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(58) Field of Search:
INT CL **B05C**
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(54) Title of the Invention: **Method and apparatus for applying a protective barrier coating to a substrate**
Abstract Title: **Applying a protective coating and de-aerating the coating**

(57) An apparatus and method for applying a protective coating to a substrate 14, especially a paper or card based substrate for use in food packing. The apparatus comprises a channelled anilox roller 16 for transferring the coating from a reservoir 20 to an applicator 12 whereupon it is applied to the substrate. The apparatus comprises a vacuum de-aerator 40 for removing gas from recycled coating and the applicator comprises a roller mounted printing plate. A peristaltic pump 26 is used to pump the coating within the apparatus. The apparatus minimises foaming of the coating without the need for an anti-foaming agent.

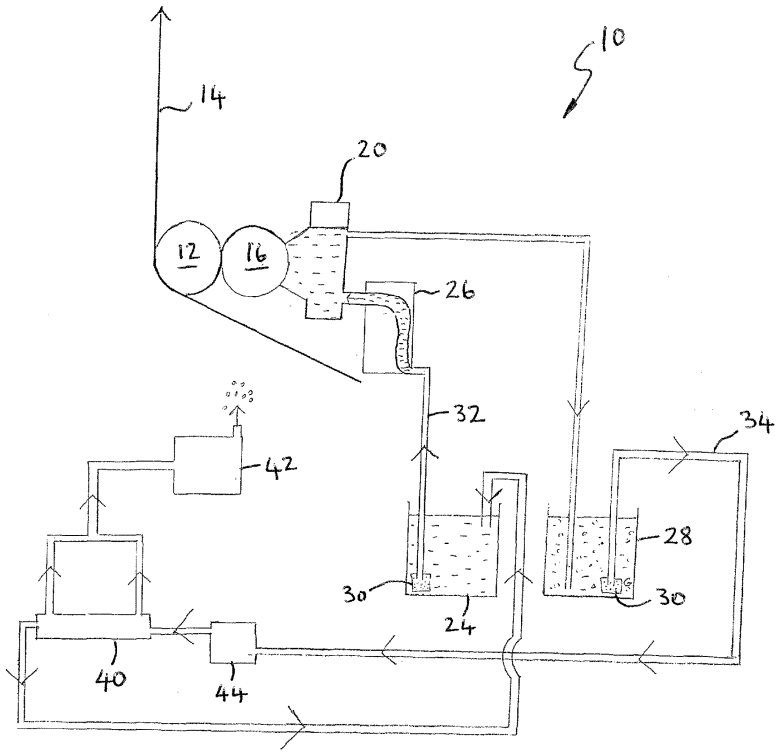

FIG. 1

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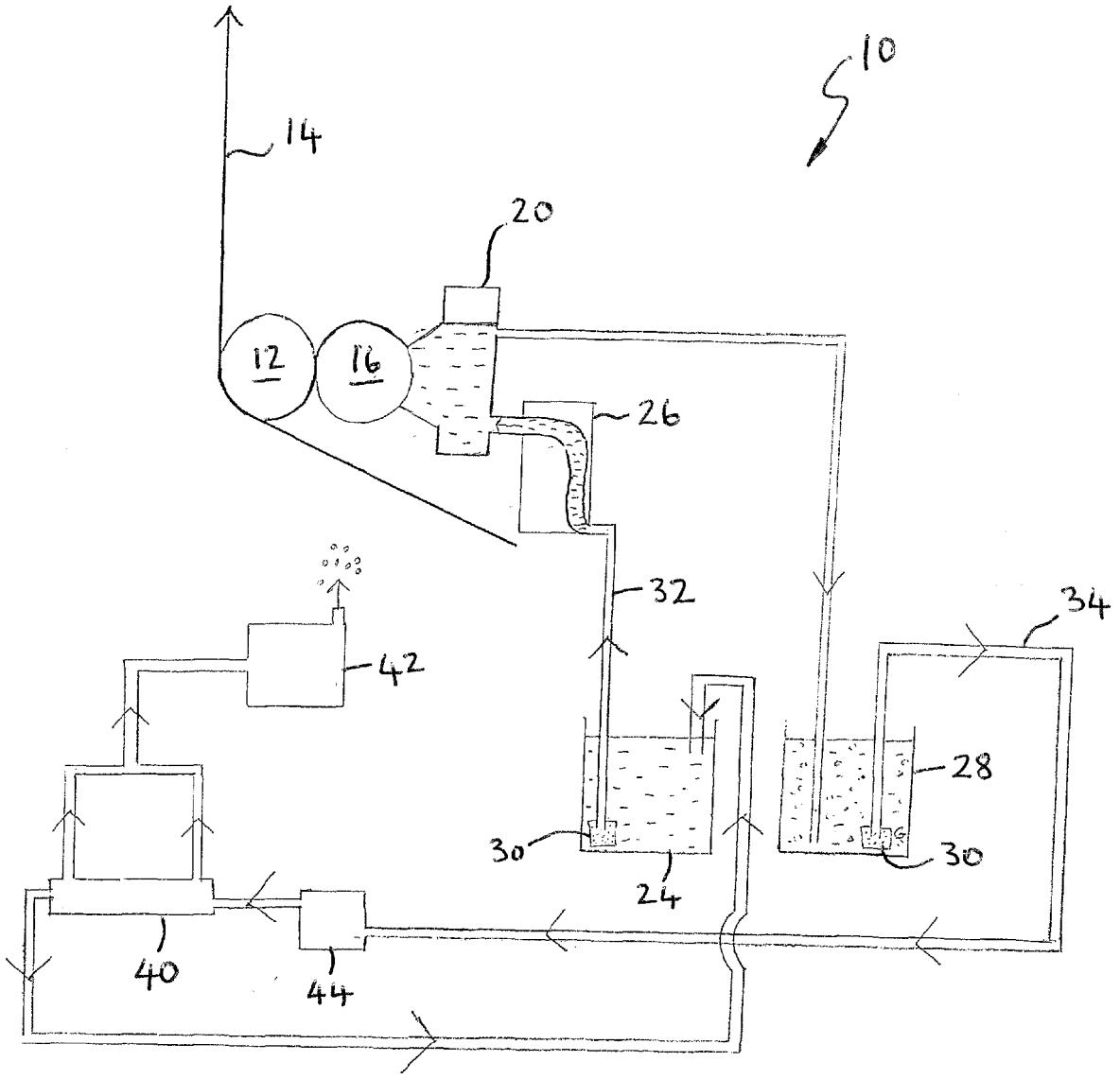

