



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.02.2008 Bulletin 2008/06

(51) Int Cl.:
B41J 3/407^(2006.01) B05B 13/04^(2006.01)

(21) Application number: **06118074.1**

(22) Date of filing: **28.07.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

- **Brodtkorb, Dagfin**
1361, Osterås (NO)
- **Lindegard, Karl-Petter**
0284, Oslo (NO)
- **Melbo, Hallgeir**
1356, Bekkestua (NO)
- **Morud, Svein Arne**
1356 Bekkestua (NO)

(71) Applicant: **ABB RESEARCH LTD.**
8050 Zürich (CH)

(72) Inventors:
• **Aaskildt, Knut**
1390, Vollen (NO)

(74) Representative: **Dahlstrand, Björn**
Legal Affairs & Compliance/Intellectual Property
ABB AB
Forskargränd 7
721 78 Västerås (SE)

(54) **Paint applicator and coating method**

(57) An applicator head (6) for applying paint to an object surface, said applicator head comprising at least one fluid supply channel (50) and at least one nozzle (57) outlet for paint. The least one nozzle is arranged in groups or arrays (3), each with means for producing a pressure

pulse in the paint so causing a small quantity of paint to be ejected from the at least one nozzle. The speed and timing of paint ejection may be controlled separately for each of the plurality of nozzles in the applicator head. For use with painting systems and automated or robotic painting systems for painting automobiles and the like.

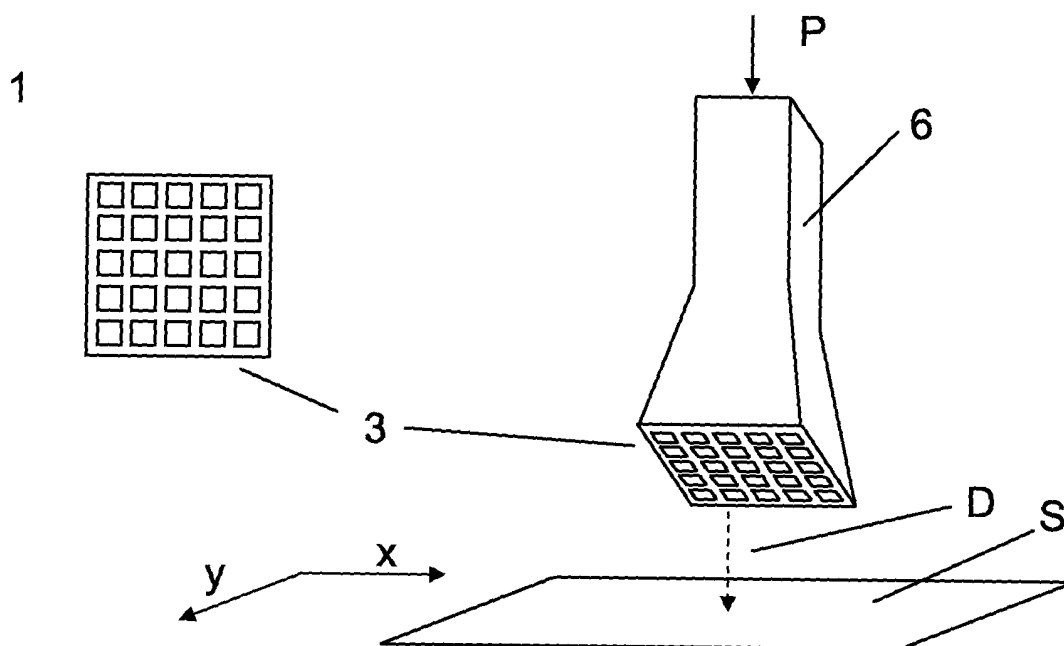


Fig. 1

Description

TECHNICAL FIELD.

[0001] The invention concerns a coating device for coating objects. In particular, the invention discloses an improved paint applicator suitable for automated or robotic installations for painting of automobiles and automobile parts.

TECHNICAL BACKGROUND

[0002] Current high performance paint robots of the type supplied by ABB and other suppliers produce for painting systems use traditional and finely tuned, sophisticated paint process elements such as gear pumps, gear flow-meters, venturi meters, paint selection valve-blocks, paint mixing devices, electrically controlled output pressure I/P, E/P regulators and so on. These and other components of an automated paint spraying system are required in order to deliver accurate amounts of paint and air to a paint applicator in a way that ensures atomization and "beamforming" of a suitable "cloud of paint" to reach the target, for example an automobile body. In a automated painting system the paint applicator is a costly device that is critical for paint system performance. The accurate and controlled input of paint and air to this device requires expensive process elements.

[0003] Among the critical elements of the automated paint process as it is practiced it is important to achieve a satisfactory amount of paint that reaches the target, a rate of flow or rate of amount of paint per time unit that can be coated on an automobile. In addition there are other technical challenges such as consistently achieving a particular quality of the coating, and quality of coating applied during bends in the paint path or for non-planar surface areas. The application of paint is often assisted by an electric field, by applying a high voltage between the paint applicator and the target, so as to ensure that a high proportion of the total amount of paint sprayed travels to the target rather than coating other surfaces in the area surrounding the automobile body or other paint target.

