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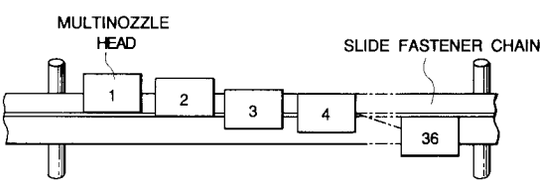
## (54) Ink jet printer for continuously travelling belt shaped article.

(57) An ink jet printer, equipped with a number of multinozzle heads each having n number of nozzles at regular spaces of p mm, for printing color patterns or symbols in a width of w (mm) onto a continuously travelling belt shaped article, wherein the total quantity of the multinozzle heads is w/(nXp) pairs, the nozzles of each of the multinozzle heads being arranged in a direction perpendicular to the direction of travel of the belt shaped article, all of the multinozzle heads being positioned successively along the path of travel of the belt shaped article, the nozzles of each pair of the multinozzle heads being shifted down by 0.5Xp (mm), the nozzles of all of the multinozzle heads being staggered so as not to overlap one another transversely of the path of travel of the belt liked article.

FIG. 1

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## BACKGROUND OF THE INVENTION

### 1. Field of the Invention:

The present invention relates to an ink jet printer for sequentially printing color patterns or characters onto the surface of a continuous length of belt shaped article running continuously.

### 2. Description of the Related Art:

Printing by ink jet printers differs from that of, for example, subliming heat transfer and melting heat transfer in that it has a variety of benefits which are expected to be applicable to a wide range of fields.

These main benefits are as follows. Firstly, this type of printing is known as the "non-contact type" of printing, as the printer does not come into contact with the surface being printed. This means that in addition to being able to print reliably onto flat surfaces, the printer can also print directly onto rough or highly flexible surfaces. Secondly, as the surface to be printed is printed directly the apparatus can be simple as no transfer or fixing is required. Thirdly, simple colors in addition to fluorescent or special colors can be faithfully reproduced with little color shift and can be clearly printed.

There are, however, practical limitations such as detrimental effects caused by dirt and air bubbles which are very difficult to remove as are fluctuations in the environment which will also effect the printing adversely. At the same time it is also necessary to increase the speed and clarity of the printing.

It has been proposed to increase the speed of printing by increasing the number of nozzles as with a full multi head where there are 1792x4 nozzles in one head. There have also been various proposals as to how to increase the degree of clarity such as, to take one example, an oscillating piezo element whereby the size of the ink particle diameter is decreased.

Various kinds of technology have been put forward for use in ink jet printers. However, the full multi head, for example, lacks the desired overall qualities. As well as being expensive, it is also difficult to maintain and the applications for it, as such, are somewhat limited. Therefore, its application to specific fields other than, for example, cut paper, is not practical, and its properties do not extend as far as to encompass application to the field of color printers.

Even though ink jet printers have the benefits described above, they cannot be applied to woven fabrics such as fashionable articles, production brand clothing and bags. This is because from a production point of view the print efficiency it not of the standard required and they are too expensive. It is necessary for the printers to be able to handle successive printing and cope with the differing widths which various woven fabrics to be printed on will have. It is also necessary for them to be able to cope with a continuous or substantially endless length, they should be capable of high speeds to increase production and should cope with changes in width easily.

For the case of an ink jet printer where the head dot density is 180 dpi (dots per inch) and a 4x4 matrix is used to give a tonal range of 16, a dot will have a side length of 0.14 mm and a picture element from the 16 tonal range 4x4 matrix will have a side length of 0.14x4 = 0.56 mm. When printing a picture element, two nozzles are moved 0.56 mm across the width of the surface to be printed while printing at the same time, after which they are sent a distance equal to one dot length 0.14 mm along the length of the surface to be printed. The two nozzles are then sent back the 0.56 mm along the width of the surface to be printed while printing at the same time. By using a multinozzle head with a total of 48 nozzles, 12 nozzles for each color to give 4 colors, when this head is moved backwards and forwards across the width of the surface to be printed a distance of 0.56 mm, a width of 3.36 mm ( = 0.56 x 12/2 ) will be printed at a time.

