United States Patent [19]

Smythe

[11] **Patent Number:** **4,732,777**

[45] **Date of Patent:** **Mar. 22, 1988**

[54] **ELECTROSTATIC COATING APPARATUS AND PROCESS**

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[73] Assignee: Sale Tilney Technology PLC, United Kingdom

[21] Appl. No.: 937,563

[22] Filed: Dec. 3, 1986

[30] **Foreign Application Priority Data**

Dec. 4, 1985 [GB] United Kingdom 8529932

[51] Int. Cl.[4] B05D 1/04

[52] U.S. Cl. 427/27; 118/708; 118/629

[58] Field of Search 118/683, 684, 629, 708, 118/630, 631, 632, 633; 427/27

[56] **References Cited**

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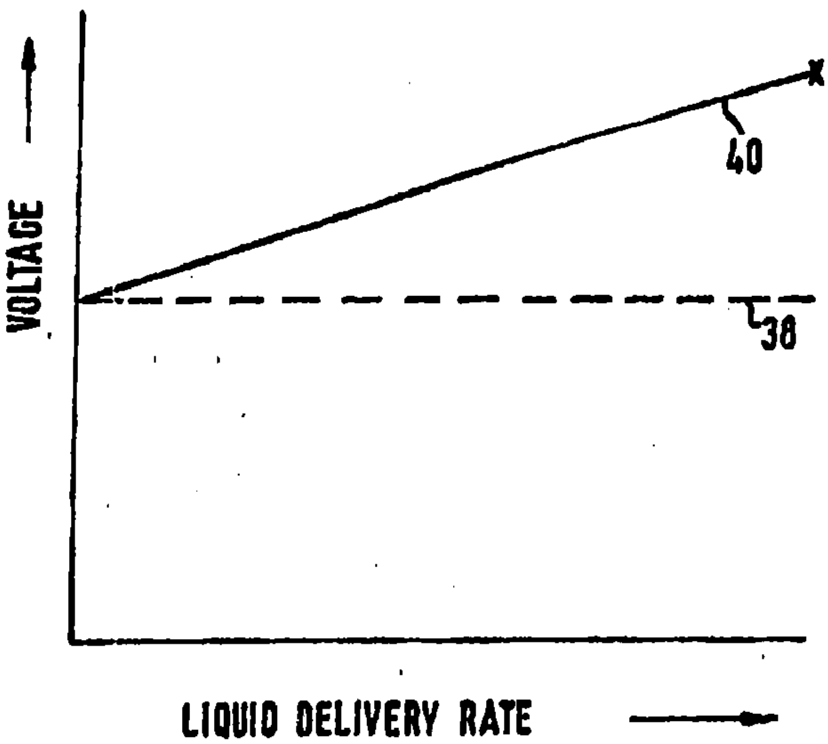
Primary Examiner—Shrive P. Beck

Attorney, Agent, or Firm—Handal & Morofsky

[57] **ABSTRACT**

An electrostatic coating apparatus is described comprising an applicator, means for supplying liquid to the applicator at a controlled rate, means for establishing an electrostatic field between the applicator and a target substrate to be coated and control means providing an output signal to the liquid supply means for setting the rate at which liquid is supplied to the applicator, the said control means also providing an output signal to the field establishing means which, in operation, sets the magnitude of the applied field, the said output signals being such that the applied field is varied in accordance with any change in the rate of supply of liquid to the applicator.

