

PATENT SPECIFICATION (11)

1 541 641

1 541 641

- (21) Application No. 33504/76 (22) Filed 12 Aug. 1976 (19)
(31) Convention Application No. 677 987 (32) Filed 19 April 1976 in
(33) United States of America (US)
(44) Complete Specification published 7 March 1979
(51) INT. CL.² B41J 7/70
(52) Index at acceptance
B6F NB



(54) WIRE MATRIX PRINTER

(71) I, CHAN HUE YEH, a citizen of the United States of America, of c/o 1031 E. East Duane Avenue, Sunnyvale, California 94086, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to wire matrix printers, for example a wire matrix printer which is particularly adapted for printing Chinese characters.

15 The invention is an improvement over my prior U.S. Patent 3,820,644 which issued 28 June 1974 and entitled "System for the Electronic Data Processing of Chinese Characters", the disclosure of which is incorporated herein by reference. In that patent
20 there is described a matrix print head comprising 24 pieces of fine wire, such as stainless steel wire of 0.010" diameter, each of which is operatively connected to a wire pin and wire driver which, in turn, is electrically
25 connected to a buffer storage means so that each of the print wires can be actuated to a buffer storage means so that each of the print wires can be actuated electromechanically and electronically. The wires are arranged in a line corresponding to one
30 column of each digitized Chinese character and can be actuated simultaneously so that one column of dots forming part of a character can be printed simultaneously. There are, however, problems with a matrix head
35 which is provided with 24 individual wires. Firstly, there is the high cost involved in the construction of a 24 wire print head using tungsten steel wire with individual electro-mechanical actuating mechanisms
40 and secondly, the large space required for such a head makes it impractical to produce a small size printer.

45 It will be appreciated that although matrix print heads are well known in the prior art, generally for use in printing the regular Roman alphabet and Arabic numerals, such print heads have limited applicability for printing Chinese characters because of the
50 much larger number of wires necessary to ensure adequate definition of the complex

characters. Normal print heads are generally designed to form a matrix of, say, five vertical columns of seven points each, and even this matrix is sometimes insufficient to produce upper and lower case characters at the same time. Efforts have therefore been made to increase the number of print wires or to move the print wires to a second location for a second printing step. Illustrative of such efforts is U.S. Patent 3,759,359 issued 18 September 1973 to Stellmach, wherein the matrix head is provided with five vertical columns of seven points each and is pivotally mounted on a carriage moveable in the direction of printing with an electromagnet on the carriage which attracts an armature plate on the matrix head to tilt the head downwardly to allow printing in a second position which is displaced from the first two by spaces, thereby effectively extending the matrix to a 5 × 9 matrix and generally permitting both upper and lower case Roman letters to be printed as desired. In practice letters requiring points in either positions 1—7 or positions 3—9 can be produced by the Stellmach device and it will be appreciated that the downward tilt must be precisely two spaces in order to achieve symmetry of the letters produced, any deviation therefrom resulting in an irregular line of printing which is not pleasing to the eye. The Stellmach system is not, however, particularly adapted or suitable for high definition printing of the vastly more complicated Chinese characters.

According to the present invention there is provided a wire matrix printer which comprises:

(a) elongate guide means parallel to a line of printing;

(b) a carriage slidably mounted on said guide means for movement in the direction of printing;

(c) a printer head pivotally mounted on said carriage and tiltable in a plane perpendicular to said direction of printing;

(d) a plurality of recording elements arranged in said printer head and adapted to be operated selectively for moving their recording ends into and out of engagement

18

with a record medium to thereby print a selected linear pattern of character elements forming part of a character to be printed; and

5 (e) means for selectively pivoting said printer head to displace the recording ends of said recording elements between first and second printing positions; and wherein the distance between centres of adjacent recording element ends is not greater than twice the diameter of each said recording element end, and the distance between said first and second printing positions is not greater than the diameter of each said recording element end so that a substantially continuous solid line pattern is produced when all said recording elements are operated sequentially in said first and second printing positions.

20 The invention also provides a method of printing with a wire matrix printer as set forth in the preceding paragraph, comprising the steps of:

25 (a) operating said printer head in said first printing position so that a selected combination of said recording elements prints a first selected linear pattern of character elements;

30 (b) pivoting said printer head to said second printing position; and

35 (c) operating said printer head in said second printing position so that a selected combination of said recording elements prints a second selected linear pattern of character elements which are interspersed between the character elements of said first linear pattern.

