In such cases, the ruler edge should be shaped that it causes a large constriction in the air flow. This is achieved by making the geometrical cross-section of the gap, very much larger than the cross-section of that part of the gap, which is filled with very rapidly flowing air. This ratio is obtained in practice by turning up the end of the ruler edge so that the required constriction of the air stream is produced.

Furthermore, it is important to produce a stream which is completely stationary with the velocity distribution decreasing as constantly as possible across the width of the gap from the ruler edge to the surface of the coating so that different coating thicknesses can be obtained as desired by varying the width of the gap and so that one can always operate with the least possible vacuum, i.e. with the smallest volume of air. With regards to the shape of the ruler edge, this means that in the region where the finished coating is being formed, the flow channel should be as short as possible compared with the width of the gap.

A thin, knife-sharp ruler might therefore be expected to produce the best coating. However, such an edge gives rise to periodic eddy currents, especially if a high vacuum is applied,and these result in a faulty coating. This can be counteracted by rounding off the ruler edge in such a way that the contour radius bears a particular relationship to the width of the gap.

In order that the formation of the coating may be achieved over a very short length in the direction of movement of the web of material which is being coated, the space in front of and behind the ruler edge must also have a certain configuration i.e. the region of the air stream should be as free as possible from obstruction by the ruler and the vacuum area should widen out sufficiently, directly behind the ruler edge. A small diameter guide roller also contributes to this effect.

The shape of the bar also determines the velocity distribution in the gap between the bar ruler edge and the web, a change in the blowing effect being best achieved

by varying the distance, this effect being increased by reducing the distance and consequently the thickness of the layer being reduced. This adjustment of the width of the gap provides a substantial advantage over a conventionally designed air brush because the thickness of the coating can be easily adjusted, by continuously varying the gap between the coating whereas in the conventional arrangement the blowing effect could only be varied by increasing the pressure head, which entails all the disadvantages described above.

The air brush of known design, in which the width of the slot and the distance of the die from the taps are adjusted to the minimum values, comprises a multipart body the parts of which can only be manufactured to a certain precision. These parts are fixed in a certain position in spite of the distorting effect of the excess pressure which determines the width of the gap, and this die body is kept at a certain distance from the blowing area and must be moved in a certain radial direction. However, according to the present invention the ruler edge is fixed on a completely rigid support of large cross-section and the result obtained depends on the position of the ruler edge in relation to the applicator roller which is located on the same support. Moreover, using a small coating gap a much better quality of coating is obtained even with a much lower vacuum, than could be obtained with the known air brush and employing a correspondingly high excess pressure.

The installation of a baffle plate in the vacuum chamber of the coating apparatus has also been found to be advantageous because it controls the flowback of the coating solution.

On one side, the baffle plate smoothes and regulates the flow of the advancing coating solution and on the other side it has the same effect on the excess coating solution which has been removed and which flows back over it.

In order to obtain a good coating, it is necessary for the coating solution to be applied uniformly and in the correct amount. On no account should the quantity applied be too small in proportion to the amount required for the coating, so that the excess can flow back in a uniformly thick layer which is free from stripes. Any of the known applicator devices may in principle be used for coating, but wedge coating processes using an apparatus as illustrated in FIG. 1 have proved to be particularly suitable. To ensure satisfactory performance of the coating apparatus described, it is also important that the methods used for the removal of the excess coating solution which flows back and the removal of the air, which forms the suction, should take place in such a manner that they do not interfere with each other, i.e. they should not have a common cross-section at any point of high flow velocity.

A coating apparatus is illustrated by way of example in the accompanying drawing in which

FIG. 1 is a cross-sectional view in elevation of one embodiment of this invention;

FIG. 2 is a fragmentary schematic cross-sectional view in elevation of a portion of the embodiment shown in FIG. 1, showing the aforementioned knife-sharp ruler which gives rise to periodic eddy currents; and

FIG. 3 is a fragmentary schematic cross-sectional view in elevation of a modified form of the portion shown in FIG. 2 of an embodiment of this invention.

In FIG. 1 the sheet material 2 is passed over the coating roller 1 and is given a preliminary coating in the wedge coating device 3 equipped with an emulsion feed tube and overflow tube 5. On passing through the gap 6 between the web 2 and the shaped bar 7, the excess emulsion solution applied is stripped off by a stream of air which is directed substantially tangentially to the web and opposite to the direction of movement of the web. This stream of air from the atmosphere going into the vacuum chamber 8 is produced by a ventilator attached to the suction tube 9. The baffle or preliminary smoothing plate 10 which has a sharp edge at the top closely adjacent gap 6 serves to smooth and regulate the flow of emulsion in the region in which the air knife acts. Preliminary smoothing plate or element 10 is concave relative to roller 1, and forms a wedge-shaped space relative to it.

When the preliminary coating is being applied by the known wedge casting process, the layer is formed in a wedge shaped gap between the sheet 2 and the wedge coater 3. The apparatus is sealed off from the vacuum chamber 8 by the seal 11 which is made of rubber or some other flexible material and is movable in the region of adjustment.

When the final coating is being produced, the thickness of the coating can be adjusted by choice of the distance between the shaped bar 7 and the sheet 2 and by adjusting the vacuum.

The emulsion stripped off by the air stream in the final coating operation is discharged through the discharge tube 12 and a receiver whilst the excess emulsion applied in the preliminary coating operation is discharged through the overflow tube 5.

As shown in FIG. 2, it is very important for the quality of the coating that the bar should be shaped ruler like and very thin in cross-section i.e. it should take up little space, and the diameter of the transporter roller should be as small as possible.

We claim:

1. An apparatus for depositing a coating of viscous solution on a longitudinally moving foil comprising a cylindrical guide member over which said foil is longitudinally traversed, a reservoir for said viscous solution contiguous to the side of said foil opposite said cylindrical guide member for applying an excess of said viscous solution to said opposite side of said foil, a ruler strip having a thin edge disposed closely adjacent the coated side of said foil to form a narrow gap between said edge and said foil, a low pressure chamber connected to said cylindrical guide member and the side of said ruler strip disposed adjacent said reservoir whereby a flow of air tangential to said foil and said cylindrical guide member is caused to flow through said gap opposite to said longitudinal movement of said foil for smoothly spreading said coating applied by said reservoir over said foil, a sharp-edged preliminary smoothing element disposed within said low pressure chamber and having a sharp edge disposed adjacent said gap, said sharp edge of said preliminary smoothing element being disposed closely adjacent to the surface of said foil to wipe excess coating solution from said foil immediately before it enters said gap to cooperate with said flow of air in providing a smooth finished coating upon said foil and said thin edge having a convexly rounded contour of a thickness which is a substantial fraction of the width of the gap.

2. An apparatus as set forth in claim 1 wherein the portion of said preliminary smoothing element disposed adjacent said foil and cylindrical guide member is concave relative to them.

3. An apparatus as set forth in claim 1 wherein said convexly rounded contour has a radius, and the ratio of said radius to the width of said gap ranging from about 0.25 to 0.75.

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