



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.05.2020 Bulletin 2020/21

(51) Int Cl.:
B41J 2/165 (2006.01)

(21) Application number: **18206777.7**

(22) Date of filing: **16.11.2018**

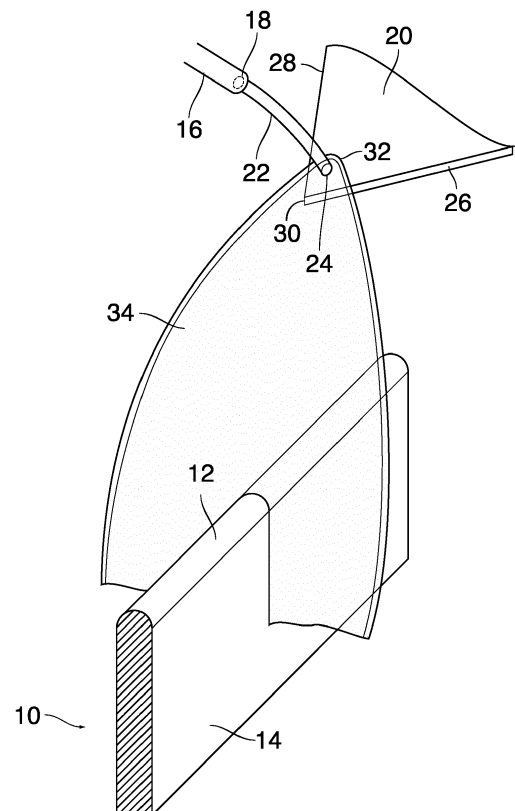
(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **METHOD OF CLEANING OF SURFACE OF AN OBJECT**

(57) A method of cleaning a surface (12) of an object (10) by directing a fan-shaped jet (34) of a cleaning liquid onto the surface characterized in the fan-shaped jet (34) is created by directing a laminar jet (22) of the cleaning liquid onto a deflector plate (20) such that the liquid impinges on a surface of the deflector plate at a target point (24) to an edge (26, 28) of the plate and the liquid on the surface of the deflector plate forms a coherent liquid curtain that splashes over the edge (26, 28) of the plate and forms the fan-shaped jet (34).

Fig. 1



Description

[0001] The invention relates to a method of cleaning a surface of an object by directing a fan-shaped jet of a cleaning liquid onto the surface.

[0002] More particularly, the invention relates to a method of cleaning a surface of a component, such as a nozzle plate wiper or a nozzle plate, of an ink jet printing system, in particular to remove dried ink from the surface of the component.

[0003] It is well known that a surface of an object can be cleaned by spraying a cleaning liquid onto the surface in the form of a jet that is shaped like a fan and therefore has a relatively large extension in one direction and can be swiped over the surface to be cleaned. Conventionally, a nozzle with a slot-shaped nozzle opening is used for creating the fan-like jet.

[0004] In order to achieve a high cleaning efficiency, the liquid impinging on the surface to be cleaned should have a relatively large momentum, which means that the liquid must be jetted out from the nozzle with considerable speed. The high speed of the liquid also assures that the jet continues to spread-out like a fan even with increasing distance from the nozzle.

[0005] On the other hand, the cross-section of the nozzle should not be too small, in order for the liquid to form an essentially coherent liquid curtain rather than being atomized right after exiting from the nozzle. The high speed of the liquid in conjunction with the large cross-section of the nozzle leads to a considerable consumption of cleaning liquid. Even if the cleaning liquid may be regenerated and recirculated, a substantial effort is required for collecting the used cleaning liquid, filtering it and recirculating it to the nozzle.

[0006] Another drawback of the conventional cleaning method is that the cleaning liquid impinging on the surface to be cleaned with high velocity will repel from the surface and form a mist that may contaminate other components in the surroundings.

[0007] It is therefore an object of the invention to provide a cleaning method that permits to reduce the consumption of cleaning liquid.

[0008] In order to achieve this object, in the method according to the invention, the fan-shaped jet is created by directing a laminar jet of the cleaning liquid onto a deflector plate such that the liquid impinges on a surface of the deflector plate a target point close to an edge of the plate and the liquid on the surface of the deflector plate forms a coherent liquid curtain that splashes over the edge of the plate and forms the fan-shaped jet.

