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(54) **Ink jet printhead with an acoustic filter**

(57) The invention relates to an ink jet printhead (2) having a plurality of ink channels (25) defined in a channel plate (8), wherein each ink channel comprises an ink supply path (30), an ink pressure chamber (24) and an ink passage (26), arranged for enabling ink to flow from a reservoir (6) through the ink supply path into the ink pressure chamber, to leave the pressure chamber and to flow through the ink passage to an associated nozzle (28), an electromechanical actuator (20) being operationally connected to the ink pressure chamber for pressurising the ink contained therein to produce an ink droplet ejection through the associated nozzle, wherein the ink supply path extends transversely of the ink pressure chamber. The printhead comprises an actuable element (38,43) for producing acoustic waves (D) in the ink contained in the ink supply path. Increased stability of the printhead is observed.

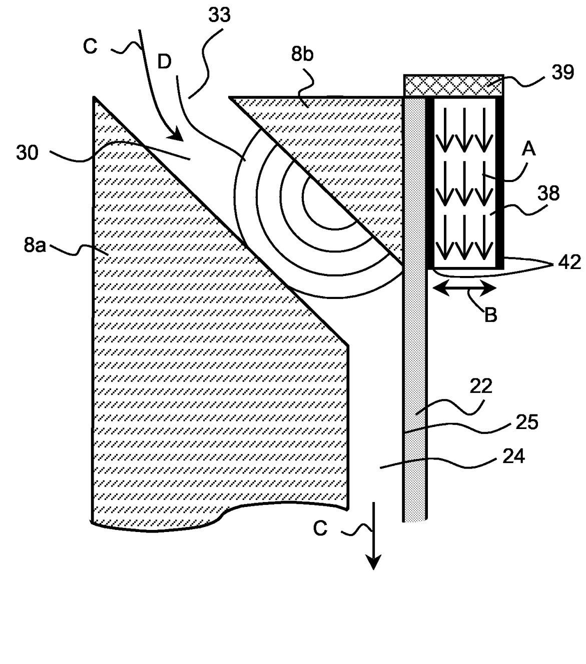

FIG. 3

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Description

[0001] The present invention relates to an ink jet printhead having a plurality of ink channels defined in a channel plate, wherein each ink channel comprises an ink supply path, an ink pressure chamber and an ink passage, arranged for enabling ink to flow from a common ink reservoir through the ink supply path into the ink pressure chamber, to leave the pressure chamber and to flow through the ink passage to an associated nozzle, an electromechanical actuator being operationally connected to the ink pressure chamber for pressurising the ink contained therein to produce an ink droplet ejection through the associated nozzle, wherein the ink supply path extends transversely of the ink pressure chamber.

[0002] This type of printhead is commonly implemented in ink jet printers. For example, a known ink jet printer comprises a carriage supporting four ink jet printheads, one for each of the colours cyan, magenta, yellow and black. The carriage can be moved in reciprocation in a main scanning direction with respect to the ink receiving medium in order to print the swaths of images.

[0003] European patent application no. 05108188 describes an ink jet printhead of the type indicated above, provided with a controller which has been programmed to control the printer to automatically carry out the steps of detecting the presence of a gas bubble inside the ink pressure chamber, interrupting the print process, modifying the print strategy to avoid an ink channel failure and continuing the printing process according to the modified print strategy. For example, a modification of the printing strategy consists in lowering the frequency at which the electromechanical actuator is driven. Moreover, the application describes the possibility to modify the frequency and/or amplitude at which the electromechanical actuator are driven in such a way that the gas bubble is actively removed from the ink chamber. However, such modifications of the print strategy are undesirable since they have an impact on the quality of printed images. For example, if an image contains many thin lines, it may happen that the printed thin lines suffer from erosion due to the fact that less droplets are jetted to form the lines.

[0004] The object of the present invention is to improve an ink jet printer of the type set-forth such that the admission of gas bubbles in the ink pressure chamber is almost avoided and such that the need to take measures to avoid ink channel failure due to the presence of a gas bubble in the ink pressure chamber is diminished.

[0005] This object is achieved by providing the printhead with an actuable element for producing acoustic waves in the ink contained in the ink supply path.

[0006] The inventors have noticed that the stability of the ink jet printhead is improved when the actuable element is operated. As a consequence of the movement of the actuable element, acoustic waves are generated in the ink present in the ink supply path. An increased stability of the printhead is observed, which means that much less ink channel failures occur during a given period of observation compared to the known printhead. Consequently, the need to take measures such as the modification of the print strategy is strongly reduced, which in turns increases the quality of the images printed by the printhead. Moreover, the productivity of the ink jet printer provided with the printhead according to the invention is greatly enhanced.

[0007] In particular, in an hot melt ink jet printhead, when many ink channels have to be activated concurrently during a printing process, the melt unit has to be supplied with ink chips or granules at a high frequency rate. Therefore, gas bubbles (i.e. air bubbles) are likely to be formed in the ink reservoir. Due to the high rate of ink consumption, with the known printhead, it occurs frequently that gas bubbles are transported with the liquid ink to the ink channels. This is highly undesirable, because this may cause an ink channel failure, which is a state in which the ink channel is no longer able to eject an ink drop through the associated nozzle when the electromechanical actuator is operated in order to pressurise the ink in the ink pressure chamber.

[0008] With the printhead of the invention, less gas bubbles (or even no gas bubble) enter the ink pressure chamber, due to the acoustic waves created in the ink supply path by the actuable element and acting as an acoustic filter. The effect of this acoustic filter is to repel the air bubbles. Consequently, the probability that the air bubbles enter the ink pressure chamber is strongly reduced. Since considerably much less gas bubbles enter the ink pressure chamber, the print strategy does not have to be modified anymore, or at least much less frequently.

