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(54) Suction nozzle

(57) A suction nozzle for the removal of the raised coating layer at the edge bead portions of a moving web, especially for high-speed coating of a continuous paper web substrate, has a dual part structure having a liquid jetting outlet (12) and a cleaning liquid suction inlet (14). means are provided for acceleration of ingressing air in speed over a long distance.

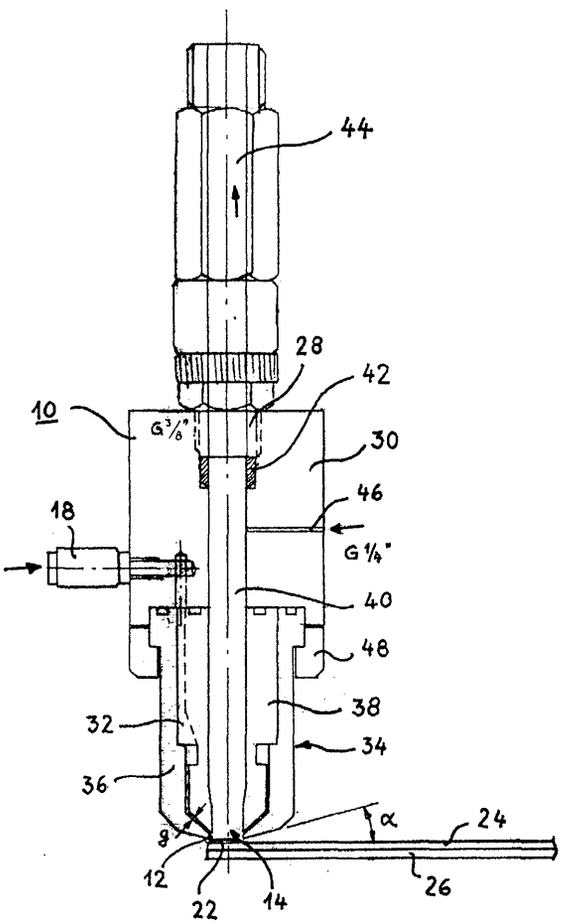

FIG. 2

EP 1 319 446 A2

Description

Field of the invention

[0001] The present invention relates to a suction nozzle and method for removing lateral edge bead portions of a coated layer of a continuously moving substrate with one or more simultaneously applied layers of liquid coating materials, and, more particularly to a suction nozzle and a method for removing said lateral edge bead portions under very high velocity from the substrate.

Background of the invention

[0002] Mainly in the field of manufacture of photographic papers or coated films, curtain coating methods and apparatus are widely known and used. Typically a continuous web or sheets are continuously moved below a coating hopper. One or more liquid compositions are provided from a hopper arrangement in the form of a liquid curtain.

[0003] For the manufacture of photographic papers, liquid compositions are used of relatively low viscosity, generally less than about 150 cP (centipoise), most in the range from about 5 to about 100 cP.

[0004] The manufacture of photographic papers is a tremendously difficult art requiring extremely accurate control. The practical use of curtain coating provides a number of difficulties coming with a need for an extremely uniform coating on the one hand and a need for coating of substrates in form of a continuous web at high speeds on the other hand.

[0005] A number of problems associated with curtain coating have been addressed in the prior art and many proposals have been made to overcome such problems.

[0006] Besides obtaining a free-falling curtain having uniform curtain characteristics over its width perpendicular to the moving direction of the substrate, one of the most often addressed problems is that the coated layer often has a tendency to rise along both lateral edges of the web to form edge bead portions due to the surface tension of the coating composition. A further problem is that the edges may be luted which leads to problems in use of the coated substrate. Also, the coated layer can not be dried uniformly at the edge bead portions. Therefore, the edge bead portions should be removed before drying of the substrate.

[0007] In EP 0 139 211 A2 the problem of removing rising coated layer at the edges of the web is described. The problem is solved by a suction nozzle and a method for applying a coating composition to an elongated flexible web which is continuously moving, wherein the suction nozzle has a dual pipe structure with a cleaning liquid jetting outlet and a liquid sucking inlet at its end, in which the jetting nozzle is offset from the longitudinal axis of the nozzle and forms an angle of 30 degrees to 85 degrees with respect to the longitudinal axis of the nozzle, and the sucking inlet is positioned on the longitudinal axis. According to the prior art, angles smaller than 30 degrees lead to the liquid flowing to the rear side of the substrate and an angle larger than 90 degrees leads to the sucking inlet not being sufficiently cleaned. In such manner, the removal of rising coated layer at the edge bead portions of the moving web may be improved which apparently allows a better coating quality of the moving web.