[0009] The laminar jet directed onto the deflector plate may be formed by means of a nozzle which has an essentially circular cross-section and, consequently, a relatively small cross-sectional area. In order to obtain the fan-shape of the liquid jet, the laminar flow of the liquid is deflected at the deflector plate and caused to splash over the edge of the deflector plate. Cohesive forces help to shape the liquid film on the surface of the deflector

plate and to prevent the fan-shaped liquid curtain that splashes over the edge of the plate from disintegrating too early. Then, the surface of the object to be cleaned may be positioned so as to be hit by the liquid curtain fanning out from the deflector plate.

[0010] More specific optional features of the invention are indicated in the dependent claims.

[0011] The jets of cleaning liquid upstream and downstream of the deflector plate have a velocity component in downward direction, so that forces of gravity may be utilized for accelerating the liquid and increasing the momentum with which the liquid impinges on the surface to be cleaned. Preferably, however, the distance over which the liquid is accelerated does not exceed the limit at which the jet disintegrates into separate droplets or the flow becomes turbulent. This also reduces the tendency of the liquid to repel from the surface to be cleaned and to form a mist.

[0012] This preferred that the surface of the deflector plate is smooth and has a surface roughness comparable to that of a glass plate, a silicon wafer or polished metal. The surface may be wetting or non-wetting and may be curved or flat.

[0013] The edge of the deflector plate over which the liquid curtains splashes may be straight or curved. In one embodiment, the deflector plate has two edges meeting in a corner at an angle between, e.g. 45° and 135°. In that case, the target point where the cleaning liquid impinges on the deflector plate will be close to the corner. Then, the angle at which the two edges meet and the distance between the corner and the target point are parameters that may be utilized to shape the liquid curtain as desired.

[0014] In general, the liquid curtain that constitutes the jet downstream of the deflector plate will initially increase in width with increasing distance from the edge of the deflector plate, but then cohesive forces will start to contract the fan again, so that its width will decrease. The distance between the edge of the deflector plate and the surface to be cleaned may be selected such that the fan-shaped jet has the largest width at the position where it hits the surface to be cleaned. Optionally, the object to be cleaned may be positioned at a smaller distance from the edge of the deflector plate, i.e. in a portion of the fan where the liquid is diverging. When the object to be cleaned is a blade-shaped object, for example, it may on the other hand be desired to place the object at a larger distance from the edge of the deflector in a region where the flow of liquid is converging again, so that the liquid may impinge on the sides of the blade-shaped object from opposite sides.

[0015] Embodiment examples will now be described in conjunction with the drawings, wherein:

Fig. 1 is a perspective view of an arrangement for cleaning a blade-shaped object;

Fig. 2 is a side view of the arrangement shown in Fig.

1; and

Fig. 3 shows a modified arrangement in a top view.

[0016] In Fig. 1, an object 10 to be cleaned is a wiper used for wiping a nozzle face of a printhead in an ink jet printer. The wiper may be made of rubber and has a rounded edge surface 12 and flat side surfaces 14. When the nozzle face of the printhead is to be cleaned, the edge surface 12 of the wiper is brought into engagement with the nozzle face and the wiper is moved over the nozzle face in a direction transverse to the longitudinal direction of the blade, so that dried ink and other contaminants that may have been deposited on the nozzle face will adhere to the edge surface 12 and will thereby be removed from the nozzle face.

[0017] The arrangement shown in Fig. 1 is used for cleaning the object 10, in particular for cleaning the edge surface 12 of the wiper blade from time to time. To that end, a nozzle 16 having a round nozzle orifice 18 is disposed above a deflector plate 20, and a jet 22 of cleaning liquid (e.g. water or a solvent) is jetted out from the nozzle 16 so as to impinge on a flat top surface of the deflector plate 20 at a target point 24.

[0018] The nozzle orifice 18 may have a diameter of 1 mm or less, and the liquid is supplied to the nozzle 16 with moderate pressure, so that the flow of the liquid in the jet 22 is laminar. The flow rate of the liquid may be in the order of magnitude of 0.1 to 2 ml/s, preferably 0.2 - 0.5 ml/s.

[0019] The deflector plate 20 may for example be a glass plate and has a smooth and flat top surface delimited by two straight sharp edges 26, 28 which meet at a certain angle at a corner 30 of the deflector plate. The position of the target point 24 is close to the corner 30 and has equal distances from the two edges 26 and 28. The deflector plate 20 is held in an inclined position sloping downwards from the target point 24 towards the corner 30.

