United States Patent [19]

Hurd, III et al.

[11] **3,814,227**

[45] **June 4, 1974**

[54] **MATRIX PRINT ROTATION**

[75] Inventors: **Edward T. E. Hurd, III,** Cinnaminson, N.J.; **David M. Stern,** Merion Station, Pa.

[73] Assignee: **Honeywell Inc.,** Minneapolis, Minn.

[22] Filed: **Sept. 27, 1972**

[21] Appl. No.: **292,618**

[52] **U.S. Cl.** ..... **197/1 R**

[51] **Int. Cl.** **B41j 3/50**

[58] **Field of Search** ..... 197/1; 101/93 C; 340/172.5

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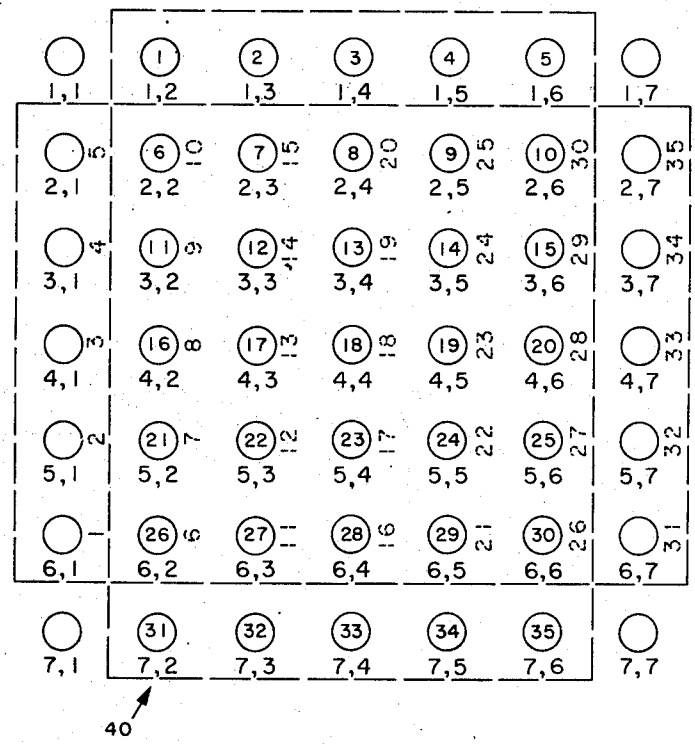
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Primary Examiner—Robert E. Pulfrey
Assistant Examiner—R. T. Rader
Attorney, Agent, or Firm—Arthur H. Swanson; Lockwood D. Burton; Mitchell J. Halista

[57] **ABSTRACT**

A printer using a matrix of printing elements arranged in a square configuration with the printing elements being used to print alpha-numeric data in either a vertical or horizontal orientation by electronically selecting a rectangular matrix from less than the full number of printing elements in the square matrix to permit selective orientation of the printed data without mechanically reorienting the print head. The print element drive circuitry also enables the printing matrix to print from either end of the selected rectangular print matrix in either the horizontal or vertical orientation to provide four possible orientations of the printed alpha-numeric data. A memory is used to store the input control signals for each of the rows of the rectangular printing matrix while a control means is provided for reading out the control signals in either direction from the memory in combination with a matrix selection control to provide energization of a rectangular print matrix in either the horizontal or vertical configuration.

