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(54) Colour ink-jet print head

(57) A colour ink jet printhead (40) comprises a tank (60) for the ink, either integrated in the head or interchangeable type, asymmetrically divided into three compartments (41, 42, 43) respectively containing a yellow ink, a magenta ink, and a cyan ink; the amount of yellow ink is proportionally greater than the amount of each of the other two inks, and is equivalent to a percentage of between 40 and 60 % of the total amount of ink contained in the tank.

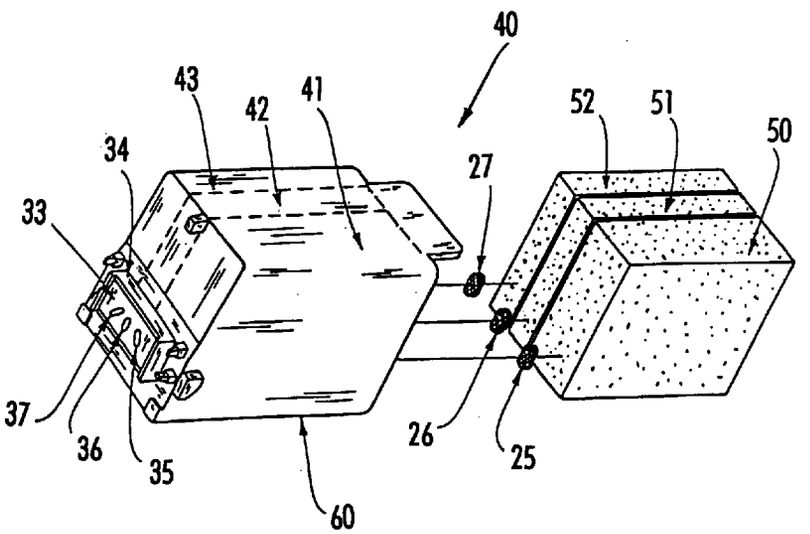

FIG. 2

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Description

TEXT OF THE DESCRIPTION

Background of the invention - The invention relates to a printhead used in equipment for producing black and colour images on a printing medium, usually though not exclusively a sheet of paper, by means of the thermal type ink jet technology, and, more particularly, to a head provided with a tank containing the inks, whether of the type that is integrated in the head itself, or of the interchangeable type.

State of the art - Equipment of the type described above is known in the art, such as for instance printers, photocopying machines, facsimile machines, etc., and in particular, printers used for producing a printout of a document through printing means generally taking the form of fixed or interchangeable printheads.

The composition and general mode of operation of an ink jet printer, as also those of the associated ink jet printhead, are already widely known in the sector art, and will not therefore be described in detail herein, the description accordingly being limited to a more detailed account of some characteristics of relevance to the understanding of the present invention.

A typical ink jet printer schematically comprises:

- a system, selectively actuated by a motor, for the feeding of the sheet of paper upon which the image is to be printed, such that the feeding occurs in a given direction in discrete steps (line feed),
- a movable carriage, sliding on ways in a direction perpendicular to that of feeding of the sheet, selectively driven by a motor to accomplish an outward motion and a return motion across the entire width of the sheet itself,
- printing means, generally, for example, a printhead removably affixed to the carriage, comprising a plurality of emission resistors deposited on a substrate (usually a silicon wafer) and arranged inside cells filled with ink, individually connected to a corresponding plurality of nozzles, through which the head is able to emit the droplets of ink contained in a tank,
- an electronic controller which, on the basis of the information received from a computer it is connected to and of the presettings effected by the user, selectively controls both the above-mentioned motors and the printhead, causing therein, through the selective heating of the resistors, the emission of the droplets of ink against the surface of the sheet, generating a visible image thereon.