[0009] According to an embodiment of the invention, the actuable element is an auxiliary electromechanical actuator in contact with a flexible sheet placed adjacently to the channel plate portion forming the ink supply path. For example, the use of a piezoelectric actuator leads to particularly good results, especially in the case that the piezoelectric actuator is operable in the shear mode d15.

[0010] According to another embodiment of the invention, the actuable element is a piece of material connected mechanically to the electromechanical actuator and arranged to transmit vibrating forces onto the channel plate portion forming the ink supply path when the electromechanical actuator is operated. This type of embodiment is easily implementable and is simple to use, since it vibrates in unison with the electromechanical actuator used to create ink jetting.

[0011] The invention is elucidated by reference to two embodiments in conjunction with the figures.

Fig. 1A is a schematic view of an hot melt ink jet printhead according to the prior art.

Fig. 1 B shows a cross sectional view of half a channel structure of the printhead of the prior art.

Fig. 2A shows a cross-section of an embodiment of the ink jet printhead according to the invention.

Fig. 2B is a section of the printhead taken along the line II-II in Fig. 2A.

Fig. 3 is a detail view of Fig. 2A, showing the ink supply path and the actuable element.

Fig. 4 shows the critical voltage amplitude of the sinus wave voltage applied to the actuable element as a function of the frequency of the sinus wave.

Fig. 5A shows a cross-section of another embodiment of the ink jet printhead according to the invention.

Fig. 5B is a section of the printhead taken along the line V-V in Fig. 5A.

[0012] Fig. 1A shows a schematic view of a known hot melt ink jet printhead 1 comprising a channel plate 8 having two ink channels arrays extending in the z-direction, one array being placed at each side of the channel plate 8. On each side of the channel plate 8, an actuator block 14 is firmly attached thereto. On the lower portion of the channel plate 8, a nozzle plate 10 defining nozzles is provided for expelling ink droplets 12 onto an ink receiving medium (not shown). Above the channel plate 8, an ink reservoir 6 is provided, said ink reservoir 6 being connected to a melting unit 4 being suited for melting hot melt ink and transferring the melt ink to the reservoir 6. Hot melt ink is fed to the melting unit 4 in solid form e.g. as granules 16 or chips.

[0013] Fig. 1 B shows a cross sectional view in a plane (x, z) of half a printhead of the prior art, crossing the channel plate in the middle plane. Only a part of the channel plate 8 is represented. The printhead comprises electromechanical actuators 20 attached to a substrate 29. Support elements 20b, also attached to the substrate 29 are provided between the electromechanical actuators 20. The electromechanical actuators 20 are made of a multilayered piezoelectric material such as a PZT material. The known ink jet printhead has a plurality of ink channels defined in the channel plate 8, wherein each ink channel comprises an ink supply path, an ink pressure chamber 24 and an ink passage, arranged for enabling ink to flow from a reservoir through the ink supply path into the ink pressure chamber, to leave the pressure chamber and to flow through the ink passage to an associated nozzle. Each electromechanical actuator 20 is operationally connected to the ink pressure chamber for pressurising the ink contained therein to produce an ink droplet ejection through the associated nozzle. One side of a flexible sheet 22 is brought onto the electromechanical actuators 20 while the other side thereof covers the ink pressure chambers 24.

[0014] An embodiment of the print head according to the invention has a general schematic view similar the one shown in Fig. 1A. Fig. 2A shows a cross-section in a plane (x, y) of the first embodiment of the ink jet printhead. The first embodiment is explained with reference to Fig. 2A, Fig. 2B (a partial section along the line II-II) and Fig. 3 (a detail view of Fig. 2A).

[0015] As is shown in Fig. 2A, a printhead 2 comprises the channel plate 8 which is made of graphite, for example, and which defines ink channels 25 enabling the melt ink 34 to flow from an ink inlet 33 along an ink flow path to an associated nozzle 28. Since the printhead 2 comprises two ink channels arrays extending in the z-direction, two facing ink channels 25 are visible in the cross section of Fig. 2, each one of the shown ink channels belonging to a different array. Within an array, the ink channels 25 and are closely spaced from one another in the z-direction in order to print ink droplets 12 of a receiving medium 40 such as a sheet of paper. The reservoir 6 is suitable for containing liquid melt ink 34 supplied by the melting unit (not shown). The ink reservoir 6 accommodates a heating element (not shown) for heating and maintaining the hot-melt ink above its melting point (e. g. at a temperature of about 100°C). A meniscus 36 of the liquid ink 34 is formed in the reservoir 6. The ink reservoir 6 further accommodates a filter 32 used to prevent solid particles from entering into the ink channels 25 and clogging the nozzles 28. The nozzle plate 10 with nozzles 28 formed therein is attached to the lower surface of the channel plate 8.

[0016] Each ink channel 25 comprises an ink supply path 30, an ink pressure chamber 24 and an ink passage 26. Ink flows from the reservoir 6 through the filter 32, through the ink inlet 33 and through the ink supply path 30 into the ink pressure chamber 24. Ink leaves the pressure chamber 24 and flows through the ink passage 26 to the associated nozzle 28. The ink pressure chambers, which have and axial direction Y that extends vertically in Fig. 2, are formed by grooves which are cut into the surfaces on either side of the channel plate 8. The ink pressure chambers 24 are covered by flexible sheets 22 that are secured to either side of the channel plate 8.

[0017] Actuator blocks 14 are bonded to either side of the channel plate 8. Each one of the actuator blocks14 comprises a piezoelectric ceramic material having a comb-like structure forming a plurality of parallel piezoelectric fingers 20 extending in the vertical direction (Y-direction). The piezoelectric fingers are attached to the substrate 29. Each piezoelectric finger 20 acts as an electromechanical actuator operationally connected to the ink pressure chamber 24. Each actuator block also comprises electrodes (not shown) associated with each piezoelectric finger 20. A flexible lead foil (not shown) is attached to each one of the actuator blocks 14 and comprises electric leads for individually energising the piezoelectric fingers 20. Each actuator block further comprises a cap 18 for protecting the piezoelectric ceramic material.