10 Claims, 3 Drawing Figures



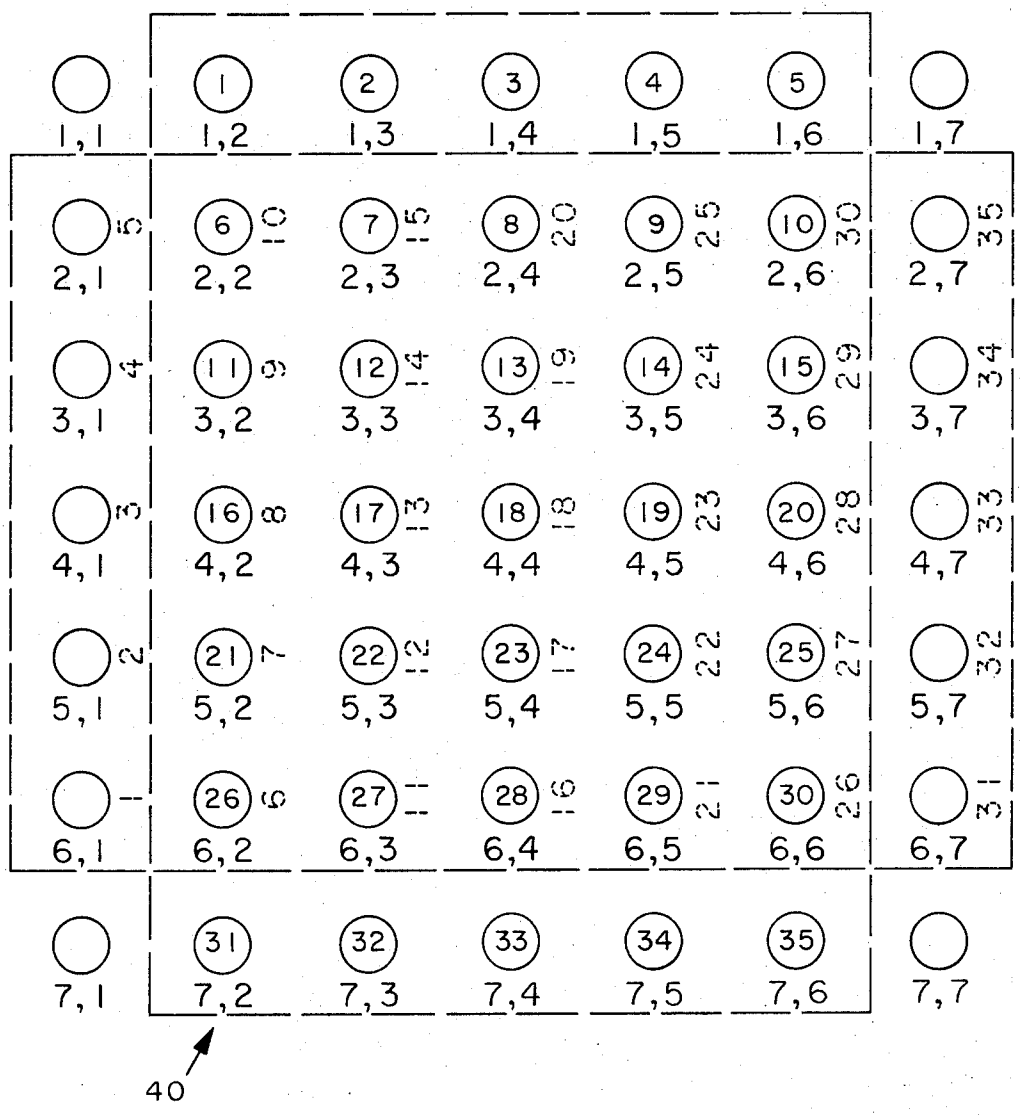

1,1
1
1,2
2
1,3
3
1,4
4
1,5
5
1,6
1,7
2,1
6
10
2,2
7
15
2,3
8
20
2,4
9
25
2,5
10
30
2,6
35
2,7
3,1
11
3,2
12
14
3,3
13
19
3,4
14
24
3,5
15
29
3,6
34
3,7
4,1
16
8
4,2
17
13
4,3
18
18
4,4
19
23
4,5
20
28
4,6
33
4,7
5,1
21
7
5,2
22
12
5,3
23
17
5,4
24
22
5,5
25
27
5,6
32
5,7
6,1
26
6
6,2
27
11
6,3
28
16
6,4
29
21
6,5
30
26
6,6
31
6,7
7,1
31
7,2
32
7,3
33
7,4
34
7,5
35
7,6
7,7
40