[0004] Another important technical challenge for automated paint application systems is that the process equipment involved, valves, colour changers, supply lines, applicators and so on need to be cleaned from time to time. To minimize the amount of paint lost on a regular basis during colour changes etc it is required that the equipment design eliminate or reduce long supply lines, excessive numbers of valves to generally reduce the amount of paint to be lost during a colour change or other process action.

[0005] In another technical field, that of printing ink on paper, inkjet technology is well established as an efficient device for printing ink on paper and several different vendors and implementations are available. Inkjet components may be based on different principles: often thermal

or piezoelectric actuation of a fluid (ink) within a cavity drives the fluid out through a relatively small nozzle forming a droplet at the output of the inkjet nozzle.

[0006] US 5,664,341 entitled Ink jet head drive apparatus and drive method, and a printer using these; assigned to Epson Corp, describes an ink jet head in which an electrostatically driven actuator is used to mechanically eject small droplets of ink from plurality of nozzles. US6,499,837 entitled Piezoelectric element and manufacturing methods and manufacturing device thereof, assigned to Epson Corp, describes methods for making piezoelectric elements for inkjet heads. US 4,646,110 entitled Liquid ejection recording apparatus, assigned to Canon, describes a type of thermal inkjet, also known as a bubble jet, in which the ink is heated in a tiny tube to create a small bubble of vapour in the ink. The bubble created by the heat drives a droplet of ink out of a nozzle.

[0007] US 4,937,678 entitled: Color image enlarging ink jet printer, to Murai et al, assigned to L.A.C. Corporation describes an ink jet printer in the form of a spray gun head equipped with a compressed air supply for spraying ink onto e.g. a surface of a wall. The device is arranged with a CPU processing image signals inputted from a television camera and a mechanism for driving the spray gun head in an X and/or Y direction.

SUMMARY OF THE INVENTION

[0008] According to one or more embodiments of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised by a plurality of nozzles each arranged for ejection of small quantities of paint.

[0009] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that the plurality of nozzles are arranged such that ejection of paint from any one nozzle of the plurality of nozzles may be controlled separately.

[0010] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of caus-

ing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that the means for producing a pressure pulse in the paint are arranged to produce a pressure such that a continuous flow of paint is ejected.

[0011] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised the means for producing a pressure pulse in the paint are arranged to produce pressure pulses such that a flow of paint droplets is ejected.

[0012] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised the ejection of paint from any one of the plurality of nozzles may be controlled separately by a signal received by the actuation means for producing a pressure pulse in the paint.

[0013] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised by that the ejection of paint from any one or more nozzle of the plurality of nozzles may be separately controlled to eject paint and coat a said object.

[0014] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that small quantities of paint are ejected from any one or more of the plurality of nozzles with a frequency of ejection that is controlled dependent on any deviation of the object surface from a flat plane so that a layer is coated on the surface of said object surface.

[0015] According to another embodiment of the present invention an improvement is provided in the form

of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that the ejection of paint from any one or more of the plurality of nozzles is controlled or switched on and off dependent on the position of each of the any one or more nozzles relative the position of the remaining plurality of nozzles.

[0016] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that the applicator head may comprise two or more separate arrays of nozzles arranged moveable relative one another to coat a predefined layer on a said object of which a part of said object may be not flat or not continuous.

[0017] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that the applicator head comprises two or more separate arrays of nozzles arranged mounted on a flexible or bendable part and moveable relative one another to focus two or more paint streams ejected from the two or more arrays and coat a layer on at least part of a said object.

[0018] According to another embodiment of the present invention an improvement is provided in the form of an applicator head for applying paint to an object surface, said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with actuation means for producing a pressure pulse in the paint so arranged capable of causing a small quantity of paint to be ejected from the at least one outlet, which said applicator is characterised in that one or more nozzles of the applicator head comprises an actuation means which is any from the group of: an electro-resistive element, a piezoelectric element, a magnetostrictive element, other electro-mechanical transducer device.

[0019] In another aspect of the invention, a method is provided for applying paint to an object surface by means of an applicator head comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with means for producing a pressure pulse in the paint so causing a small quantity of paint

to be ejected from the at least one outlet, characterised by a step of ejecting a small quantity of paint from any of a plurality of nozzles arranged comprised in said applicator head.

[0020] In yet another aspect of the invention, an improved system is provided for applying paint to an object surface, comprising an apparatus with at least one applicator head, said applicator head comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with means for producing a pressure pulse in the paint so causing a small quantity of paint to be ejected from the at least one outlet, characterised in that the at least one said applicator head comprises a plurality of nozzles each arranged for ejection of small quantities of paint.

[0021] In a first aspect of the invention an improved paint applicator is described which is similar to and in some ways developed from a modified inkjet device. The improved paint applicator has the potential to reduce cost not only of present day paint applicators but also to reduce the heavy requirements for upstream process elements and thereby both weight and cost. Reduction of weight for the paint applicator and of the upstream process elements is important since all or most of the process equipments are arranged mounted on the arm of a robot or manipulator and thus and determine the size and cost of the robot or manipulator arm itself.

