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

(11) EP 1 661 712 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
31.05.2006 Bulletin 2006/22

(51) Int Cl.:
B41J 2/175 *(2006.01)*

(21) Application number: **05111015.3**

(22) Date of filing: **21.11.2005**

(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

(30) Priority: **25.11.2004 EP 04106060**

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

(72) Inventors:
- **Nottelman, Frank J.H.**
  5951 AW, Belfeld (NL)
- **Hennissen, Jeroen J.M.**
  6035 CW, Ospel (NL)

(74) Representative: **Vanoppen, Ronny R.J. et al**
Océ-Technologies B.V.
Postbus 101
NL-5900 MA Venlo (NL)

(54) Apparatus and method for controlling pressure in an ink reservoir of an ink jet printer

(57) The invention relates to an apparatus for controlling pressure in an ink reservoir of an ink jet printer. The invention also relates to an ink jet printer comprising a printhead with an ink reservoir containing liquid ink and a gas volume above the level of the ink. The invention further relates to a method for controlling pressure in an ink reservoir of an ink jet printer.

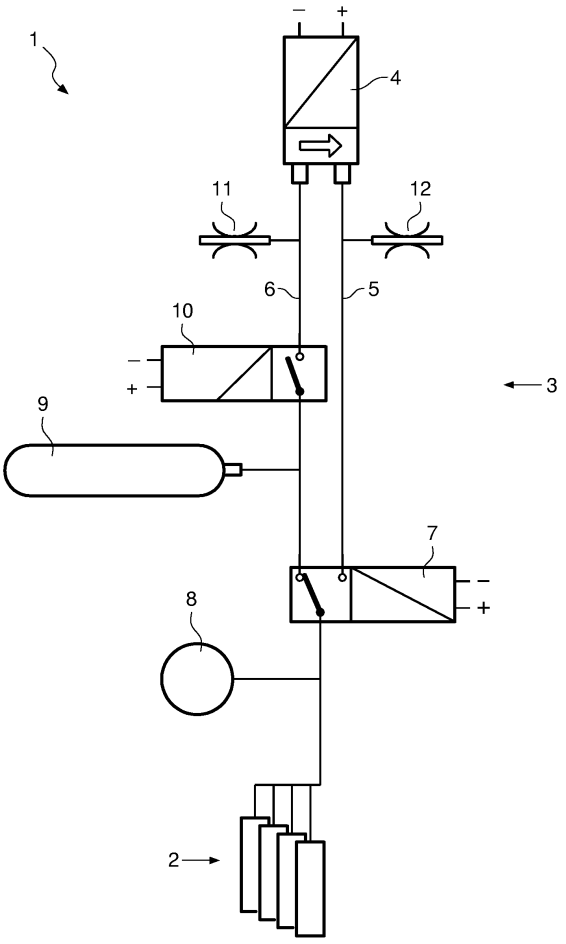

FIG. 1

EP 1 661 712 A1

Description

[0001] The invention relates to an apparatus for controlling pressure in an ink reservoir of an ink jet printer. The invention also relates to an ink jet printer comprising a printhead with an ink reservoir containing liquid ink and a gas volume above the level of the ink. The invention further relates to a method for controlling pressure in an ink reservoir of an ink jet printer.

[0002] An ink jet printer typically comprises printheads having one or more nozzle arrays and an ink reservoir from which liquid ink is supplied to the nozzles of the nozzle arrays, so that ink droplets may be ejected from the nozzles by thermal or piezoelectric action, as is generally known in the art. When the level of ink in the ink reservoir is higher than the level of the nozzles, the ink reservoir should be kept at subatmospheric pressure in order to avoid ink from leaking out through the nozzles. Since the difference between the internal pressure in the ink reservoir and the atmospheric pressure has an influence on the process of droplet generation and hence on the quality of the printed image, it is desirable to keep this pressure difference constant. Since, however, the internal pressure in the ink reservoir may vary in response to changes of the ink volume contained therein, thermal expansion and the like, it is necessary to control the internal pressure in the ink reservoir.