FIG. 1

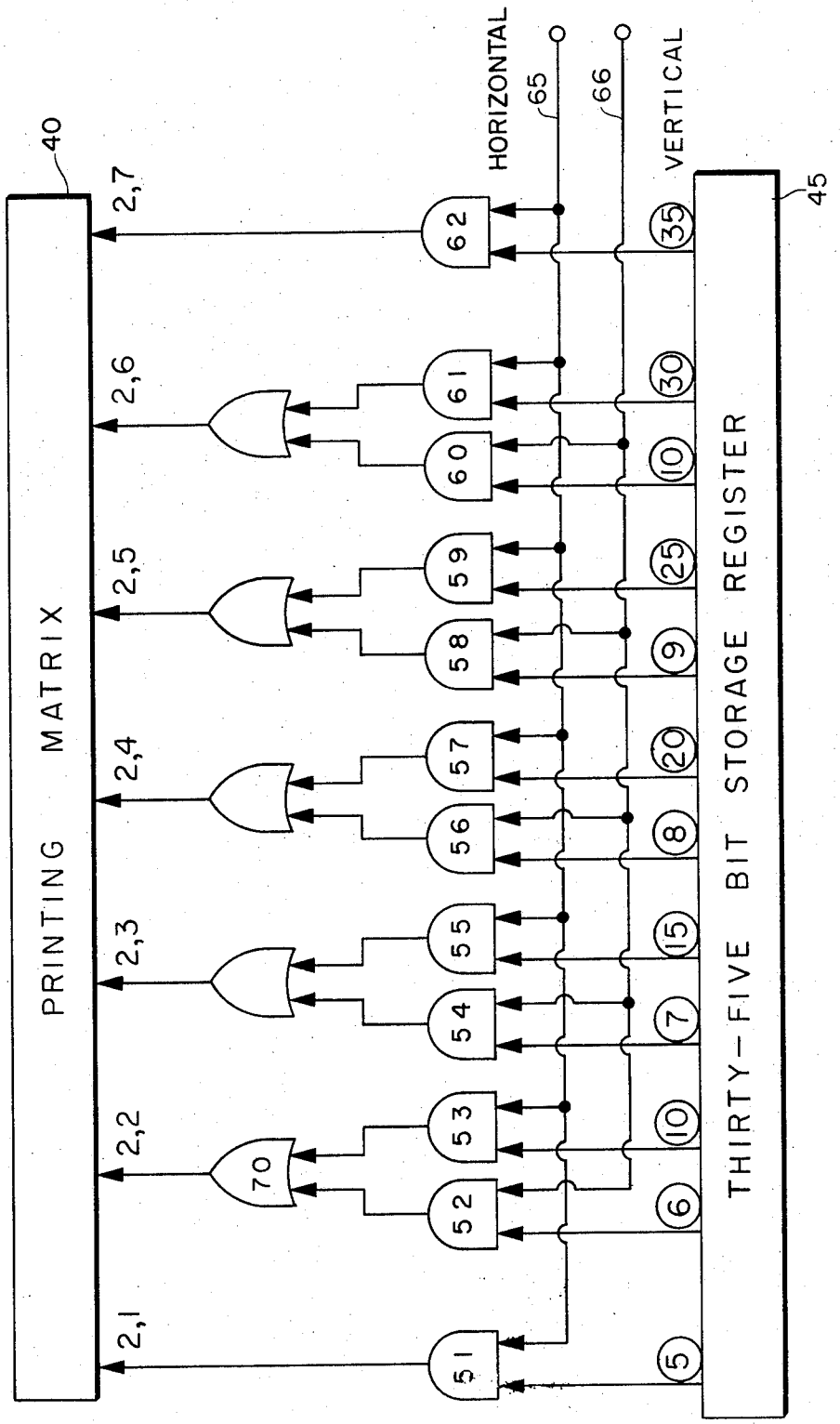
