(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 491 346 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.12.2004 Bulletin 2004/53

(51) Int Cl.[7]: **B41J 11/06**, B41J 11/00, B41J 11/20, B41J 25/308

(21) Application number: **04076721.2**

(22) Date of filing: **14.06.2004**

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

(30) Priority: **27.06.2003 EP 03077004**

(71) Applicant: **Océ-Technologies B.V.**
5914 CC Venlo (NL)

(72) Inventors:
- **Stoot, Andreas C.**
  5913 GN Venlo (NL)
- **De Grijs, Eduard T.H.**
  5914 SM Venlo (NL)

(74) Representative:
Rongen, Josephus Wilhelmus et al
Océ-Technologies B.V.,
Corporate Patents,
P.O. Box 101
5900 MA Venlo (NL)

(54) Apparatus and method for applying an ink image to a receiving material

(57) Apparatus for applying an ink image to a receiving material (3) adapted to be advanced in a direction of advance, comprising:

ink application means (6) for applying an ink image to a strip of receiving material, which strip extends in a direction transverse to the direction of advance of the receiving material, wherein the ink application means are movable over the strip of receiving material,

carrier means for keeping said strip in a predetermined position with respect to the ink application means, which carrier means comprise a carrier plate (5) for carrying said strip, said carrier plate having recesses and said carrier plate being provided with holes,

vacuum means for sucking away air via said holes from the space between the carrier plate and a strip of receiving material lying on the carrier plate, and

correction means for correcting local variations in the distance between the receiving material and the ink application means.

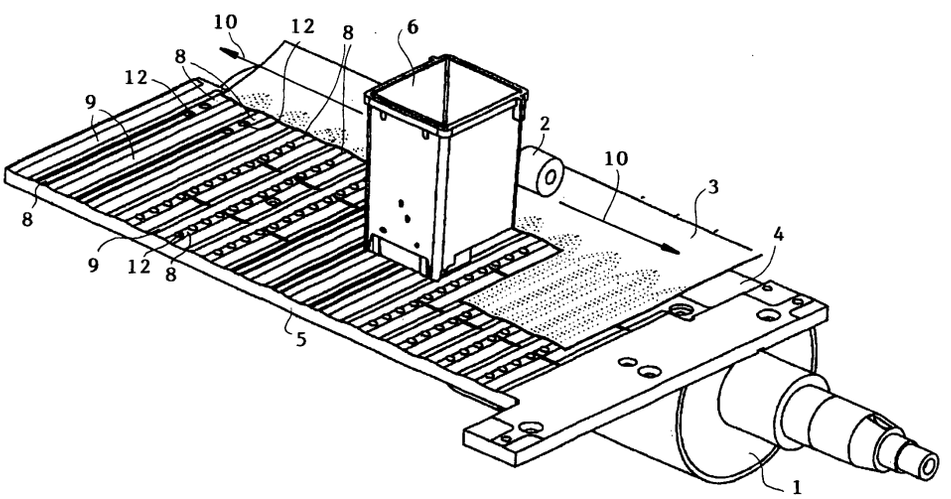

FIG.1

EP 1 491 346 A2

Description

[0001] The invention relates to an apparatus for applying an ink image to a receiving material. In particular the invention relates to copiers or printers, more particular to photocopiers or inkjet printers, wherein the receiving material is retained against a carrier plate. The invention further relates to a method for applying an ink image to a receiving material.

[0002] An apparatus for keeping a receiving material flat against a carrier plate during the application of an ink image thereto is generally known. The carrier plate is, for example, provided with V-shaped channels, which extend in the direction in which the receiving material is movable stepwise over the carrier plate. Ribs which separate the channels from one another are provided with suction openings in order to draw bubbles, which are formed by moisture absorption in the receiving material, into the channels by vacuum pressure, in order to prevent said bubbles from coming into contact there with ink application means which are flatly movable over the carrier plate.

[0003] The receiving material is pulled against the carrier plate with considerable force so that it is possible to ensure with a great degree of certainty that parts of the receiving material, particularly bubbles projecting in the direction of the ink application means, remain out of contact with the ink application means.

[0004] A disadvantage of the known apparatus is that the ink images on some receiving materials are distorted due to, for example, locally occurring line broadening and density variations in area-fills.

[0005] An object of the invention is to improve on this.

[0006] A further object of the invention is to provide an apparatus having an improved control over the process of the application of an ink image onto the receiving material in order to, at least, reduce the distortions mentioned above.

[0007] From one aspect, the invention provides an apparatus for applying an ink image to a receiving material adapted to be advanced in a direction of advance, comprising:

ink application means for applying an ink image to a strip of receiving material, which strip extends in a direction transverse to the direction of advance of the receiving material, wherein the ink application means are movable over the strip of receiving material,

carrier means for keeping said strip in a predetermined position with respect to the ink application means, which carrier means comprise a carrier plate for carrying said strip, said carrier plate having recesses and said carrier plate being provided with holes,

vacuum means for sucking away air via said holes from the space between the carrier plate and a strip of receiving material lying on the carrier plate, and

correction means for correcting local variations in the distance between the receiving material and the ink application means.

[0008] Some receiving materials, particularly slack or compliant receiving materials, are pulled into the recesses to some extent due to the vacuum pressure. On the one hand this is favourable since it reduces the extent to which bubbles project in the direction of the ink application means. On the other hand the sagging of the receiving material into the recesses may result in positioning errors in the ink image.