Therefore, even using the usual nozzle head to its limits a print width of 3.36 mm cannot be exceeded. Also, driving machinery is necessary to move the head backwards and forwards the 0.56 mm distance across the printing width when printing a picture element which makes the construction more complicated. In addition to this, the surface being printed can only move forward a distance of 0.14 mm during this process, which greatly restricts the print speed to a degree which renders it unsuitable for manufacturing processes.

Although it is possible to make progress with regards to removing the need for backwards and forwards movement and increasing the print speed by using the full multi head described previously, as mentioned previously these heads are expensive. More particularly, as there is a great deal of variation in the width and handling, the kind of system design required to adapt to the needs of types of woven textiles must overcome many problems. As there are also other points such as the troublesomeness of the maintenance of such equipment this equipment is not suitable for production and manufacturing.

## SUMMARY OF THE INVENTION

It is therefore the object of the present invention to forward an ink jet printer employing a mul-

tinozzle head which can sequentially print on belt shaped woven articles in an efficient manner.

According to this invention, there is provided an ink jet printer, equipped with a number of multinozzle heads each having n number of nozzles at regular spaces of p mm, for printing color patterns or symbols in a width of w (mm) onto a continuously travelling belt shaped article, wherein the total quantity of the multinozzle heads is w/(nXp) pairs, the nozzles of each of the multinozzle heads being arranged in a direction perpendicular to the direction of travel of the belt shaped article, all of the multinozzle heads being positioned successively along the path of travel of the belt shaped article, the nozzles of each pair of the multinozzle heads being shifted down by 0.5Xp (mm), the nozzles of all of the multinozzle heads being staggered so as not to overlap one another transversely of the path of travel of the belt liked article.

With this printer, partly since each nozzle head have n number of nozzles at regular spaces of p mm and partly since there are w/(nXp) pairs of the multinozzle heads in total, it is possible to simplify the printer structure and realize an improved printing speed, which is 2w/(nXp) times that of the conventional printer using only one similar multinozzle head movable back and forth transversely of the belt shaped article by a drive means.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an outline plan view of an example arrangement of the fixed multinozzle heads for the ink jet printer in the present invention;

FIG. 2 is a side view of that shown in FIG. 1;

FIG. 3 is an outline view of the way in which the picture elements output by the ink jet printer usually make up a picture; and

FIG. 4 is a view illustrating the operation of the nozzle during the formation of one picture element for the printer of FIG. 3.

## DETAILED DESCRIPTION

The following is a description with the aid of the diagrams of an embodiment of an ink jet printer for printing onto the surface of a slide fastener of width 60 mm (w). Here, FIG. 1 is an outline plan view of an example arrangement of the fixed multinozzle heads for the ink jet printer in the present invention, FIG. 2 is a side view of that shown in FIG. 1, FIG. 3 is an outline view of the way in which the picture elements output by the ink jet printer usually make up a picture and FIG. 4 is a view describing the operation of the nozzle during the formation of one picture element for the printer of FIG. 3.

The ink jet printer used employs a multinozzle head which; gives a dot density of 180 dpi; uses a 4x4 matrix to give a tonal range of 16; has a nozzle constant (n) of 12, giving 12 nozzles for each color; and has 4 colors, giving a total of 48 nozzles.

In ink jet printers where the dot density is 180 dpi and a 4x4 matrix is used to give a tonal range of 16, the fact that there are 180 dots within one inch means that if the dot is square then the length of one side will be 1 inch/180, which is equal to 25.4 mm/180, which means one side will be 0.14mm long. The dot spacing (p) will then be 0.28 mm (0.14x2). As is shown in FIG. 3, one picture element will have side of length 0.56 mm although this will depend on the use of a 4x4 matrix to give a tonal range of 16.