40 An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

45 Figure 1 is a perspective view of a Chinese matrix printer according to my prior U.S. Patent;

Figure 2 is a schematic diagram showing the electrical connection between the buffer and a matrix print head according to my prior U.S. patent;

50 Figure 3 is a side view of the matrix print head of Figure 2;

Figure 4 is a schematic diagram of the structure inside the print head of Figure 3 comprising 24 pieces of fine wire with only one piece of printing wire being shown for clarity;

Figure 5 is a sketch of a Chinese character "Pei", meaning "north";

60 Figure 6 is a sketch of the Chinese character Pei as it would be printed using the matrix printer of Figure 2;

Figure 7 is a sketch of the Chinese character Pei as it would be printed using a matrix printer according to the present invention;

Figure 8 is a cross sectional view of a 12 wire print head in the printer;

Figure 9 is a close-up view of a wire used in a preferred embodiment of the print head;

Figure 10 is a sketch showing the column produced by the first printing operation using the print head of Figure 8; and

Figure 11 is a sketch showing the column produced after the second printing operation using the print head of Figure 8.

Referring to Figure 1, there is shown a perspective view of a Chinese matrix printer according to my aforesaid United States patent, in which a paper 141 which is to have characters printed thereon is inserted around a roller 142 rotated in response to printing head 144 reaching the end of each row and contained in body 143 of the printer. It is appreciated that the matrix print head 144 is an essential part of the system.

As shown in Figure 2, matrix print head 144 comprises 24 pieces of fine wire 150 (only two of which are shown), such as stainless steel wire, with a diameter of 0.010", each having a wire pin 152 and wire drive 153 (see also Figure 4). Each wire 150 is operatively connected to its associated wire pin 152 which is actuated by wire driver 153 which is, in turn, electrically connected to buffer storage means in a display unit (not shown) the buffer storage means here being designated 146, through register 147 by conductors 148-148 and 145-145. They are operated in response to signals from buffer storage means 146 (see Figure 2), wherein "a" and "b" represent 20 points on a row and 24 points in a column of the matrix grid, respectively.

In this way, each of the print wires can be actuated electromechanically and electronically. Twenty four pieces of wire are arranged in a line corresponding to one column of each digitized Chinese character (see Figure 3). In particular, the ends 151 of wires 150 (as viewed in Figure 3 from the ends of wires 150) represent a column of 24 grid points of a digitalized character. In other words, all of the wires are actuated simultaneously and one column of dots forming part of a character is printed simultaneously. When less than all the wires are actuated, only parts of the column are printed. Thus, matrix print head 144 will print the digitalized Chinese character one column at a time from left to right. The data for dots in the column, which together form the pattern of a character and number of characters to be printed per line, is obtained from display buffer storage means 146.

Figure 4 shows a schematic diagram of a single printer wire 150 within print head 144, one end of which is free and normally held in the surface of the printing head out

(19)

of contact with the surface of paper 141 by the force of spring 154 between retainer 155 and a flange on a wire pin 152. A stop 156 on wire pin 152 limits movement of wire pin 152, and thus wire 150, away from the paper 141. A wire driver 153 is mounted on a support member 157. When wire driver 153 is actuated for example by solenoid or fluidic means, wire pin 152 and wire 150 are pushed, and end 151 of wire 150 projects out of surface of print head 144 and into contact with the surface of paper 141 to form a dot as part of the pattern in accordance with the data obtained from display buffer storage means 146.

It should be pointed out that the scale of the print head shown in Figure 4 is considerably enlarged for the purpose of clarity. In practice, each wire is about 0.010" in diameter and the total length of the line of 24 pieces of wire would be about 0.24". In a length of $\frac{1}{4}$ " for the line of wires there is some clearance for the lubrication of the wires.

There are two conventional styles of writing Chinese documents. One is horizontally from left to right and then from top to bottom. The other is vertically from top to bottom and then from right to left. The CPU is programmed for supplying data for the character to the buffer storage means 146 in either style, and the proper program is selected by pressing "vertical" or "horizontal" buttons on a keyboard.

If the vertical style is selected, the matrix printer will print the document as if it is for horizontal style except one character from each vertical line is printed and then from left to right. As far as the printer is concerned, it is not aware of which style is to be or being printed, for it simply follows the bit pattern in the display buffer storage means 146. The pattern in which the data is placed in the buffer storage means 146 determines the style.

Figure 5 shows the Chinese character "Pei" which means north and Figure 6 shows how this character appears when it has been digitalized, i.e. the points on the grid are represented in binary form with the points occupied by dots having one binary form and the unoccupied points having the other binary form, and converted into a hexadecimal form in conventional manner, using the print head of my aforesaid U.S. Patent. In contrast thereto, Figure 7 shows the appearance of Pei when reproduced using the modified 12-wire print head in a printer according to the present invention.