[0009] For example, if a line of equidistant dots is to be printed onto the receiving material, the ink image of these dots is distorted when the line crosses a part of the receiving material that has sagged into a recess. In the direction of movement of the ink application means, the distance between the dots on the receiving material will increase when the ink application means move over a downward slope of the sagged receiving material. This distance will decrease when the ink application means move over an upward slope of the sagged receiving material. Since this distortion of the ink image is repeated in each strip of receiving material, these distortions add up to form a pattern in the direction of advance of the receiving material.

[0010] Moreover, the carrier plate can be provided with a series of regularly spaced recesses or channels as known in the art. As a consequence of this, the above-mentioned distortions appear around the position of each recess, so that these distortions add up to form a longitudinal wave pattern in a direction perpendicular to the direction of advance of the receiving material.

[0011] Providing the apparatus for applying an ink image to a receiving material with correction means for, at least partially, correcting local variations in the distance between the receiving material and the ink application means, may result in a substantial improvement of the ink image due to the reduction of the misalignment of the ink dots which make up the ink image.

[0012] In a first embodiment, the correction means comprise timing means for adjusting the moment of ink release by the ink application means. Local distance variations cause variations in flight time of the ink droplets from the ink application means to the receiving material. Said variations in flight time of the ink droplets can be compensated by adjusting the moment of ink release. For example, when the receiving material has sagged into a recess, the distance between the receiving material and the ink application means is locally enlarged and the flight time of the ink droplet will increase. Advancing the moment of ink release by the ink application means can compensate this increased flight time and can correct the misalignment of the position of the ink droplet due to the sagging of the receiving material into the recess.

[0013] In a further development, the timing means are

arranged for advancing the moment of ink release when the ink application means is near a downward slope of a recess, and for delaying the moment of ink release when the ink application means is near an upward slope of a recess. Preferably the advance and delay are defined by an undulatory electronic signal, wherein the leading and tailing edges of the undulatory signal correspond to the downward and upward slopes of the recesses, respectively. The differences in flight time can thus be corrected using a simple electronic correction of the signal that controls the moment of ink release by the ink application means.

[0014] In a further development, the application means are arranged for moving with uniform velocity over the carrier plate. In this case, and in combination with regularly spaced recesses on the carrier plate, the undulatory electronic signal is also regular, and a simple regular electronic wave signal can be used.

[0015] In a second embodiment, the correction means comprise speed adjustment means for adjusting a relative velocity between the ink application means and the carrier plate. In a further development, the speed adjustment means are arranged for reducing the relative velocity when the ink application means is near a downward slope of a recess, and for increasing the relative velocity when the ink application means is near an upward slope of a recess. Due to this variation in relative velocity between the ink application means and the carrier plate, the trajectories of the ink droplets can be adjusted to compensate for said local distance variations between the ink application means and the receiving material.

[0016] This adjustment of the relative velocity between the ink application means and the carrier plate, can be carried out with the speed adjustment means which comprise translation means for moving the carrier plate in the direction substantially parallel to the direction of the strip of receiving material. In a further development, the translation means are arranged for a reciprocating movement of the carrier plate. Such a translation means for moving the carrier plate has the advantage that no changes have to be made to the ink application means, and that the known ink application means can be used in the apparatus of the invention.

[0017] Alternatively, the speed adjustment means comprise means for adjusting the velocity of the ink application means. This adjustment of the velocity of the application means may be defined by an undulatory electronic signal, wherein the leading and tailing edges of the undulatory signal correspond to the downward and upward slopes of the recesses, respectively. The variation of the velocity can thus be achieved by a simple electronic correction of a signal for controlling the velocity of the ink application means.

[0018] The above-mentioned means for adjusting the velocity of the ink application means and the translation means for moving the carrier plate in the direction substantially parallel to the direction of the strip of receiving material, can also be combined. In this case the required adjustment of the relative velocity between the ink application means and the carrier plate can be divided between said means for adjusting the velocity of the ink application means and said translation means. In this way the amount of adjustment of each of these means can be reduced. In particular, the velocity of the translation means for moving the carrier plate can be reduced.

[0019] A further advantage of the above mentioned first and second embodiments is that the distance between the carrier plate and the ink application means is not affected by the correction means. Thus the risk that the receiving material may come into contact with the ink application means is as low as in the prior art.

[0020] In a third embodiment the correction means comprise adjustment means for locally adjusting the distance between the ink application means and the carrier plate. In a further development, this adjustment results in essentially a constant distance between the ink application means and the receiving material. This adjustment of the distance may also be defined by an undulatory electronic signal where the leading and tailing edges of the undulatory signal correspond with downward and upward slopes of the recesses.

[0021] In a further development, the adjustment means comprise first movement means for moving the carrier plate in a direction for adjusting a distance between the ink application means and the carrier plate. The adjustment means may also, or in addition, comprise second movement means for moving the ink application means in a direction for adjusting the distance between the ink application means and the carrier plate. In an apparatus comprising first and second movement means, the extent of adjustment can be divided between these two movement means, thereby reducing the required amount of adjustment of each of these movement means.

[0022] In a preferred embodiment the apparatus further comprises controlling means for controlling the correction means depending on of at least one of the following characteristics selected from the group comprising: receiving material characteristics, ink characteristics, ink image characteristics, print mode, carrier plate characteristics, distance between the ink application means and the carrier plate, and the velocity of the ink application means with respect to the carrier plate. Using at least one of these characteristics, the extent to which the receiving material is pulled into the recesses, can be estimated, derived or determined. Subsequently, the controlling means control the correction means for correcting this estimated extent of sagging of the receiving material into the recesses. The use of such a controlling means results in a very flexible apparatus, which can easily adapt to various conditions such as, for example, various different types of receiving materials.