8 Claims, 3 Drawing Figures



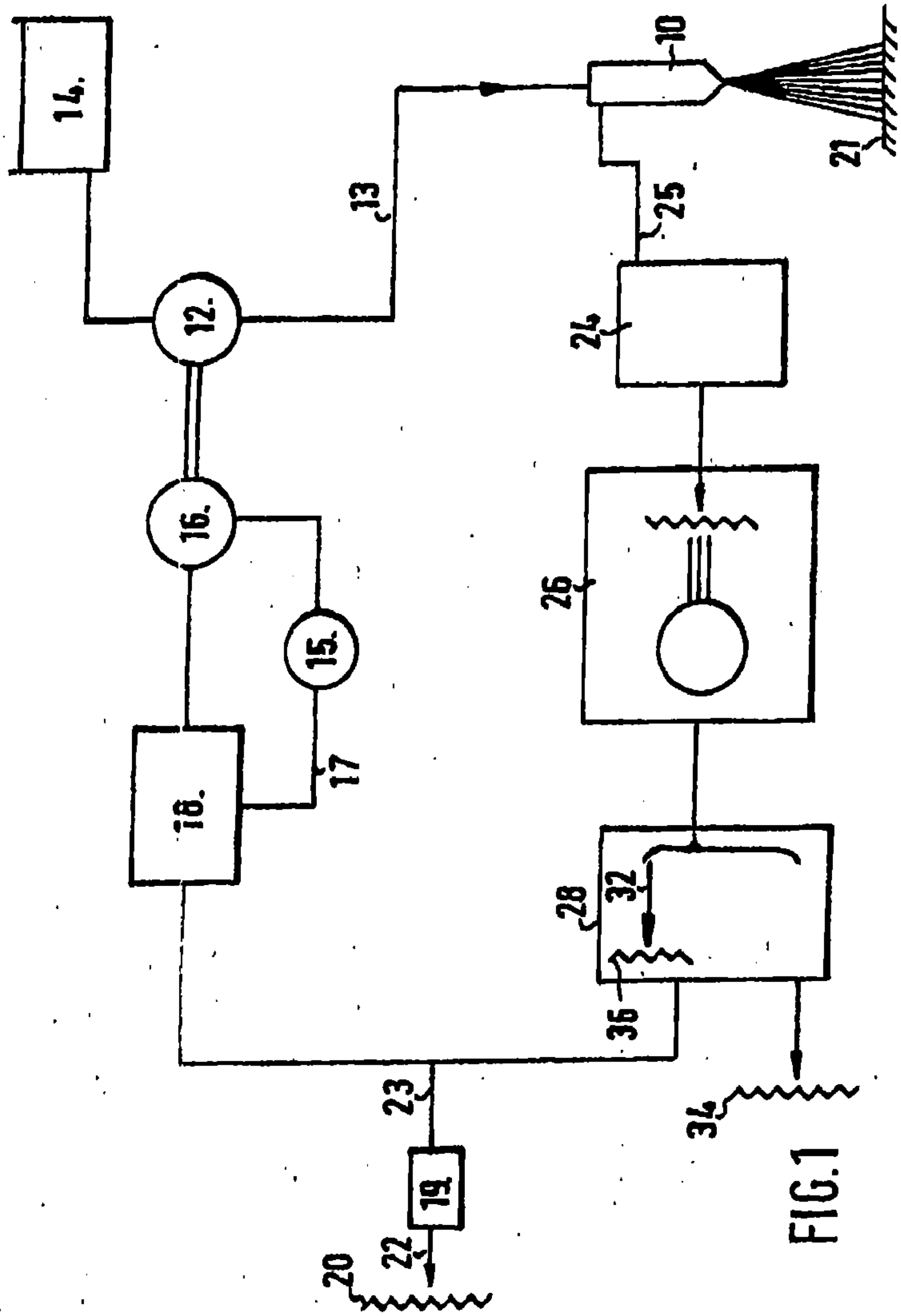


FIG.1

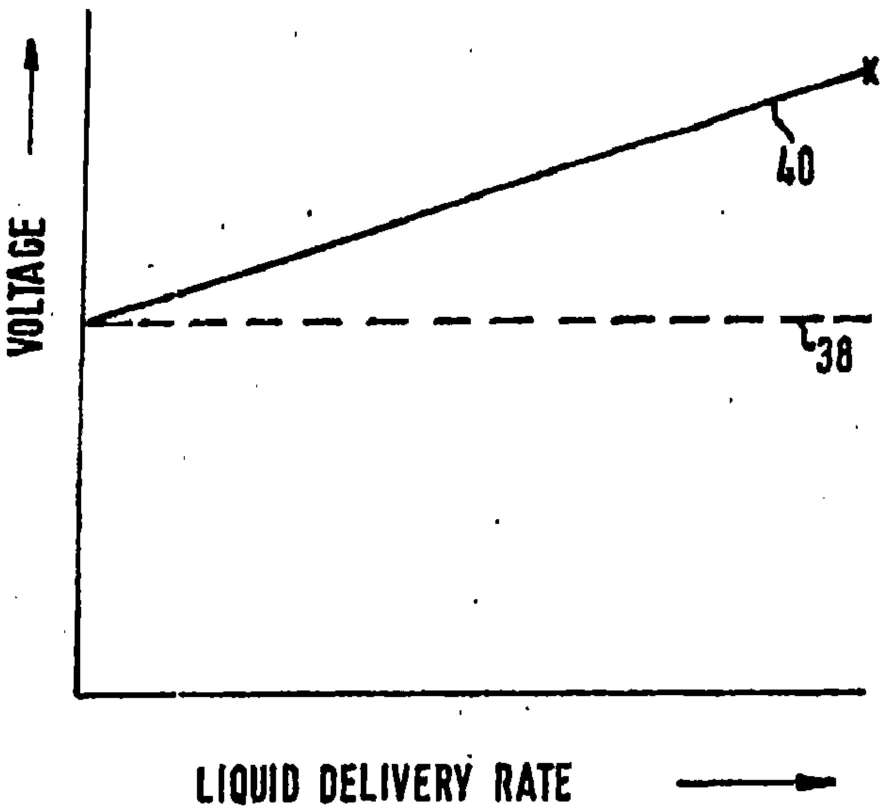


FIG. 2

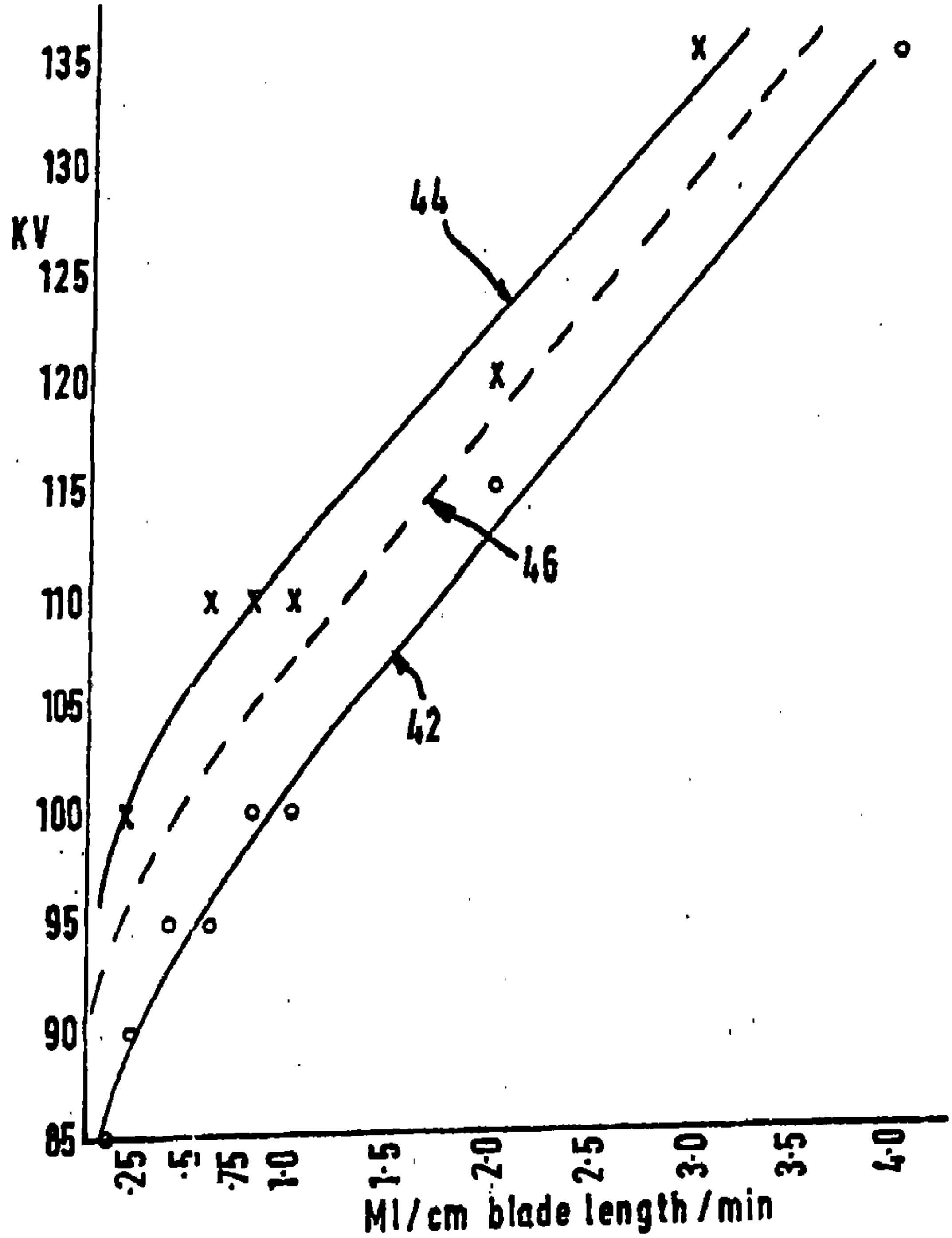

KV
135
130
125
120
115
110
105
100
95
90
85
44
46
42
·25
·5
·75
1·0
1·5
2·0
2·5
3·0
3·5
4·0
Ml/cm blade length/min

FIG.3

ELECTROSTATIC COATING APPARATUS AND PROCESS

The present invention relates to an electrostatic coating apparatus that includes an electrostatic applicator, e.g. a coating blade or a rotary atomiser, and in particular the invention is concerned with an apparatus that permits a wider range of coating weights (or thicknesses) that was hitherto possible.

Electrostatic coating apparatuses are well-known and are used for applying a liquid, e.g. oil or paint, onto a conductive substrate by maintaining an electrostatic field between the substrate and the applicator. When liquid is supplied to the applicator, the field breaks the liquid up into charged droplets which are drawn by the field towards the substrate. In this way, an even coating of the liquid is produced on the substrate. The electrostatic field is usually produced by maintaining the substrate at zero potential, i.e. it is earthed, and charging the applicator to a fixed potential that produces the desired field; the potential is set according to the nature of the liquid to be applied and in particular to the resistivity of the liquid. The substrate is usually conveyed past the coating device, which is in a fixed location, by an earthed conveyor.

The amount of liquid applied to the substrate, which is generally known as the 'coating weight' and is measured in g/m^2, can be changed by varying the volume of liquid supplied by a metering pump to the applicator. The metering pump is driven by a motor whose speed is regulated according to the desired coating weight to be applied and according to the speed that the conveyor moves the substrate past the coating apparatus. In this way, the pump is automatically adjusted to provide the correct amount of liquid for the rate of travel of the substrate past the coating device. The potential applied to the applicator is pre-set by a manually-operated external potentiometer.

As stated above, the coating weight can be altered by varying the amount of liquid fed to the applicator but this is only true within a limited range because the rate at which liquid can be discharged from an applicator is itself limited and, outside a certain range, the discharge rate cannot be altered by supplying more (or less) liquid to the applicator: if the rate at which liquid is supplied to the blade is too high, it floods and operation is both messy and wasteful and furthermore the droplets produced are large, which leads to a nonuniform coverage of the target substrate; if, on the other hand, the rate of liquid supply to the applicator is too low, operation becomes intermittent. In the range between these two extremes, the operation is generally satisfactory. In the case of an electrostatic blade, the discharge rates can typically be varied between 0.5 and 6 ml of liquid per cm of blade length per minute (ml/cm blade length/min).

We have now discovered that the range of discharge rates (and therefore the range of coating weights) can be greatly increased if the field between the applicator and the target substrate is set in accordance with the rate of supply of liquid to the applicator. Using the present invention, we have achieved discharge rates from a given blade of between 0.03 and 15 ml/cm blade length/minute. Thus, the ratio of the highest possible discharge rate to the lowest possible rate that could be achieved hitherto was approximately 30:1 whereas the same ratio using the present invention is 500:1; such a increase is not only surprising but also it is highly advantageous to modern industry, since it allows greater flexibility in the coating weight that can be applied and in particular it permits very low coating weights to be applied. Hitherto, the connection between the field applied and the amount of liquid supplied was not appreciated.

The target substrate is not always moved past the applicator at a steady rate and, for example when coating steel strip with oil in a steel mill, the strip starts at a standstill and is quickly accelerated to a desired steady speed. However the leading part of the strip is not always properly coated because its speed past the applicator, and therefore the oil delivery rate, is lower than that required to achieve an acceptable spray pattern at the single fixed potential. The process of the present invention overcomes this problem because of the broadening of the range of rates at which liquid can be discharged satisfactorily from the applicator.

According to the present invention, there is provided an electrostatic coating apparatus comprising an applicator, means for supplying liquid to the applicator at a controlled rate, means for establishing an electrostatic field between the applicator and a substrate to be coated and control means providing an output signalto the liquid supply means for setting the rate at which liquid is supplied to the applicator, the said control means also providing an output signal to the field establishing means which, in operation, sets the magnitude of the applied field, the said output signals being related to each other so that the applied field is varied in accordance with any change in the rate of supply of liquid to the applicator.

The output signal to the liquid supply means is advantageously the same signal as is fed to the field establishing means.

The control means may comprise means for measuring the relative speed between the substrate and the applicator, in which case the control means preferably sets the output signals in accordance with the speed measured by the measuring means so as to apply to the target substrate a uniform coating weight irrespective of the relative speed between the substrate and the applicator.

As stated above, the field between the applicator and the target substrate is usually produced by applying a potential to the applicator and maintaining the target at earth potential and the following discussion will be directed to such an arrangement although it should be borne in mind that the invention is not limited to this arrangement and the field may be established by applying potential to the substrate instead of, or in addition to, the applicator.

In many cases, it is sufficient for the field establishing means to provide to the applicator a fixed base potential and, on top of the base potential, a flow-dependent potential that is directly or indirectly proportional to the output of the control means. Other arrangements for setting the potential of the applicator can of course be used. It is not necessary for the applicator potential to be directly proportional to the rate at which liquid is supplied to the applicator and it is possible for these two parameters to be indirectly proportional to each other; any desired relationship between the applicator potential and the rate of supply of liquid to the applicator can be used, e.g. the graph of applicator potential versus liquid supply rate may be curved. This can be achieved using analog shaping circuits or digital processing using a programmable read only memor (PROM), e.g. an erasable programmable read only memory (EPROM). It is evident that the liquid and potential supplied to the applicator may be controlled by digital or by analog circuits.

An electrostatic coating apparatus in accordance with the present invention will not be described with reference to the accompanying drawings in which:

FIG. 1 is a schematic drawing of the apparatus,

FIG. 2 is a graph showing the variation of the potential of the applicator with changing liquid delivery rates, and

FIG. 3 is a graph showing the variation in the discharge rate from a blade against the applied voltage.

Referring to FIG. 1, the electrostatic coating apparatus has a coating blade 10, a pump 12 for supplying liquid from a reservoir 14 along line 13 to the blade, a motor 16 for driving the pump, a speed controller 18 that governs the speed of motor 16 and therefore the amount of liquid supplied to the blade, a device 19 measuring the speed that a target substrate 21 is moved past the blade 10 and a computer- or manually-controlled potentiometer 20 that has an output 22. A tachometer 15 measures the speed of the motor 16 and is connected via a feedback loop 17 to the speed controller 18. The coating weight is set on potentiometer 20 and its output 22 is modified by speed monitoring device 19 according to the speed of the substrate 21 to produce an output 23 that is fed to the speed controller 18 and that controls the rate of supply of liquid to the blade 10. By using the device 19 to modify output 22, the amount of liquid supplied to the coating blade 10 is adjusted automatically if the speed of the substrate 21 is altered and therefore a uniform coating weight is applied to each substrate irrespective of the rate at which it moves past the blade.