[0022] As mentioned previously inkjet components may be based on different principles: often thermal or piezoelectric actuation of the fluid within a cavity drives the fluid through a relatively small nozzle forming a droplet at the output of the nozzle. More information may be found in the previously mentioned applications US 5,664,341; US 6,499,837; US 4,646,110.

[0023] Whether the actuation that produces a pressure pulse in the ink is by means of an actuator based on mechanical, thermal or piezoelectric principles, the actuator may be applied at a relatively high frequency and a stream of essentially identical droplets are thrown out of the device. A matrix of cavities, actuators and nozzles may be formed into a single structure and the actuators of each nozzle can usually be controlled individually so that for instance the high definition patterns of standard inkjet printers is obtained.

[0024] An "inkjet paint applicator" has to be closer to the target, such as an automobile body, than current applicators during the traditional paint process. The close proximity offers a potential for lower paint loss. In addition, the individual control of the nozzles in a matrix of an inkjet applicator offers the possibility to save paint, for instance when the applicator moves across an edge or corner of the target.

[0025] An additional advantage of the principles is that the use of the very expensive and sophisticated high voltage electrostatically assisted paint application system may, in some cases, prove unnecessary due to low paint losses achieved when using the inkjet applicator. If electrostatic assistance is still needed, a much lower voltage

is necessary for the same field strength due to much lower distance between applicator and target.

[0026] The principle advantage of the improved paint applicator is a more effective paint transfer to the coating target, with reduced paint loss. In part this is because the applicator head is operated close to the target, and considerably closer than traditional spray gun or bell applicator heads.

[0027] Another benefit of the invention is a greatly reduced paint loss in respect of cleaning the applicator head and nozzles. In traditional painting with a spray gun or bell applicator the applicator is flushed through on a repeated basis. However there is only a very small volume of paint in the improved inkjet applicator array or matrix. When the inkjet applicator requires cleaning, the paint loss is reduced. The volume of paint containing cavities or channels is very small. Accordingly, for situations where a solvent is used to clean any paint residues in the inkjet paint applicator and possibly upstream process equipment as well, the amount of solvent necessary is correspondingly reduced.

[0028] Another advantage particular to the improved paint applicator is that very rapid control over flow from the inkjet applicator is achieved. The applicator may be switched on or off very rapidly, as compared to, say, a bell applicator. A bell applicator may take one or more seconds to switch on or off. In contrast, the inkjet applicator fires or switches at a high frequency, and may so be switched on or off within a fraction of a second. This technical improvement gives better control over coating, and especially during coating involving changes of shape of the target. This may involve changes in surface such as painting over an edge or corner, and painting concave and convex shapes, protrusions or recesses in the surface.

[0029] The compact size and shape of the improved applicator together with the elimination of a compressed air supply for propelling the paint out of a spray gun in normal operation means that the applicator has a lighter weight. Normally supply lines, valves and regulators for each supply of process air and compressed air are arranged at the applicator. The improved applicator head gives a perhaps unexpected benefit in that a reduction in weight of the applicator due in part to leaving out the compressed air equipment. This in turn means reduced demands in terms of power acceleration on the robot structure and motors in order to carry the applicator which is mounted at the end of a robot arm.

[0030] In a preferred embodiment of the method of the invention the method may be carried out or controlled by a computing device comprising one or more microprocessor units or computers. The control unit(s) comprises memory means for storing one or more computer programs for carrying out the improved methods for controlling the operation of an improved paint applicator. Preferably such computer program contains instructions for the processor to perform the method as mentioned above and described in more detail below. In another embodi-

ment the computer program is provided on a computer readable data carrier such as a DVD, an optical or a magnetic data device, a memory device or programmable memory device, as firmware, or supplied via a data network from a server, data server or similar.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Embodiments of the invention will now be described, by way of example only, with particular reference to the accompanying drawings in which:

FIGURE 1 is a schematic diagram for an improved applicator head according to an embodiment of the invention;

FIGURE 2a and 2b are schematic diagrams for an improved applicator head comprising more than one nozzle arrangement according to another embodiment of the invention;

FIGURE 3 is a schematic diagram for a way of operating an improved applicator head according to an embodiment of the invention;

FIGURE 4 is a flowchart for a method to operate an improved applicator head according to an embodiment of the invention.

FIGURE 5 shows a schematic diagram of a fluid ejector nozzle arrangement of the inkjet type.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0032] Generally speaking inkjet-type components may be based one or more of: mechanical, thermal or piezoelectric actuation of a fluid within a cavity. The actuation drives the fluid out from the cavity through a relatively small nozzle forming a droplet at the output of the nozzle. Each inkjet-type nozzle is arranged with means for ejection and/or control of paint droplets. The improved applicator head for applying a coating of paint comprises a group, array or matrix of ejector nozzles. The improved applicator head is also arranged with one or more means for communicating control signals and/or means to transfer power (such as electrical power, compressed air etc) to the nozzles in the applicator head to control and/or power the actuation means of the nozzles comprised in the matrix.