[0023] In a further development, the controlling means comprise input means for inputting said charac-

teristics. One or more of said characteristics or values defining the state of said characteristics may be inputted or modified via said input means when changing, for example, from one type of receiving material to an other type of receiving material or from one type of printing ink to an other type of printing ink. Said values may be numerical values, but may also comprise other characters, such as alphanumeric characters.

[0024] The receiving material characteristics may comprise at least one of the characteristics selected from the group comprising: the grade, the type, the thickness, the moisture content, the weight or substance per unit area, and the sizing.

[0025] The ink characteristics may comprise at least one of the characteristics selected from the group comprising: the viscosity, the water or solvent content of the ink, and the wetting characteristics of the ink.

[0026] The ink image characteristics may comprise at least one of the characteristics selected from the group comprising: area fraction covered by ink, pixel density.

[0027] The print mode may comprise at least one of the following selected from the group comprising: last mode, normal mode, and best mode. In the last mode, the ink image is printed in one single move of the ink application means over the strip of receiving material. Whereas in the normal mode, the ink image is printed in a reciprocating movement of the ink application means over the strip of receiving material. In the best mode, the ink image is printed in more than one forward motion or reciprocating motion.

[0028] The carrier plate characteristics may comprise at least one of the characteristics selected from the group comprising: configuration of the recesses, profile of the recesses and magnitude of the vacuum pressure generated by the vacuum means.

[0029] In a further development, the apparatus comprises detection means for detecting the positions of the recesses with respect to a path of the ink application means. The information about the relative position of the recesses with respect to the path of the application means can then be transferred to the controlling means. This information can be used for controlling the correction means as described above. Said detection means can be used for calibration or recalibration of the correction means and may for example be used in a start-up phase of the apparatus according to the invention for detecting the relative positions of the recesses with respect to the actual path of the ink application means.

[0030] From a second aspect, the invention provides a method for applying an ink image to a receiving material using an apparatus adapted to advance the receiving material in a direction of advance, wherein the method comprises the steps of:

placing a strip of receiving material on a carrier means in a predetermined position with respect to an ink application means, which carrier means comprise a carrier plate for carrying said strip, said carrier plate having recesses extending in the direction substantially parallel to the direction of advance of the receiving material, and said carrier plate being provided with holes,

keeping the strip of receiving material on the carrier means by sucking away air via said holes from the space between the carrier plate and the strip of receiving material lying on the carrier plate using the vacuum means,

applying an ink image to the strip of receiving material using the ink application means, which strip extends in the direction transverse to the direction of advance of the receiving material, and

correcting local variations in the distance between the receiving material and the ink application means using correction means during the movement of the application means over the strip of receiving material.

[0031] Said correction can be performed by adjusting the moment of ink release by the ink application means, using timing means as described above.

[0032] In addition or alternatively said local variations can also be corrected by adjusting the relative velocity with which the ink application means is moved over the carrier plate for applying the ink image to the strip of receiving material.

[0033] Furthermore, adjusting the distance between the ink application means and the carrier plate can correct said local variations.

[0034] In a further development, the local variations in the distance between the receiving material and the ink application means are estimated or determined using at least one of the characteristics selected from the group comprising: ink characteristics, receiving material characteristics, ink image characteristics, print mode, carrier plate characteristics, distance between the ink application means and the carrier plate, and the velocity of the ink application means with respect to the carrier plate. Such characteristics may be inputted into a controlling means for controlling the correction means.

[0035] The invention will be elucidated on the basis of exemplary embodiments shown in the attached drawings, in which:

Figure 1 is a top view of a detail of an apparatus according to the prior art;

Figure 2 is a cross-sectional view of a detail of the carrier means;

Figures 3A, 3B and 3C are schematic representations of exemplary embodiments according to the invention;

Figure 4 is a schematic view of an electronic signal for controlling the correction means; and

Figure 5 is a diagram of the controlling means for controlling the correction means of the invention.

[0036] The apparatus as shown in figure 1 comprises

a transport roller 1 with a transport nip 2 in a feed path for feeding a receiving material 3 originating from a stock (not shown). Roller system 1 is formed by a drivable roller with a diameter of about 80 mm and a number of soft rubber contact pressure rollers with a diameter of about 14 mm to provide a slip-free intermittent transport of the receiving material 3 through the in-line transport nip 2. The feed path in which the transport nip 2 is situated is formed by guide plate 4 over which the receiving material 3 moves. Guide plate 4 is followed in transport direction by a carrier plate 5 which forms a carrying surface for a part of the receiving material 3 which is fed thereon. Printing a part of the receiving material 3 lying on the carrier plate 5 is effected by an ink application means such as an inkjet printhead 6. One or more printheads may be used for applying an ink image to the receiving material 3 in a known manner.

[0037] As shown in figure 1, the carrier plate 6 has a profiled form consisting of V-shaped ribs 7 which extend parallel to the direction of advance of the receiving material 3 over the carrier plate 5. Each rib 7 is formed by a top surface 8, which top surfaces 8 lie in a plane which extends at a short distance d beneath the underside of the printhead 6 (see figures 3A, 3B and 3C). This distance d is herein referred to as the distance between the ink application means 7 and the carrier plate 5.

[0038] Between the ribs 7, recesses 9 are formed which serve to prevent contact between the receiving material 3 on the carrier plate 5 and the printhead 6 moving in a reciprocating motion 10 over the receiving material 3. The receiving material 3 may locally curl up, most likely due to moisture absorption during the printing with an aqueous ink in particular. Any bubbles above the channel shaped recesses 9 can sag therein.