Electric power is supplied to the blade along conductor 25 by a high voltage power unit 24 consisting of a transformer and a voltage doubler circuit; the potential supplied to the power unit 24 is set by a voltage stabilizer unit 26 of the motorised auto transformer type which in turn is governed by the output of a voltage tracking unit 28. The voltage tracking unit is an addition circuit whose output voltage is the sum of the output voltage of an external potentiometer 34 and a voltage 32 that is proportional to the output 23 of the speed monitoring device 19. The magnitude of the voltage 32 is set by a potentiometer 36, that is to say, the relationship between the output 23 and the output 32 is set by potentiometer 36.

The potentiometer 20 is set to provide the desired coating weight on the target substrate and the voltage applied to the blade 10 is then set automatically to provide an optimum spray pattern. If it is desired to change the coating weight, the potentiometer 20 is adjusted to alter output 22 and hence output 23, which in turn changes the volume of liquid supplied to blade 10. Simultaneously the output 32 is changed which thereby adjusts the potential of the blade 10 to the optimum value for the new coating weight.

Generally, the blade potential is increased when the rate of supply of liquid to the blade increases, which in turn increases when the desired coating weight is increased and/or when the substrate 21 is moved faster past the blade 10. This is illustrated graphically in FIG. 2. The base voltage (shown by the dashed line 38) supplied to the blade 10 is derived from the setting of potentiometer 34 and the variation in voltage with the liquid supply rate to blade 10 derived from output 23 is added to the base potential to provide the potential that is applied to the applicator shown by solid line 40; the slope of the line 40 is set by potentiometer 36.

Although the control circuits described in connection with FIG. 1 have been analog, it is, of course, possible for them to be digital. The relationship between the liquid supply rate and the applied voltage shown in FIG. 2 need not be linear and may be any shape, e.g. curved, that is found to provide the optimum field for a given coating weight. Such a departure from a linear relationship may be achieved using analog suitable shaping circuits instead of unit 28 or it may be achieved digitally using an EPROM.

Instead of the illustrated blade 10, a rotary atomizer may be used.

The relationship between the rate at which liquid is discharged from a coating blade and the applied voltage is shown in FIG. 3. The tests were conducted at 20° C. using a blade as described inour copending patent application Ser. No. 898,260 of J. P. Grenfell filed Aug. 20, 1986 for "Electrostatic coating blade and method of electrostatic spraying" and assigned to Sale Tilney Technology PLC, the assignee herein and oil of type Nalco. XL 174. In FIG. 3, the discharge rate is given in ml/cm of blade length/minute along the x-axis and the applied voltage in KV along the y-axis. The points at which flooding occurred are shown as circles while the points at which discharge became intermittent are shown by crosses; these points are plotted as lines 42 and 44 respectively while line 46 shows the optimum voltage/discharge rate.

It is clear from FIG. 3 that there is a correlation between the discharge rate and the applied voltage which was not recognized hitherto.

If one were to use a fixed voltage of, say, 115 KV, it can be seen from FIG. 3 that the range of discharge rates that could be applied is limited to between 1.5 and 2.2 ml/cm blade length/minute whereas by varying the voltage in accordance with the discharge rate, a much broader range of discharge rates can be achieved.

I claim:

1. An electrostatic coating apparatus comprising an applicator, means for supplying liquid to the applicator at a controlled rate, means for establishing an electrostatic field between the applicator and a substrate to be coated and control means providing an output signal to the liquid supply means for setting the rate at which liquid is supplied to the applicator, the said control means also providing an output signal to the field establishing means which, in operation, sets the magnitude of the applied field, the said output signals being related to each other so that the applied field is varied automatically in accordance with any change in the rate of supply of liquid to the applicator.

2. An apparatus as claimed in claim 1, wherein the output signals to the liquid supply means and to the field establishing means are a single output signal supplied to both the liquid supply means and the field establishing means.

3. An apparatus as claimed in claim 1, wherein the control means includes means for measuring the relative speed between the substrate and the applicator.

4. An apparatus as claimed in claim 3, wherein the control means sets the output signals in accordance with the speed measured by the measuring means so as to apply to the substrate a uniform coating weight irre-

spective of the relative speed between the substrate and the applicator.

5. An apparatus as claimed in claim 1, wherein the field establishing means provides to the applicator a fixed base potential and, on top of the base potential, a flow-depending potential that is directly or indirectly proportional to the output of the control means.

6. An apparatus as claimed in claim 1, wherein a graph of the applicator potential versus liquid supply rate is curved or straight.

7. A process of electrostatically coating a substrate with a liquid, which process comprises feeding liquid to an electrostatic applicator, establishing a field between the substrate and the applicator, adjusting the rate at which liquid is fed to the applicator and automatically adjusting the field according to the change in the rate at which liquid is supplied to the applicator.

8. A process as claimed in claim 7, which includes moving the substrate past the applicator and setting the rate which the liquid is supplied to the applicator in accordance with the speed of the substrate past the applicator.

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United States Patent [19]

Grenfell

[11] Patent Number: 4,830,872

[45] Date of Patent: May 16, 1989

[54] ELECTROSTATIC COATING BLADE AND METHOD OF APPLYING A THIN LAYER OF LIQUID THEREWITH ONTO AN OBJECT

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[73] Assignee: Sale Tilney Technology PLC, London, United Kingdom

[21] Appl. No.: 898,260

[22] Filed: Aug. 20, 1986

[30] Foreign Application Priority Data

Sep. 3, 1985 [GB] United Kingdom 8521835
Sep. 6, 1985 [GB] United Kingdom 8522144

[51] Int. Cl.[4] B05D 5/00

[52] U.S. Cl. 427/30; 118/626; 239/3; 239/690; 239/521

[58] Field of Search 427/27, 30; 118/626, 118/629; 239/3, 6, 90, 708, 521, 690

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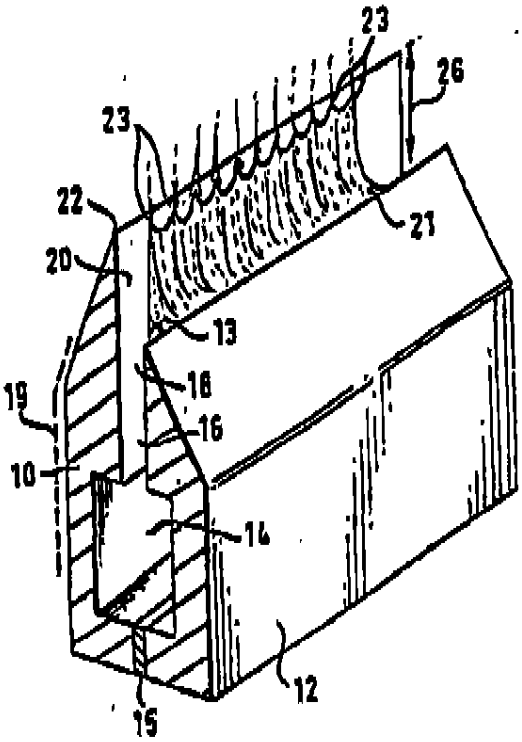
Primary Examiner—Shrive Beck
Assistant Examiner—Alain Bashore
Attorney, Agent, or Firm—[illegible]andal & Morofsky

[57] ABSTRACT

An electrostatic blade is disclosed having a slot extending the length of the blade and leading from a central duct to an outlet. A surface made of non-conductive material extends in front of the outlet and terminates in a discharge edge which is spaced 0.05 to 4 mm from the slot outlet. In use, liquid is passed from the duct along the slot to the outlet where it collects as a bead. An electrostatic field is applied between the liquid at the slot outlet and the object to be coated which draws liquid along the non-conductive surface in a tapering stream and further causing the liquid to be discharged from the edge. Because the stream of liquid reaching the discharge edge is very thin, very low liquid discharge rates can be achieved while still maintaining a uniform coating on the target object.