[0033] Figure 5 shows a general schematic of a cross section of a group of an inkjet type fluid ejectors. It comprises a nozzle 57, which is the exit for a cavity 56 containing the fluid to be ejected. Each cavity 56 is supplied with fluid eg paint P by an inlet means such as inlet 50. An actuation means, an inkjet ejector means or actuation means 54, periodically exerts a pressure on the fluid in cavity 56, to eject a drop (or droplet) D from the nozzle 57. The actuator or inkjet ejector means 54 is supplied via a terminal or connection point 51 with power to actuate the actuation means, for example, an electric pulse. The electric pulse is commonly used to superheat a resistive element and form a vapour bubble that exerts pressure.

An electric pulse may also be used to power a piezoelectric crystal, a magnetostrictive element or other electromechanical transducer device.

[0034] Figure 1 shows a schematic layout for an improved applicator head. The figure shows a group 3 of nozzles which in this example are formed in the shape of a matrix or array. The matrix of nozzles 3 is arranged in housing of the applicator head. The applicator head is supplied with paint P in a controlled way. The nozzles, when actuated produce a stream of droplets D which are directed towards a target to be coated. The nozzles are usually arranged substantially perpendicular to a target surface S. The applicator head may be moved over the surface S at a substantially fixed distance or height from surface in a plane parallel to the surface or in for example a horizontal plane in which it may be moved along any path in the plane, x or y.

[0035] Figure 2a shows that two matrices of nozzles, or two applicator heads may be arranged together. Figure 3b shows an arrangement of two matrices or applicator heads arranged together. One matrix or applicator head is directed in a different direction from the other, with a difference of angle α (alpha). A group of inkjet devices (each of which consisting of a matrix 3 of nozzles) may be mounted on a "flexible substrate" of some kind or mounted in some other way to be moveable with respect to one another. The arrangement may be actuated to bend or be bent, angled and so on into a shape depending on or according to the shape of the target. Thus two or more matrices 3 or arrays of nozzles may be arranged moveable relative to one another to "focus" on a small radius curve or other surface feature. This is a way to optimize the paint result, in particular when, for example, paint droplets being ejected at right angles to the surface gives better and more predictable results. In addition, such a "bending matrix" may be used to focus the paint beam or cloud to achieve higher intensity at the target when so required. For example when coating a convex shape in a surface or coating a surface containing a hole, passageway or recess.

[0036] Figure 3 is a schematic diagram for operating an array or nozzle matrix relative to a direction of movement. The figure shows a relative direction of travel T of a nozzle matrix 3 above a target (not shown). Nozzle matrix 3 is shown in four states. In each state, a group of nozzles 5 are actuated, switched on, and thus ejecting droplets of paint. The nozzles or groups of nozzles 5 switched on vary according to the direction of travel. In this way the amount of paint ejected may be controlled dependent the direction the applicator head is moved in, which may in turn be dependent on the shape etc of the surface to be coated. Thus:

- fine control may be exerted up to an edge of a surface so that spray beyond the edge of a panel or surface is avoided;
- the amount of paint ejected may be carefully controlled for specific parts of the target surface.

[0037] Figure 4 shows a flowchart for a method to operate the improved applicator head according to another aspect of the invention.

In the method, each of the separate nozzles singly or in groups may be activated to eject droplets at the same time or at different times. In a first step 12 a computer program calculates which of the nozzles shall be fired or switched on in the next firing pulse. Optionally a predetermined pattern or group of nozzles and or matrices may be selected instead or as well in part. In a subsequent and optional step 14' a length of time for which the selected nozzles shall remain switched on may be calculated or retrieved from a predetermined value, stored pattern or signal; or else the process may skip 14' and go direct from step 12 to step 16, and switch on the nozzles that were preselected at 12. At the required time, the nozzles are switched off 18. A sequence such as 12-14'-16-18 or 12-16-18 may be repeated over and over again, as indicated by Loop 19. In another embodiment the sequence may comprise in part steps 12-18 only and/or repeated loops thereof.

[0038] In another embodiment the nozzle matrix or array is arranged to cooperate with one or more with sensors, for example proximity sensors, that may detect if the inkjet applicator approaches a corner or edge of the target. Such sensor measurements may be used to assist the control system to turn off or otherwise control the paint matrix actuators of the paint applicator head(s). For example, if the applicator head is mounted on a robot arm or a manipulator arm the scheme of regulation of individual nozzles will be coordinated with the robot arm position/movement control.

[0039] It should be noted that while the above describes exemplifying embodiments of the invention, there are several variations and modifications which may be made to the disclosed solution without departing from the scope of the present invention as defined in the appended claims.