[0003] It is common to apply pressure regulating valves coupled to a pump for allowing compensation of an excessive pressure drop monitored by the detecting means in order to maintain the underpressure in the ink reservoir within a certain predetermined pressure range. Pressure regulating valves are however commonly relatively expensive and sensitive. Withal, relatively large membranes are required to achieve a relatively high degree of precision of the regulation of the pressure within the ink reservoir. Furthermore, commonly other critical components are required, often resulting in a relatively high mutual friction and are therefore often subjected to a considerable amount of wear. Rubber parts commonly used in the known apparatus to control the pressure within the ink reservoir become fatigued relatively quickly, resulting in a decreased capacity to counteract loads during operation of the apparatus. Thus, the known device is from a constructive point of view relatively complex and hence relatively expensive. Moreover, the components used in the known device are commonly subjected to a considered amount of wear during operational use.

[0004] It is an object of the invention to provide a relatively simple and durable device for controlling the pressure in an ink reservoir of an inkjet printer.

[0005] This object can be achieved by providing, according to the present invention, an apparatus for controlling pressure in an ink reservoir of an ink jet printer, the apparatus comprising: pressure applying means for applying a certain pressure in said ink reservoir, detecting means for monitoring the actual pressure in said ink reservoir, the detecting means comprising at least one electronic pressure sensor and controlling means for controlling the pressure applying means dependent on the actual pressure monitored by said detecting means. The electronic pressure sensor can electronically detect an underpressure and/or overpressure in a relatively simple though painstaking manner. To this end, no complex and moving components are required to accurately measure the pressure over a gaseous fraction in the ink reservoir. This omission reduces wear by friction of the apparatus and hence increases the life span of the low-maintenance apparatus. Moreover, since no complex (moving) components are used the cost price of the apparatus can be reduced significantly. It is noted that commonly an underpressure is applied within the ink reservoir to prevent uncontrolled drop-out of ink via the nozzles. However, in certain circumstances it is though advantageous to apply a certain overpressure within said ink reservoir for cleaning purposes. Both pressures (underpressure and overpressure) can be detected by the electronic pressure sensor, which is commonly not possible by means of the conventional mechanical (one-way) detecting means, the latter commonly being able to detect merely an underpressure. The expressions overpressure and underpressure are relative expressions relating to the pressure surrounding the apparatus, and in particular the nozzles. Commonly, a single electronic pressure sensor will be applied to monitor simultaneously the underpressure in all printheads. However, it is also conceivable to apply multiple electronic pressures to monitor the pressure in multiple parts of the apparatus according to the invention. To this end, it is possible to apply multiple electronic pressure sensors, wherein each electronic pressure sensor is in communication with a printhead provided with a specific coloured ink. It is also imaginable to apply multiple electronic pressure sensors, wherein a second electronic pressure sensor forms a backup sensor for a first electronic pressure sensor in case the first electronic pressure sensors fails.

[0006] The pressure applying means can be adapted to generate a certain underpressure and/or a certain overpressure within the ink reservoir. Thereby, the pressure applying means can be formed in various ways. Preferably, said pressure applying means comprises at least one pump, more preferably a pump of which the capacity is adjustable. Thereby, the capacity of the pump can be adjusted by applying variable frequencies and/or voltages, wherein by means of an electromagnet the moving speed of a plunger of the pump can be adjusted. Said pump is preferably formed by a membrane pump or any other pump of which the output can be regulated electronically. The specifications of the pump can be chosen by a person skilled in the art dependent on the situational conditions of the apparatus according to the invention. For example, a (membrane) pump can be applied with a pump discharge of about one litre per minute to achieve a pressure from 0 to 300 millibar. However, as mentioned above the underpressure in the ink reservoir during operational use is rather critical and is nor-

mally lain at between 5 and 50 millibar with an allowed deviation of certain millibars dependent on the desired underpressure in the ink reservoir.