[0039] The carrier plate 5 is provided with holes 12 which are connected beneath the carrier plate 5 to an air chamber 13 which is connected to vacuum means 14 for sucking away air via said holes 12 from the space between the carrier plate 5 and a strip of receiving material 3 lying on the carrier plate 5. In figure 1 these holes 12 are provided in the top surface 8 of the ribs 7. However, these holes 12 may also be provided in the channels 9, as depicted in figure 2. Due to the vacuum pressure between the carrier plate 5 and the receiving material 3, the receiving material 3 is to some extent pulled in the channels 9 as depicted in figure 1. This situation is schematically depicted in the cross-section view of figure 2. Here the depth to which the receiving material 3 sags into the channels 9 is indicated by the symbol X. This depth normally is approximately 1 mm, but may be as large as 3 - 4 mm.

[0040] In order to, at least partially, compensate for the local variations in the distance between the ink application means 6 and the receiving material 3, the apparatus according to the invention comprises correction means as depicted in the figures 3A, 3B and 3C.

[0041] In a first exemplary embodiment as schematically depicted in figure 3A, the apparatus according to the invention is provided with timing means 31 for adjusting the moment of ink release by the printhead 6 during the motion 10 of the printhead 6 over the receiving material 3 lying on the carrier plate 5.

[0042] In a second exemplary embodiment as schematically depicted in figure 3B, the apparatus of the invention is provided with speed adjustment means 41, 43 for adjusting the relative velocity of the ink application means 7 with respect to the carrier plate 5. This relative velocity can be adjusted by translation means 41 which move the carrier plate 5 in a reciprocating motion 42 in a direction substantially parallel to the direction of the motion 10 of the printhead 6 over the receiving material 3 lying on the carrier plate 5. In addition or alternatively said relative velocity can be adjusted by speed adjustment means 43, which adjust the velocity of the printhead 6 during its motion 10 over the receiving material 3.

[0043] In a third exemplary embodiment as schematically depicted in figure 3C, the apparatus according to the invention is provided with adjustment means 51, 53 for adjusting the distance d between the printhead 6 and the carrier plate 5. This distance d can be adjusted by first movement means 51 for moving the carrier plate 5 in a direction 52 substantially perpendicular to the motion 10 of the printhead 6 over the receiving material 3 lying on the carrier plate 5. In addition or alternatively said distance d can be adjusted by second movement means 53 for moving the printhead 6 in a direction 54 substantially perpendicular to the motion 10 of the printhead 6.

[0044] The positions of the channels 9 with respect to the path of the printhead 6 during its motion 10 over the carrier plate 5 with said channels 9, and the relative velocity with which the printhead 6 moves over the strip of receiving material 3, are known or can be determined. The correction means 31, 41, 43, 51, 53 are controllable by an undulatory electronic signal 60 as depicted in figure 4, wherein the leading 61 and tailing 62 edges of the undulatory signal 60 correspond with downward and upward slopes of the channels 9 (compare with the channels 9 of figure 2).

[0045] The amplitude A of the signal 60 is adjustable depending on the depth X to which the receiving material 3 sags into the channels 9. To this end, the above-mentioned exemplary embodiments of the apparatus according to the invention can be provided with controlling means 70 as depicted in figure 5. Said controlling means comprises a microprocessor 71 and memory means 72. Characteristics of the print process are stored in said memory means 72. Such characteristics of the print process may comprise: receiving material 3 characteristics, ink characteristics, ink image characteristics, print mode, carrier plate 5 characteristics, distance between the printhead 6 and the carrier plate 5, and the velocity of the printhead 6 with respect to the carrier plate 5. Coupled to said controlling means 70 is a keyboard control panel 74 for inputting or changing said characteristics in the memory means 72. When, for

example, the first receiving material is replaced by a second receiving material with different characteristics, the characteristics of the first receiving material as stored in the memory means 72 can be replaced with the characteristics of the second receiving material.

[0046] The microprocessor 71 can determine or derive the depth X to which the receiving material 3 will sag into the channels 9 from said characteristics of the print process as stored in the memory means 72. In response to this information, the microprocessor 71 produces or adjusts a control signal, for example the amplitude Amp of the signal 60 as depicted in figure 4, which control signal is sent via an output 75 of the controlling means 70 to an input 35, 45, 46, 55, 56 of the correction means 31, 41, 43, 51, 53.

Claims

1. Apparatus for applying an ink image to a receiving material adapted to be advanced in a direction of advance, comprising:

ink application means for applying an ink image to a strip of receiving material, which strip extends in a direction transverse to the direction of advance of the receiving material, wherein the ink application means are movable over the strip of receiving material,
carrier means for keeping said strip in a predetermined position with respect to the ink application means, which carrier means comprise a carrier plate for carrying said strip, said carrier plate having recesses and said carrier plate being provided with holes,
vacuum means for sucking away air via said holes from the space between the carrier plate and a strip of receiving material lying on the carrier plate, and
correction means for correcting local variations in the distance between the receiving material and the ink application means.

2. Apparatus as claimed in claim 1, wherein the correction means comprise timing means for adjusting the moment of ink release by the ink application means.

3. Apparatus as claimed in claim 2, wherein the timing means are arranged for advancing the moment of ink release when the ink application means is near a downward slope of a recess, and for delaying the moment of ink release when the ink application means is near an upward slope of a recess.

4. Apparatus as claimed in claims 2 or 3, wherein the ink application means are arranged for moving with uniform velocity over the carrier plate.

5. Apparatus as claimed in any one of the preceding claims, wherein the correction means comprise speed adjustment means for adjusting a relative velocity between the ink application means and the carrier plate.

6. Apparatus as claimed in claim 5, wherein the speed adjustment means are arranged for reducing the relative velocity when the ink application means is near a downward slope of a recess, and for increasing the relative velocity when the ink application means is near an upward slope of a recess.