[0008] There are still remaining drawbacks affecting the quality of curtain coating methods, in particular with respect to curtain coating of paper substrates at coating speeds higher than approximately 150 m/min and especially at very high coating speeds of approximately 1200 to 2400 m/min.

Summary of the invention

[0009] It is therefore an object of the invention to provide an improved curtain coating method and suction nozzle particularly for high-speed coating of a paper web substrate, more particularly for high-speed coating of a continuous paper web substrate, more particularly in connection with a coating liquid having a relatively high viscosity compared to the coating liquids used for the manufacture of photographic papers, that is having a low shear viscosity of generally well above 1.5 Pa·s.

[0010] Briefly stated, these and other features, objects and advantages are obtained by providing a suction nozzle in which a means to get a longer distance of acceleration is provided. The problems are also solved by providing a method for removing lateral edge bead portions of a coated layer of a higher speed continuously moving substrate like a paper web by sucking air into the nozzle opening over a long accelerating way wherein a substrate is moved below a hopper arrangement providing one or more liquid coating materials in the form of a free-falling curtain impinging the substrate at a dynamic wetting line, wherein the dynamic wetting line of the coating curtain on the substrate or web is oriented generally perpendicular to the moving direction of the substrate or web.

[0011] By such accelerated speed of ingressing air the nozzle is able to thoroughly remove the elevated coated layer at edge bead portions at the high speed of the moving substrate.

[0012] Preferably, the nozzle end in the area of its opening is provided such that ingressing air is accelerated in speed. Preferably the end is relatively flat to elongate the distance of acceleration. More preferably, the air ingress angle relative to the plane of the substrate to be coated is small, especially smaller than 30 degrees, more preferably smaller than 20 degrees, most preferably between 0 and about 10 degrees.

[0013] In preferred embodiments of the method according to the invention the moving speed of the substrate is above 1000 m/min, preferably in a range of about 20 m/s to about 40 m/s. In a further preferred embodiment of the method the air speed at air inlet for in-

gressing air of suction or vacuum means or suction nozzle exceeds double the speed value of the moving substrate, most preferred about 200 m/s to about 250 m/s.

[0014] In a preferred embodiment the nozzle comprises an inlet for scavenging fluid or cleaning liquids running through the nozzle opening. The scavenging or cleaning liquids are supplied from a cleaning liquid supply support through a conduit in the nozzle. The outlet for that cleaning liquid runs around the nozzle opening, preferably inside the nozzle opening. The gap to supply the cleaning liquid in the area of the nozzle opening measures preferably 0.5 mm, more preferably 0.2 mm. It is preferred to have a small gap to diffuse the cleaning liquid over the whole edge bead portions. In a preferred embodiment of the invention the cleaning liquid is supplied at 250 ml/min or 151/h.

[0015] In a further preferred embodiment of the invention the suction nozzle comprises a pressure gauging means in a vacuum line to control the amount of vacuum supplied.

[0016] A suction nozzle according to the invention is preferably provided with a ring which may preferably be adapted to permit a free flow of ingressing air and detaching coating material.

Brief description of the drawings

[0017]

Figure 1 is a schematic overview showing generally a suction nozzle arrangement as known from the prior art;

Figure 2 is a schematic view of an improved suction nozzle according to a preferred embodiment of the invention in a partly cross sectional view; and

Figure 3 is a view on top of the nozzle according to Figure 2.

Detailed description of the invention

[0018] Figure 1 shows a suction nozzle arrangement over a substrate having coated layer risen along both lateral edges of the substrate or web formed as edge bead portions as known from the prior art. A conventional suction nozzle 10 is of a dual part structure having a liquid jetting outlet 12 and a cleaning liquid suction inlet 14 at the end. The jetting outlet 12 is offset of the longitudinal axis 16 of the nozzle. The sucking inlet 14 is located on this axis. Also provided is a cleaning solution supply port 18 to which water or solvent is supplied. The cleaning solution runs through a groove 20, which is straight. The angle between the jetting outlet 12 and the longitudinal axis of the nozzle which is the angle Θ in figure 1 may be in the prior art in the range of 30 to 85 degrees.

[0019] The nozzle is moved along an edge bead portion 22 of the coated layer 24 provided on the substrate or web 26. Through an evacuating port 28 which is connected to a vacuum pump, not shown in figure 1, the lateral edge bead portions are removed after dilution together with the cleaning liquid from the coated layer. The cleaning liquid runs, for the purpose of this application, downstream the nozzle and the removed lateral edge bead portions together with the cleaning liquid from the coated layer run upstream for the purpose of this application.