[0007] In a preferred embodiment said pressure applying means comprises at least one buffer reservoir. Said buffer reservoir is adapted to enclose a (gaseous) medium with a certain (under)pressure which communicates with the gaseous volume within the ink reservoir. In this manner it is also possible to achieve a desired underpressure and/or overpressure in the ink reservoir without making use of a conventional pump. The volume of the buffer reservoir can be either constant, preferably of between 1 and 20 litre, or can be adjustable. In the latter embodiment the capacity of the buffer reservoir can be adjusted, for example by means of a plunger. In a particular preferred embodiment said buffer reservoir is positioned between said ink reservoir and said pump. In this case, the buffer reservoir can be applied to absorb pumping pulses generated by the pump to avoid (extreme) fluctuation of the internal pressure within the ink reservoir. Moreover, the buffer reservoir can act as surrogate pump in case the actual pump is turned off for example due to a power breakdown, or in case the actual pump is temporary switched to a standby mode, for example between two print sessions. Preferably, said buffer reservoir is isolatable from the communication between the pump and the ink reservoir, for example in case a temporary overpressure needs to be applied to the ink reservoir for rinsing the ink reservoir. Isolation of the buffer reservoir from the pump and the ink reservoir can be realised by means of a switch, in particular a pneumatic or eventually hydraulic or electronic switch. In an alternative embodiment it is conceivable to apply multiple buffer reservoirs, wherein, for example, each printhead may be in communication with a separate buffer reservoir. In this manner, the pressure per printhead can be regulated more precisely and even independent of the pressures prevailing in the other printheads.

[0008] The invention also relates to an ink jet printer according to the preamble, characterized in that said gas volume is connected to an apparatus according to the invention.

[0009] While the printhead of an ink jet printer is generally mounted on a moving carriage, the pressure control apparatus is preferably mounted on a stationary frame of the printer and is preferably connected to the ink reservoir on the printhead through a flexible hose. Application of a flexible hose commonly increases the degree of freedom of design of the inkjet printer, whereas the deformation of the hose will easily be adapted to the mutual orientation of the printhead(s) on one side and the apparatus according to the invention on the other side. If the printhead comprises a plurality of ink reservoirs, for example in a colour printer, all ink reservoirs may, however not necessarily, be connected to same pressure control apparatus.

[0010] In a preferred embodiment the pressure control apparatus is mounted on a moving carriage of the printer, and the pressure applying means for withdrawing or adding gas from respectively to the ink reservoir is driven by the relative movement of the carriage and supporting structure of the printer carrying said moving carriage. In this manner a relatively advantageous printer construction can be obtained.

[0011] The invention further relates to a method for controlling pressure in an ink reservoir of an ink jet printer, comprising the steps of : A) applying a certain pressure to an ink reservoir by a pressure applying means communicating with said ink reservoir, B) electronically monitoring the actual pressure in the ink reservoir by a electronic pressure sensor, and C) adjusting the pressure monitored by the electronic pressure sensor in case this monitored pressure exceeds a certain value. Advantages to apply this method according to the invention have been elucidated above in a comprehensive manner.

[0012] The invention can further be illustrated by way of the following non-limitative embodiment, wherein:

figure 1 shows a schematic view of a preferred embodiment of an assembly of multiple printheads and an apparatus for controlling the pressure in said printheads according to the invention.

[0013] Figure 1 shows a schematic view of a preferred embodiment of an assembly 1 of multiple printheads 2 and an apparatus 3 for controlling the pressure in said printheads according to the invention. The apparatus 3 comprises a membrane pump 4, the capacity of which can be adjusted by way of applying variable frequencies to the pump 4. The pump 4 is adapted for generating an overpressure and/or an underpressure and is in communication with ink reservoirs incorporated in said printheads 2. Both an overpressure conduit 5 and an underpressure conduit 6 are coupled to a diverter valve 7, the latter being adapted to apply either an overpressure or an underpressure in said ink reservoirs. Under normal printing conditions a critical underpressure in the ink reservoirs is required of about between 5 and 20 millibar, wherein the diverter valve 7 is switched such, that the ink reservoirs are in communication with the underpressure conduit 6, and wherein the overpressure conduit 5 is dead-ended (not connected). Between the diverter valve 7 and the printheads 2 an electronic pressure sensor 8 is provided to electronically detect the pressure in the ink reservoirs. Electronically detecting the internal pressure within the ink reservoirs electronically is constructively relatively simple, relatively durable, and therefore relatively cheap. The apparatus 3 further comprises a control unit (not shown) for controlling the pump capacity of the membrane pump 4 dependent on the pressure in the ink reservoir monitored by the electronic pressure sensor 8. The underpressure conduit 6 is in communication with a buffer chamber 9 with a predetermined volume of preferably between 1 and 20 litre. The buffer chamber 9 encloses a (vacuous) space having a multilateral functionality. The buffer chamber 9 is adapted to absorb sub-