As has been previously indicated the print head 201 (see Figure 8) in a printer according to the present invention is provided with only 12 wires 202 instead of the 24 wires 150 of the print head shown in

Figure 4, because of the high costs associated with the production of the complicated head of Figure 4, the multiplicity of electro-mechanical actuating mechanisms and the difficulty of making a small compact unit. It has also been found that the relatively small diameter of the wires 150 (0.01") result in considerable maintenance problems, which can be at least partially overcome by the 12 wire system which employs 0.0125" or even larger diameter wires as will be described in more detail hereinafter.

A side sectional view of a preferred 12 wire matrix head is shown in Figure 8 and shows a tiltable head 201 containing 12 wires 202 connected to wire actuating mechanisms 203. The 12 wires 202, 0.0125" in diameter are preferably spaced 0.02" apart on centres so that upon actuation of all mechanisms 203 a column as shown in Figure 10 is produced. Solenoid 204 may then be actuated to cause the head 201 to tilt downward by an amount of 0.01", against the action of return spring 205, and upon a second actuation of mechanisms 203 a second column of 12 points interspersed between the points of the first actuation is produced as shown in Figure 11. After the second actuation the return spring 205 causes the head to return to the normal or first position. It will be appreciated that because the distance between centres of the 24 dots produced is 0.01" and the diameter of the wire is 0.0125", the printed odd number points or dots and the even number points or dots overlap each other thereby providing, when all 24 points are printed, a substantially continuous solid line pattern which is superior to the pattern printed by the 24 wire print head of the prior art, because the ends of the 24 wires are placed next to each other, with just sufficient spacing to allow for lubrication and the like, so that no overlap of printed points is possible. The definition of the product of the 12-wire print head operated in the two printing positions is superior and highly desirable for such complicated forms as Chinese characters.

It will be appreciated that although each column which makes up the Chinese character may be printed in two sequential printing steps described hereinabove, it is preferred to print a line of Chinese characters using the 12-wire print head by printing all the odd number points across the line for each character from left to right and then tilt the head downwardly to print even number points for each character from right to left. Thus, the number of print head tilt movements is reduced and the return motion of the print head from right to left is utilized to print even numbered points

of all characters, thus effecting a substantial improvement in printer performance.

In a still more preferred embodiment of this invention the print wires 202 are made from 0.014" diameter wire which is superior in strength and handling characteristics, but which is rather too thick to provide the high resolution which is possible and desirable when using 0.012" diameter wire. The solution to this problem, when enables the best utilization of all properties, is to grind the tip of each 0.014" diameter wire to 0.012" as shown in Figure 9. It is preferred that the grinding should be effected in two stages from 0.014" to 0.013" and then to 0.012" as shown in Figure 9. It will of course be appreciated that many other modifications may be made within the scope of the appended claims, for example, although the present invention has been described with particular reference to preferred wire diameters such diameters are not critical to the operability of the invention provided always that the defined ratios between the wire diameter and the spacing between the wires is substantially maintained.

WHAT WE CLAIM IS:—

1. A wire matrix printer which comprises:

(a) elongate guide means parallel to a line of printing;

(b) a carriage slidably mounted on said guide means for movement in the direction of printing;

(c) a printer head pivotally mounted on said carriage and tiltable in a plane perpendicular to said direction of printing;

(d) a plurality of recording elements arranged in said printer head and adapted to be operated selectively for moving their recording ends into and out of engagement with a record medium to thereby print a selected linear pattern of character elements forming part of a character to be printed; and

(e) means for selectively pivoting said printer head to displace the recording ends of said recording elements between first and second printing positions; and wherein the distance between centres of adjacent recording element ends is not greater than twice the diameter of each said recording element end, and the distance between said first and second printing positions is not greater than the diameter of each said recording element end so that a substantially continuous solid line pattern is produced when all said recording elements are operated sequentially in said first and second printing positions.

2. A wire matrix printer as claimed in claim 1 and adapted to print Chinese characters.

3. A wire matrix printer as claimed in

claim 1 or claim 2 wherein twelve said recording elements are provided in said printer head to thereby provide a capacity of twenty-four recording element end printing positions when said print head is operated in said first and second positions.

4. A wire matrix printer as claimed in any preceding claim wherein said plurality of recording elements comprises a plurality of steel wires each having a diameter in the range of from 0.010 inches to 0.014 inches.

5. A wire matrix printer as claimed in claim 4 wherein the diameter of each said wire is 0.014 inches and the recording end thereof is ground to a diameter of 0.012 inches.