7. Apparatus as claimed in claims 5 or 6, wherein the speed adjustment means comprise translation means for moving the carrier plate in the direction substantially parallel to the direction of the strip of receiving material.

8. Apparatus as claimed in claim 7, wherein the translation means are arranged for a reciprocating movement of the carrier plate.

9. Apparatus as claimed in claims 5, 6, 7 or 8, wherein the speed adjustment means comprise means for adjusting the velocity of the ink application means.

10. Apparatus as claimed in any one of the preceding claims, wherein the correction means comprise adjustment means for adjusting the distance between the ink application means and the carrier plate.

11. Apparatus as claimed in claim 10, wherein the adjustment means comprise first movement means for moving the carrier plate in a direction for adjusting the distance between the ink application means and the carrier plate.

12. Apparatus as claimed in claims 10 or 11, wherein the adjustment means comprise second movement means for moving the ink application means in a direction for adjusting the distance between the ink application means and the carrier plate.

13. Apparatus as claimed in any one of the preceding claims, wherein the correction means are controllable by an undulatory electronic signal, wherein the leading and tailing edges of the undulatory signal correspond with downward and upward slopes of the recesses.

14. Apparatus as claimed in any one of the preceding claims, wherein the apparatus further comprises controlling means for controlling the correction means depending on at least one of the characteristics selected from the group comprising: receiving material characteristics, ink characteristics, ink image characteristics, print mode, carrier plate char-

acteristics, distance between the ink application means and the carrier plate, and the velocity of the ink application means with respect to the carrier plate.

15. Apparatus as claimed in claim 14, wherein the receiving material characteristics comprise at least one of the characteristics selected from the group comprising: the grade, the type, the thickness, the moisture content, the weight or substance per unit area, and the sizing.

16. Apparatus as claimed in claim 14, wherein the ink characteristics comprise at least one of the characteristics selected from the group comprising: the viscosity, wetting characteristics of the ink.

17. Apparatus as claimed in claim 14, wherein the ink image characteristics comprise at least one of the characteristics selected from the group comprising: area fraction covered by ink, pixel density.

18. Apparatus as claimed in claim 14, wherein the print mode comprises at least one selected from the group comprising: last mode, normal mode, and best mode.

19. Apparatus as claimed in claim 14, wherein the carrier plate characteristics comprise at least one of the characteristics selected from the group comprising:

configuration and/or profile of the recesses, magnitude of a vacuum pressure generated by the vacuum means,

20. Apparatus as claimed in claim 19, wherein the apparatus further comprises detection means for detecting the positions of the recesses with respect to a path of the ink application means.

21. Apparatus as claimed in any one of the claims 14-20, wherein the controlling means comprise input means for inputting said at least one characteristic.

22. Method for applying an ink image to a receiving material using an apparatus adapted to advance the receiving material in a direction of advance, wherein the method comprises the steps of:

placing a strip of receiving material on a carrier means in a predetermined position with respect to an ink application means, which carrier means comprise a carrier plate for carrying said strip, said carrier plate having recesses and said carrier plate being provided with holes,
keeping the strip of receiving material on the carrier means by sucking away air via said holes from the space between the carrier plate and the strip of receiving material lying on the carrier plate using vacuum means,
applying an ink image to a strip of receiving material using an ink application means, which strip extends in a direction transverse to the direction of advance of the receiving material, and
correcting local variations in the distance between the receiving material and the ink application means using correction means.

23. Method as claimed in claim 22, wherein the correction means comprises timing means as claimed in claims 2, 3, or 4.

24. Method as claimed in claim 22, wherein the correction means comprises speed adjustment means as claimed in claims 5, 6, 7, 8, or 9.

25. Method as claimed in claim 22, wherein the correction means comprises adjustment means as claimed in claims 10, 11 or 12.

26. Method as claimed in claims 22, 23, 24 or 25, wherein the correction means are controlled by an undulatory electronic signal, wherein the leading and tailing edges of the undulatory signal correspond with downward and upward slopes of the recesses.

27. Method as claimed in claims 22, 23, 24, 25 or 26, wherein the correction means are controlled by controlling means as claimed in claims 14 - 21.

28. Apparatus for applying an ink image to a receiving material substantially as hereinbefore described with reference to the accompanying drawings.