[0018] When, in the print process, an ink droplet is to be expelled from a selected one of the nozzles 28, a voltage is applied via the lead foil to the piezoelectric actuator finger 20 associated with that nozzle, so that the piezoelectric finger 20 contracts in the X-direction and draws the flexible sheet 22 away from the ink pressure chamber 24. As a result, the volume of the ink pressure chamber 24 is increased and ink is sucked-in from the ink supply system. Then, when the voltage is removed or a voltage with opposite plurality is applied, the piezoelectric finger will expand in the X-direction and will flex the sheet 22 into the ink pressure chamber 24, thereby increasing the pressure of the ink, so that a pressure wave will propagate through the flow passage 26, and an ink droplet 12 will be jetted out from the nozzle 28 in a direction normal to the nozzle plate 10.

[0019] As is shown in Fig. 2A, the ink supply path 30 extends transversely of the ink pressure chamber 24. Its cross section is significantly larger than that of the ink pressure chamber 24. Therefore, when a negative pressure wave propagates in the liquid ink from the ink pressure chamber 24 towards the ink supply path 30, the transition between the ink pressure chamber and the ink supply path acts like an open end at which the acoustic wave is reflected almost completely, creating reversal in the propagation direction. Consequently, a positive pressure wave is reflected which propagates in the ink pressure chamber 24 towards the ink passage 26 and the nozzle 28. At an appropriate timing, the piezoelectric finger 20 is driven again to expand in order to boost the positive pressure wave.

[0020] The ink jet printhead of the present invention is provided with an actuable element for creating acoustic waves in the liquid ink present in the ink supply path.

[0021] In the example shown in Fig. 2A, Fig. 2B and in more detail in Fig. 3, an actuable element such as a piezoelectric element 38 is positioned adjacent to the top edge of the flexible sheet 22. The piezoelectric element 38 is attached by means of a block 39 to the printhead assembly. Since the channel plate 8 defines in its top area the ink supply path 30, the channel plate is split in its top area in a main part 8a, and a sub part 8b to which the flexible sheet 22 is attached. Some bridges 8c (see Fig. 2B) are provided in the channel plate for defining the ink supply paths 30 and for attaching the sub part 8b to the main part 8a, such bridges being able to be deformed. The channel plate 8 and its sub-parts 8a, 8b and 8c are made of a soft material, such as graphite, for example. When the piezoelectric element is driven with alternate polarity voltage, a vibrating pressure is exerted on the sub part 8b, the flexible bridges 8c expand and retract periodically and the volume available for the ink in the ink supply is decreased and increased periodically. Consequently, acoustic waves are generated in the ink present in the ink supply path 30.

[0022] The piezoelectric element 38 is provided with electrodes 42 for applying a voltage thereto and thus causing expansion and retraction strokes of said element. The arrows A in Fig. 3 indicate the direction of the polarisation of the piezoelectric material 38. The arrow B indicates the directions of the expansion and retraction strokes. The arrow C indicates the direction of the ink flow. Due to the flexibility of the sheet 22 and the softness of the channel plate material, when a periodic voltage is applied to the piezoelectric element 38, an alternating pushing and pulling force is exerted onto the sub-part 8b in the X-direction, following the expansion and retraction strokes of the piezoelectric element 38. Since the bridges 8c are able to deform, the volume of the ink in the ink supply is increased and decreased in an alternative way. This gives rise to the acoustics waves D. Preferably, the piezoelectric material is operable in the shear mode d15. The amplitude of the movement of the tip of the piezoelectric element 38 is typically comprised between 10 nm and 60 nm, depending on the material and the applied voltage.

[0023] As a consequence of the alternately pulling and pushing pressure exerted on the channel plate sub-part 8b, acoustic waves D are created in the ink present in the ink supply path 30. Surprisingly, the inventors have noticed that the stability of the jetting behaviour of the printhead is strongly improved when a voltage having an alternate polarity is applied to the piezoelectric element 38. It has been noticed that stable printheads are obtained, even at high ink flow rates. The jetting stability was investigating in several series of experiments of which three are described hereunder.

[0024] **In a first series of experiments**, 128 neighboured piezoelectric fingers 20 located on one side of the channel plate 8 were activated while a new hot-melt ink granule 16 was fed into the melt unit 4 (see Fig. 1) every 10s. The piezoelectric fingers 20 were driven with an alternative voltage having the following features: amplitude=48V; trapezium-shaped wave of the type 5,5,3; frequency=20 kHz. Under such conditions, the jetting speed then reaches about 8 m/s. Among the 128 ink channels 25 associated to the 128 activated piezoelectric fingers, 21 ink channels were selected to carried out the observation of a potential ink channel failure. The behaviour of the 21 associated ink channels and nozzles was thus observed during the actuation. Concurrently, the piezoelectric element 38 was driven with an alternative voltage signal having a block-shaped wave with a frequency of 100 kHz, and an adjustable amplitude.

[0025] In a first experiment 1.1, the piezoelectric element 38 was driven with a zero amplitude signal (i.e. no voltage was applied). The first experiment serves as a reference, because it reproduces the behaviour of the known printhead. After 20 to 30 s of actuation of the piezoelectric fingers 20, about six ink channels out of the 21 observed ink channels had a failure. An ink channel failure is a state in which the ink pressure chamber is no longer able to eject an ink drop through the associated nozzle when the piezoelectric finger is actuated. This creates an unstable jetting behaviour.

[0026] In a second experiment 1.2, the piezoelectric element 38 was driven with a 100 V amplitude signal. After 60s, less than four ink channel failures were observed. This signs a relatively stable jetting behaviour.