FIG. 1

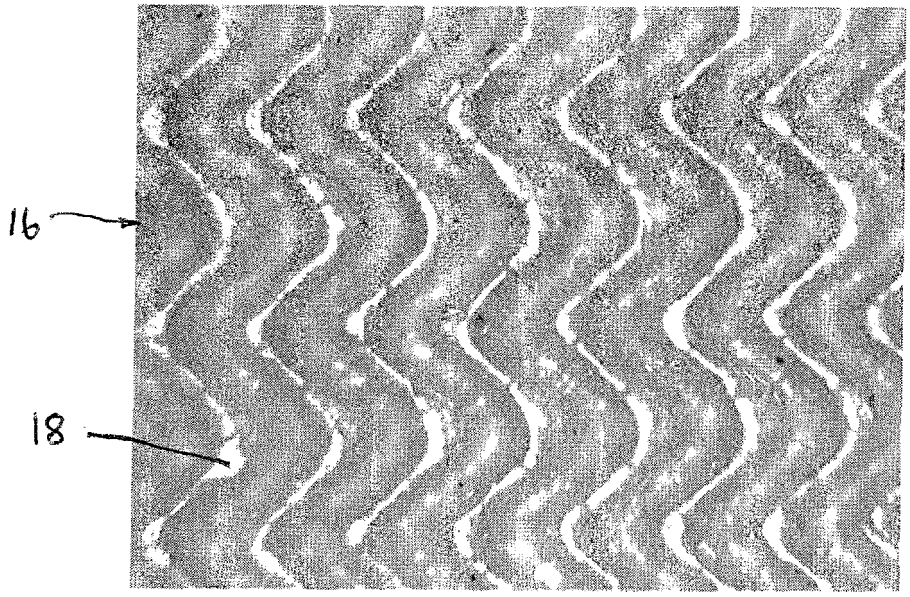

FIG. 3

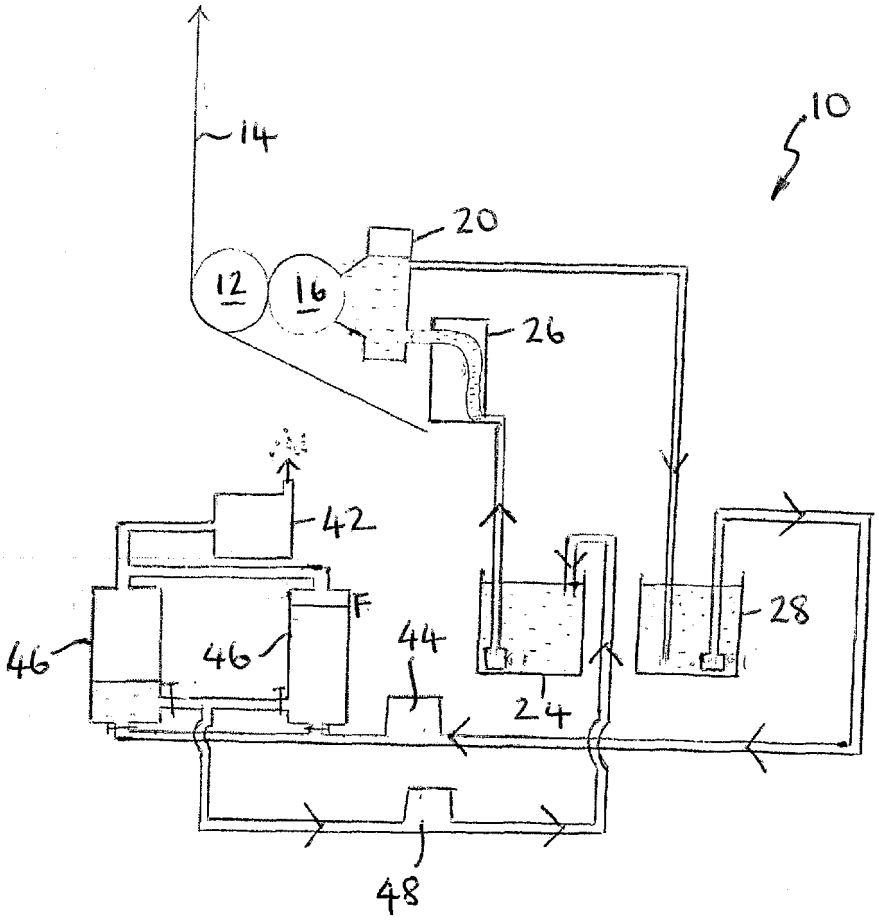

FIG. 2

Method and Apparatus for Applying a Protective Barrier Coating to a Substrate

Field of the Invention

The invention relates to the application of protective barrier coatings to a substrate. The invention relates particularly to substrates for use in food packaging or food containers.

Background to the Invention

It is known to apply a protective barrier coating to cardboard or paper substrates. The purpose of the coating is to provide a protective layer against water, moisture, oils fats and greases etc. Recently, "eco friendly" protective coatings have been devised, which are recyclable along with the rest of the packaging/container.

A problem with protective barrier coatings is that they have a tendency to foam during the application process. This in turn can increase the viscosity of the coating, causing it to adhere to the printing plate and/or foul the application roller. It can therefore be difficult or impossible to apply the coating to the substrate correctly and/or can clog the machinery that applies the coating. A conventional solution to this problem is to introduce an anti-foaming agent. However, these are considered to be either non-eco friendly and/or to be unacceptable for coatings that end up in contact with food for consumption by humans.

It would be desirable to mitigate the problem outlined above.

Summary of the Invention

A first aspect of the invention provides an apparatus for applying a protective coating to a substrate, the apparatus comprising an applicator and a roller,

preferably an anilox roller, being co-operable such that the roller applies, in use, controlled quantities of said coating to the surface of said applicator, wherein a plurality of channels are formed in the surface of said roller.