14 Claims, 2 Drawing Sheets



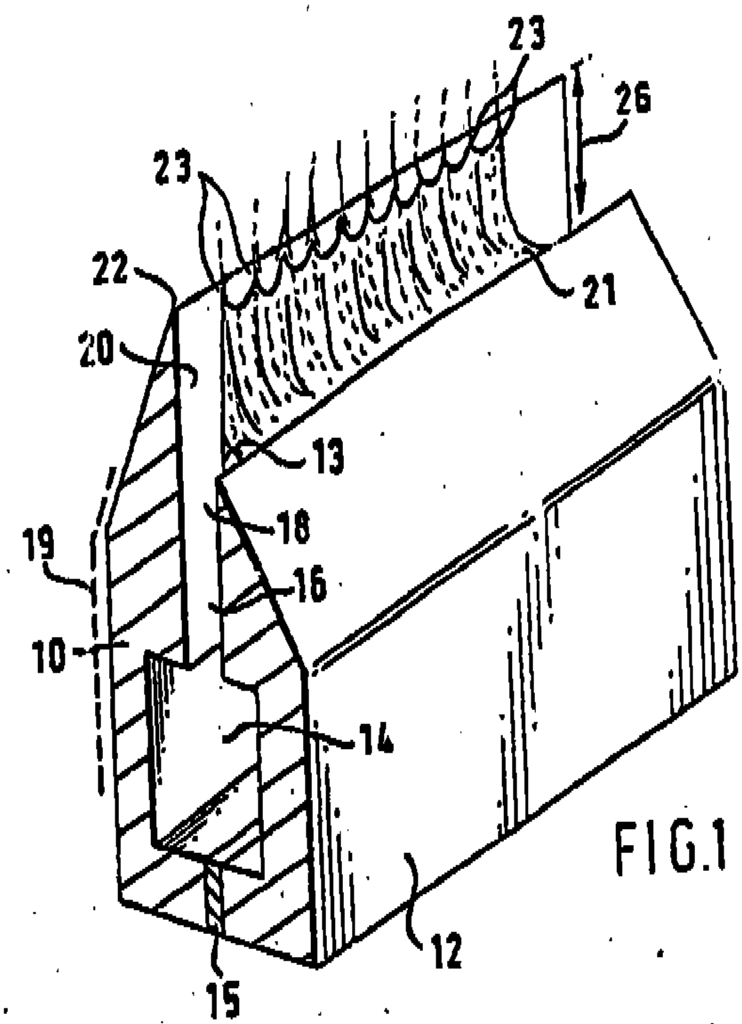


FIG.1

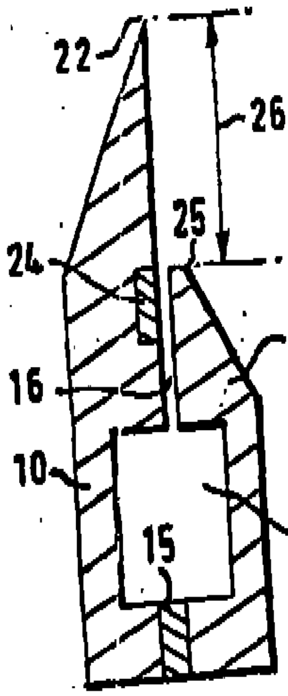


FIG.2

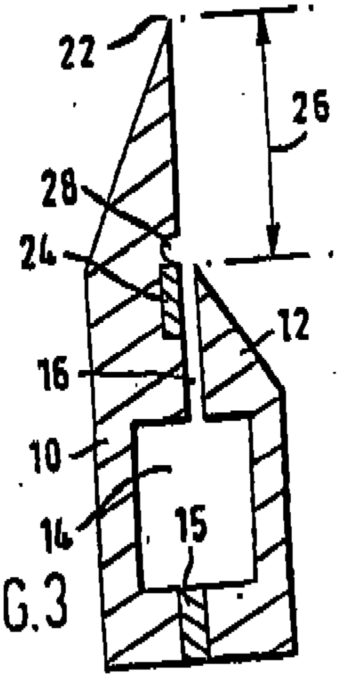


FIG.3

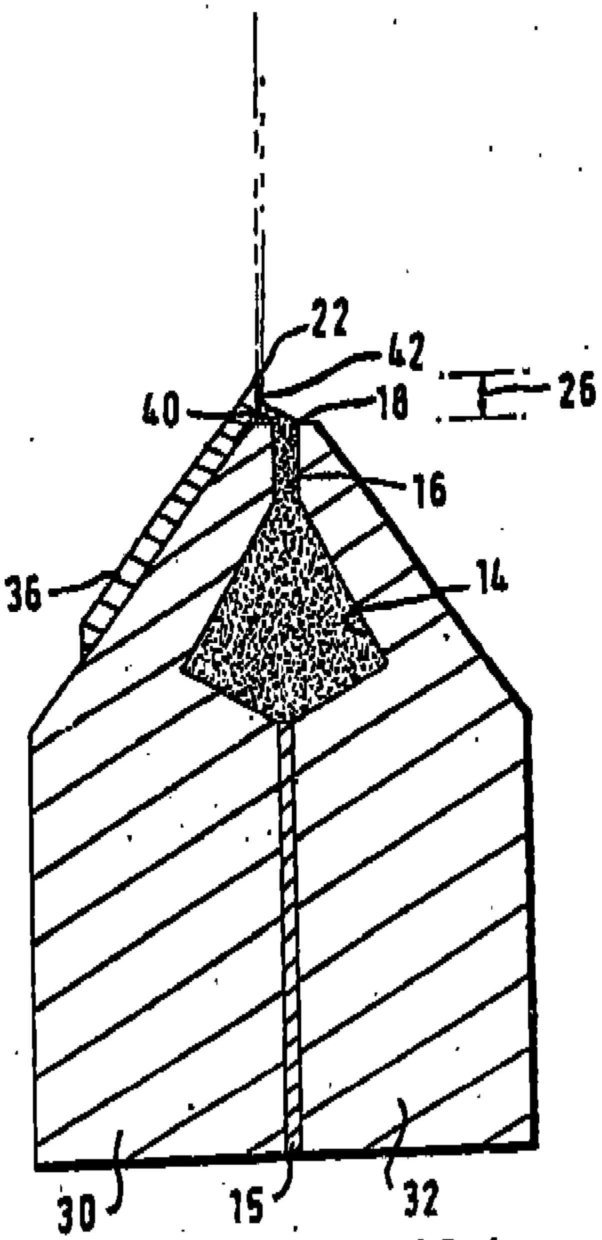


FIG. 4

ELECTROSTATIC COATING BLADE AND METHOD OF APPLYING A THIN LAYER OF LIQUID THEREWITH ONTO AN OBJECT

BACKGROUND OF THE INVENTION

The present invention relates to an electrostatic coating blade for applying a thin layer of a liquid, e.g. oil, onto a target object; the present invention also provides a method of applying a coating of a liquid onto an object by eletrostatic spraying.

Electrostatic coating blades are well known for applying layers of paint or oil. One type of blade currently in use is made of metal and has a wedge shape that tapers to a discharge edge. A conduit extends longitudinally along the blade and a slot connects this conduit to the discharge edge for supplying liquid from the conduit to the discharge edge. When an electrostatic field of 50 to 140 kV is created between the object to be coated and the blade and when liquid, e.g. oil, is pumped along the conduit and through the slot, the field breaks up the liquid at the discharge edge into a number of conical streams which then in turn break up into charged droplets that are drawn by the field onto the object, which is thus covered in a thin liquid film. Using a blade of this type it is possible to achieve a minimum liquid discharge rate from the blade of approximately 0.5 ml/cm of blade per minute for a given oil but rates lower than this are not possible because, instead of steady conical streams, individual streams become intermittent which causes a discontinuous film on the object.

Attempts have been made to provide a uniform thin coating layer by limiting the amount of liquid fed to the discharge edge. One blade of this type is described in U.S. Pat. No. 2,695,002; the blade has a cylindrical body and a downwardly pointing lip extending along its length terminating in a discharge edge. A conduit extends along the length of the blade in which a rotor provided with a helical groove is located. As the rotor turns, liquid in the groove is fed into an outlet slot and from there the liquid flows onto the upper surface of the lip to form a thin stream that flows by the action of gravity to the discharge edge where it is discharged. The blade is usually made of steel but if the liquid is conductive, the blade may be made of an insulating material; however, the specification does not state how conductive a liquid must be to allow the blade to be made of insulating material. The width of the lip from the slot to the discharge edge is approximately 0.9 inches (23 mm). The minimum discharge rate of this blade necessary to produce a uniform coating on the target object is too high for the requirements of modern industry. Furthermore, since the blade relies on gravity to feed liquid from the slot to the discharge edge, the blade can only operate as a top blade, i.e. it can only coat objects located below it.

A further attempt to limit the amount of liquid reaching the discharge edge was to require liquid leaving a liquid outlet to flow over a surface towards the discharge edge under the action of gravity. A blade of this sort, which was produced commercially, is described in U.S. Pat. No. 3,486,483; the blade has a cylindrial body and a downwardly pointing lip that terminates in a discharge edge. The body is composed of an insulating material, while the lip has a sandwich construction with a conductive strip being located between two insulator layers; the edge of the strip is exposed near the discharge edge. The distance between the conductive strip and the discharge edge is approximately 10mm. A conduit extends along the length of the blade and exit holes are provided at the top of the cylindrical body so that liquid discharged from the exit holes flows over the outside of the body and onto the top surface of the lip; as the liquid stream flows over the cylindrical surface of the body and down the lip, it becomes thinner. When it reaches the discharge edge, the liquid stream is discharged at the discharge edge by virtue of the electrostatic field established between the object to be coated and the exposed edge of the conductive strip in the blade lip. However, the minimum discharge rate of this blade (while still producing a uniform coating on the target object) is still of the order of 0.5 ml/cm of blade length/minute; furthermore, since the flow of liquid between the outlet holes and the discharge edge depends on gravity, the blade can only be used as a top blade.

There is an increasing demand for a blade that can apply a thinner layer of liquid onto a target object while still requiring that the coating layer is continuous. This is particularly important in the steel industry where electrostatic coating blades are used to apply a layer of oil onto steel strip to prevent corrosion.

We have developed an electrostatic coating blade which has achieved application rates of oil as low as 0.03 ml/cm of blade length/per minute while still producing a uniform, continuous coating.

We have discovered that low discharge rates can be achieved by establishing an electrostatic field between the target object and the outlet(s) of one or more closed channels (by "closed" we mean that the channel has an inlet and an outlet but otherwise is not open to atmosphere) and placing an insulating surface in front of the channel outlets in such a way that a discharge edge provided at the end of the insulating surface is 0.5 to 4 mm from the channel outlets. In this way, liquid is drawn by the electrostatic field along the insulating surface in an ever tapering stream to the discharge edge and a very thin but uniform stream of liquid reaches the discharge edge where it is discharged evenly.

Summary

According to the present invention, there is provided an electrostatic coating blade for applying a coating of a non-conductive liquid onto an object, the blade comprising one or more liquid-conducting channels each extending to a channel outlet, means present at the or each outlet for applying an elecrostatic potential to liquid present at the outlet(s), a surface composed of non-conductive material located in front of the channel outlet(s) and a discharge edge at the end of the surface, wherein the distance between the discharge edge and the channel outlet(s) is in the range of from 0.5 to 4 mm.

The present invention also provides a method of operating the blade.

The liquid is drawn from the channel outlet(s) and along the surface under the influence of the applied electrostatic field as a film of gradually decreasing thickness and thus a consistent, thin film of liquid is supplied to the discharge edge leading to the formation at the discharge edge of a large number of small conical streams which are broken down by the electrostatic field into very small droplets that are drawn by the field to the target object. The droplets produced by the blade of the present invention are very much smaller than those produced by known blades and consequently uniform coatings can be obtained even at very low discharge rates. With this arrangement, application rates of the order of 0.03 cc/cm of blade/minute are possible. It may happen that before the film of liquid flowing along the surface reaches the discharge edge, it breaks up into several rivulets but this does not affect the operation of the blade because each rivulet in turn forms a conical stream at the discharge edge. Liquid can collect at the channel outlet(s) as a bead and liquid is drawn from the bead to the discharge edge by the electrostatic field (and to a small extent by surface tension). Thus there can be a gap between the liquid outlet(s) and the start of the non-conducting surface in which the liquid bead can collect.