stantially (under)pressure pulses generated by the membrane pump 4, such that undesired pressure fluctuations in the ink reservoirs can be prevented. Moreover, said buffer chamber 9 can act as autonomous suction device for, at least temporarily, maintaining the critical underpressure in the ink reservoirs in case the membrane pump 4 is not running, for example due to a power breakdown. The buffer chamber 9 can be fully isolated by means of the diverter valve 7 on the one side and an non-leakage valve 10, the latter being positioned in the underpressure conduit 6 between the pump 4 and the buffer chamber 9. In case of a power breakdown, or at least in case the membrane pump 4 is turned off during a printing operation the non-leakage valve 10 can be switched, thereby disconnecting the membrane pump 4 from the printheads 2, and hence preventing leakage of gas, preferably air, from the buffer chamber 9 to the membrane pump 4. During a printing operation the diverter valve 7 is already switched towards the underpressure conduit 6, as a result of which the critical underpressure in the ink reservoirs can be maintained at least temporary. Switching the diverter valve 7 and the non-leakage valve 10 can be realised either pneumatically, hydraulically or electronically by the control unit. The apparatus 3 further comprises an underpressure restriction 11 to prevent excessive underpressure in the ink reservoirs during printing, and an overpressure restriction 12 to prevent excessive overpressure in the ink reservoirs during purging.

Claims

1. Apparatus for controlling pressure in an ink reservoir of an ink jet printer, comprising:

   - pressure applying means for applying a pressure in the ink reservoir, the pressure applying means communicating with the ink reservoir via a first conduit,
   - a buffer reservoir communicating with the ink reservoir via a second conduit different from the first conduit,
   - detecting means for monitoring the actual pressure in the ink reservoir, the detecting means comprising at least one electronic pressure sensor, and
   - controlling means for controlling the pressure applying means dependent on the actual pressure monitored by the detecting means.

2. Apparatus according to claim 1, wherein the pressure applying means comprises at least one pump, the capacity of the pump being adjustable.

3. Apparatus according to claim 2, wherein the pump is formed by a membrane pump.

4. Apparatus according to any preceding claim, wherein the second conduit connects the buffer reservoir with the first conduit at a location between the pressure applying means and the ink reservoir.

5. Apparatus according to any preceding claim, wherein the volume of said buffer reservoir is adjustable.

6. Ink jet printer comprising a printhead with an ink reservoir containing liquid ink and a gas volume above the level of the ink, **characterised in that** said gas volume is connected to an apparatus according to any of the preceding claims.

7. Ink jet printer according to claim 6, wherein the apparatus is mounted on a stationary frame of the printer and is connected to the moving printhead by a flexible hose.

8. Ink jet printer according to claim 7, wherein the pressure control apparatus is mounted on a moving carriage of the printer, and the pressure applying means for withdrawing or adding gas from respectively to the ink reservoir is driven by the relative movement of the carriage and supporting structure of the printer carrying said moving carriage.