[0027] In a third experiment, 1.3 the piezoelectric element 38 was driven with a 30 V amplitude signal. After 60s, less than four ink channel failures were observed. Again, the jetting behaviour is relatively stable.

[0028] **In a second series of experiments**, 128 neighboured piezoelectric fingers 20 located on one side of the channel plate 8 were activated while a new hot-melt ink granule 16 was fed into the melt unit 4 (see Fig. 1) every 10s. The behaviour of 21 ink channels and nozzles was observed during the actuation of the 21 associated piezoelectric fingers 20. The piezoelectric fingers 20 were driven with an alternative voltage having the following features: amplitude=48V; trapezium-shaped wave of the type 5,5,3; frequency=20 kHz.

[0029] Concurrently, the piezoelectric element 38 was driven with an alternative voltage having a sinus-shaped wave with adjustable amplitude and frequency. Several experiments were carried out, each one of the experiments in the series corresponding to a single pair amplitude/frequency of said sinus-wave voltage. The frequency was varied between 0 and 400 kHz, and the amplitude of the sinus waves was varied between 0 and 100 V.

[0030] In a first experiment 2.1, the piezoelectric element 38 was driven with a zero amplitude signal (i.e. no voltage was applied). Again, the first experiment serves as a reference. After 20 to 30 s of actuation of the piezoelectric fingers 20, about six ink channels out of the 21 observed ink channels had a failure. This signs an unstable jetting behaviour.

[0031] During a second experiment 2.2, the piezoelectric element 38 was driven with a sinus voltage signal having a frequency of 100 kHz and an amplitude equal to 100 V. After 60s, less than four ink channel failures were observed. This signs a relatively stable jetting behaviour.

[0032] During a third experiment 2.3, the piezoelectric element 38 was driven with a sinus voltage signal having a frequency of 200 kHz and an amplitude equal to 50 V. After 60s, less than four ink channel failures were observed. Again, the jetting behaviour was relatively stable.

[0033] During a fourth experiment 2.4, the piezoelectric element 38 was driven with a sinus voltage signal having a frequency of 400 kHz and an amplitude equal to 20 V. After 60s, less than four ink channel failures were observed. Again, the jetting behaviour was relatively stable.

[0034] Considering the first and second series of experiments, it appears that the activation of the piezoelectric element 38 causes an increased stability of the jetting behaviour, compared to the situation whereby the piezoelectric element 38 is absent or not activated.

[0035] **In a third series of experiments,** 128 neighboured piezoelectric fingers 20 located on one side of the channel plate 8 were activated while a new hot-melt ink granule 16 was fed into the melt unit 4 (see Fig. 1) every 10s. The behaviour of 21 chosen ink channels and nozzles was observed during the actuation of the associated piezoelectric fingers. The observation period was 60 s. The 128 piezoelectric fingers 20 were driven with an alternative voltage having the following features: amplitude=48V; trapezium-shaped wave of the type 5,5,3; frequency=20 kHz.

[0036] Concurrently, the piezoelectric element 38 was activated with an alternative voltage signal having a sinus-shaped wave with adjustable amplitude and frequency. For a given frequency of the alternative voltage signal, an amplitude of 200 V was firstly applied. Then, the amplitude of the sinus-shaped wave was decreased by a small voltage step and the observation of the selected ink channels was carried out during 60 s. These steps were repeated until a so-called critical voltage amplitude was reached. For the given frequency, the critical voltage amplitude is defined as the amplitude below which the jetting behaviour is unstable. An unstable behaviour is defined as the occurrence of at least four ink channel failures among the 21 observed ink channels and nozzles during the observation period of 60 s. A stable jetting behaviour means that less than four ink channel failures occur after 60 s of observation. According to these definitions, for a stimulating sinus wave voltage having an amplitude above the critical amplitude, the jetting behaviour is stable. On the other hand, for a stimulating sinus wave voltage having an amplitude below the critical amplitude, the jetting behaviour is unstable.

[0037] Fig. 4 shows a graphical representation of the value of the critical amplitude as a function of the frequency of the stimulating voltage sinus wave applied to the piezoelectric element 38. Since the critical amplitude decreases with increasing frequency, it appears that high frequency values are very-well suited for activating the piezoelectric element 38 such that a stable ink jet printhead is obtained. In particular, for frequencies larger that 300 kHz, a very good stability of the jetting behaviour of the printhead can be achieved for voltages as low as a few volts.

[0038] In Fig. 3, the arrow C indicates the direction of the ink flow. With the known printhead, it occurs frequently that gas bubbles are taken with the liquid ink flowing into the direction C. This is especially the case at high ink flow rates. It is believed that the acoustic waves D act as an acoustic filter avoiding the gas bubbles present in the reservoir to enter the ink pressure chamber 24. The acoustic filter is probably able to repel the air bubbles which naturally have the tendency to follow the ink flow (arrow C in Fig. 3) and maintain the air bubbles in the top portion of the ink supply path 30. This could be at the origin of the absence of air bubbles in the ink pressure chamber, and be responsible for an improved stability of the printhead, even at high ink flow rates.

[0039] Another embodiment of the printhead according to the invention is shown in Figs. 5A and 5B (a partial section along the line V-V in Fig. 5A). The actuable element is now a piece of material 43 connected mechanically to the piezoelectric finger 20 by means of the substrate 29. When the piezoelectric finger 20 is actuated, the substrate 29 will follow the expansion and retraction strokes thereof in the x-direction. Since one side of the element 43 is fixed onto the substrate 29, while the opposite side of the element 43 is attached to the top portion of the flexible sheet 22 being itself attached to the subpart 8b of the channel plate, the element 43 is able to exert an alternately pushing and pulling force in the x-direction onto the channel plate portion 8b when the electromechanical actuator 20 is operated. Due to the flexibility of the sheet 22 and to the softness of the channel plate material, when the element 43 applies an alternately pushing and pulling force onto the channel plate portion 8b, the bridges 8c are consequently alternately compressed and expanded, following the expansion and retraction strokes of the electromechanical actuator 20. As a consequence of the changes of the volume available in the ink supply path 30, acoustic waves D are created in the ink present in the ink supply path 30. The element 43 has an adequate rigidity such that is able to transmit the vibrating forces caused by the operated piezoelectric finger 20 to the sub-part 8b.