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

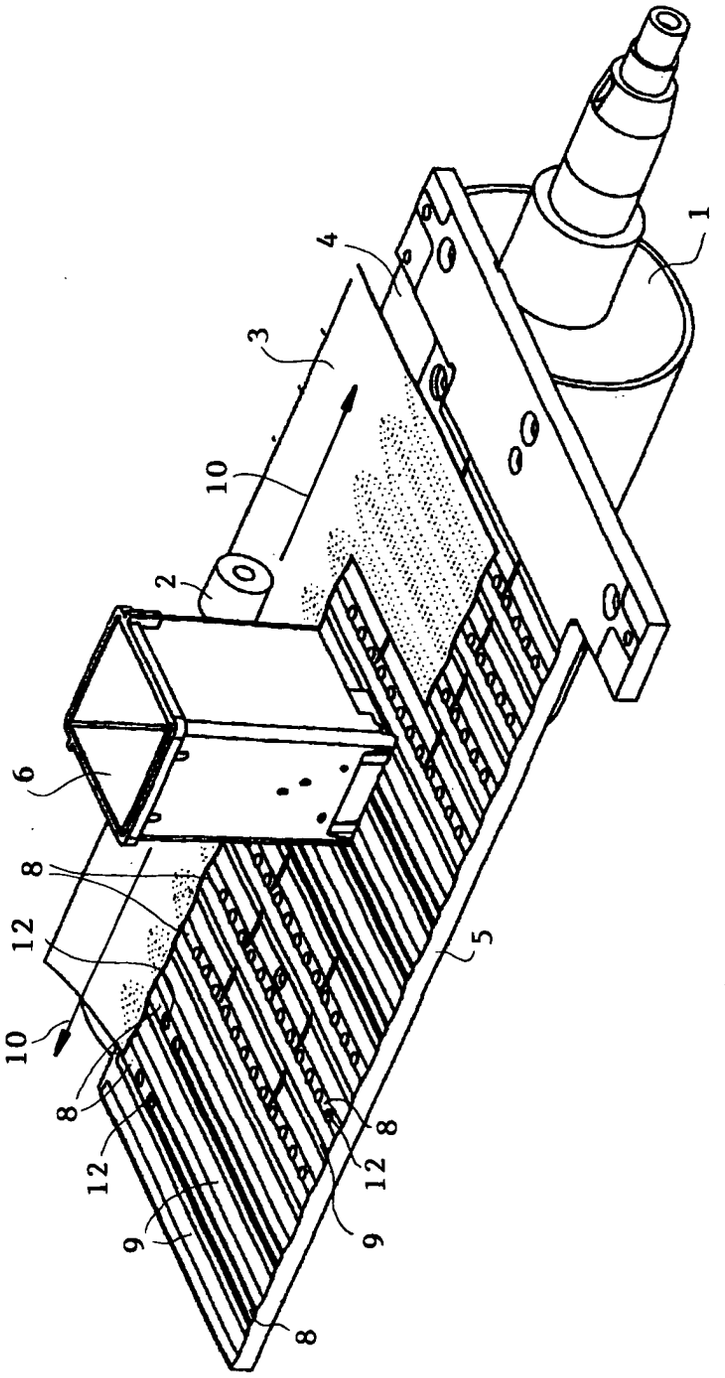

FIG.1

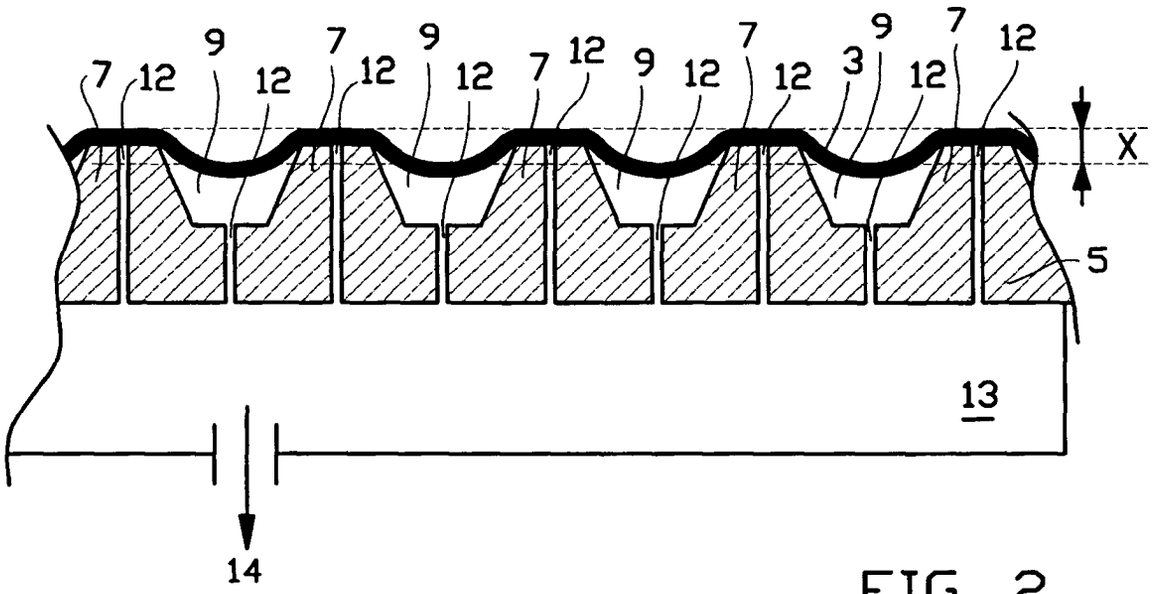