The printheads, as previously stated, in addition to the emission resistors, also comprise a tank containing a certain amount of ink, a tank that may be an integral part of the head, in the case of the so-called monobloc or disposable heads; or it may be interchangeable being removably fitted on the head, in the case of the so-called refillable type heads. The tank in the heads for colour printing, irrespective of which of the types described above they belong to, is generally divided into at least three independent compartments not in communication with each other, each containing one of the three primary colours, yellow, magenta and cyan: a typical example of a printhead of this type is described in detail in the US Patent No. 4,771,295.

Partially represented in Fig. 1 is a printhead 10 according to the principles of the cited Patent, with enlarged view's of its characteristic components; in particular, a body 20 of the tank of ink is shown, internally comprising three identical tank compartments 21, 22 and 23, as indicated by the dashed lines drawn on the exterior of the body 20. The body 20 also comprises a support surface 33 to which is affixed the printhead true and proper (not shown in the figure), or head for generation of the droplets of ink, which bears the components (resistors) for the generation of the bubbles of ink and the nozzles through which the droplets of ink are emitted. The support surface 33 is bounded by side walls 34 and is provided with three passages 35, 36 and 37 for the ink and which communicate respectively with the three tank compartments 21, 22 and 23.

Three capillary sponge bodies 30, 31 and 32 of similar dimensions and chemical/physical characteristics, impregnated respectively with yellow, magenta and cyan ink, are inserted in the corresponding tank compartments 21, 22 and 23. Also fitted in the latter-named are three ink filters 25, 26 and 27, typically made of stainless steel meshing, for filtering any air bubbles or solid impurities when the ink flows from the sponge bodies 30, 31 and 32 towards the three passages 35, 36 and 37.

Colour heads that are divided into four independent compartments are also known in the art, the fourth compartment containing a black ink, or into five independent compartments, the fifth compartment containing a further black ink of a different type from the previous one. In any case, however, the amounts of ink of the three primary colours contained in the tank are substantially the same.

Taking as an example the case of the colour head 10, illustrated in Fig. 1, with the tank containing the three inks of the primary colours, yellow, magenta and cyan, when even one of these tuns out, either the entire head (for the monobloc heads) or the entire tank (for the refillable heads) must necessarily be substituted, even though there is still a certain, sometimes even considerable, amount of ink of the other two colours remaining: this results in a waste which is reflected in a higher cost per printed page.

Summary of the invention - The object of the present invention is to define a colour ink jet printhead that considerably reduces the problem of wastage of heads (or of tanks still partly full) due to one of the three primary colours running out before the other two.

Another object of the invention is to define a colour ink jet printhead in which the tank of primary inks (whether incorporated or interchangeable type) contains a greater amount of one of the coloured inks, in particular yellow, than that of each of the other two.

It has in fact been found experimentally that, in the average, current practice, over a wide range of different colour images to be printed, the yellow ink is always the first to run out. A thorough verification designed to produce numerical data on this phenomenon was conducted by the inventor adopting the following method of procedure:

- first, a specimen was defined of digitalized images selected from those commercially available in a variety of different graphic formats as "copyright free" collections stored on CD-ROM;
- next, for each of the above-mentioned images, a print file was obtained, using a normal print driver program commercially available for a colour ink jet printer, for example the OliChrome® driver for Windows '95™ of the Olivetti Lexikon JP 790 printer,
- the print file thus obtained was analysed by a specific program for breaking the image down into the three colour planes - yellow, magenta and cyan and, for each plane, the total number of pixels was counted (and thus the number of droplets of yellow, cyan and magenta ink respectively required for printing of the image in question).

The results of the verification carried out showed that, on average, the number of droplets of yellow ink required to print the specimen of images varies between 40 and 60% of the total number of droplets of the three primary colour inks, yellow, magenta and cyan, for an average of about 50%.

Therefore, a colour ink jet printhead, characterized as defined in the main claim, is capable of fully achieving the above objects.

These and other objects, characteristics and advantages of the invention will become clear from the following description of a preferred embodiment, provided by way of a non-exhaustive example, with reference to the accompanying drawings.

LIST OF THE FIGURES

Fig. 1 - is a schematic representation of a partial enlarged view of a colour printhead according to the known art.