[0040] Other elements placed in the vicinity of the ink supply path and suited for generating acoustic waves in the ink present in the ink supply path are also suitable. Examples are electro-mechanical transducers able to cause periodic movements having an amplitude of a few tens of nm.

Claims

1. Ink jet printhead (2) having a plurality of ink channels (25) defined in a channel plate (8), wherein each ink channel (25) comprises an ink supply path (30), an ink pressure chamber (24) and an ink passage (26), arranged for enabling ink to flow from a reservoir (6) through the ink supply path (30) into the ink pressure chamber (24), to leave the pressure chamber (24) and to flow through the ink passage (26) to an associated nozzle (28), an electromechanical actuator (20) being operationally connected to the ink pressure chamber (24) for pressurising the ink contained therein to produce an ink droplet ejection through the associated nozzle (28), wherein the ink supply path (30) extends transversely of the ink pressure chamber (24), **characterised in that** the printhead (2) comprises an actuable element (38, 43) for producing acoustic waves (D) in the ink contained in the ink supply path (30).

2. Ink jet printhead according to claim 1, wherein the actuable element is an auxiliary electromechanical actuator (38) in contact with a flexible sheet (22) placed adjacently to the channel plate portion (8b) forming the ink supply path (30).

3. Ink jet printhead according to claim 2, wherein the auxiliary electromechanical actuator (38) is a piezoelectric actuator operable in the shear mode d15.

4. Ink jet printhead according to claim 1, wherein the actuable element is a piece of material (43) connected mechanically to the electromechanical actuator (20) and arranged to transmit vibrating forces onto the channel plate portion (8b) forming the ink supply path (30) when the electromechanical actuator (20) is operated.

5. Ink jet printhead according to claim 4, the piece of material (43) being attached to a support structure serving as a substrate element (29) for the electromechanical actuator (20).