[0020] The liquid in the jet 22 is somewhat accelerated by gravity on its way to the target point 24, and when it impinges on the surface of the deflector plate, it can spread evenly in all directions, thus creating a divergent liquid film on the surface of the deflector plate. In the inward direction of the deflector plate 20, the liquid in the liquid film has to flow uphill and therefore ends in a hydraulic jump 32 already after a short distance. In the directions essentially in parallel with the edges 26 and 28, the hydraulic jump is farther away from the target point 24. In the directions towards the edges 26, 28 and towards the corner 30, the liquid in the liquid film flows downhill and then splashes over the sharp edges 26, 28 to form a jet 34 in the form of a fan-shaped coherent liquid curtain in which the liquid flows further downwards under the action of gravity until part of the liquid impinges on the edge surface 12 of the object 10 to be cleaned.

[0021] In the liquid film on the deflector plate 20, the liquid flowing towards the edge 26 on the one hand and

the liquid flowing towards the edge 28 on the other hand have different directions, so that the fan-shaped jet 34 tends to spread further with increasing distance from the deflector plate. However, cohesive forces in the liquid limit the spread of the jet 34 and eventually cause the flows of liquid at the opposite edges of the fan to converge again.

[0022] In the example shown, the object 10 is arranged such that its edge surface 12 to be cleaned is positioned in a height where the fan-shaped jet 34 has approximately its largest width, which may for example be in the order of magnitude of 10 mm. Thus, it is assured that the surface 12 to be cleaned is safely hit by the jet 34. Further, the side faces 14 of the object 10 may be cleaned by the convergent flows of the liquid on either side of the jet 34.

[0023] The vertical distance between the corner 30 of the deflector plate 20 and the top edge of the object 10 may be in the order of magnitude of 20 mm. Thus, the liquid in the jet 34 that impinges on the edge surface 12 will gather momentum due to gravitational forces before it hits the object 10. In this way, any contaminants such as dried ink on the edge surface 12 may be removed efficiently.

[0024] Fig. 2 shows the same arrangement as Fig. 1, but in a side view, so that the inclined arrangement of the nozzle 16 and the deflector plate 20 are visible more clearly. In this example, the flat surface of the deflector plate 20 is inclined at an angle of 45°. As a consequence, the jet 34 is shaped like a parabola in the side view according to Fig. 2. By varying the height of the object 10 relative to the deflector plate 20 and/or varying the inclination of the deflector plate 20, the angle at which the jet 34 impinges on the top edge of the object 10 may be adjusted so as to achieve an optimal cleaning effect.

[0025] Moreover, the position of the target point 24 on a line that bisects the angle between the edges 26 and 28 of the deflector plate may be varied in order to control the spread of the jet 34. The distance between the target point 24 and the corner 30 should however not be made too large in order to avoid that the velocity of the liquid is reduced by friction.

[0026] In Fig. 3, a modified arrangement is shown in a top view. In this embodiment, the nozzle (not shown in Fig. 3) and the deflector plate 20 are rotated relative to the object 10 about a vertical axis, so that the liquid curtain formed by the jet 34 is inclined relative to the longitudinal direction of the object 10. This increases the portion of the liquid that hits the top edge surface 12 of the object to be cleaned.

[0027] It is clear that, in general, other arrangements of the nozzle and the deflector plate are possible as well, depending upon the nature and shape of the object to be cleaned. Moreover, the object to be cleaned does not have to be a blade-shaped object but might for example be the nozzle face of the printhead or any other component of the printer that tends to be contaminated with ink or other contaminants. In that case, the surface to be cleaned may for example be oriented in a vertical plane,

and the liquid in the jet 34 may have a larger horizontal velocity component so as to hit the surface to be cleaned under a suitable angle.