Fig. 2 - is a schematic representation of a partial enlarged view of a colour printhead according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 2 is a schematic representation of a partial enlarged view of a colour printhead 40 of the monobloc type according to the invention, similar in construction to the known head 10 of Fig. 1 and wherein the same parts have been given the same numbering as the head 10; the head 40 comprises a body 60 of an integrated tank internally divided into three tank compartments 41, 42 and 43 respectively housing sponge bodies 50, 51 and 52, each of which containing, by capillary means, a yellow ink, a magenta ink and a cyan ink, in the order cited.

The volume of the sponge body 50, and correspondingly the amount of yellow ink contained therein by capillary means, is substantially double the volume of the sponge bodies 51 and 52, which are substantially the same; similarly, the volume of the tank compartment 41 of the tank 20 is substantially double the volume of the tank compartments 42 and 43, which are substantially the same. Accordingly, if we indicate with Q the total amount (understood as the volume of liquid) of ink of the three primary colours yellow, magenta and cyan contained in the body 60 of the tank, the following equations may be obtained:

$$Q_{yellow} \cong 0.5\,Q; \quad (1)$$

$$Q_{magenta} \cong Q_{cyan} \cong 0.25\,Q, \quad (2)$$

where Q_{yellow} represents the amount of yellow ink in the tank compartment 41, $Q_{magenta}$ represents the amount of magenta ink in the tank compartment 42, and Q_{cyan} represents the amount of cyan ink in the tank compartment 43.

As in the case of the head 10 of Fig. 1, the ink contained in the sponge bodies 50, 51 and 52 passes through the corresponding filters 25, 26 and 27, and subsequently by means of the three passages 35, 36 and 37, reaches the ink droplet generating head (not shown in the figure) which bears the components (resistors) for the generation of the ink bubbles and the nozzles through which the said ink droplets are emitted.

The greater amount of yellow ink contained in the printhead 40 compensates for the greater amount of this ink consumed during the printing of a plurality of colour images, with the result that the three primary inks, yellow, magenta and cyan, run out substantially simultaneously, in this way, use of the ink contained in the tank is optimized and the actual duration of the head is increased, with obvious economic advantages for the user.

Naturally changes may be made to the invention described above, without exiting from the scope of the invention.

For example, it is possible to modity the relative percentages of yellow ink with respect to the other two primary inks within a range with a lower limit as defined by the following equations:

$$Q_{yellow} \cong 0.4\,Q; \quad (3)$$

$$Q_{magenta} \cong Q_{cyan} \cong 0.3\,Q, \quad (4)$$

and an upper limit as defined by the following equations:

$$Q_{yellow} \cong 0.6\,Q; \quad (5)$$

$$Q_{magenta} \cong Q_{cyan} \cong 0{,}2\,Q, \quad (6)$$

Or, again within a range in which

$$0.4\,Q \leq Q_{yellow} \leq 0.6\,Q, \quad (7)$$

the remaining portion of ink contained in the tank may be divided into non-equal parts between magenta ink and cyan ink.

It is also possible to apply the principle of the invention to a printhead in which the body 60 of the tank is removably affixed to the head true and proper, thus representing an interchangeable tank.

It is also possible to apply the principle of the invention to an ink jet printhead that comprises, as well as the coloured inks, one or more black inks, whether physically and chemically compatible with the coloured inks or not.

It is also possible to apply the principle of the invention to a printhead provided with a tank, whether of the integrated or removable type, in which the ink is contained not in a sponge body by capillary means, but in a housing of rigid or flexible walls, such a container being either completely bereft internally of capillary elements (for example, sponges, felt, nibs or non-woven textiles) or filled only partially with the latter.

Finally it is possible to apply the principle of the invention to an ink jet printhead that uses the piezoelectric, rather than thermal, technology for the generation of the bubbles of ink.

In short, without prejudice to the principle of the present invention, the construction details and forms of embodiment may be amply varied with respect to those described and illustrated in the foregoing, without exiting from the scope of the invention.