6. Ink jet printer with an ink jet printhead as claimed in any of the preceding claims.

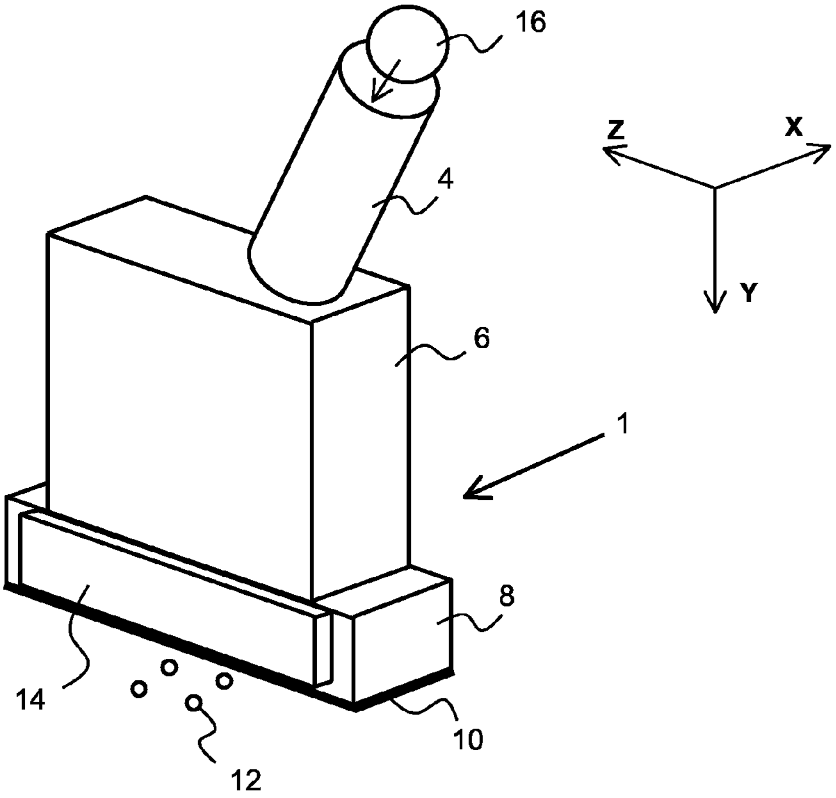

FIG. 1A

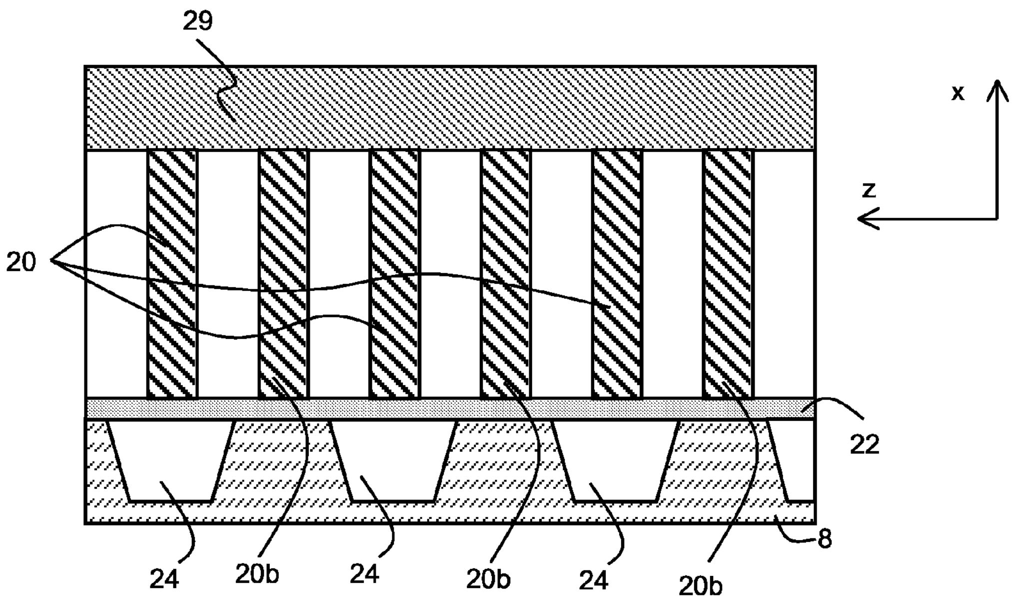

FIG. 1B

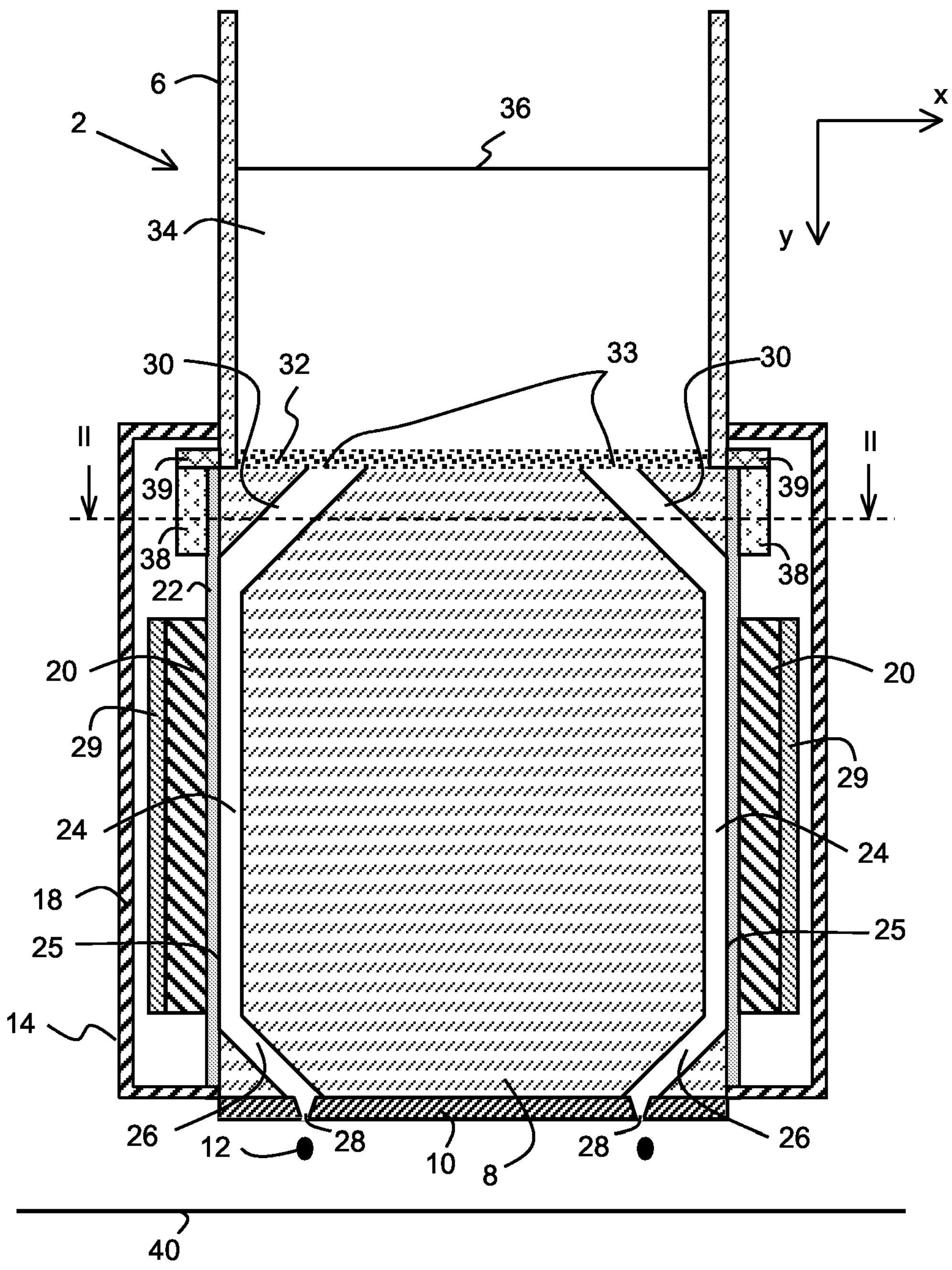