Preferably, said channels run substantially parallel with one another. In some embodiments, said channels run circumferentially around, or at least partly around, said roller. The channels, or at least their longitudinal axis, may run substantially perpendicular to the rotational axis of the roller. In some embodiments, the channels, or at least part of each channel, may run obliquely with respect to said rotational axis. In a particularly preferred embodiment, the channels are wave-like, or zig-zagged, in shape. In such cases, the longitudinal axis of each channel may run substantially perpendicularly to the rotational axis of the roller, such that successive portions of each channel are oblique with respect to the rotational axis in an alternating direction.

Said applicator typically comprises a roller including a printing plate surface, especially a flexographic printing plate.

The apparatus typically further includes a first coating reservoir for supplying coating to said anilox roller. Conveniently, the anilox roller is co-operable with the first reservoir to draw coating directly from the reservoir.

One or more scrapers, in the preferred form of blades, are associated with the anilox roller for controlling the application of coating onto said anilox roller.

In preferred embodiments, the apparatus includes a second coating reservoir in fluid communication with the first coating reservoir for supplying coating thereto. At least one peristaltic pump is advantageously provided for pumping coating from the second reservoir to the first reservoir.

Advantageously, coating is recycled from said first reservoir to said second reservoir by means of a fluid recycling path that includes means for de-aerating said coating. Said de-aerating means preferably comprises at least one vacuum de-aerator. In preferred embodiments, said de-aeration means comprises at least one membrane contactor, in particular at least one in-line membrane contactor, typically coupled to a vacuum pump. Alternatively, said de-aeration means comprises at least one, and preferably a plurality of, vacuum vessels coupled to one or more vacuum pumps.

At least one pump, advantageously a peristaltic pump, is provided between said first reservoir and said de-aeration means for pumping said coating to said de-aeration means. Preferably, a buffer reservoir is provided between said first reservoir and said at least one pump.

A second aspect of the invention provides an apparatus for applying a protective coating to a substrate, the apparatus comprising means for de-aerating said coating, said de-aerating means preferably comprising at least one vacuum de-aerator.

A third aspect of the invention provides an apparatus for applying a protective coating to a substrate, the apparatus comprising at least one peristaltic pump for pumping or otherwise circulating said coating within the apparatus.

A fourth aspect of the invention provides a method of applying a protective coating to a substrate, the method comprising one or more of the following features: using an anilox roller having a plurality of channels are formed in its surface; de-aerating said coating as it is recycled in the apparatus; and/or using at least one peristaltic pump to pump or circulate said coating within the apparatus.

In some embodiments, the anilox roller may be replaced by alternative means for transferring the coating onto the printing plate or other applicator(s). For example, the transferring means may comprise one or more rubber roll or rollers co-operable with a pan or other receptacle for holding the coating. The arrangement may be such that the coating may be lifted from a reservoir of coating held in the receptacle and transferred to the printing plate, or other applicator, and then onto the substrate.

The invention is particularly suited for use with paper or card based substrates, e.g. carton board, especially those intended for use in food packaging or as a food container.

The invention is particularly suited for use with water-based barrier coatings. Such coatings typically include a component, such as plastics, acrylic, and/or resin, that help the coating to act as a barrier to moisture.

Other preferred features are recited in the dependent claims.

Further aspects of the invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention and with reference to the accompanying drawings.

Brief Description of the Drawings

Embodiments of the invention are now described by way of example and with reference to the accompanying drawings in which like numerals are used to indicate like parts and in which:

Figure 1 is a schematic view of an apparatus for applying a protective barrier coating to a substrate embodying one aspect of the invention;

Figure 2 is a schematic view of an alternative embodiment of an apparatus for applying a protective barrier coating to a substrate; and

Figure 3 is a plan view of a contact surface of a preferred anilox roller for use with the apparatus of Figures 1 or 2.

Detailed Description of the Drawings

Referring now to Figure 1 of the drawings, there is shown, generally indicated as 10, an apparatus for applying a protective barrier coating to a substrate, the apparatus 10 embodying one aspect of the present invention.

The apparatus 10 is particularly suitable for use with substrates formed from paper or cardboard, especially those, for example carton board, intended for use in food packaging or food containers (including drinks packaging and drinks containers). Such substrates can generally be referred to as paper-based substrates (embracing card-based substrates). Typically, an obverse face of the substrate is printed and the reverse face is intended for contact with foodstuffs. The protective barrier coating is to be applied to the reverse face in order to protect the substrate against ingress of moisture, grease and the like, which may otherwise be absorbed by the substrate during use. It will be understood that the apparatus 10 is not limited to use with such substrates and may be used to apply a coating to any substrate.