The distance between the channel outlet(s) and the discharge edge at the end of the non-conducting surface is critical. If it is less than 0.5 mm, then there is insufficient distance to draw out the liquid into a fine stream and a low discharge rate cannot be achieved. When the distance is greater than 4 mm and the blade is pointing downwards, the stream breaks up and an uneven coating is obtained or the liquid is discharged straight from the channel(s); when the blade is pointing upwardly, the stream can stop completely. The optimum distance between the channel outlets and the discharge edge depends on the viscosity and resistivity of the oil, but it is generally 1 to 3 mm, e.g. approximately 2.5 mm.

It is important that the channel(s) leading up to the liquid outlet are closed since in this way liquid can be supplied to the liquid outlet consistently rather than relying on other factors, e.g. gravity, to supply the liquid. Also, since the channel(s) is/are closed, the blade can be used for coating objects above, below or to the side of the blade. Although more than one channel can be used for supplying liquid to the outlet, it is preferred that a single slot is used that extends along practically the entire length of the blade.

The blade of the present invention is primarily designed to apply oil and typically the liquid will have a resistivity of 5×10^6 to 3×10^{10} ohm cm and preferably from 2×10^7 to 8×10^8 ohm cm.

It is preferred that the blade comprise two side pieces with the channel(s) being provided by a gap between them; such an arrangement is known per se. However, in the blade according to the invention, a first side piece can extend beyond the other side piece (the second side piece) so that the discharge edge and the surface leading to the discharge edge are provided on the first side piece. The first side piece can be made of non-conductive material; the second side piece can be made of similar material or it can be made of metal to provide the electrostatic charge to the liquid. The charge may alternatively be applied by a conductive wire or strip in the vicinity of the outlet(s). Preferably the two side pieces are slidable with respect to one another so as to adjust the distance between the discharge edge and the liquid outlet.

It is possible to adapt a known coating blade to form a blade in accordance with the present invention by extending one of the sides of the blade with a strip of non-conductive material so that the strip projects in front of the liquid outlet of the original blade. Thus, the extension provides the discharge edge of the modified blade and the non-conductive surface leading to it.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in further detail, solely by way of example, with reference to the accompanying drawings, in which;

FIG. 1 is a perspective view of a sectional part of a blade in accordance with the present invention;

FIG. 2 is a transverse sectional view through a second blade in accordance with the present invention;

FIG. 3 is a transverse sectional view through a third blade in accordance with the present invention; and

FIG. 4 is a transverse sectional view through a fourth blade in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring initially to FIG. 1, a blade is shown having two side pieces 10 and 12, with a liquid conduit 14 being provided between them. The conduit runs along the length of the blade and is provided with liquid under pressure from a pump (not shown). A slot 16 is also provided between the side parts 10 and 12; the slot is between 120 and 380, e.g. 250, micrometres wide and receives liquid from the conduit 14 and conducts it to a liquid outlet 18, where the liquid collects as a bead 13. The width of slot 16 is determined by the width of a shim 15 and can be changed by changing the shim for one of different thickness. As can be seen, side piece 10 extends beyond side piece 12 and thus provides a surface 20 leading from the liquid outlet 18 to a discharge edge 22 at the end of side piece 10. The side pieces are held together by bolts (not shown) preferably the arrangement being such that the two side pieces can slide with respect to each other when the bolts are not fully tightened but, when fully tightened, the bolts clamp the side pieces and prevent any sliding movement. This arrangement allows the distance between discharge edge 22 and outlet 18 to be adjusted.

The side piece 10 is made of a non-conductive material, e.g. polymethylmethacrylate or an epoxy resin (Perspex or Tufnol, which are Trade Marks), ceramics or any other insulating material. The other side piece 12 may be made of metal, e.g. aluminium, and is connected to a high voltage source in order to supply electrostatic charge to the liquid at the outlet 18. Alternatively, side piece 12 may be made of a non-conductive material in which case there should be a conductive wire or strip in the slot 16 to provide charge to the liquid at the outlet 18. Such a strip is shown in FIG. 2 by the reference numeral 24 and is connected to a high voltage source: the strip is embedded in side piece 10 which is made of insulating material as is side piece 12. The strip 24 may equally be embedded in side piece 12 or a strip 24 may be embedded in both of side pieces 10 and 12. The strip 24 may be in the position shown or it may be located further down the slot 16. The distance 26 between the slot outlet 18 and the discharge edge 22 is between 0.5 and 4 mm, e.g. approximately 2.5 mm.

Referring to FIG. 1, when one side piece is conductive and the other side piece is non-conductive, an electrode 19 may be placed on or near the outer side of the non-conductive side piece 10 to counteract the field produced by the conductive side piece 12. If electrode 19 were not provided, the liquid might migrate and wet the outer surface of side piece 10. The electrode may be in the form of a conductive layer or plate attached to the side piece 10 or it may be a plate spaced slightly from the side piece 10.

In operation, liquid collects at the outlet 18 as a bead of liquid 13 and is maintained there either by providing a flat surface 25 at the top of side piece 12 (see FIG. 2) or by providing a groove 28 in side piece 10 in which the liquid can accumulate as shown in FIG. 3. A strip of conductive material 24 may be provided within or below the groove 28 to supply electrostatic charge to the liquid.

The blade shown in FIG. 4 has two side pieces 30 and 32 both made of aluminium and a spacing shim 15 located between them. A liquid conduit 14 extends along practically the whole length of the blade and a single slot 16 is provided for conducting the liquid from conduit 14 to an outlet 18. The width of slot 16 is determined by the width of the shim 15. A strip 36 of 1.5 mm thick Tufnol (Trade mark), which is an insulating material, is secured to the outer surface of blade side piece 30 and extends so that a leading edge 22 of the strip lies in front of the outlet 18. The distance 26 between the slot outlet 18 and the leading (or discharge) edge 22 is approximately 2.5 mm.

The blades shown in FIGS. 1 to 3 operate as follows: liquid is supplied under slight pressure to conduit 14 and it flows along slot 16 to outlet 18 where it collects as a bead 13. An electrostatic field is established between the blade and the object to be coated usually by holding the object at earth potential and charging the blade up to the working potential of 50 to 120 kV. This potential is supplied to side piece 12 when it is conductive or to strip 24 when sidepiece 12 is non-conductive. The liquid is thereby also charged. As shown in FIG. 1, the electrostatic field draws the liquid 21 from the outlet 18 to the discharge edge 22. The liquid stream flowing along edge 22 and it may actually be formed into distinct rivulets 23 as shown in FIG. 1 or it may reach the edge 22 as a single stream. In either case, only a small amount of liquid reaches the discharge edge, where it is atomised. The discharge is constant even at low discharge rates.

The operation of the blade shown in FIG. 4 is very similar to the operation of the blades shown in FIGS. 1 to 3. Electrostatic charge is applied to the liquid at the outlet via the side piece 30 and/or 32, the liquid collects as a bead 40 at the outlet 18 but that bead does not extend as far as discharge edge 22. Liquid from the bead is accelerated under the influence of the applied electrostatic field along surface 42 of the strip 36 until it reaches the leading edge 22 where it is discharged. As it is drawn along surface 42 by the electrostatic field, the liquid forms a film of decreasing thickness and in this way, very small discharge rates of liquid can be achieved as described above.

Although the blade has been described primarily in an operaton in which very small amounts of liquid are discharged, the baldes can also be operated to provide much higher discharge rates.

The blade according to the present invention is primarily designed to coat objects with oil to protect them from corrosion but it may also be used to apply any liquid that is customarily applied by electrostatic coating techniques.

EXAMPLE

An electrostatic coating blade as shown in FIG. 4 was used to coat an object with Nalco oil (type XL 174) having a resistivity 6.5×10^7 hm cms at 35° C. The target object is held at earth potential and the blade is charged to a negative potential of 90 kV. The insulating strip is made of 6F45 Tufnol (Tufnol is a Trade Mark) which is an epoxy resin containing a fine weave fabric. The target object is located 9 inches (23 cms) from the blade. A discharge rate of 0.03 ml/cm of blade length/minute was obtained while still producing a uniform, continuous coating of the oil. The voltage was then increased to 120 kV and the rate of liquid supply to the blade was increased. Using these parameters, a discharge rate of 15 ml/cm of blade length/minute was obtained.

LA BLADE

A blade as illustrated in U.S. Pat. No. 2,695,002 was used to coat a similar object with XL 174-type Nalco oil; the minimum discharge rate that could be obtained was 0.5 ml/cm of blade length/minute but even at this rate, the object had uncoated patches caused by the fact that the blade produced large droplets. In order to provide a coating of the same degree of uniformity as the blade of the present invention operating at a discharge rate of 0.03 ml/cm of blade length/minute, the blade of U.S. Pat. No. 2,695,002 required a discharge rate of 1.2 ml/cm of blade length/minute, i.e. 40 times that required by the present invention. The maximum discharge rate that could be obtained from the blade of U.S. Pat. No. 2,695,002 was 6 ml/cm of blade length/minute; at higher rates, liquid is discharged from areas of the blade in addition to the discharge edge and this leads to an unsatisfactory uneven coating.

OLD BLADE

It is clear from the above that the blade of the present invention can be used over a much wider range of discharge rates than the blade illustrated in U.S. Pat. No. 2,695,002.

I claim:

1. An electrostatic coating blade for applying a coating of a liquid onto an object, the blade comprising at least one liquid conducting channel extending to an associated channel outlet, means present in and at each outlet for applying an electrostatic potential to liquid present at the outlet(s), a surface composed of a non-conductive material located in front of the channel outlet(s) and a discharge edge forming an end of the

2. A blade as claimed in claim 1, wherein the distance between the channel outlet(s) and the discharge edge is in the range of from 1 to 3 mm.

