Bubble Ink-Jet Technology with Improved Performance

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The drop-on-demand ink jet technology is without doubt one of the most interesting printing technologies today and is certainly the printing technology with the highest growth rate on the market.

Never before has such high quality been achieved at such a low cost.

Its reliability, the possibility of writing on many "normal papers", and the ease of colour printing complete the picture.

There are however some critical points; to mention some:

• quality is high, but at times still below that of electrophotographic printing technology; to obtain a similar quality it is often necessary to take certain precautions (e.g., short distance between printhead and paper) which create problems for the manufacturers.

• ink drying time is rather high and again creates problems in paper management.

In the attempt to improve these aspects we developed a new concept which as given promising results.

The basic idea consisted of better distributing the ink on the paper, by using more, smaller droplets.

An obvious method would be to greatly increase the resolution, but this approach leads to considerable increases in the cost of both the printer and the printhead.

Furthermore the printhead becomes much more complex.

We therefore decided to utilize several nozzles for each pressure chamber, so that a fine shower of ink is deposited on the paper.

The technology used was the thermal ink jet on demand, also called bubble, in the top-shooter version.

Various tests were carried out, with 2, 3, 4 or more nozzles for each pressure chamber, as shown below:

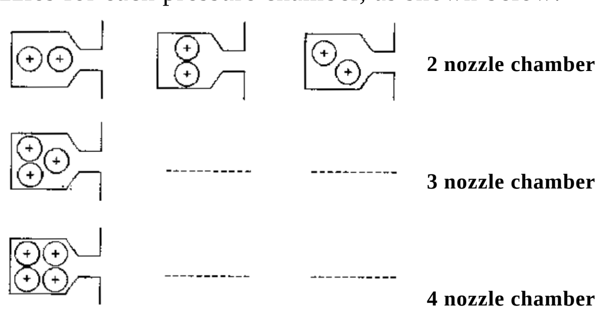

Figure 1.

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with one or two resistors for each pressure chamber, in series or in parallel.

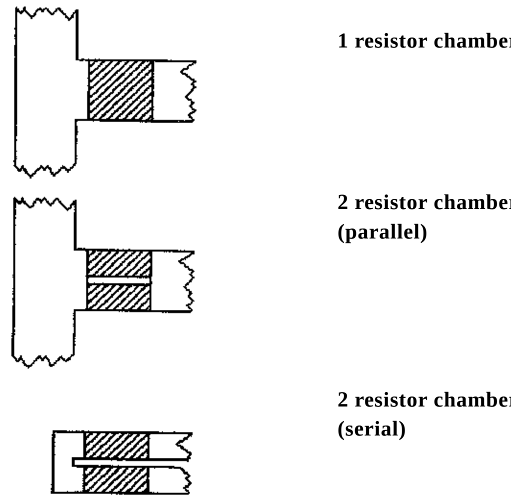

Figure 2.

The dimensions and the distances between nozzles are selected so that the droplets are emitted and travel separately (although not independently) but slightly overlap on the paper to form the elementary dot, for example the dot of a printout at 300 dots per inch.

The first interesting result is that it is possible to obtain shapes other than round on the paper.

This is remarkable, since it is known that only round spots can be obtained with a single nozzle, whatever its shape.

For example, utilizing a version with four nozzles per pressure chamber, a square elementary dot can be obtained.

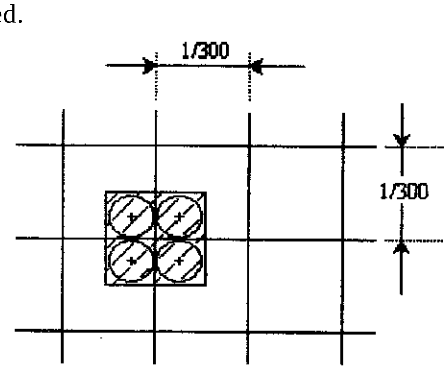

Figure 3.

With square dots it is also easier to completely cover an area using less ink than with round dots.

The ink saving obtained is not very great (seems to be around 15 %) but, considering that the relationship between volume of ink and drying time is not linear, there is a considerable advantage in drying time.

Using square dots it is also easier to obtain good linearity in the shades of grey.

If we consider the comparison between the minimum dimensions of round and square dots to obtain complete overlapping:

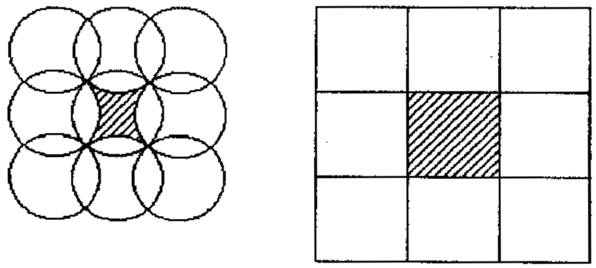

Figure 4.

it is quite evident that, while the blank area which remains if dots are eliminated is proportional to the number of square dots missing, in the case of round dots this is not so.

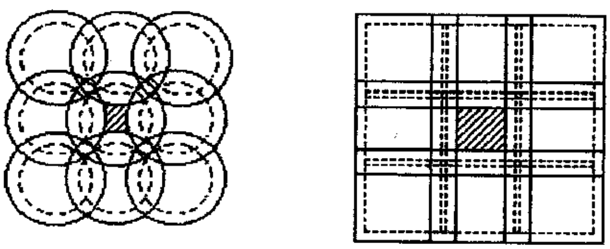

Figure 5.

In reality, since dots are normally bigger than the theoretical minimum dimensions, the phenomenon is even more evident.

Therefore it is normal that, utilizing round dots and wishing to ensure a high degree of black, the relationship between optical density and percentage of printed dots, which ideally should be a straight line, tends towards saturation.

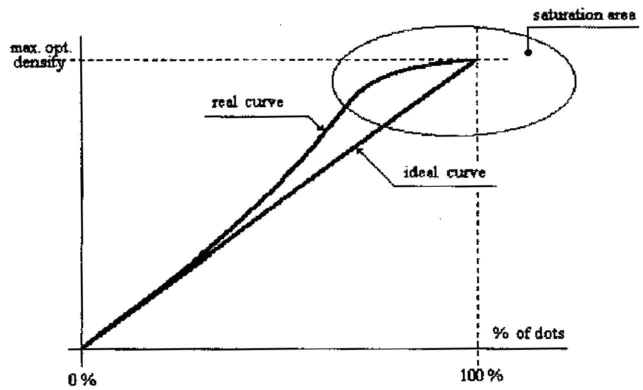

Figure 6.

It is much easier to follow the ideal curve using square dots.The second result obtained has been an increase in the dot ejection rate.

Mainly due to the fact that the nozzles are smaller and therefore have higher capillarity, it has been possible to increase the frequency from 5000 to 7500 set of droplets/sec. for each actuator.

The hydraulic tuning between the entrance duct and the outlet nozzles is however rather complex and requires a lot of experimentation.

In conclusion, combining the above mentioned advantages it has been possible, at laboratory level, to achieve a printing system with higher throughput and better printing quality.