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Claims

1. A method of cleaning a surface (12) of an object (10) by directing a fan-shaped jet (34) of a cleaning liquid onto the surface **characterized in** the fan-shaped jet (34) is created by directing a laminar jet (22) of the cleaning liquid onto a deflector plate (20) such that the liquid impinges on a surface of the deflector plate at a target point (24) to an edge (26, 28) of the plate and the liquid on the surface of the deflector plate forms a coherent liquid curtain that splashes over the edge (26, 28) of the plate and forms the fan-shaped jet (34). 10 15
2. The method according to claim 1, wherein the laminar jet (20) has a velocity component in downward direction. 20
3. The method according to claim 1 or 2, wherein the fan-shaped jet (34) has a velocity component in downward direction at a point where it hits the object (10) to be cleaned. 25
4. The method according to claim 3, wherein the deflector plate (20) is inclined to slope downwards from the target point (24) towards the edge (26, 28). 30
5. The method according to any of the preceding claims, wherein the surface of the deflector plate (20) is smooth and has a surface roughness comparable to that of a glass plate. 35
6. The method according to any of the preceding claims, wherein the surface of the deflector plate (20) is non-wetting. 40
7. The method according to any of the preceding claims, wherein the surface of the deflector plate (20) flat. 45
8. The method according to any of the preceding claims, wherein the edge (26, 28) of the deflector plate over which the liquid curtain splashes is straight. 50
9. The method according to any of the preceding claims, wherein the deflector plate (20) has two edges (26, 28) over which the liquid curtain splashes, said edges meeting in a corner (30). 55