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FIG. 2A

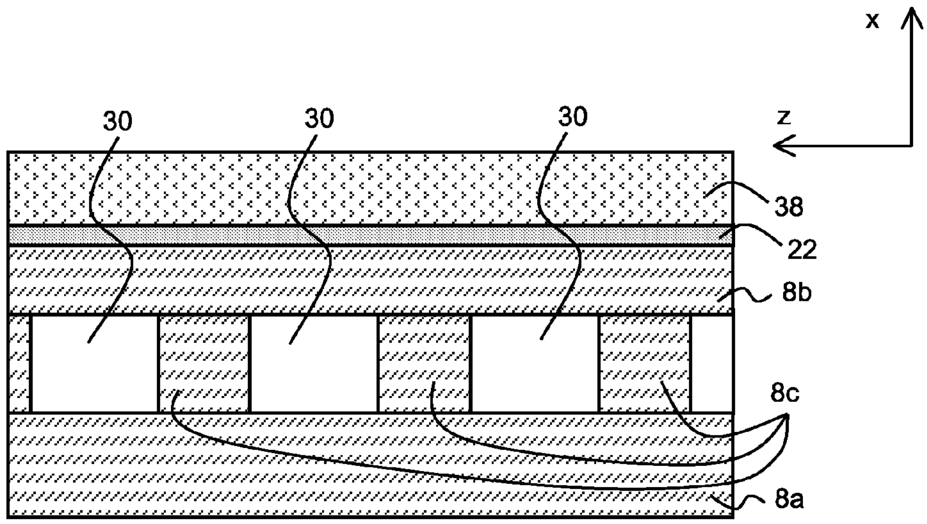

FIG. 2B

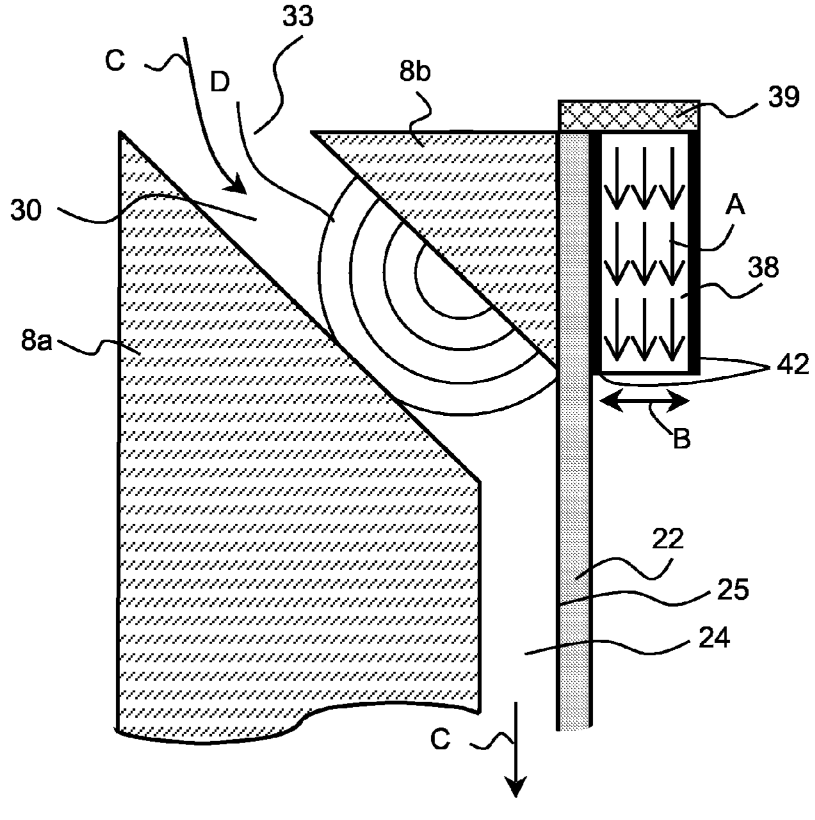

FIG. 3

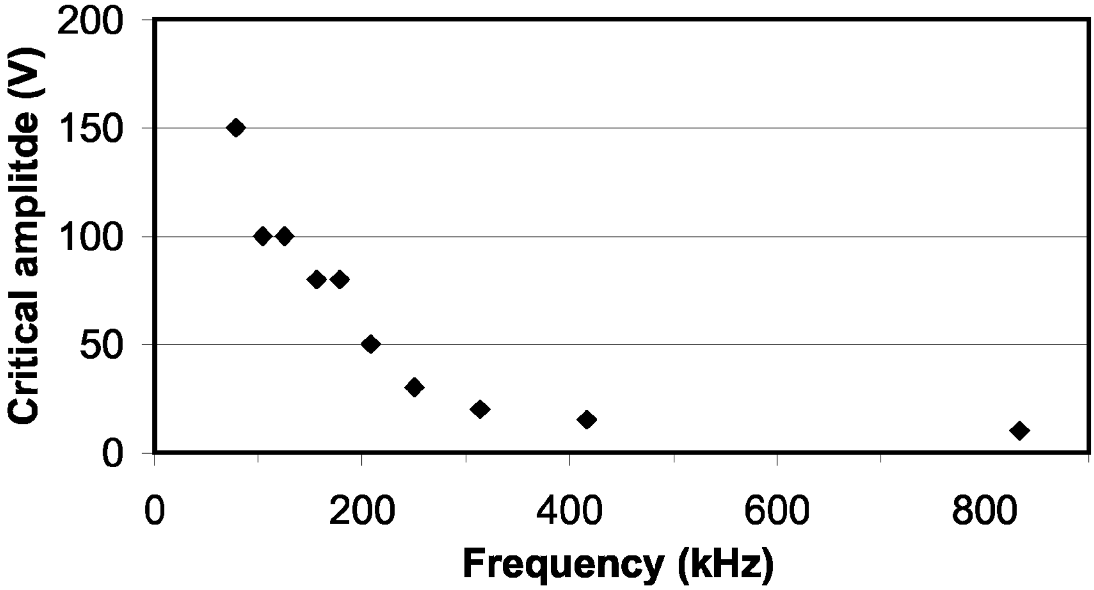
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FIG. 4