Claims

1. Colour ink jet printhead (40) comprising a tank (60) of said ink, said tank having a body divided internally into a plurality of tank compartments, a first compartment (41) of said plurality of compartments containing a first amount Q_{yellow} of a yellow ink, a second compartment (42) of said plurality of compartments containing a second amount $Q_{magenta}$ of a magenta ink, and a third compartment (43) of said plurality of compartments containing a third amount Q_{cyan} of a cyan ink, characterized by the fact that said first amount Q_{yellow} of said yellow ink, said second amount $Q_{magenta}$ of said magenta ink, and said third amount Q_{cyan} of said cyan ink are such that the following relation is true:

$$0.4 \leq \frac{Q_{yellow}}{(Q_{yellow}+Q_{magenta}+Q_{cyan}} \leq 0.6$$

2. Printhead according to claim 1, characterized by the fact that the following relation is true:

$$\frac{Q_{yellow}}{(Q_{yellow}+Q_{magenta}+Q_{cyan}} \cong 0.5$$

3. Printhead according to claim 1, characterized by the fact that said first amount Q_{yellow} of said yellow ink, said second amount $Q_{magenta}$ of said magenta ink, and said third amount Q_{cyan} of said cyan ink are contained by capillary means inside corresponding spongy bodies (50, 51, 52).

4. Printhead according to claim 1, characterized by the fact that said first mount Q_{yellow} of said yellow ink, said second amount $Q_{magenta}$ of said magenta ink, and said third amount Q_{cyan} of said cyan ink are contained inside a housing (60) with rigid walls.

5. Printhead according to claim 4, characterized by the fact that said housing (60) is filled at least partially with capillary elements (50, 51, 52).

6. Printhead according to claim 1, characterized by the fact that said first amount Q_{yellow} of said yellow ink, said second amount $Q_{magenta}$ of said magenta ink, and said third amount Q_{cyan} of said cyan ink are contained inside a housing with flexible walls.

7. Printhead according to claim 1, characterized by the fact that said second amount $Q_{magenta}$ of said magenta ink and said third amount Q_{cyan} of said cyan ink are substantially the same.

8. Printhead according to claim 1, characterized by the fact that said tank (60) is integrated in said head.

9. Printhead according to claim 1, characterized by the fact that said tank is removably affixed to said head, so that it may be substituted when one of said inks runs out.

10. Printhead according to claim 1, also comprising a droplet generating head, characterized by the fact that said droplet generating head is of the thermal type.

11. Printhead according to claim 1, also comprising a droplet generating head, characterized by the fact that said droplet generating head is of the piezoelectric type.

12. Printhead according to claim 1, characterized by the fact that said tank also comprises a fourth tank compartment containing a first black ink.

13. Printhead according to claim 12, characterized by the fact that said tank also comprises a fifth tank compartment containing a second black ink, different from said first black ink.

14. Printhead according to claim 12, characterized by the fact that said first black ink is physically and chemically compatible with said yellow ink, with said magenta ink and with said cyan ink.