Claims

1. An applicator head (6) for applying paint to an object surface (S), said applicator comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with means (54) for producing a pressure pulse in the paint so causing a small quantity of paint to be ejected from the at least one outlet, **characterised in that** said applicator comprises a plurality (3) of nozzles (57) each arranged for ejection of small quantities of paint.
2. A device according to claim 1, **wherein** the plurality of nozzles for ejection of paint are arranged such that ejection of paint from any one nozzle of the plurality of nozzles may be separately controlled.
3. A device according to claim 1 or 2, **wherein** the means for producing a pressure pulse in the paint are arranged to produce a pressure such that a continuous flow of paint is ejected.
4. A device according to claim 1 or 2, **wherein** the means for producing a pressure pulse in the paint are arranged to produce pressure pulses such that a flow of paint droplets is ejected.
5. A device according to claim 2, **wherein** the ejection of paint from any one of the plurality of nozzles may be controlled separately by a signal received by the means (54) for producing a pressure pulse in the paint.
6. A device according to claim 1 or 3, **wherein** the ejection of paint from any one or more nozzle of the plurality of nozzles may be separately controlled to eject paint and coat a said object.
7. A device according to claim 1, **wherein** the applicator head and the object are moved (T) with respect to one another and ejection of paint from any one or more nozzles of the plurality of nozzles is controlled dependent on the relative movement such that a predefined layer is coated on said surface of the object.
8. A device according to claim 1, **wherein** small quantities of paint are ejected from any one or more of the plurality of nozzles with a frequency of ejection that is controlled dependent on any deviation of the object surface from a flat plane so that a predefined layer is coated on the surface of said object surface.
9. A device according to claim 8, **wherein** the number and/or relative position of nozzles operating and ejecting paint at any time is arranged controllable dependent on any deviation of the object surface from a flat plane so that a layer is coated on the surface of said object surface.
10. A device according to claim 7, **wherein** the ejection of paint from any one or more of the plurality of nozzles is controlled or switched on and off dependent on the position (5) of each of the any one or more nozzles relative the position of the remaining plurality of nozzles.
11. A device according to claim 1, **wherein** the applicator head comprises two or more separate arrays of nozzles (3a, 3b) arranged moveable relative one another to coat a predefined layer on a said object of which a part of said object may be not flat or not continuous.
12. A device according to claim 1, **wherein** the applicator head comprises two or more separate arrays of nozzles (3a, 3b) arranged mounted on a flexible or bend-

able part and moveable relative one another to focus two or more paint streams ejected from the two or more arrays and coat a layer on at least part of a said object.

13. A device according to claim 1 or 8 or 9, **wherein** a rate of travel of the applicator head over the object surface may be varied to coat a layer on at least part of said object surface (S).
14. A device according to any previous claim, **wherein** one or more nozzles of the applicator head comprises an actuation means which is any from the group of: an electro-resistive element, a piezoelectric element, a magnetostrictive element, other electro-mechanical transducer device.
15. A **method** for applying paint to an object surface with an applicator head comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with means for producing a pressure pulse in the paint so causing a small quantity of paint to be ejected from the at least one outlet, **characterised by** ejecting a small quantity of paint from any of a plurality (3) of nozzles (57) arranged comprised in said applicator head (6).
16. A method according to claim 15, including **wherein** a step of separately controlling the ejection of paint from any one nozzle of the plurality of nozzles for each nozzle.
17. A method according to claim 15, including **wherein** a step of separately controlling the ejection of paint from any one of the plurality of nozzles dependent on receiving a signal in the means for producing a pressure pulse in the paint.
18. A method according to claims 16-17, including **wherein** a step of separately controlling the ejection of paint from any one or more nozzle of the plurality of nozzles to paint and coat a layer on a surface of an object.
19. A method according to claim 15, including **wherein** a step of moving the applicator head and the object with respect to one another and by ejecting paint from any one or more nozzles of the plurality of nozzles is controlled dependent on the relative movement.
20. A method according to claim 15, **wherein** phasing the one or more nozzles of the plurality of nozzles are controlled or switched on or off dependent on a direction of travel (T) of the applicator head over the surface of the object.
21. A method according to claim 20, including **wherein**

a step of separately controlling the ejection of small quantities of paint from any one or more of the plurality of nozzles controlled a frequency of ejection or by switching ejection on or off dependent on a deviation of the object surface from a flat plane, so that a predefined layer is coated on the surface of the object regardless of any deviation in the surface from a flat plane.

22. A method according to claim 20 or 21, including **wherein** a step of phasing the one or more nozzles of the plurality of nozzles dependent on a direction of travel (T) of the applicator head is carried out on each separate nozzle by means of any from the group of: on-off switching, amplitude regulation, frequency regulation.
23. A method according to claim 21, including **wherein** a step of controlling or switching ejection on or off of paint from any one or more of the plurality of nozzles dependent on the position of each of the any one or more nozzles relative the position of the remaining plurality of nozzles.
24. A method according to any of claims 15-23, including **wherein** a step of separately controlling or switching ejection on or off for any one or more of the plurality of nozzles is determined dependent in part on a measurement by a proximity sensor of a distance between said applicator head and said object.
25. A computer program for controlling a method for applying paint to an object surface with an applicator head comprising a plurality of nozzles, said computer program comprising computer code means and/or software code portions for making a computer or processor perform the method according to any of claims 15-24.
26. A computer program product comprising the computer program according to claim 25 comprised in one or more computer readable media.
27. A system for applying paint to an object surface, comprising an apparatus with at least one applicator head, said applicator head comprising at least one fluid supply channel and at least one outlet for paint, the at least one outlet being arranged with means for producing a pressure pulse in the paint so causing a small quantity of paint to be ejected from the at least one outlet, **characterised in that** the at least one said applicator head (6) comprises a plurality (3) of nozzles (57) each arranged for ejection of small quantities of paint.
28. A system according to claim 27, **wherein** said apparatus comprising said least one applicator head (6) is arranged for movement in one or two degrees

of freedom.