In order to print the entire width of a slide fastener chain of width 60 mm (w) at the same time with one color it would be necessary to have 60/0.14 = 428 nozzles. For four colors, 428x4 = 1712 nozzles would be necessary. As one multinozzle head has a nozzle constant n of 12 ( that is to say 12 nozzles ), if 428/12 = approximately 36 multinozzle heads are used it will be possible to print all 60 mm of the slide fastener at the same time.

Here, the nozzle spacing within one head (p) is 0.28 mm, that is to say, twice the side length of the dots (0.14 mm). Usually, when printing one picture element using a 4x4 matrix to give a tonal range of 16, as is shown in FIG. 4, if the surface which is being printed on is moved forward the width of one dot, two nozzles would be moved backwards and forwards a distance of 0.56 mm (0.14x4) in a direction at right angles to the direction of movement of the surface which is being printed on. This would enable the overall number of nozzles to be reduced by half to 214 and the number of multinozzle heads to be reduced to 18. However, this means that it becomes necessary to provide driving machinery to move the heads backwards and forwards. This not only makes the overall construction more complex, but also makes it difficult to reduce its size or to increase its speed.

Also, as the overall dimensions of the surface of one multinozzle head are 100 mm by 100 mm, the size of one multinozzle head alone will exceed the 60 mm width of the slide fastener chain.

Therefore, in this invention 36 multinozzle heads have been designated to be necessary to cover the 60 mm width of the slide fastener chain. These 36 multinozzle heads are arranged sequentially in pairs diagonally across the slide fastener chain in the manner shown in FIGS. 1 and 2. With regards to each pair of multinozzle heads, one of the pair will be placed at a distance equal to the dot side length of 0.14 mm which is half that of the nozzle spacing (0.14x2) down from the other of the

pair across the width of the slide fastener chain. In this way no two nozzle positions of two multinozzle heads will coincide with each other.

It follows that in the ink jet printer in this invention, the 36 multinozzle heads are arranged along the 360 mm length of the slide fastener chain. Also, with regards to each pair of multinozzle heads, one of the pair will be placed at a distance equal to the dot side length of 0.14 mm which is half that of the nozzle spacing (0.14x2) down from the other of the pair across the width of the slide fastener chain. Additionally, each pair of multinozzle heads will be placed at a distance of 3.36 mm (= 0.14x2x12 mm) down from the preceding pair of multinozzle heads across the width of the slide fastener chain.

This invention is not necessarily limited to the head arrangement shown in the diagrams whereby the multinozzle heads are arranged sequentially in pairs diagonally across the slide fastener chain. Any arrangement where the multinozzle heads are arranged along the length of the slide fastener chain in such a way as to cover the width of the chain without any two multinozzle heads coinciding with each other would also be suitable.

By adopting a construction such as the one in this invention employing 36 nozzle heads it becomes possible to produce an ink jet printer which is both inexpensive and capable of printing at high speeds. For example, an ink jet printer which adopts the method of moving six multinozzle heads such as the one used in this invention backwards and forwards across the width of a slide fastener chain to print the width of the chain instantaneously would take four minutes to print an area equivalent to an A4 size (20 cm x 30 cm). This means that this method would print a total of 270 m of slide fastener chain in 15 hours. The ink jet printer in this invention, however, does not require any driving machinery to move it backwards and forwards. It can therefore print 9800 m of slide fastener chain in 15 hours, which is 36 times faster than the conventional printer.

It therefore follows that at least 100,000 high quality graphically detailed printed fasteners of a continuous length can be produced per month which is 1580 m of tape printed per day. Although it would have taken 6 of the conventional printers which move the multinozzle heads backwards and forwards, this can be achieved using just one of the machines made according to the present invention.

As becomes clear from the above explanation, the ink jet printer according to the present invention is practical, while at the same time can sequentially print a continuous belt shaped article both inexpensively and at a high speed and yet can still achieve a very high level of production output.