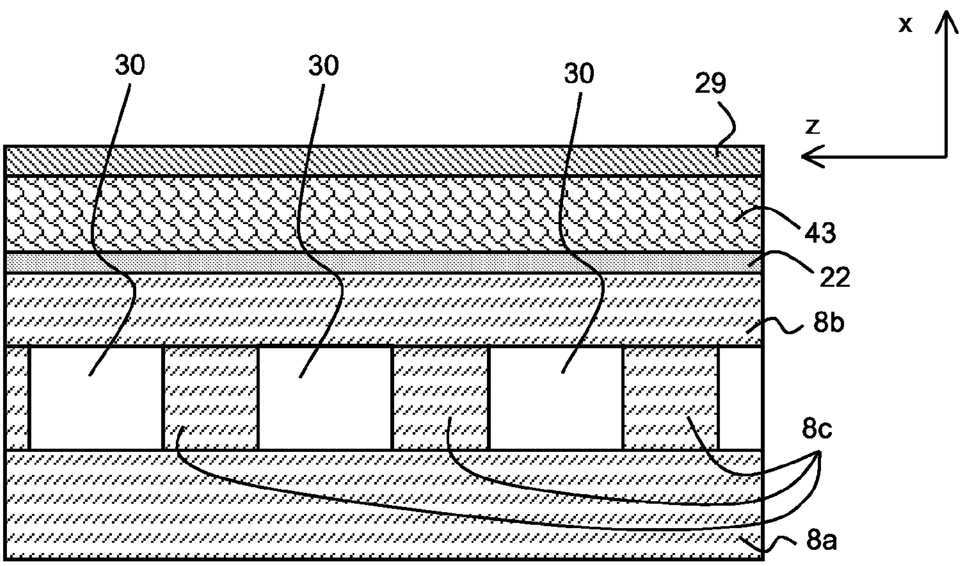
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FIG. 5B

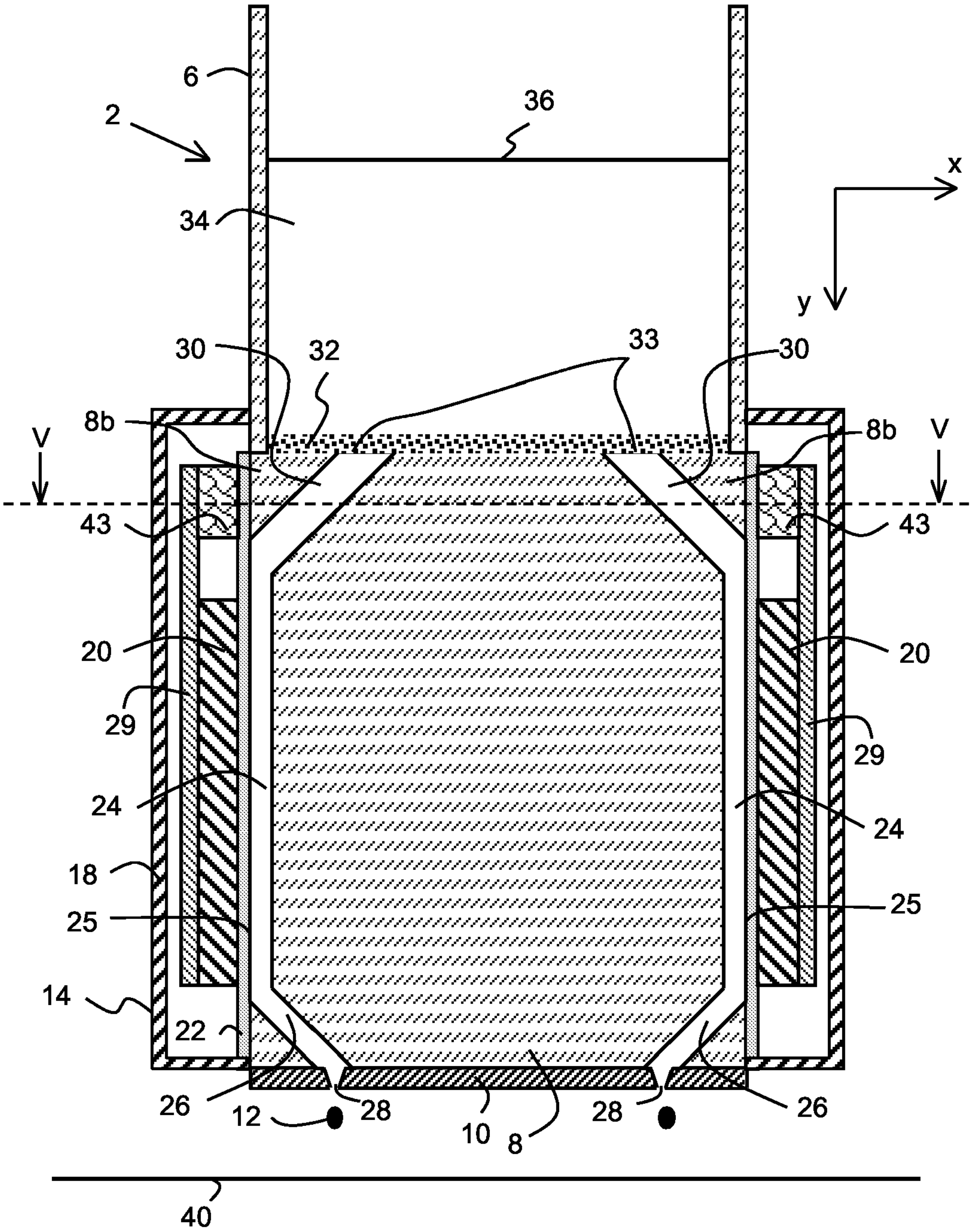
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FIG. 5A

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 11 6215

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 Y A	DE 24 31 457 B1 (OLYMPIA WERKE AG, 2940 WILHELMSHAVEN) 18 September 1975 (1975-09-18) * the whole document *	1,2,6 3 4,5	INV. B41J2/19 B41J2/14
Y	US 5 910 810 A (BROOKS JEFFREY B [US] ET AL) 8 June 1999 (1999-06-08) * column 3, line 43 - column 4, line 23 * * figure 2 *	1,6	
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A	WO 95/12109 A (SPECTRA INC [US]) 4 May 1995 (1995-05-04) * page 3, line 31 - page 5, line 24 * * figure 2 *	1,6	TECHNICAL FIELDS SEARCHED (IPC) B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 November 2006	Brännström, Sofie

1

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons
& : member of the same patent family, corresponding document

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