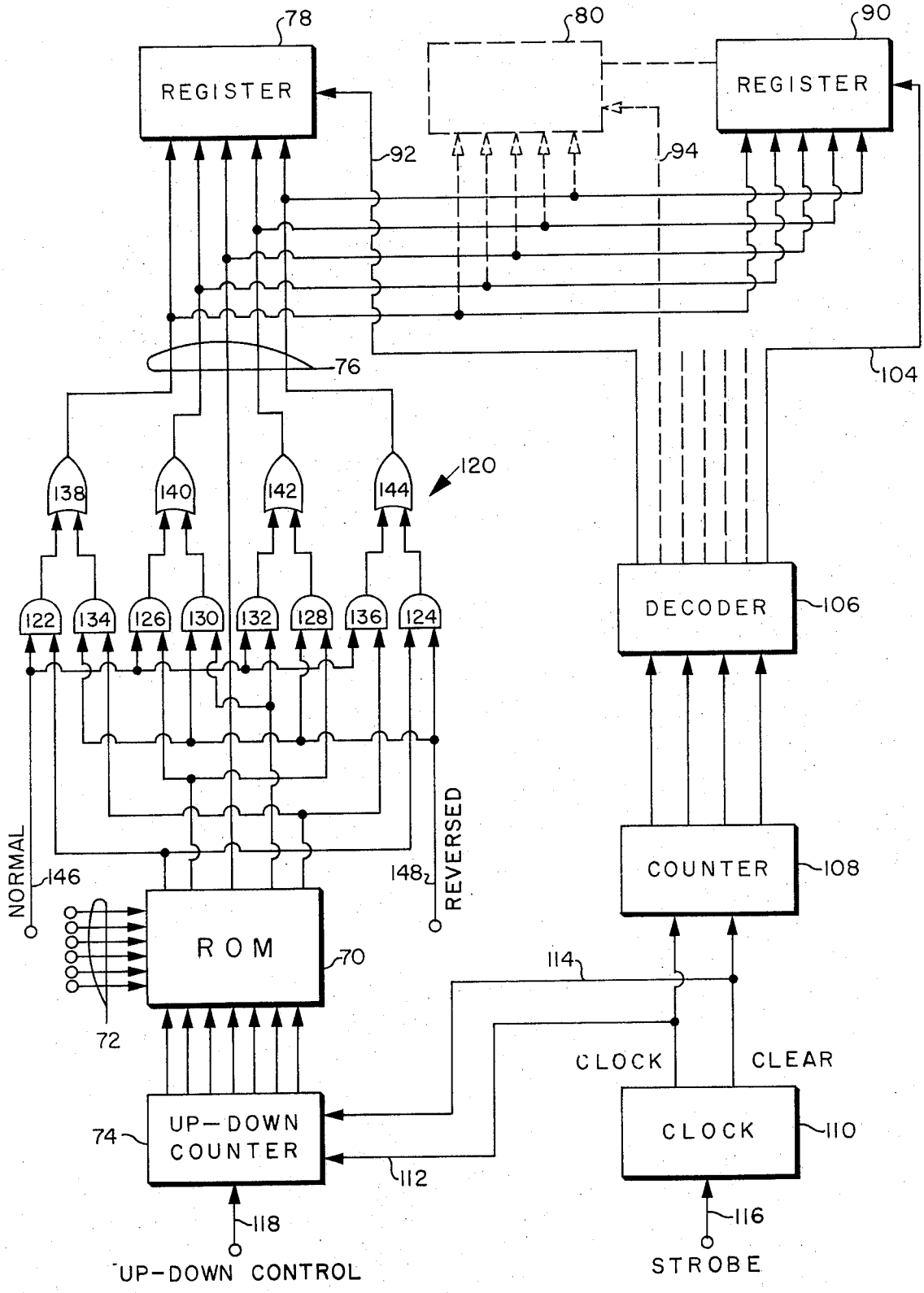