Fig. 1

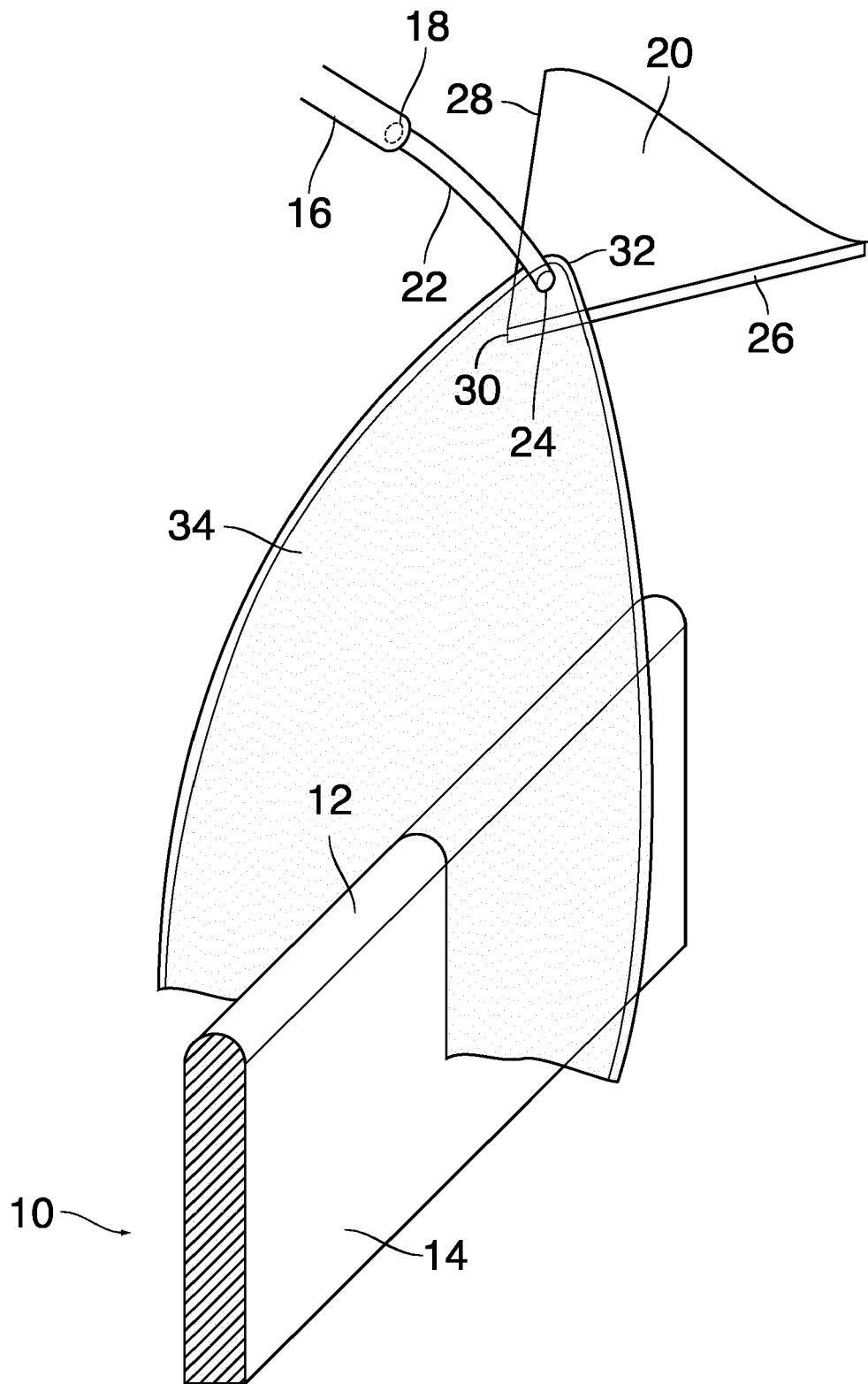


Fig. 2

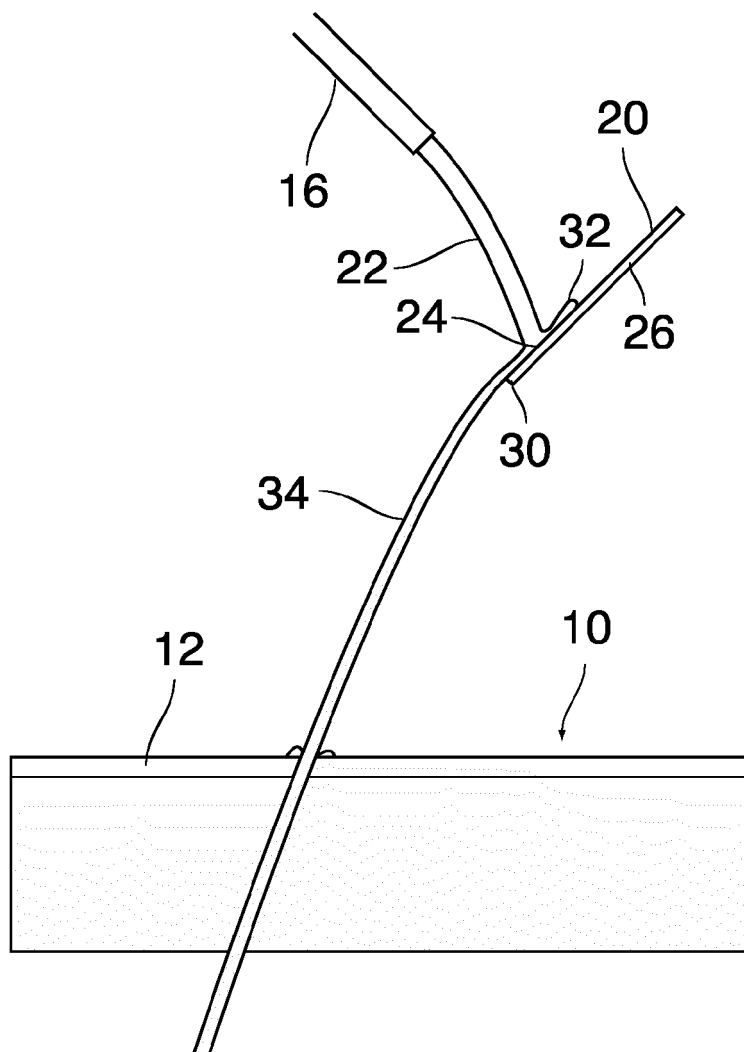
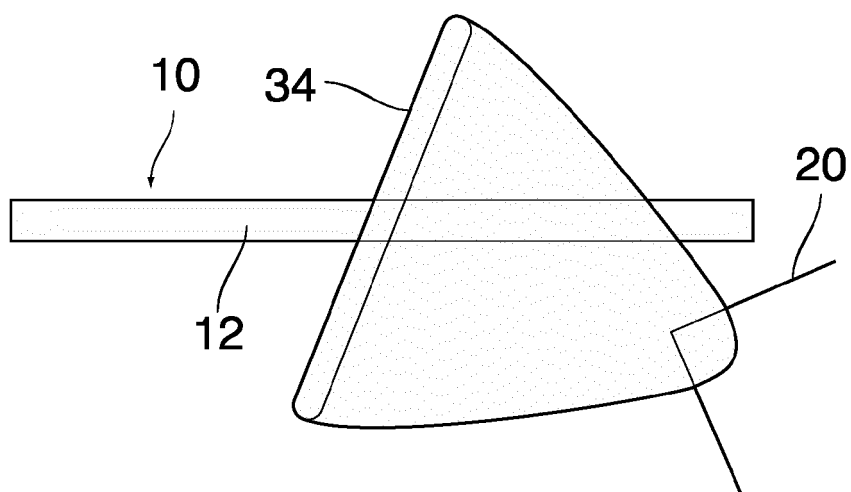


Fig. 3





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Application Number
EP 18 20 6777

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 14 May 2019	Examiner João, César
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			

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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