3. A blade as claimed in claim 1, wherein the distance between the channel outlet(s) and the discharge edge is approximately 2.5 mm.

4. A blade as claimed in claim 1, which includes a conduit extending along the length of the blade and wherein the or each channel extends between the conduit and said channel outlet.

5. A blade as claimed in claim 1, wherein the blade is composed of first and second halves, the said channel(s) extending between the two halves and the said first half being composed of an insulating material and terminating in the said discharge edge and also extending beyond the second half to provide said non-conductive surface between the channel outlet(s) and the discharge edge.

6. A blade as claimed in claim 5, wherein the said second half is composed of an insulating material.

7. A blade as claimed in claim 5, wherein the said second half is composed of a conductive material.

8. A blade as claimed in claim 7, wherein the first half has an outer coating of a conductive material.

9. A blade as claimed in claim 1, wherein the means for applying an electrostatic potential to liquid present at the outlet(s) is a metal strip located in the or each channel in the vicinity of the outlet thereof.

10. A blade as claimed in claims 1, wherein the blade is composed of two conductive halves between which the channel(s) extend and a strip of insulating material extends in front of the channel outlet(s), the said non-conductive surface and the said discharge edge being formed on the said insulating strip.

11. A blade as claimed in claim 1, wherein the insulating surface is composed of a material selected from the group consisting of a polycarbonate, a ceramics material, a polymethylmethacrylate and an epoxy resin.

12. A method of applying a coating of a liquid onto an object using an electrostatic coating blade to which the liquid is fed, the blade comprising one or more channels each extending to a channel outlet and a surface made of non-conductive material located in front of the channel outlet(s) and terminating in a discharge edge, the discharge edge being located 0.5 to 4 mm from the channel outlet(s), wherein the method comprises supplying liquid to the channel outlet(s), applying an electrostatic potential to liquid in and at the channel outlet(s) and

establishing an electrostatic field between the liquid at the channel outlet(s) and the object to be coated, thereby causing a stream of reducing thickness to be drawn towards the discharge edge and further causing liquid to be discharged from the discharge edge onto the object.

13. A method as claimed in claim 12, wherein liquid collects as a bead at the liquid outlet(s).

14. An electrostatic coating blade for applying a coating of a liquid onto an object, the blade comprising at least one liquid conducting slot extending to a slot outlet, means present in and at the slot outlet for applying an electrostatic potential to liquid present at the outlet, a surface composed of non-conductive material located in front of the slot outlet and a discharge edge forming an end of the surface, wherein there is a distance between the slot outlet and the discharge edge in the range of from 1.0 to 4 mm.

* * * * *

United States Patent [19]
Smythe

[11] **Patent Number:** 4,521,462
[45] **Date of Patent:** Jun. 4, 1985

[54] **ROTARY ATOMIZER FOR COATING WORKPIECES WITH A FINE LAYER OF LIQUID MATERIAL, AND A METHOD OF OPERATING THE SAID ATOMIZER**

[75] Inventor: Kenneth R. Smythe, Farnborough, United Kingdom

[73] Assignee: Sale Tilney Technology Plc., Weybridge, United Kingdom

[21] Appl. No.: 635,619

[22] Filed: Jul. 30, 1984

[30] **Foreign Application Priority Data**

Aug. 2, 1983 [GB] United Kingdom 8320827

[51] Int. Cl.[3] B05D 1/02
[52] U.S. Cl. 427/421; 118/300; 118/323; 239/703; 239/223; 239/224
[58] Field of Search 118/300, 317, 323; 239/703, 223, 224; 427/421

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4,337,895 7/1982 Gallen .... 239/223 X

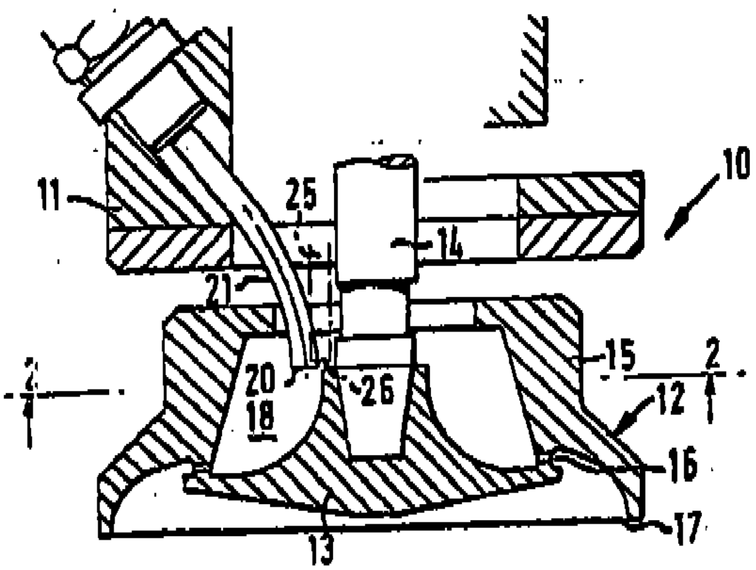
Primary Examiner—Shrive P. Beck
Attorney, Agent, or Firm—Kerkam, Stowell, Kondracki & Clarke

[57] **ABSTRACT**

A rotary atomizer for coating workpieces with a fine layer of liquid material, and a method of operating the said atomizer.

A rotary atomizer (10) for coating workpieces with a fine layer of liquid material fed at very low flow rates includes a bell-type rotatable atomizing device (12) for dispensing the liquid from an edge (17) in an atomized condition under the effect of centripetal forces. The liquid fed into a tube (21) having an outlet (20) within the bell (12) appears as discontinuous drops (40) at the outlet (20). Air is also fed into the bell (12) via a tub (25) having an outlet (26) disposed adjacent the liquid outlet (20) such that the air jet (41) breaks up the drops (40) and forms a spray (42) directed at the internal wall of the bell (12). The spray (42) coalesces into a continuous film of liquid as it travels on the internal wall of the bell (12) to the discharge edge (17).

9 Claims, 3 Drawing Figures



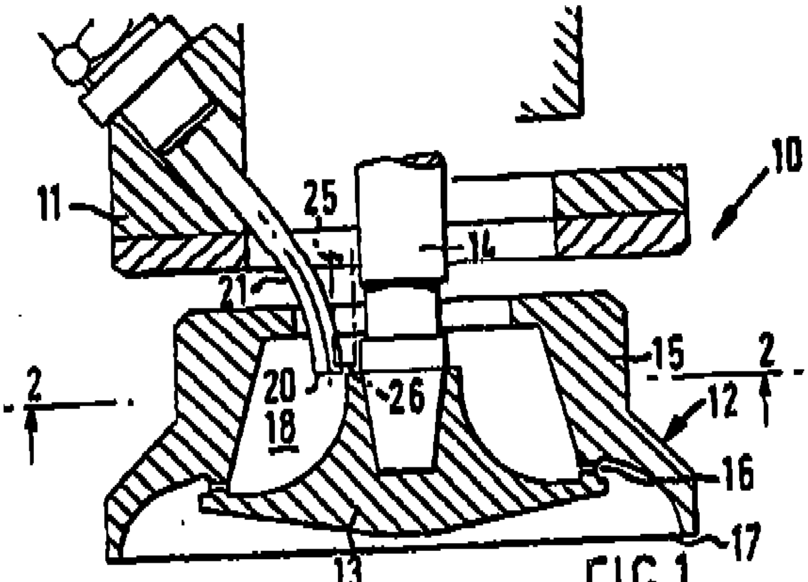


FIG.1

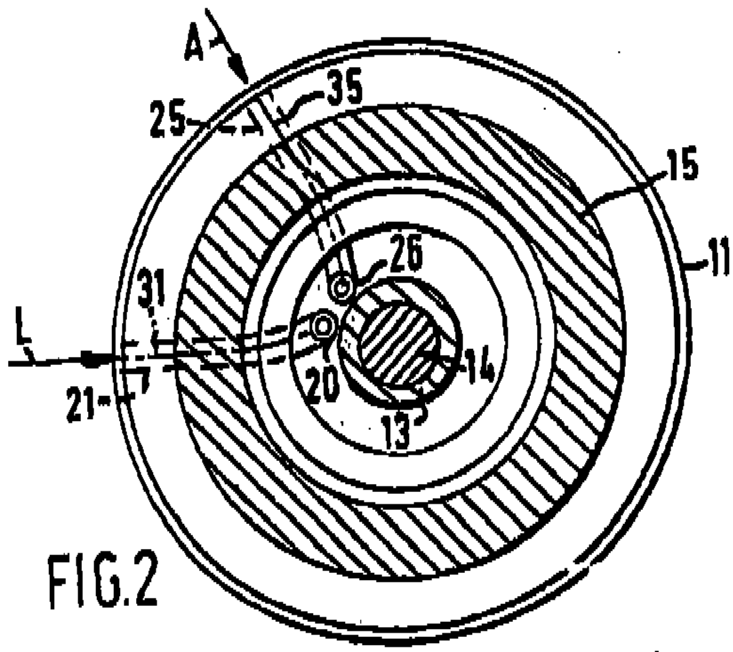


FIG.2

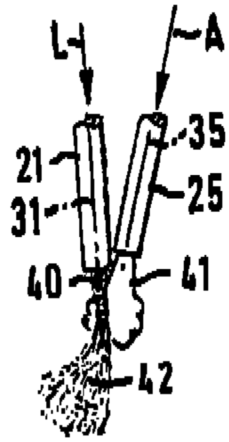


FIG.3

ROTARY ATOMIZER FOR COATING WORKPIECES WITH A FINE LAYER OF LIQUID MATERIAL, AND A METHOD OF OPERATING THE SAID ATOMIZER

The present invention concerns a rotary atomizer for coating workpieces with a fine layer of liquid material, and a method of operating the said atomizer. Although the invention is not so restricted, it will hereafter be particularly described with reference to a rotary atomizer for use in aluminium strip finishing lines, e.g. for coating aluminium strip before it is made into cans for containing beverages.