29. A system according to claim 27, **wherein** said apparatus comprising said least one applicator head (6) is arranged for movement in at least two degrees of freedom. 5
30. A system according to claim 27, **wherein** said apparatus comprising said least one applicator head is arranged mounted on a robot or manipulator arm arranged with 5 or more degrees of freedom. 10
31. A system according to claim 27, **wherein** program means for controlling the ejection of paint dependent on the relative movement of an object to be coated such that a predefined layer is coated on the surface of the object. 15
32. A system according to claim 27, **wherein** program means for controlling the ejection of paint from any one or more of the plurality of nozzles dependent on paint ejection switching on or off and/or by controlling a frequency of ejection of paint. 20
33. A system according to claim 27, **wherein** program means for controlling the ejection of paint dependent on a position of each any one or more nozzles relative the position of the remaining plurality of nozzles. 25
34. A system according to claim 27, **wherein** by comprising one or more proximity sensors arranged to measure a distance between the at least one applicator head and said object surface. 30
35. A system according to claim 27, **wherein** one or more nozzles of the applicator head comprises an actuation means (54) which is any from the group of: an electro-resistive element, a piezoelectric element, a magnetostrictive element, other electro-mechanical transducer device. 35
40
36. A system according to any of claims 27-34, **wherein** the ejection of small quantities of paint from any one or more of the plurality of nozzles of the at least one applicator head is arranged controllable dependent in part on a measurement by a proximity sensor of a distance between said applicator head and said object. 45
37. Use of an applicator head for applying paint to an object surface, said applicator head comprising a plurality of nozzles and according to any of claims 1-14 to apply a paint or another coating to automobile bodies, automobile parts, vehicle parts, white goods and the like. 50
55
38. Use of a system for applying paint to an object surface, said system comprising an apparatus with at

least one applicator head comprising a plurality of nozzles and according to any of claims 27-36 for applying a coating of paint, water-based paint, solvent based paint, primer, base coat, clear coat, for electrostatic coating, anti-corrosion treatment material, wax, sealant, glue and the like.