The apparatus 10 is particularly, but not exclusively, intended for use with protective barrier coatings that are water-based and, preferably, recyclable and/or biodegradable. Such coatings typically include plastics, acrylic, or resin. These coatings may be referred to broadly as water-based barrier coatings.

During conventional printing processes, micro and macro air bubbles are trapped in the coating. Traditionally anti-foaming agents and defoaming agents are used to reverse this process.

The apparatus 10 comprises a coating applicator 12 in the preferred form of a roller. In use the applicator 12 applies a layer of the protective coating to the substrate 14. The applicator 12 typically comprises a printing plate, especially a flexographic printing plate, conveniently provided on a roller. Flexographic photopolymer printing plates are preferred, for example those provided by DuPont under the trade name CYREL. The CYREL FAST DFS printing plate is an example of a suitable printing plate.

The apparatus 10 also includes means for supporting and conveying the substrate 14. Any suitable conventional means, e.g. a motorised roller system, may be employed and is not illustrated or described herein for reasons of clarity. One or other or usually both of the applicator 12 and anilox 16 may be driven, in use, to rotate about their rotational axis by any suitable drive means (not illustrated), e.g. comprising a motor.

An anilox roller 16 (also known as an anilox roll or anilox) is co-operable with the applicator 12 to apply controlled quantities of the coating to the surface of the applicator 12. To this end, the surface of the anilox 16 is provided with a plurality of recesses (not shown in Figure 1) for holding quantities of the coating such that the coating can be applied to the applicator 12 in a metered fashion. The recesses typically cover substantially the entire roller surface of the anilox 16, preferably in a substantially even pattern. Figure 3 illustrates the preferred form of the recesses. It will be seen that the preferred recesses take the form of channels 18 running substantially circumferentially around the anilox 16, the channels 18 preferably being substantially parallel with one another. The channels 18 are preferably wavelike or zigzag in shape. In preferred embodiments, the channels 18 are continuous. The provision of channels in the anilox 16 is in contrast to conventional aniloxes used in printing, where the surface of the anilox is covered with individual cells or pockets. It is found that the cells contribute to foaming and as such are unsuitable for use in the present context. In alternative

embodiments, the channels need not be wavelike; instead they may be substantially straight. Another alternative (whether the channels are wavelike, straight or otherwise) is that the channels run around the anilox 16 in a direction that is oblique with respect to the rotational axis of the anilox 16. This is in contrast to the preferred arrangement whereby the channels run substantially perpendicularly to the rotational axis. Aniloxes having channels of different dimensions may be used for different coat weights, as desired. For example, the dimensions of the channels may be selected to give a coat weight of typically between 5 and 20 g/m^2. Typically, the channels are dimensioned to define a channel volume in the order of between 5 and 20 cm^3/m^2. In the preferred embodiments, the channel dimensions are selected to provide a channel volume of either approximately 11 cm^3/m^2 or approximately 14 cm^3/m^2.

The anilox 16 is co-operable with a source of the coating such that quantities of the coating can be applied to the surface of the anilox. In the preferred embodiment, the anilox 16 is arranged with respect to a first coating reservoir 20 such that quantities of coating are applied to the anilox 16 as it rotates. As can be seen from Figure 1, this is conveniently achieved by positioning the anilox 16 such that a portion of it is in contact with the contents of the reservoir 20. To prevent excess coating being applied to the anilox 16, at least one scraper 22 is provided to remove excess coating from the surface of the anilox 16 as it rotates. In the illustrated embodiment, two spaced apart scrapers 22 are provided, defining between them the contact region between the anilox 16 and the reservoir 22. As the anilox rotates, the scrapers 22 control the application of coating onto the anilox surface. The scrapers 22 conveniently take the form of one or more blades, sometimes known as doctor blades.

In alternative embodiments (not illustrated), one or more intermediate devices, e.g. rollers, maybe provided between the reservoir 20 and the anilox 16.