When coating can material with a protective layer of wax or an oil, such as e.g. dioctyl sebacate, it is very important to keep the layer to very fine dimensions, i.e. to keep the layer very thin and moreover to make the layer of uniform thickness. But with known atomizers this is very difficult to achieve because thinness of the layer implies very low flow rates of the coating liquid and very low flow rates in turn imply a risk of unevenness of the coating. At very low flow rates of the liquid coating, the flow becomes intermittent and drips appear at the outlet orifice. The exact numerical value for the formation of drips varies with the viscosity and surface tension of the liquid, but a flow rate of 7 cm^3/min is typical.

When constant flow ceases and drips appear, the spray pattern from known rotary atomizers pulses at intervals coincident with the drips forming. This results in eneven coating.

Of course, rotary atomizers have been well-known for a long time. Generally, they include a motor-driven or turbine-driven member, variously called a bell, cup or disc having a fast-rotating dispensing edge from which the coating material is dispensed in spray form under the effect of the centripetal forces. It is known also in rotary atomizers to provide air jets or streams around the dispensing edge to control the shape of the spray and3or to assist in atomization.

Furthermore, it is known from GB-A-2 086 765 to reduce any maldistribution of coating material under the effect of a partial vacuum caused by the high-speed rotation of a turbine-type atomizer by supplying air into the spray along the axis of rotation of the atomizer. However, this air enters the spray downstream of the dispensing edge, i.e. outside the atomizer, and has no influence whatsoever on the liquid *within* the cup or bell. The outlet of the air supply and the outlet within the cup or bell of the paint tube in GB-A-2 086 765 are spatially well separated and have absolutely no interaction.

None of the known atomizers addresses itself to, or is capable of solving the problem of uneven coating arising at very low liquid coating material feed rates.

The present invention seeks to overcome the problem of uneven coating at low feed rates of the coating material by providing a rotary atomizer, and a method of operating it, as set out below. It will be seen that, essentially, a small amount of air (or other gas) is used to break the surface tension of the coating material as it emerges inside the bell from its feed tube. The drips from the feed tube are changed into smaller droplets, mixed with the air, and the mix or spray is then transferred to the internal wall of the rotating atomizer to travel to the edge under the centrifugal force as a coherent or quasi-coherent film, to be discharged from the edge in a constant spray pattern.

According to one aspect of the present invention, there is provided a rotary atomizer for coating workpieces with a fine and even layer of liquid coating material, comprising an atomizing device having a discharge edge, means for rotating said atomizing device, a liquid feed tube connectible to a source of coating liquid and terminating in an outlet within said atomizing device, and means for controlling the rate of flow of said liquid in the feed tube such that the flow is intermittent. The invention is characterised in that there is provided a gas or air supply tube having an outlet disposed adjacent the outlet of the liquid tube within the atomizing device and connectible to a source of pressurized gas or air, the relative positions of said outlets being such that in use a regulated stream of gas or air is directed at or adjacent the liquid outlet so as to break up drips of said liquid appearing at the outlet into smaller droplets and deflect them towards the internal wall of the said atomizing device upstream of said dispensing edge.

Preferably, the outlet of the liquid feed tube and the outlet of the said supply tube are not coplanar, the latter terminating somewhat upstream of the former. Although the said supply tube could surround the said feed tube, in a preferred embodiment the two tubes are discrete tubes extending into the atomizing device at circumferentially spaced apart positions and with their respective longitudinal axes inclined to each other at an acute angle.

According to another aspect of the present invention, there is provided a method of coating workpieces with a liquid at very low outputs by utilizing a rotary atomizer, comprising providing a liquid feed tube terminating in an outlet disposed within the rotary atomizing device, e.g. bell, of said atomizer, supplying the feed tube with said liquid at a rate such that flow of said liquid is intermittent and drops form at the outlet of the feed tube. This method is characterized by directing a stream of gas or air at said outlet within said atomizing device to break up the drops into smaller droplets and to transfer them to the internal wall of the said device, e.g. bell, to be discharged from the discharge edge thereof in a substantially uniform spray pattern.

Advantageously, the rate of flow of liquid may not exceed 7 cubic centimeters per minute, and the air or gas pressure is less than 70×10^3 P; most typically 2-3 pounds per square inch (14-21×10^3 P).

The invention is illustrated, purely by way of example, with reference to the accompanying diagrammatic drawing, wherein:

FIG. 1 is a longitudinal section of part of a rotary atomizer according to the invention,

FIG. 2 is cross-section taken along the plane indicated by the lines 2—2 in FIG. 1, and

FIG. 3 is an enlarged schematic detail to illustrate the operation of the rotary atomizer.

In the drawing, a rotary atomizer 10 includes a housing 11, shown only partially, to the front end of which is secured an atomizing device 12. The device 12 consists of a mushroom-shaped boss 13 secured to the end of a shaft 14 projecting from the housing 11 and in use rotated at high speed, e.g. 30.000 r.p.m., by a motor or turbine, not shown. The boss 13 is unitary with a generally cup-shaped member 15, hereafter referred to as 'bell 15'.

A row of circumferential holes 16 is formed at the junction of the radially outer edge of the head of the

United States Patent [19]

Smythe

[11] **Patent Number:** 4,521,462

[45] **Date of Patent:** Jun. 4, 1985

[54] **ROTARY ATOMIZER FOR COATING WORKPIECES WITH A FINE LAYER OF LIQUID MATERIAL, AND A METHOD OF OPERATING THE SAID ATOMIZER**

[75] Inventor: Kenneth R. Smythe, Farnborough, United Kingdom

[73] Assignee: Sale Tilney Technology Plc., Weybridge, United Kingdom

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[52] U.S. Cl. 427/421; 118/300; 118/323; 239/703; 239/223; 239/224

[58] Field of Search 118/300, 317, 323; 239/703, 223, 224; 427/421

[56] **References Cited**

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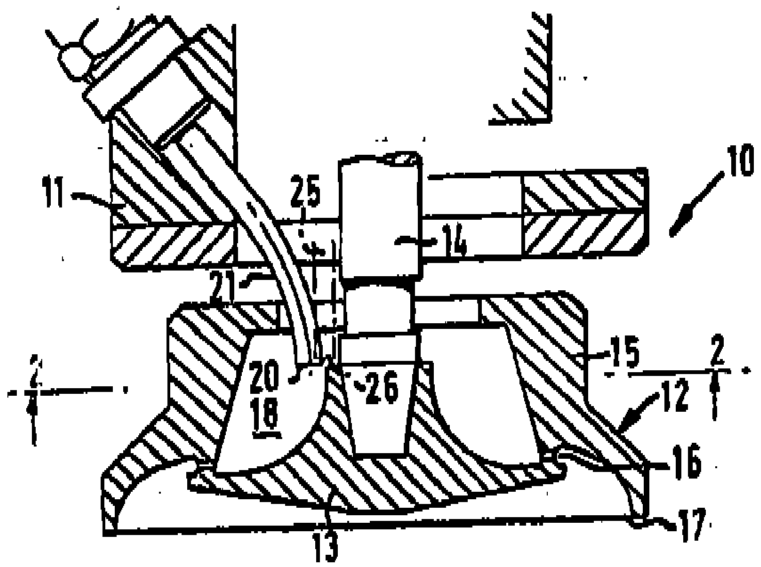
Primary Examiner—Shrive P. Beck
Attorney, Agent, or Firm—Kerkam, Stowell, Kondracki & Clarke

[57] **ABSTRACT**

A rotary atomizer for coating workpieces with a fine layer of liquid material, and a method of operating the said atomizer.

A rotary atomizer (10) for coating workpieces with a fine layer of liquid material fed at very low flow rates includes a bell-type rotatable atomizing device (12) for dispensing the liquid from an edge (17) in an atomized condition under the effect of centripetal forces. The liquid fed into a tube (21) having an outlet (20) within the bell (12) appears as discontinuous drops (40) at the outlet (20). Air is also fed into the bell (12) via a tub (25) having an outlet (26) disposed adjacent the liquid outlet (20) such that the air jet (41) breaks up the drops (40) and forms a spray (42) directed at the internal wall of the bell (12). The spray (42) coalesces into a continuous film of liquid as it travels on the internal wall of the bell (12) to the discharge edge (17).