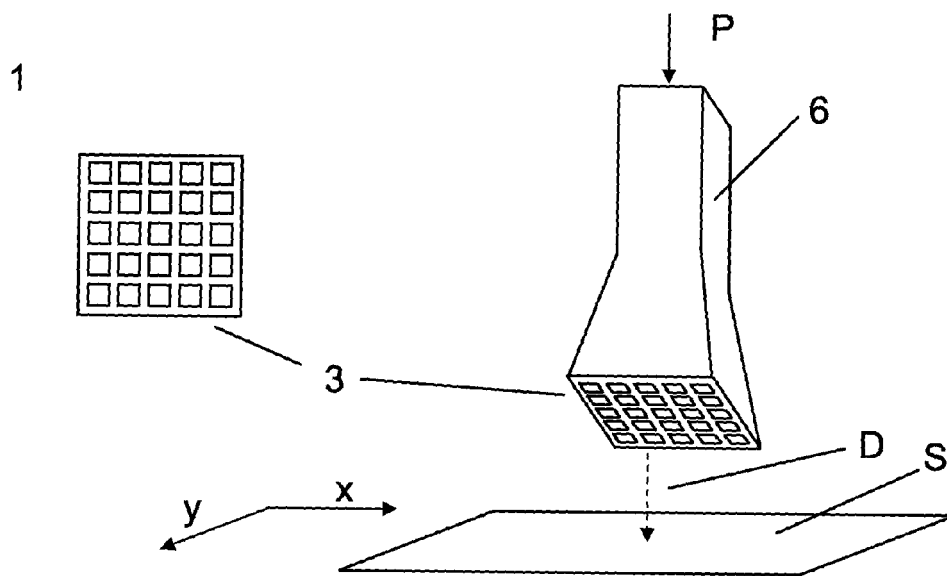


Fig. 1

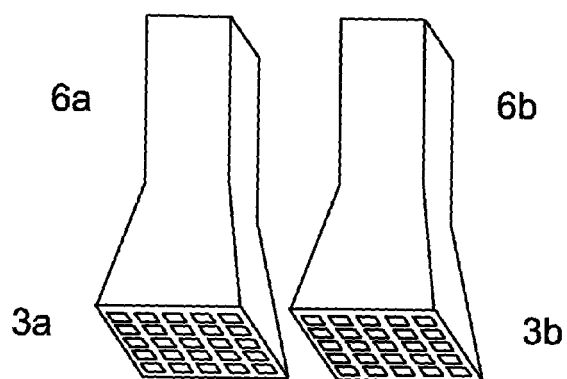


Fig. 2a

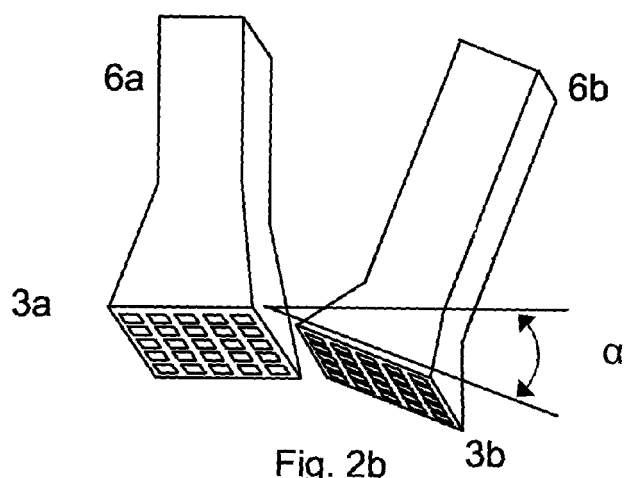


Fig. 2b

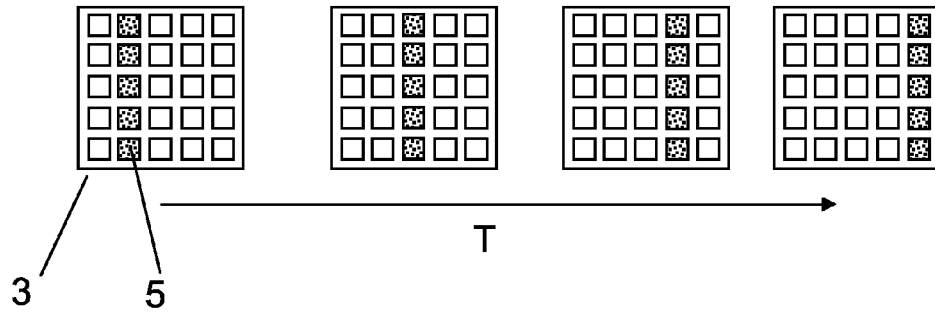


Fig. 3

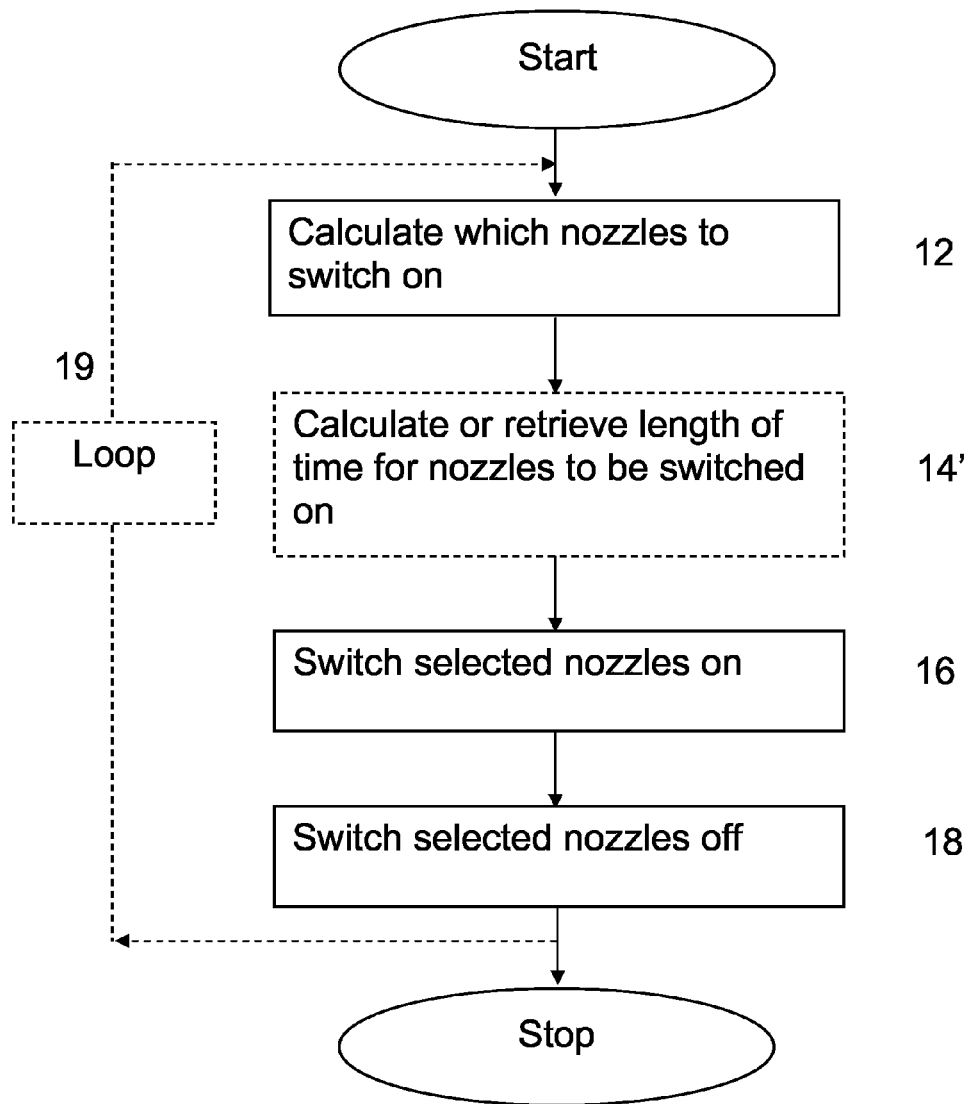


Fig. 4

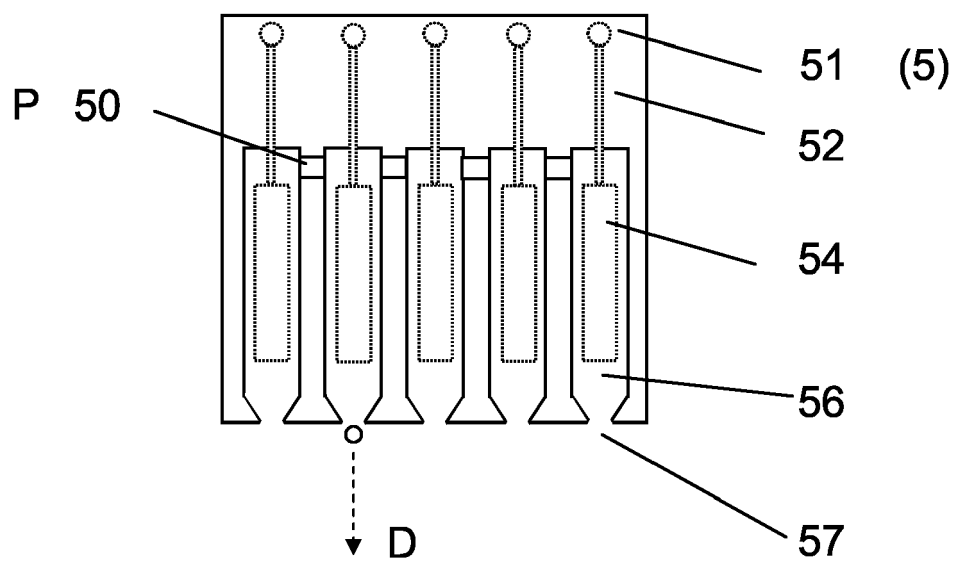


Fig. 5



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 11 8074

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 32 50 105 C2 (CANON KK [JP]) 22 February 2001 (2001-02-22)	1,2,4-6, 14-18, 25-27, 32,33, 35,38	INV. B41J3/407 B05B13/04
Y	* column 2, line 25 - column 6, line 12; figures 1-4 *	7,10-13, 19,20, 22,24, 28,29, 31,34, 36,37	
X	----- DE 83 02 134 U1 (DOMINO PRINTING SCIENCES PLC, CAMBRIDGE, GB) 27 August 1987 (1987-08-27) * the whole document *	1-3,5,6, 14-18, 25-27, 32,33, 35,38	
X	----- DE 200 23 641 U1 (BAUER JOERG R [DE]) 19 May 2005 (2005-05-19) * paragraph [0010] - paragraph [0042] * * paragraph [0052] - paragraph [0053]; figures 1-5 *	1,2,4-7, 10-20, 22, 24-29, 31-36,38	TECHNICAL FIELDS SEARCHED (IPC) B41J B05B
X	----- US 2006/044376 A1 (BAIRD RICHARD W [US] ET AL) 2 March 2006 (2006-03-02) * paragraph [0003] * * paragraph [0008] - paragraph [0028]; figures 2-6 * ----- -/--	1,2,4,6, 7,10,13, 15,16, 18-20, 22, 24-34, 36-38	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 January 2007	Examiner Rente, Tanja
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