The capacity of the first coating reservoir 20 is not usually enough to sustain a typical coating run. Therefore, a second reservoir 24 for the coating is provided. A pump 26 is provided for pumping the coating from the second reservoir 24 to the first reservoir 20. Advantageously, the pump 26 is a peristaltic pump. It is found that the action of the peristaltic pump 26 introduces fewer bubbles into the coating than other conventional pumps, e.g. diaphragm pumps, that are usually found in printing apparatus.

In preferred embodiments, the coating is recycled to the second reservoir 24 from the first reservoir 20. It is advantageous to remove bubbles (or gas) from the coating during the recycling process. To this end, the apparatus 10 preferably also includes de-aerating means in the recycling path between the first and second reservoirs. The path may be implemented by any suitable means, e.g. one or more fluid conduits. Preferably, the de-aerating means comprises a vacuum de-aerating apparatus, i.e. an apparatus configured to perform vacuum de-aeration on the coating. In the embodiment of Figure 1, the apparatus 10 includes a vacuum de-aerating apparatus comprising a membrane contactor 40. The membrane contractor 40 is provide in-line with the flow of coating and serves to remove bubbles from the coating. The membrane contractor 40 contains a hollow fibre membrane (not shown) and the coating is forced over the membrane as it passes through the contactor 40. The preferred membrane is made from semi-permeable porous material with a non-porous gas permeable barrier on the outer surface of the fibre. By way of example, the SUPER-PHOBIC (trade mark) membrane contactor provided by Membrana GmbH of Wuppertal, Germany is an example of a suitable membrane contactor. A vacuum pump 42 is connected to the membrane contactor 40 to facilitate the operation thereof. During use, entrained air in the coating is removed through the selectively permeable membrane.

The membrane contactor 40 requires that the coating be pumped through it. To this end, a pump 44 is provided, preferably a peristaltic pump. In some cases the pump 44 may be omitted, for example if the vacuum effect generated by vacuum

pump 42 is sufficient to draw the coating through the membrane contactor 40. The provision of pump 44 in the recycling path requires the provision of a buffer reservoir 28 in the recycling path, although the buffer reservoir 28 may still be provided when the pump 44 is not. This is because the action of the pump 44 on the first reservoir 20 (in the absence of the buffer 28) would create a pressure differential that would prevent operation of the apparatus 10. The buffer reservoir 28 is provided between the first reservoir 20 and the de-aerating apparatus.

Preferably, a respective filter 30 is provided at the respective outlet lines 32, 34 of the reservoirs 24, 28. Not only can the filters 30 remove unwanted particulate material from the coating, but they may also help to reduce the bubble content. For example, the filters 30 may have a grade of 125 micron.

In the embodiment of Figure 1, the membrane contactor 40 removes bubbles (or gas) in a continuous process as the coating is recycled. An alternative embodiment is illustrated in Figure 2 (in which like numerals are used to denote like parts and to which the same or similar description applies as would be apparent to a skilled person), in which the coating is de-aerated in batches. The de-aerating apparatus comprises at least two vacuum vessels 46. By selective control of a respective valve on the inlet of the vessels 46, the coating is pumped into one or other of the vessels 46. By means of a vacuum pump 42, the coating in the respective vacuum vessel 46 is subjected to vacuum which removes entrained air in the coating and therefore its viscosity, facilitating the application of the coating. Once de-aeration is completed, a valve at the outlet of the vessel 46 is operated to allow the coating to be fed to the second reservoir 24. Typically, the coating is fed to the second reservoir under the action of a pump 48, preferably a peristaltic pump. Pump 44 is provided to feed the coating to the vessels 46, although may be omitted.

One or more other de-aerators may be used as well as, or instead of, the vacuum de-aerators described herein, for example a centrifugal separator, especially a

vacuum centrifugal separator. These may be configured to perform continuous or batch de-aeration, as desired and subject to the limitations of the respective technology. It is preferred however, to use de-aerators that minimize the agitation of the coating since, as well as causing foaming, this can disrupt the emulsion phase of the coating.