[0020] A suction nozzle or vacuum means according to the present invention is shown in a partly cross sectional view in figure 2. Parts being the same or similar to those described above depicted by the same reference number for the ease of understanding. The cleaning liquid supply port 18 is continued into the nozzle body 30. A liquid supply line 32 is provided essentially perpendicular to the cleaning liquid supply port 18 and is provided as a groove in the front part 34 of the nozzle. The front part 34 to the nozzle comprises an inner and an outer part 36, 38, where the inner part is spaced a distance from the outer part in the end area of the front part of the nozzle. There is provided a small gap g between the inner and the outer part 36, 38. The gap is formed as a ring and ends in the cleaning liquid jetting outlet 12. It is provided surrounding the cleaning liquid sucking inlet 14 at the end of the nozzle. The gap g preferably measures about 0.5 to 0.2 mm.

[0021] In order to have a long accelerating distance for the ingressing air the angle α between the outer surface of the opening end of the nozzle and the surface of the coated substrate is small and may be in the range of 30 degrees, preferably 20 degrees, more preferably 0 to about 10 degrees. Advantageously, with such small angles of ingressing air, removal of edge bead portions is possible with very high speeds of moving substrate 26 in the curtain coating process. The drawbacks of luted edges covered with rising coated layer may be overcome. Also, because of the cleaning liquid jetting outlet 12 surrounding the cleaning liquid sucking inlet 14 at the inside of the nozzle the nozzle maintains clean at all times such that the coating compositions will not solidify or accumulate inside the nozzle such that the nozzle may be operated for long periods of time.

[0022] The flow through the passageway 40 running through the nozzle and the evacuating port 28 may be controlled by a filler ring 42 surrounding the passage way inside the nozzle body 30. Accordingly, free flow is possible.

[0023] The flow is initiated by a vacuum pump or the like connected to a vacuum port 44.

[0024] To control the flow through the passageway there is also provided a port 46 for connecting a vacuum gauge. The port 46 is provided in the nozzle body 30. The nozzle body 30 is essentially block-like and screwed together with the front part 34 of the nozzle as schematically shown in figure 3. For such connection

the nozzle body is assembled by two parts one of which, 48, may be screwed to the other having a recess where the front part of the nozzle 34 is inserted and held in place.

[0025] Where this invention has been described in terms of a preferred embodiment, the present invention can be further modified within the spirit and the scope of this disclosure. This application is therefore intended to cover any variations, uses or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of any claims directed to this invention.

Claims

1. A suction nozzle for the removal of the raised coating layer at the edge bead portions of a moving web, especially for high-speed coating of a continuous paper web substrate, with a dual part structure having a liquid jetting outlet (12) and a cleaning liquid suction inlet (14) **characterised in that** it includes a means for acceleration of ingressing air in speed over a long distance.