PRINTING MATRIX
40
2,7
2,6
2,5
2,4
2,3
2,2
2,1
HORIZONTAL
65
66
VERTICAL
45
THIRTY-FIVE BIT STORAGE REGISTER
62
61
60
59
58
57
56
55
54
53
52
51
70
35
30
10
25
9
20
8
15
7
10
6
5

FIG. 2

FIG. 3


78
REGISTER
80
90
REGISTER
92
94
76
104
120
138
140
142
144
122
134
126
130
132
128
136
124
DECODER
106
NORMAL
146
148
REVERSED
COUNTER
108
ROM
70
72
114
CLOCK
CLEAR
74
UP-DOWN COUNTER
112
CLOCK
110
116
118
UP-DOWN CONTROL
STROBE

MATRIX PRINT ROTATION

The present invention relates to printers. More specifically, the present invention relates to matrix-type printers.

An object of the present invention is to provide an improved matrix-type printer.

Another object of the present invention is to provide an improved matrix-type printer having a matrix print head capable of printing in one of four possible orientations without mechanically reorienting the print head.

SUMMARY OF THE INVENTION

In accomplishing these and other objects, there has been provided, in accordance with the present invention, a matrix printer having a print head arranged in a square configuration of print elements. A rectangular print matrix is formed from the square configuration of print elements by selecting less than all of the print elements of the square matrix. Thus, either a horizontal or vertical arrangement of the rectangular print matrix may be formed from the square matrix of print elements by a collection of the print elements from top to bottom or side to side of the square matrix, respectively. A memory is provided for storing the control signal to energize selected ones of the print elements in the desired rectangular configuration to form the alpha-numeric data to be printed. A control means for reading out the data from the memory is provided whereby the stored signals may be readout from the memory in either direction to enable the printed character to have either a normal or inverted orientation. Additionally, the control signals from the memory are applied to the rectangular printing matrix through a control means for routing the control signals to appropriate ones of the printing elements in response to a selection of a horizontal or vertical orientation of the rectangular print matrix. Thus, any one of four possible orientations of the printed alpha-numeric character can be selected by the combined control of the readout of the memory and the selective application of the control signals to the print elements in the rectangular printing matrix.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention may be had when the following detailed description is read in connection with the accompanying drawings in which:

FIG. **1** is pictorial illustration of a print head for a matrix printer,

FIG. **2** is a schematic illustration of a print matrix drive circuit embodying the present invention, and

FIG. **3** is a block diagram of a control circuit for the matrix drive circuit shown in FIG. **2.**

DETAILED DESCRIPTION

Referring to FIG. **1** in more detail there is shown a so-called 5 × 7 rectangular matrix print head **40** for use with the system of the present invention. The reference numbers **1** to **35** have been used in the drawing to designate the print elements of the print head **40,** which print elements may use any suitable well-known printing technique, e.g., thermal, spark, etc. The 5 × 7 print head **40** is derived from a larger 7 × 7 square matrix print head wherein the four corner printing elements

are not used. However, in FIG. **1** all of the printing elements of the larger 7 × 7 print head are identified by illustrative reference numerals with print head **1, 1** being the first printing element of the first vertical column and first horizontal column of the 7 × 7 print head with the numbers identifying the printing elements being sequentially arranged from left to right and with the first reference number for each print element identifying the horizontal row in the 7 × 7 matrix while the second number identifies the vertical column. Thus, the last element in the 7 × 7 matrix is identified as element **7, 7.** The vertical 5 × 7 rectangular print head is composed of the rows of print elements in the second to sixth columns, i.e., from element **1, 2** to element **7, 6.** On the other hand, the horizontal rectangular 5 × 7 print head is composed of the second to sixth horizontal rows of printing elements in all of the vertical columns, i.e., from element **2, 1** to element **6, 7.** The reference numerals of the printing elements with respect to the digital bits used to control the printing elements in the horizontal print head are shown in dotted form adjacent to the printing elements to distinguish their designation from the solid line reference number for the digital bit arrangement used for the vertical 5 × 7 print head.

In FIG. **2,** there is shown a schematic illustration of a portion of a suitable circuit for energizing the printing matrix **40** shown in FIG. **1.** The circuit shown in FIG. **2** is a partial representation for purposes of illustration and is directed to a print element energizing circuit for the second horizontal row from the printing element **2, 1** to printing element **2, 7** with other rows being energized by substantial duplicates of the circuit shown in FIG. **2.** A 35 bit storage register **45** is used to store a group of 35 bit digital control signals arranged to energize the printing matrix **40** for each alpha-numeric character. Generally, each of the printing elements can be energized by one of two digital control bits stored in the register **45** depending on the selection of either a vertical print matrix or a horizontal print matrix. The exceptions to this general rule are the first and second columns which are used only in the horizontal print matrix and the first and second rows which are used only in the vertical print matrix. Thus, using the partial circuit of FIG. **2,** the print element **2, 1** is driven only by a digital bit in the fifth storage stage of the storage register **45** and the print element **2, 7** is driven by digital bit in the 35 storage stage of the storage register **45.** The printing elements **2, 2** to **2, 6,** on the other hand, are used in both the horizontal and vertical print matrices and, accordingly, are each driven from either of two respective bit storage stages in the storage register **45.** For example, the printing element **2, 2** is driven by either a bit stored in the sixth or a bit stored in the tenth storage location in the storage register **45.** In order to use the stored bit for the desired print head orientation the storage stages of the storage register **45** which are used in pairs are connected as one input of respective AND gates **52** to **61.** A second input for each of the AND gates **52** to **61** is derived from either a horizontal signal control line **65** or a vertical control line **66.** The control lines **65** and **66** are connected to respective signal sources (not shown) which are each arranged to supply a control signal representative of a desired matrix orientation, e.g., a manually operable switch and a signal source capable of energizing the AND gates **51** to **62.** For example, using the print element **2, 2,** a first