In alternative embodiments (not illustrated) one or more centrifugal or rotary vacuum de-aerator may be used instead of the membrane 40 (in the embodiment of Figure 1), or the vacuum vessels 46 (in the embodiment of Figure 2). A centrifugal or rotary vacuum de-aerator typically comprises one or more de-aeration chamber that includes a rotatable device such as a plate or bowl. Coating to be de-aerated is drawn into the chamber under vacuum resulting in a thin film or layer of the coating on the rotating device whereupon it is de-aerated. Such de-aerators can be used in a continuous de-aeration mode (similar to the embodiment of Figure 1) or a batch de-aeration mode (similar to the embodiment of Figure 2). The de-aerator may be provided with an integrated vacuum pump, in which case a separate vacuum pump is not required. In typical embodiments a pump (such as pumps 44, 48) is not required to feed the coating to the de-aerator, although one or more such pumps may be provided, especially depending on the coating's viscosity and/or the desired throughput rate. By way of example, the MiniVac (Trade Mark) vacuum de-aerator or the DA-VS (Trade Mark) vacuum de-aerator as provided by the Grinding and dispersing Business Unit of the Netzsch Group (www.netzsch-grinding.com) are suitable for use as the vacuum de-aerator.

In alternative embodiments, vacuum de-aeration may be performed off-line, i.e. not as part of a recycling path. The coating may be removed, e.g. from one or both of the reservoirs 20, 24 or other part of the apparatus 10, by any suitable means, de-aerated using any suitable vacuum de-aerator, and returned to the apparatus. The vacuum de-aerator may still be regarded as part of the apparatus.

It will be seen from the foregoing that preferred embodiments include the following advantageous features:

1. One or more peristaltic pumps to minimise the amount of air entrainment by the pumping system.
2. A printing plate in a material that is maximised for releasing the coating onto the substrate without causing the plate to harden or soften in commercial use.
3. An anilox roll having channels for holding the coating.
4. Means for performing vacuum de-aeration of the coating.

The preferred apparatus enables environmentally sustainable coatings to be applied to a substrate at the printing stage with relatively low levels of foaming and advantageously without the use of an anti-foaming agent. The preferred printing plate 12 increases the efficiency with which the coating is transferred to the substrate 14 thereby causing less coating to be returned to the anilox 16. The preferred design of the anilox is such that the surface tension and pressure exerted on the coating is minimised therefore reducing the amount of trapped air in the coating. As the coating is pumped from the machine the trapped air can be removed by vacuum de-aeration.

By reducing the amount of air being trapped by the coating during application, and removing entrained air from the coating, the apparatus 10 can be used to apply the coating for periods that a much longer than is possible using conventional apparatus.

In an alternative embodiment, the anilox roller may be replaced by alternative means for transferring the coating onto the printing plate or other applicator(s). For example, the transferring means may comprise one or more rubber roll or rollers co-operable with a pan or other receptacle for holding the coating.

The arrangement may be such that the coating may be lifted from a reservoir of coating held in the receptacle and transferred to the printing plate, or other applicator, and then onto the substrate. The anilox based apparatus is preferred, however, since it allows a metered amount of coating to be applied to the substrate and gives a more consistent and controllable finished product.

The invention is not limited to the embodiments described herein, which may be modified or varied without departing from the scope of the invention.

CLAIMS:

1. An apparatus for applying a protective coating to a substrate, the apparatus comprising an applicator for applying the coating to the substrate, and means for transferring the coating to the applicator from a first reservoir, wherein the apparatus comprises means for de-aerating said coating.

2. An apparatus as claimed in claim 1, wherein said de-aerating means comprises at least one vacuum de-aerator.

3. An apparatus as claimed in claim 1 or 2, wherein said de-aeration means is included in a fluid recycling path by which, in use, said coating is taken from and returned to said first reservoir.

4. An apparatus as claimed in claim 3, wherein said fluid recycling path is configured to recycle said coating between said first reservoir and a second reservoir.

5. An apparatus as claimed in any one of claims 2 to 4, wherein said at least one vacuum de-aerator comprises at least one membrane contactor.

6. An apparatus as claimed in any one of claims 2 to 4, wherein said at least one vacuum de-aerator comprises at least one vacuum vessel.

7. An apparatus as claimed in any one of claims 2 to 4, wherein said at least one vacuum de-aerator comprises a rotary or centrifugal de-aerator.

8. An apparatus as claimed in any one of claims 2 to7, wherein said at least one vacuum de-aerator includes or is coupled to at least one vacuum pump arranged to draw said coating into or through said at least one de-aerator.