4

EPO FORM 1503 03 82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 11 8074

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 970 811 B1 (LAC CORP [JP]) 21 September 2005 (2005-09-21) * paragraph [0001] - paragraph [0003] * * paragraph [0036] - paragraph [0053]; figures 1-11 *	1-3,6,7, 10-13, 15,16, 18-20, 22, 25-29, 31-34, 36-38	
Y	US 2002/024544 A1 (CODOS RICHARD N [US]) 28 February 2002 (2002-02-28) * paragraph [0006] - paragraph [0010] * * paragraph [0013] * * paragraph [0036] - paragraph [0043]; figures 1A,3 *	7,10-13, 19,20, 22,24, 28,29, 31,34, 36,37	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
Place of search Munich		Date of completion of the search 9 January 2007	Examiner Rente, Tanja
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

4

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 06 11 8074

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-01-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3250105	C2	22-02-2001	NONE
DE 8302134	U1	27-08-1987	NONE
DE 20023641	U1	19-05-2005	NONE
US 2006044376	A1	02-03-2006	WO 2006026240 A1 09-03-2006
EP 0970811	B1	21-09-2005	CN 1242262 A 26-01-2000 EP 0970811 A1 12-01-2000 US 6096132 A 01-08-2000
US 2002024544	A1	28-02-2002	NONE

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5664341 A [0006] [0022]
- US 6499837 B [0006] [0022]
- US 4646110 A [0006] [0022]
- US 4937678 A [0007]