6. A method of printing with a wire matrix printer as claimed in any one of claims 1 to 5 comprising the steps of:

(a) operating said printer head in said first printing position so that a selected combination of said recording elements prints a first selected linear pattern of character elements;

(b) pivoting said printer head to said second printing position; and

(c) operating said printer head in said second printing position so that a selected combination of said recording elements prints a second selected linear pattern of character elements which are interspersed between the character elements of said first linear pattern.

7. A method as claimed in claim 6 wherein said printer head is:

(a) successively slidably advanced along said guide means and selectively operated in said first printing position to produce a plurality of said first linear patterns;

(b) pivoted to said second printing position; and

(c) successively slidably returned along said guide means and selectively operated in said second printing position to produce a plurality of said second linear patterns of character elements aligned with and interspersed between the character elements of pertinent said first linear patterns.

8. A method as claimed in claim 6 and substantially as described herein with reference to Figs. 7 to 11 of the accompanying drawings.

9. A wire matrix printer substantially as described herein with reference to Figs. 7 to 11 of the accompanying drawings.

MICHAEL BURNSIDE & PARTNERS,
Chartered Patent Agents,
Hancock House,
87 Vincent Square,
London SW1P 2PH.
Agents for the Applicants.



of all characters, thus effecting a substantial improvement in printer performance.

In a still more preferred embodiment of this invention the print wires 202 are made from 0.014" diameter wire which is superior in strength and handling characteristics, but which is rather too thick to provide the high resolution which is possible and desirable when using 0.012" diameter wire. The solution to this problem, when enables the best utilization of all properties, is to grind the tip of each 0.014" diameter wire to 0.012" as shown in Figure 9. It is preferred that the grinding should be effected in two stages from 0.014" to 0.013" and then to 0.012" as shown in Figure 9. It will of course be appreciated that many other modifications may be made within the scope of the appended claims, for example, although the present invention has been described with particular reference to preferred wire diameters such diameters are not critical to the operability of the invention provided always that the defined ratios between the wire diameter and the spacing between the wires is substantially maintained.

WHAT WE CLAIM IS:—

1. A wire matrix printer which comprises:

- (a) elongate guide means parallel to a line of printing;
- (b) a carriage slidably mounted on said guide means for movement in the direction of printing;
- (c) a printer head pivotally mounted on said carriage and tiltable in a plane perpendicular to said direction of printing;
- (d) a plurality of recording elements arranged in said printer head and adapted to be operated selectively for moving their recording ends into and out of engagement with a record medium to thereby print a selected linear pattern of character elements forming part of a character to be printed; and

(e) means for selectively pivoting said printer head to displace the recording ends of said recording elements between first and second printing positions; and wherein the distance between centres of adjacent recording element ends is not greater than twice the diameter of each said recording element end, and the distance between said first and second printing positions is not greater than the diameter of each said recording element end so that a substantially continuous solid line pattern is produced when all said recording elements are operated sequentially in said first and second printing positions.

2. A wire matrix printer as claimed in claim 1 and adapted to print Chinese characters.

3. A wire matrix printer as claimed in

claim 1 or claim 2 wherein twelve said recording elements are provided in said printer head to thereby provide a capacity of twenty-four recording element end printing positions when said print head is operated in said first and second positions.

4. A wire matrix printer as claimed in any preceding claim wherein said plurality of recording elements comprises a plurality of steel wires each having a diameter in the range of from 0.010 inches to 0.014 inches.

5. A wire matrix printer as claimed in claim 4 wherein the diameter of each said wire is 0.014 inches and the recording end thereof is ground to a diameter of 0.012 inches.

6. A method of printing with a wire matrix printer as claimed in any one of claims 1 to 5 comprising the steps of:

(a) operating said printer head in said first printing position so that a selected combination of said recording elements prints a first selected linear pattern of character elements;

(b) pivoting said printer head to said second printing position; and

(c) operating said printer head in said second printing position so that a selected combination of said recording elements prints a second selected linear pattern of character elements which are interspersed between the character elements of said first linear pattern.

7. A method as claimed in claim 6 wherein said printer head is:

(a) successively slidably advanced along said guide means and selectively operated in said first printing position to produce a plurality of said first linear patterns;

(b) pivoted to said second printing position; and

(c) successively slidably returned along said guide means and selectively operated in said second printing position to produce a plurality of said second linear patterns of character elements aligned with and interspersed between the character elements of pertinent said first linear patterns.

8. A method as claimed in claim 6 and substantially as described herein with reference to Figs. 7 to 11 of the accompanying drawings.

9. A wire matrix printer substantially as described herein with reference to Figs. 7 to 11 of the accompanying drawings.

MICHAEL BURNSIDE & PARTNERS.
Chartered Patent Agents,
Hancock House,
87 Vincent Square,
London SW1P 2PH.
Agents for the Applicants.