FIG. 2

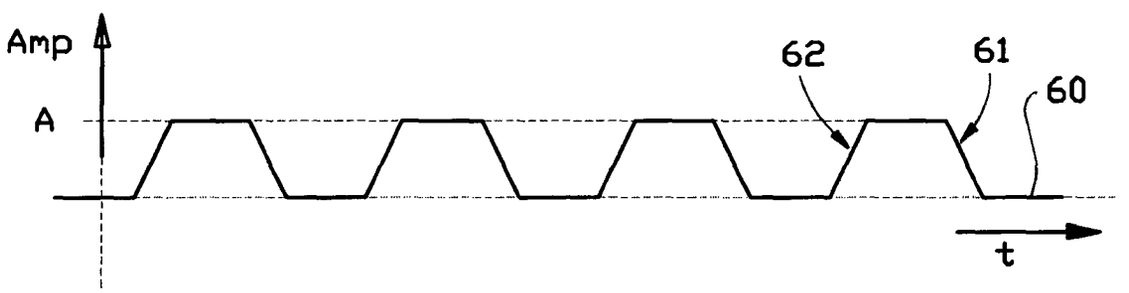

FIG. 4

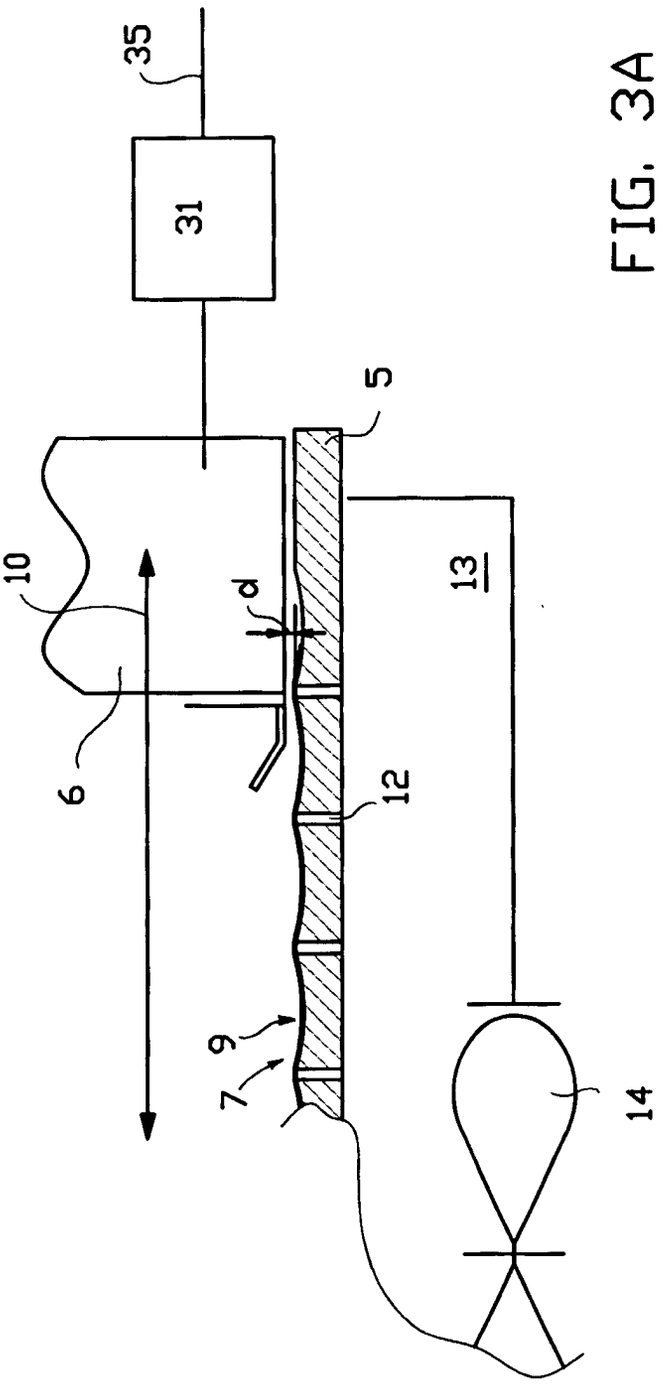

FIG. 3A