input for AND gate **52** is obtained from the sixth storage stage of the storage register **45** while a second input for the AND gate **52** is obtained from the vertical control line **66.** Concurrently, a first input for the second AND gate **53** associated with the same print element **2, 2** is obtained from the tenth storage stage of the storage register **45** while a second input for the AND gate **53** is obtained from the horizontal control line **65.**

The output signals from the AND gates **52** and **53** are applied to a first OR gate **70** with the output signal from the OR gate **70** being applied as an energizing signal to the print element **2, 2.** Thus, for example, the presence of a control signal on the horizontal control line **65** and the presence of a digital bit stored in the tenth storage stage of the storage register **45** is effective to energize the print element **2, 2** while a control signal on the vertical control line **66** and a digital bit stored in the sixth stage of the storage register **45** is effective to, also, energize the print element **2, 2.** It should be noted, however, that the print element **2, 2** is matrix element number **6** in the vertical print head orientation and is matrix element number **10** in the horizontal print head orientation. The print elements **2, 2** to **2, 6** are similarly energized from digital bit signal stored in respective pairs of stages in the register **45** as controlled by the horizontal and vertical control lines **65** and **66.** On the other hand, the first print element **2, 1** in the second horizontal row is used only in the horizontal rectangular matrix orientation and is energized by an output signal from the first AND gate **51** in response to a bit stored only in the fifth stage of the register **45** and the presence of control signal on the horizontal control line **65.** Similarly, the last print element **2, 7** in the second horizontal row is energized by an output signal from the last AND gate **62** in response to a bit stored only in the 35th stage of the register **45** and the presence of a control signal on the horizontal control line **65.** This scheme of energizing the print elements is applicable to all of the print elements shown in FIG. **1** except those in the first and last rows, i.e., print elements **1, 1** to **1, 7** and print elements **7, 1** to **7, 7** and those in the first and last columns, elements **1, 1** to **7, 1** and elements **1, 7** to **7, 7.** Specifically, the corner print elements **1, 1; 1, 7; 7, 1** and **7, 7** may be either unused or selectively energized to provide special print notations by any suitable circuits (not shown) since these print elements do not form a part of either rectangular print matrix. Additionally, the remaining print elements first and last rows, i.e., print element **1, 2** to **1, 6** and print elements **7, 2** to **7, 6** are used only in the vertical orientation and, accordingly, are energized by the concurrent presence of a vertical control signal and a digital bit stored in the stage of the register **45** corresponding to the position of these print elements in the vertical print matrix as identified by the reference numbers in FIG. **1.** The vertical control signal and digital bits for controlling these print elements would be applied to AND gates in a manner similar to that described above for AND gates **51** and **62** shown in FIG. **2.** Similarly, the print elements in the first and last columns **2, 1** to **6, 1** and **2, 7** to **6, 7** are used only in a horizontal orientation and, accordingly, are energized by the concurrent presence of a horizontal control signal and a digital bit stored in the stage of the register **45** corresponding to the position of these print elements in the horizontal print matrix. Finally, it should be noted that a storage position in the register **45** may be used to energize a print element in a different position in the horizontal print matrix from that in the vertical print matrix, e.g., storage position **10** is used for print elements **2, 2** and **2, 6.**