## Claims

1. An ink jet printer, equipped with a number of multinozzle heads each having n number of nozzles at regular spaces of p mm, for printing color patterns or symbols in a width of w (mm) onto a continuously travelling belt shaped article, wherein the total quantity of said multinozzle heads is w/(nXp) pairs, said nozzles of each of said multinozzle heads being arranged in a direction perpendicular to the direction of travel of the belt shaped article, all of said multinozzle heads being positioned successively along the path of travel of the belt shaped article, said nozzles of each pair of said multinozzle heads being shifted down by 0.5Xp (mm), said nozzles of all of said multinozzle heads being staggered so as not to overlap one another transversely of the path of travel of the belt liked article.

FIG. 1

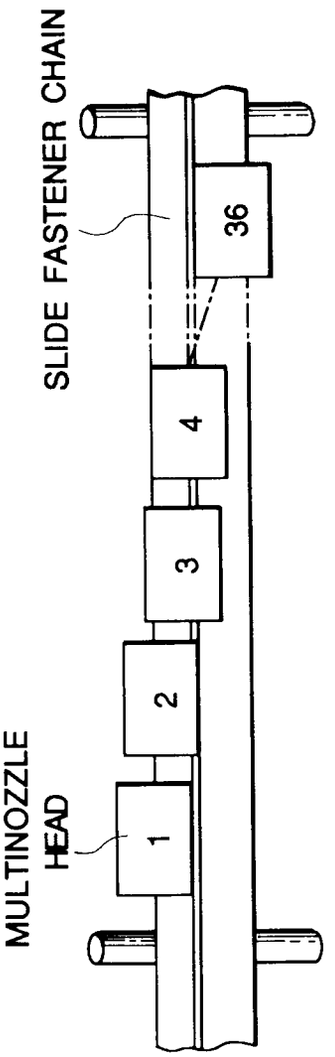


FIG. 2

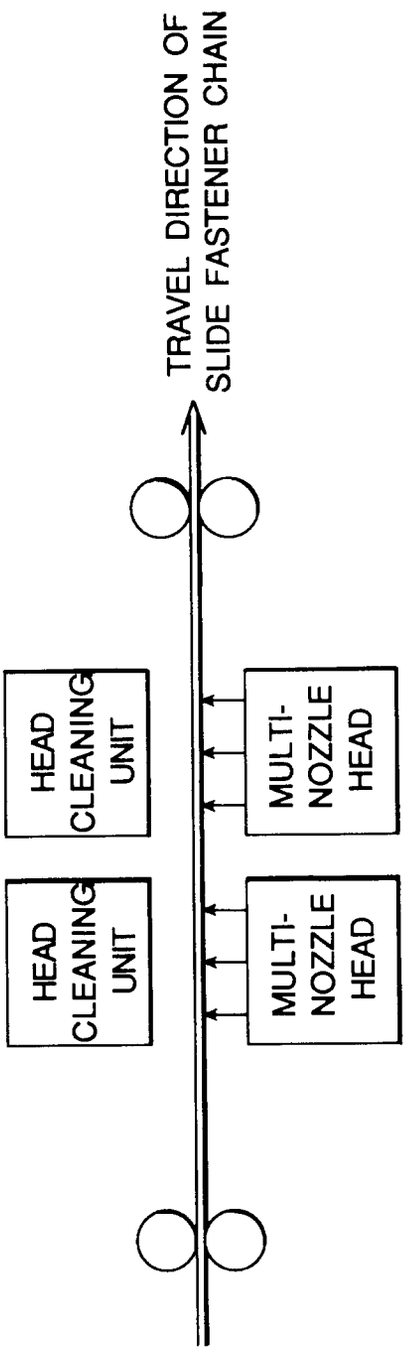
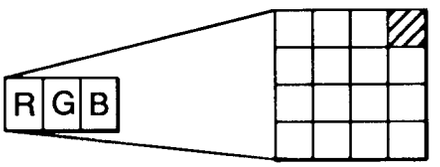

TRAVEL DIRECTION OF SLIDE FASTENER CHAIN
HEAD CLEANING UNIT
MULTI-NOZZLE HEAD
HEAD CLEANING UNIT
MULTI-NOZZLE HEAD

FIG. 3




CRT ; INPUT PICTURE ELEMENT

PRINTER ; OUTPUT PICTURE ELEMENT

FIG. 4