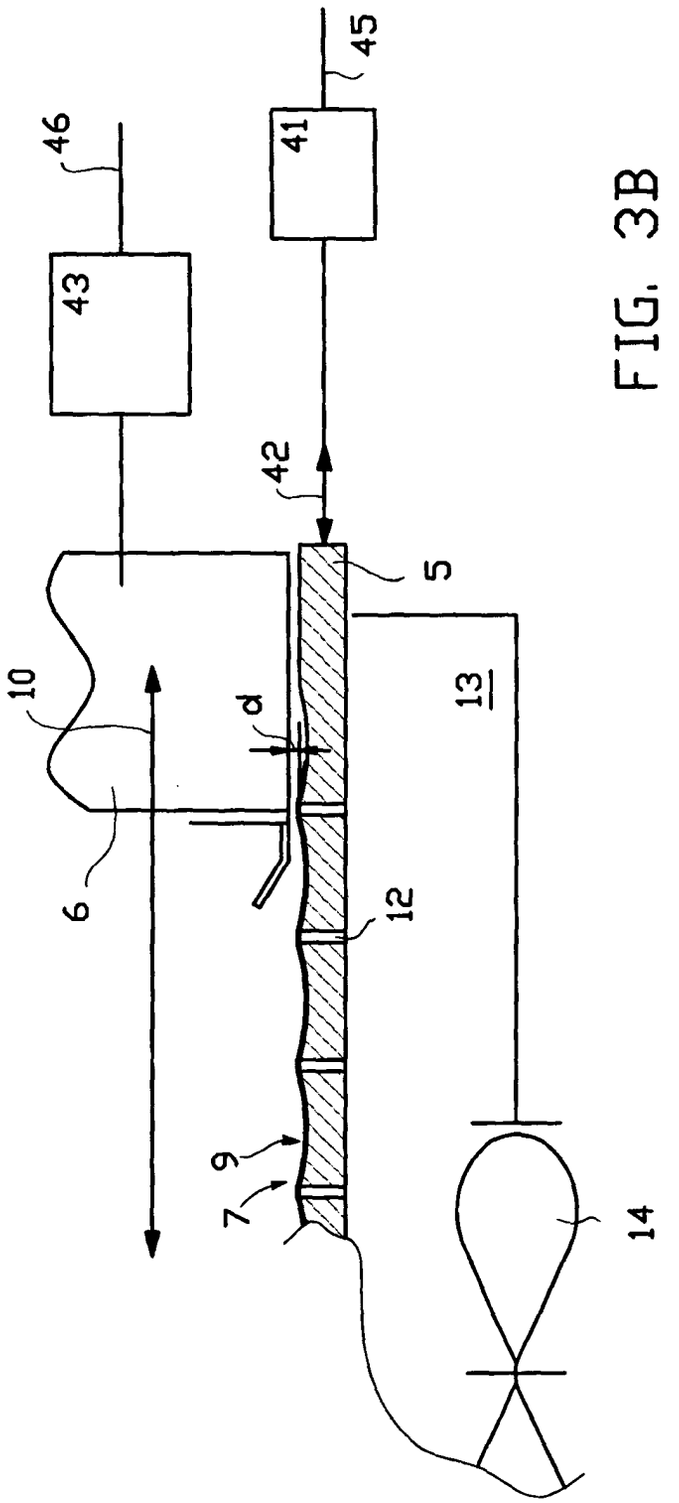

FIG. 3B

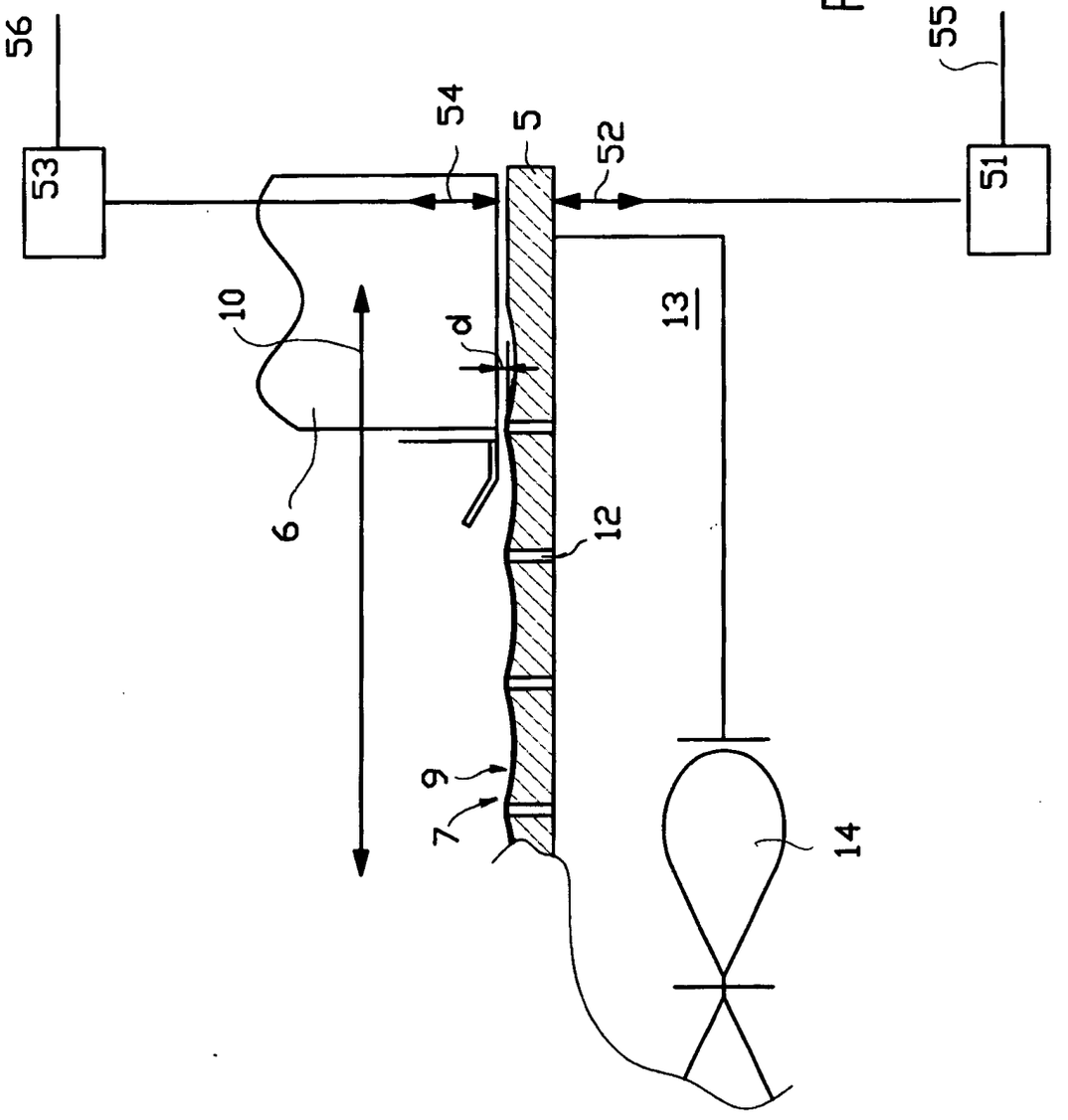

FIG. 3C

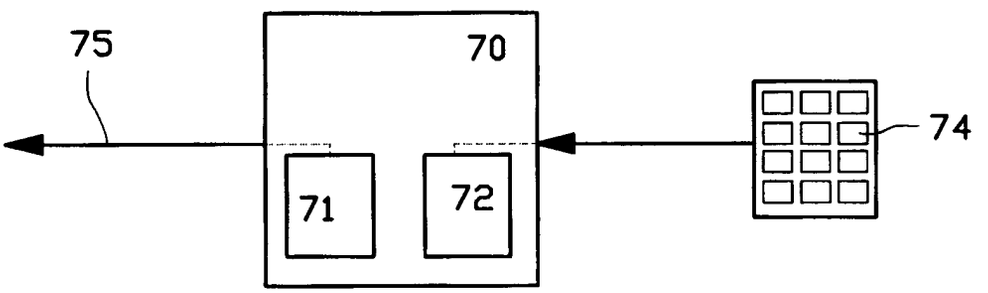

FIG. 5