9. An apparatus as claimed in any preceding claim, wherein said transferring means comprises a roller co-operable with said applicator such that the roller applies, in use, said coating to the surface of said applicator, wherein a plurality of channels are formed in the surface of said roller.

10. An apparatus as claimed in claim 9, wherein said channels run substantially parallel with one another.

11. An apparatus as claimed in claim 9 or10, wherein said channels run circumferentially around, or at least partly around, said roller.

12. An apparatus as claimed in any one of claims 9 to 11, wherein he channels, or at least their longitudinal axis, runs substantially perpendicular to the rotational axis of the roller.

13. An apparatus as claimed in any one of claims 9 to 12, wherein the channels, or at least part of each channel, run obliquely with respect to the rotational axis of the roller.

14. An apparatus as claimed in claim 13, wherein the channels are wave-like, or zig-zagged, in shape.

15. An apparatus as claimed in claim 14, wherein the longitudinal axis of each channel runs substantially perpendicularly to the rotational axis of the roller, such that successive portions of each channel are oblique with respect to the rotational axis in an alternating direction.

16. An apparatus as claimed in any one of claims 9 to 15, wherein said roller comprises an anilox roller.

17. An apparatus as claimed in any one of claims 9 to 16, wherein one or more scrapers, in the preferred form of blades, are associated with the roller for controlling the application of coating onto said roller.

18. An apparatus as claimed in any preceding claim, wherein said applicator comprises a roller having a printing plate surface.

19. An apparatus as claimed in claim 17, wherein said printing plate surface comprises a flexographic printing plate.

20. An apparatus as claimed in any preceding claim, wherein at least one peristaltic pump is provided for pumping coating around at least part of said fluid recycling path.

21. An apparatus as claimed in claim 20, wherein said fluid recycling path is configured to recycle said coating between said first reservoir and a second reservoir, said at least one peristaltic pump being arranged to pump said coating from the second reservoir to the first reservoir.

22. An apparatus as claimed in any preceding claim, wherein at least one pump, preferably a peristaltic pump, is provided between said first reservoir and said de-aeration means for pumping said coating to said de-aeration means.

23. An apparatus as claimed in any preceding claim, wherein at least one pump, preferably a vacuum pump, is associated with said de-aeration means, arranged to draw said coating into or through said de-aeration means.

24. An apparatus as claimed in claim 22 or 23, wherein a buffer reservoir is provided between said first reservoir and said at least one pump, or between said first reservoir and said de-aeration means.

25. An apparatus as claimed in any preceding claim, wherein said substrate is comprised of a paper or card based material, for example carton board.

26. An apparatus as claimed in any preceding claim, wherein said protective coating is water-based and includes a component, for example plastics, acrylic, and/or resin, for causing the coating to act as a barrier to moisture.

27. A method of applying a protective coating to a substrate, the method comprising transferring the coating to an applicator from a first reservoir; applying the coating to the substrate using the applicator; and de-aerating said coating.

28. A method as claimed in claim 27, including de-aerating said coating as it is recycled in the apparatus.

29. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

Application No: GB1208287.1 **Examiner:** Mr Rhys J. Williams

Claims searched: 1-29 **Date of search:** 9 August 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 2, 9-15 & 27 at least	JP 2001191014 A (NIKKU) See WPI abstract no. 2001-525660.
X	1, 2 & 27 at least	EP 2096209 A1 (VOITH) See WPI abstract no. 2009-M41728.
X	1, 2 , 20 & 27 at least	US 5480487 A (FIGINI) See the asbstract particularly.
X	1, 2 & 27 at least	JP 2007090127 A (FUJI FILM) See WPI abstract no. 2007-337788.
X	1, 2 & 27 at least	JP07100423 A (MITSUBISHI) See WPI abstract no. 1995-182237.
X	1, 2 & 27 at least	EP1080865 A1 (BEIERSDORF) See WPI abstract no. 2001-282986.
X	1 & 27	JP 2001121067 A (NIPPON KOKAN) See WPI abstract no. 2001-393632.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

Worldwide search of patent documents classified in the following areas of the IPC

B05C

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
B05C	0011/10	01/01/2006
B05C	0001/08	01/01/2006