9 Claims, 3 Drawing Figures



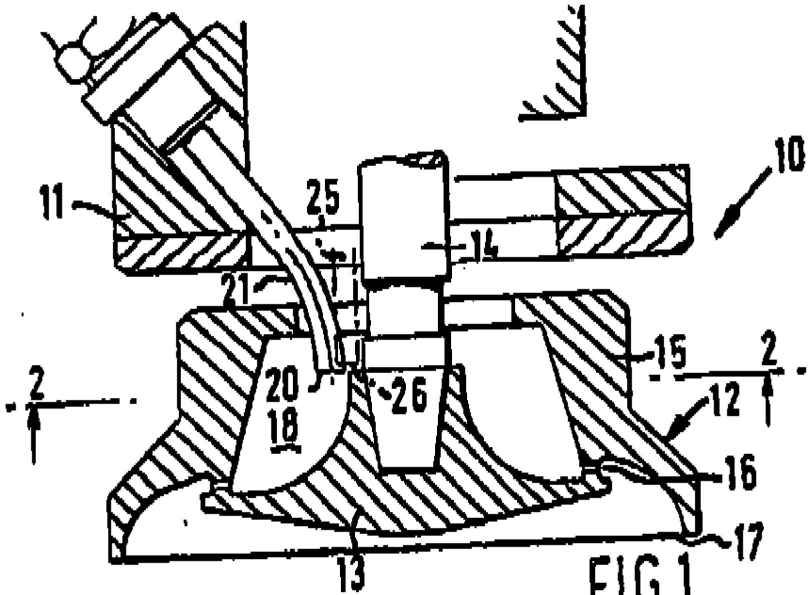


FIG.1

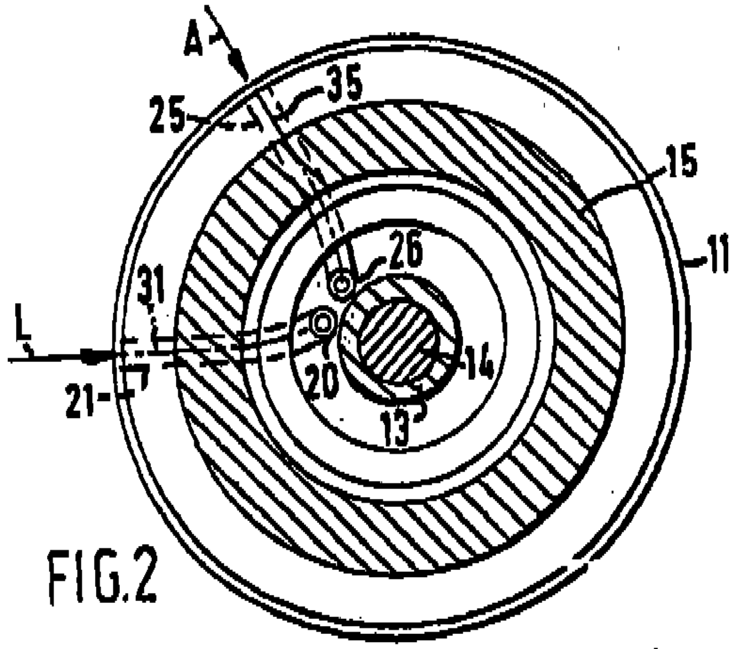
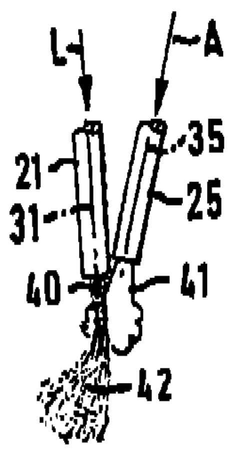


FIG.2

FIG.3



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Of course, rotary atomizers have been well-known for a long time. Generally, they include a motor-driven or turbine-driven member, variously called a bell, cup or disc having a fast-rotating dispensing edge from which the coating material is dispensed in spray form under the effect of the centripetal forces. It is known also in rotary atomizers to provide air jets or streams around the dispensing edge to control the shape of the spray and3or to assist in atomization.

Furthermore, it is known from GB-A-2 086 765 to reduce any maldistribution of coating material under the effect of a partial vacuum caused by the high-speed rotation of a turbine-type atomizer by supplying air into the spray along the axis of rotation of the atomizer. However, this air enters the spray downstream of the dispensing edge, i.e. outside the atomizer, and has no influence whatsoever on the liquid *within* the cup or bell. The outlet of the air supply and the outlet within the cup or bell of the paint tube in GB-A-2 086 765 are spatially well separated and have absolutely no interaction.

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According to one aspect of the present invention, there is provided a rotary atomizer for coating workpieces with a fine and even layer of liquid coating material, comprising an atomizing device having a discharge edge, means for rotating said atomizing device, a liquid feed tube connectible to a source of coating liquid and terminating in an outlet within said atomizing device, and means for controlling the rate of flow of said liquid in the feed tube such that the flow is intermittent. The invention is characterised in that there is provided a gas or air supply tube having an outlet disposed adjacent the outlet of the liquid tube within the atomizing device and connectible to a source of pressurized gas or air, the relative positions of said outlets being such that in use a regulated stream of gas or air is directed at or adjacent the liquid outlet so as to break up drips of said liquid appearing at the outlet into smaller droplets and deflect them towards the internal wall of the said atomizing device upstream of said dispensing edge.

Preferably, the outlet of the liquid feed tube and the outlet of the said supply tube are not coplanar, the latter terminating somewhat upstream of the former. Although the said supply tube could surround the said feed tube, in a preferred embodiment the two tubes are discrete tubes extending into the atomizing device at circumferentially spaced apart positions and with their respective longitudinal axes inclined to each other at an acute angle.

According to another aspect of the present invention, there is provided a method of coating workpieces with a liquid at very low outputs by utilizing a rotary atomizer, comprising providing a liquid feed tube terminating in an outlet disposed within the rotary atomizing device, e.g. bell, of said atomizer, supplying the feed tube with said liquid at a rate such that flow of said liquid is intermittent and drops form at the outlet of the feed tube. This method is characterized by directing a stream of gas or air at said outlet within said atomizing device to break up the drops into smaller droplets and to transfer them to the internal wall of the said device, e.g. bell, to be discharged from the discharge edge thereof in a substantially *uniform* spray pattern.

Advantageously, the rate of flow of liquid may not exceed 7 cubic centimeters per minute, and the air or gas pressure is less than 70×10^3 P; most typically 2-3 pounds per square inch ($14-21\times10^3$ P).

The invention is illustrated, purely by way of example, with reference to the accompanying diagrammatic drawing, wherein:

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In the drawing, a rotary atomizer 10 includes a housing 11, shown only partially, to the front end of which is secured an atomizing device 12. The device 12 consists of a mushroom-shaped boss 13 secured to the end of a shaft 14 projecting from the housing 11 and in use rotated at high speed, e.g. 30,000 r.p.m., by a motor or turbine, not shown. The boss 13 is unitary with a generally cup-shaped member 15, hereafter referred to as 'bell 15'.

A row of circumferential holes 16 is formed at the junction of the radially outer edge of the head of the boss 13 and a projection on the internal wall of the bell 15. The downstream edge 17 of the bell 15 is a sharp discharge edge. The stem of the boss 13 and the internal wall of the bell 15 form an annular chamber 18. Into this chamber 18 extends the outlet 20 of a feed tube 21 for the liquid coating material, connected at its other end to a source of the liquid and a pump, not shown. The direction of flow of the liquid along the feed tube 21 is indicated by an arrow L in FIGS. 2 and 3.

The apparatus described thus far is conventional.

According to a preferred embodiment of the invention, an air (or other gas) supply tube 25 having an outlet 26 projects into the chamber 18 at a location radially and circumferentially spaced from tube 21. This tube 25 is connected in use to a source of supply delivering air at a relatively low pressure of 2–3 p.s.i. or about $14–21\times10^3$ pascals.

The relative dispositions of the tube outlets 20 and 26 may be seen most clearly in FIGS. 2 and 3. The longitudinal axes 31, 35 of the tubes 21, 25, respectively intersect each other at an acute angle. The outlet 26 of the air tube 21 terminates axially backwardly (upstream) of the outlet 20 of the liquid feed tube 21. In a typical application, the inner diameter of each tube 21, 25 is 0.24 cm and the axial spacing of the tube outlets 20, 26 is 0.16 cm. This configuration of the tubes and tube outlets has the following effect in use, explained in conjunction with FIG. 3:

When liquid is fed in the direction L along the tube 21 at very low feed rates of 7 cm^3/min., the flow is intermittent. Drops of liquid appear at the outlet 20. Air flowing in the pipe 25 along the direction of arrow A issues from outlet 26 (illustrated schematically at 41) and intersects the pattern 40 of the liquid. More particularly the air jet 41 shears the drips of liquid off the outlet 20 of the tube 21 and forms a spray which is deflected from the direction of the axis 31 of the tube 21 towards the outer wall of the chamber 18 (FIG. 1). The spray then impinges on the outer wall of the chamber 18 and coalesces into a thin, coherent or quasi-coherent film. This film then travels under the effect of the centripetal forces through the bores 16 to the discharge edge 17, from where it is discharged as a uniform spray. In this way, the above-mentioned pulsing and uneven coating due to the low feed rate and drip formation are reliably prevented.

Although the invention has so far been described in terms of a rotary atomizer not employing electrostatic charging of the coating material, it is readily adaptable to include an electrostatic charger.

I claim:

1. A rotary atomizer for coating workpieces with a fine and even layer of liquid coating material, comprising an atomizing device having a discharge edge, means for rotating said atomizing device, a liquid feed tube

connectible to a source of coating liquid and terminating in an outlet within said atomizing device, and means for controlling the rate of flow of said liquid in the feed tube such that the flow is intermittent and produces drops at said outlet, characterised in that there is provided a gas or air supply tube having an outlet disposed adjacent the outlet of the liquid feed tube within the atomizing device and connectible to a source of pressurized gas or air, the relative positions of said outlets being such that in use a regulated stream of gas or air is directed at or adjacent the liquid outlet so as to break up drops of said liquid appearing at the outlet into smaller droplets and deflect them towards the internal wall of the said atomizing device upstream of said discharge edge.

2. A rotary atomizer according to claim 1, characterized in that the outlet of the liquid feed tube and the outlet of the said air or gas supply tube are not coplanar, the latter terminating somewhat upstream of the former to promote forward projection of the resulting spray.

3. A rotary atomizer according to claim 1, characterized in that the two tubes are discrete tubes extending into the atomizing device at circumferentially spaced apart positions and with their respective longitudinal axes inclined to each other at an acute angle.

4. A rotary atomizer according to claim 1, characterized in that the flow rate of the liquid is adjusted so as not to exceed 7 cm^3/min.

5. A rotary atomizer according to claim 1, wherein the pressure of the air or gas is adjusted so as not to exceed 10 p.s.i. ($=70\times10^3$ Pascals).

6. A rotary atomizer according to claim 2, characterized in that the distance between the said outlets is substantially 0.16 cm.

7. A rotary atomizer according to claim 1, characterized in that the inner diameter of each tube is substantially 0.24 cm.

8. A rotary atomizer according to claim 2, characterized in that the two tubes are discrete tubes extending into the atomizing device at circumferentially spaced apart positions and with their respective longitudinal axes inclined to each other at an acute angle.

9. A method of coating workpieces with a liquid at very low outputs by utilizing a rotary atomizer, comprising providing a liquid feed tube terminating in an outlet disposed within a rotary bell of said atomizer, supplying the feed tube with said liquid at a rate such that flow of said liquid is intermittent and drops form at the outlet of the feed tube, characterized by directing a stream of gas or air at said outlet within the bell of said atomizing device to break up the drops into smaller droplets and to transfer them as a spray to the internal wall of the said bell, to be discharged from a discharge edge thereof in a substantially uniform spray pattern.

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