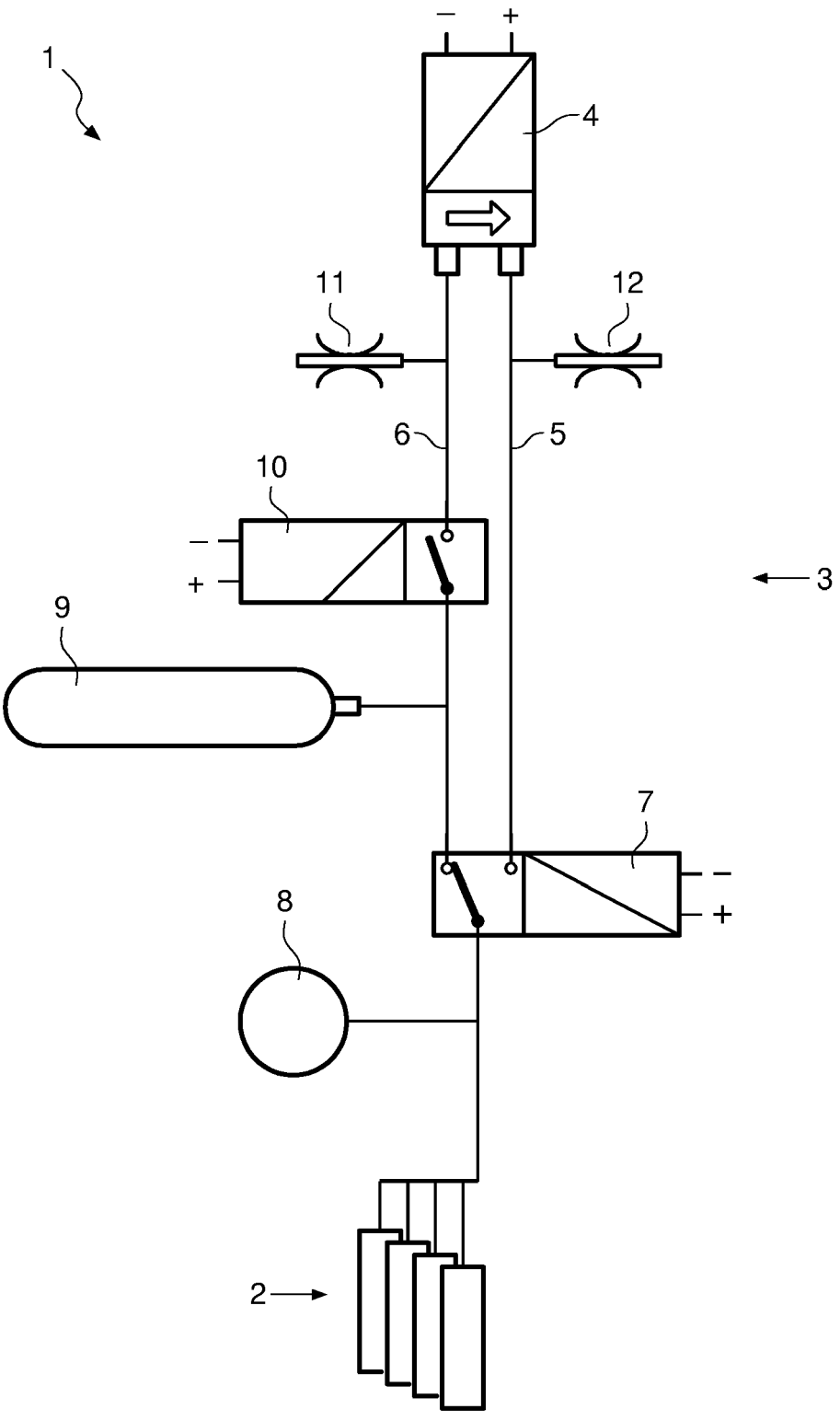

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 11 1015

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 290 343 B1 (LEWIS RICHARD H ET AL) 18 September 2001 (2001-09-18) * column 13, line 10 - column 19, line 39; claim 1; figures 1A,16,17 *	1	B41J2/175
A	US 2002/097284 A1 (VOSAHLO JINDRICH) 25 July 2002 (2002-07-25) * paragraphs [0045], [0046], [0050], [0051]; claims 1,3,9,16 *	1	
A	EP 1 415 816 A (HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P) 6 May 2004 (2004-05-06) * paragraphs [0010], [0012], [0013], [0016], [0030], [0032], [0035], [0046] *	1	
A	US 2002/089576 A1 (ISHIZAWA TAKU ET AL) 11 July 2002 (2002-07-11) * paragraph [0181] - paragraph [0197] *	1	
			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
The Hague	2 March 2006	Van Oorschot, J

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 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 11 1015

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.

02-03-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6290343 B1	18-09-2001	NONE	
US 2002097284 A1	25-07-2002	AT 277768 T	15-10-2004
		DE 60014354 D1	04-11-2004
		DE 60014354 T2	24-11-2005
		EP 1177103 A1	06-02-2002
		WO 0068018 A1	16-11-2000
EP 1415816 A	06-05-2004	JP 2004148822 A	27-05-2004
		US 2004085412 A1	06-05-2004
US 2002089576 A1	11-07-2002	US 2002093556 A1	18-07-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82