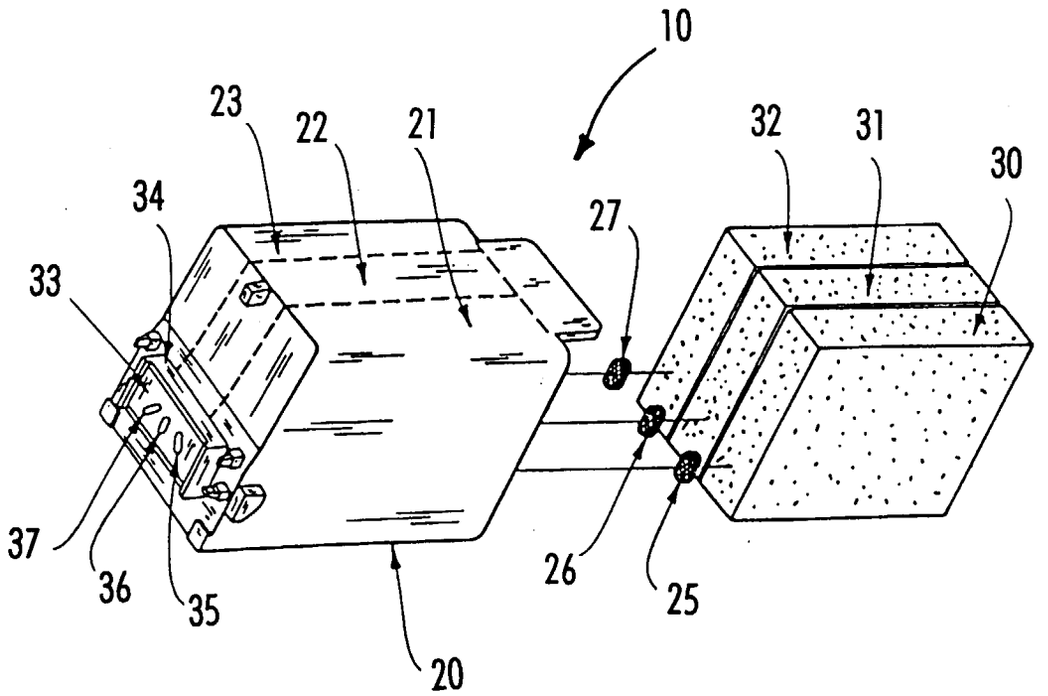
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FIG. 1

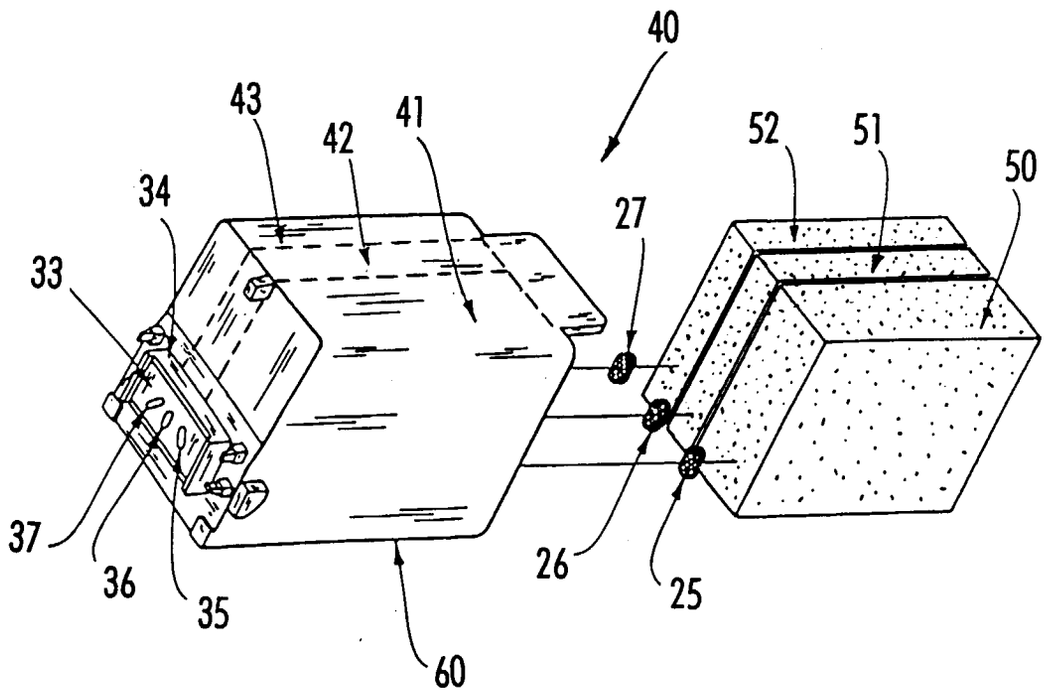
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FIG. 2