In FIG. **3,** there is shown a block diagram of a control circuit for the matrix drive circuit shown in FIG. **2.** The print element drive pattern which drives the printing matrix is derived from a read-only memory **70.** Thus, a particular symbol pattern to be displayed by a 5×7 printing matrix is selected from the read-only memory **70** by a character code selection signal applied to input lines **72** derived from any suitable source, e.g., an encoding typewriter keyboard. In the arrangement shown in FIGS. **2** and **3** the 5×7 matrix symbol pattern is read out of the memory **70** one row at a time with successive memory addresses being required to read out the successive rows of the pattern data. These successive addresses are produced by an up-down counter **74.** The output signals from the memory are applied in five parallel data lines **76** for application to a storage register. These data lines represent the five columns of data contained within one row of a 5×7 matrix. The output signals from the memory **70** are applied in parallel to seven five-bit registers **78** to **90** which are shown in only partial representation in FIG. **3** for the sake of clarity and which correspond in total to the register **45** shown in FIG. **2.** However, each of the registers are successively enabled for loading of the output signals from the read-only memory **70** by successive output signals applied on respective register select lines. For example, the first register **78** is enabled by a select signal applied on a first register select line **92** while the last register **90** is enabled by a register select signal applied on a select line **104.** The select lines **92** to **104** are successively energized by a decoder circuit **106** which, in turn, is driven by a four-bit counter **108.** The decoder circuit **106** may be any suitable prior art device for translating the count in the counter **103** into successive energizations of the select lines **102** to **104.** The counter **108** and the counter **74** are both driven by clock signals from a clock source **110** supplied over a clock signal line **112.** Similarly, the counter **74** and **108** are "cleared" by a "clear" signal from the clock source **110** applied on a clear signal line **114.** The signals from the clock **110** are initiated upon receipt of a "strobe" pulse on a strobe input line **116** from any suitable means (not shown) which is used to initiate the printing cycle after the selection signals on lines **72** are applied to the memory **70.**

In operation, the control circuit shown in FIG. **3** is effective to start the printing of a character after the selection of a character by the signals on lines **72** by a "strobe" pulse applied on the strobe line **116** to the clock **110.** The "strobe" may be derived from the same source used to produce the selection signals on lines **72** and may be applied concurrently therewith to the circuit shown in FIG. **3.** This "strobe" pulse produces a "clear" pulse from the clock **110** which is applied to the counters **74** and **108.** Subsequently, the clock **110** is arranged to produce a burst of seven clock pulses on clock line **112** for application to the counters **74** and **108** to increment the counters concurrently. The successive count signals stored in the counter **108** in response to the clock pulses are decoded by the decoder **106** to successively enable the registers **78** to **90.** Concurrently, the clock signals applied to the counter **74** are applied to the read-only memory **70** as address signals for each of the seven rows of the data pattern for

a 5 × 7 matrix which has been selected by the input signals on input lines **72.** In order to further increase the printing abilities of the printer, the counter **74** is arranged to be an up-down counter which under control of an up-down control signal applied on a control line **118** will either increment or decrement its count with the receipt of each clock pulse on clock line **112.** In other words, when the up-down counter **74** is in an up-count mode, the rows in the read-only memory **70** for the selected character pattern are read out in order from **1** through **7.** Conversely, when the counter **70** is in a count-down mode, the selected character pattern in the read-only memory **70** is read out in order from row **7** through **1.** Therefore, in the count-down mode of the counter **74** the data pattern from the read-only memory is read out to print a character which the reverse of a character printed by a count-up mode of the counter **74.** Accordingly, the combination of the signal on the up-down control line **118** and the vertical and horizontal control as shown in FIG. **2** permit a 5 × 7 character pattern to be displayed in any one of four possible orientations, i.e., the character can be normal or reversed in the horizontal print configuration and either normal or reversed in the vertical print configuration.