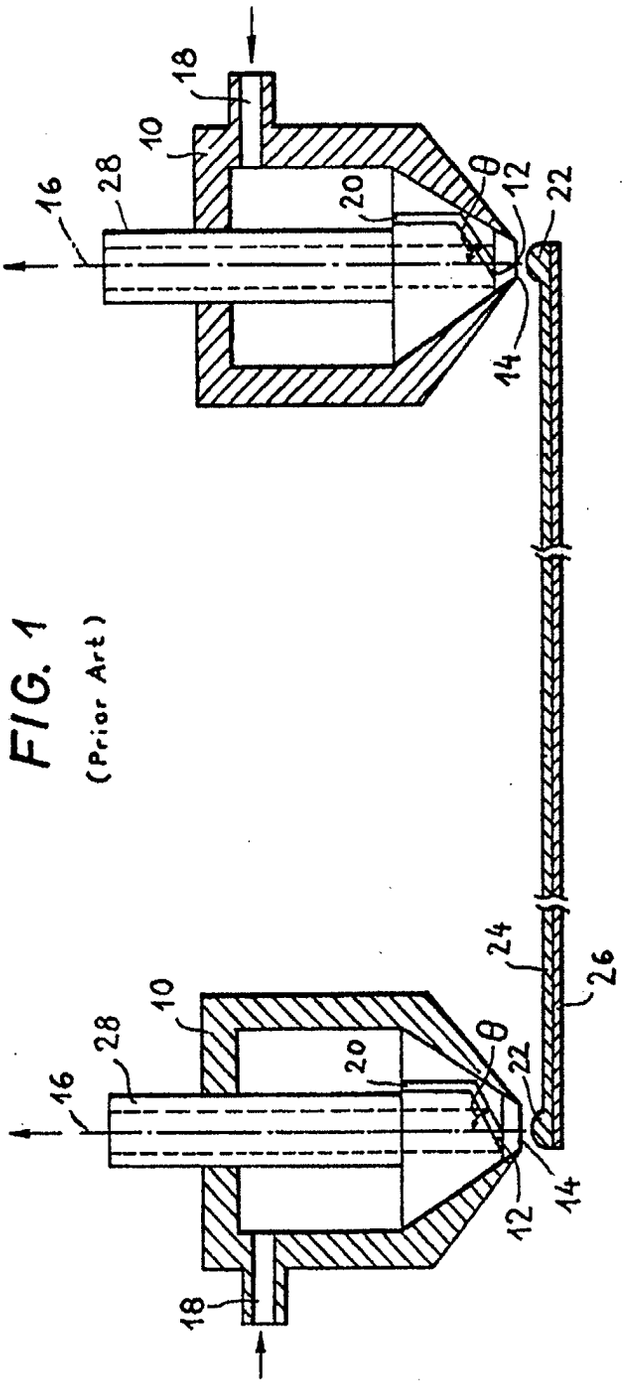

FIG. 1
(Prior Art)

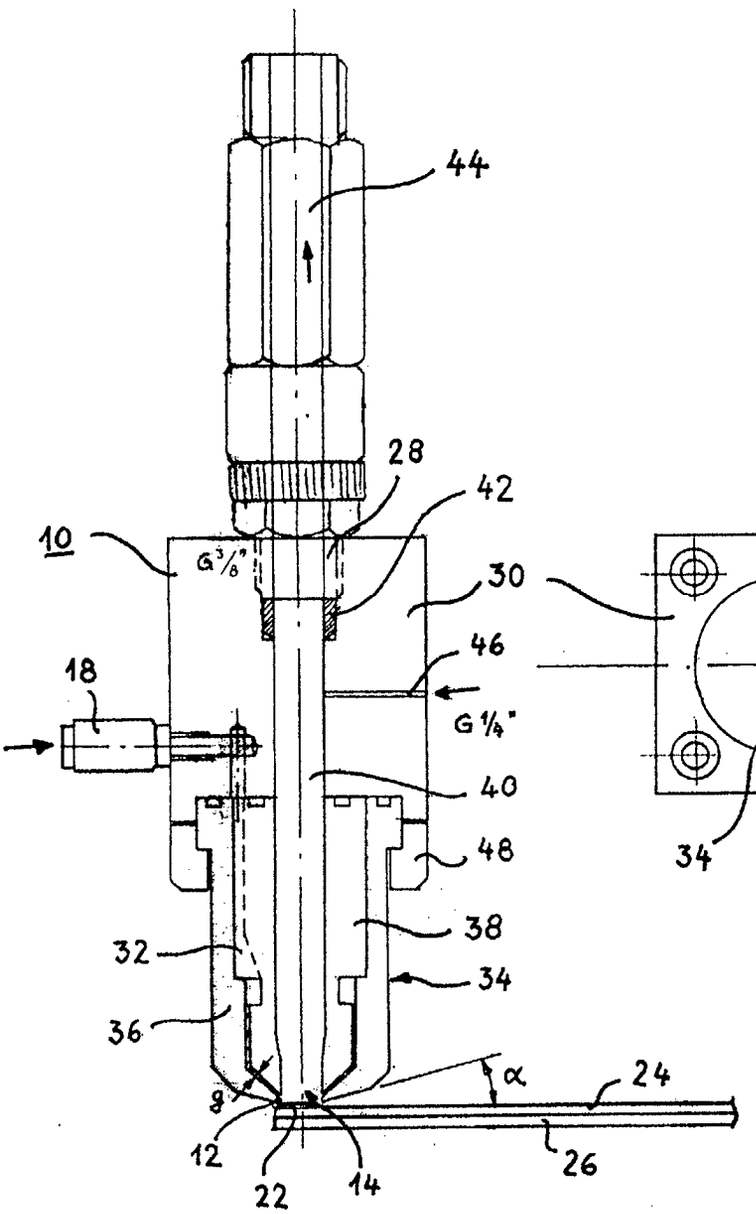

FIG. 2

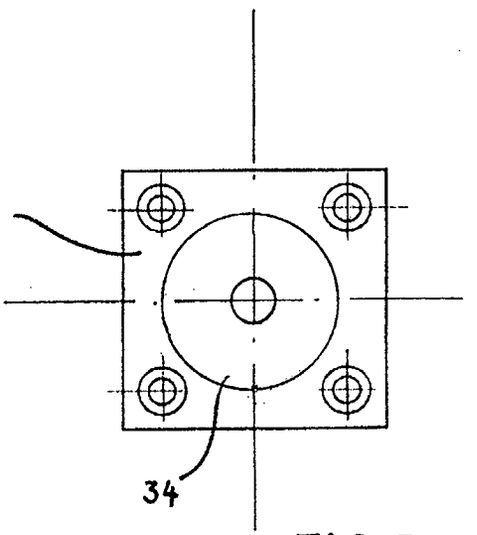

FIG. 3