In order to correctly print the characters in the reversed mode in either the horizontal or vertical configuration to avoid a mirror-image printing, the circuit shown in FIG. **3** uses a set of AND-OR gates **120** interposed in the output lines **76** from the ROM **70** to produce either a left-to-right or a top-to-bottom reversal of the character pattern. Specifically, the first output line from the ROM **70** is connected to a first AND gate **122** and a second AND gate **124.** A second output line from the ROM **70** is connected to a third AND gate **126** and a fourth AND gate **128.** The third output line from the ROM **70** is passed directly to the output lines **76** since it determines the center of the character which is not affected by the reversed mode. The fourth output line from the ROM **70** is connected to a fifth AND gate **130** and a sixth AND gate **132.** The fifth output line from the ROM **70** is connected to a seventh AND gate **134** and an eight AND gate **136.** The outputs of the first and eight AND gates **122** and **134** are connected to a first OR gate **138** having an output line connected to a first one of the output lines **76.** The outputs from the third AND gate **126** and the fifth AND gate **130** are connected to a second OR gate **140** having its output line connected to a second one of the output lines **76.** The outputs from the sixth AND gate **132** and the fourth AND gate **128** are connected to a third OR gate **142** having its output connected to a fourth one of the output lines **76.** Finally, the output of the eighth AND gate **136** and the second AND gate **124** are connected to a fourth OR gate **144** having its output connected to fifth one of the output lines **76.** A pair of control signal lines **146** and **148** are used to control the normal and reversed mode of operation, respectively. These control lines **146** and **148** are used to apply energizing signals to predetermined ones of the AND gates in the set of AND-OR gates **120** to route the output signals from the ROM **70** to desired ones of the output lines **76.**

Specifically, the "normal" control line **146** is connected to the AND gates **122, 126, 132** and **136** while the "reverse" control line **148** is connected to the AND gates **124, 128, 130** and **134.** Consequently, the first and second output lines of the ROM **70** can be selectively connected to either the fourth and fifth ones of the output lines **76** or the first and second ones of the output lines **76.** The aforesaid interchange of the first and second output lines of the ROM **70** with the fourth and fifth output lines of the ROM **70** are effected concurrently by a signal on either one of the control lines **146** and **148.** This interchange has the net effect of rotating the character pattern around the pattern center represented by the third output line from the ROM **70** which is connected directly to the third output line of the output lines **76.** The control signals on the control lines **146** and **148** are related to the up-down control signal on the up-down control line **118** since in the count-up mode of operation of the counter **74,** the "normal" control signal on line **146** would be applied to control the routing of the output signals from the ROM **70** while the "reverse" control signal on line **148** would be applied during the count-down mode of operation of the counter **74.**

Accordingly, it may be seen that there has been provided, in accordance with the present invention, an improved matrix printer for printing alpha-numeric data oriented along a vertical axis as well as a horizontal axis without involving mechanical reorientation of a print head.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A printer comprising:

a print head having a fixed spatial arrangement of a plurality of printing elements,

selection means for selecting a plurality of groups of said printing elements out of said fixed spatial arrangement to form each of a corresponding plurality of printing matrices with each of said plurality of printing matrices being rotatably displaced from any other one of said plurality of printing matrices,

energizing means for generating energizing signals for said printing elements to actuate said printing elements to form corresponding printed representations by said printing elements, and

energizing signal means for selectively applying said energizing signals to said printing elements in a printing matrix selected by said selection means from said plurality of printing matrices.

2. A printer as set forth in claim **1** wherein said fixed spatial arrangement is a square with the same number of printing elements on each side of the square and each printing matrix selected by said selection means from said plurality of printing matrices is a rectangle with a different number of printing elements on adjacent sides of the rectangle and

including control means selectively operable to control said selection means for switching between a first rectangular printing matrix and a second rectangular printing matrix rotatably displaced from said first rectangular printing matrix.

3. A printer as set forth in claim **1** wherein each selected print matrix has less than all of the available print elements.

4. A printer as set forth in claim **1** wherein said fixed spatial arrangement is a square with the same number of printing elements on each side of the square and said printing matrix is a rectangle with a different number of printing elements on adjacent sides of the rectangle and including a control means selectively operable to

control said selection means for switching between a first rectangular printing matrix and a second rectangular printing matrix angularly displaced from said first rectangular printing matrix.

5. A print as set forth in claim **4** wherein said first and second rectangular printing matrices of printing elements have the same number of print elements.

6. A printer as set forth in claim **4** wherein said first and second rectangular printing matrices are displaced 90° from each other.

7. A printer as set forth in claim **1** wherein said energizing means includes a memory means for storing control signals for said print elements and readout means arranged to read out said control signals from said memory means for application to the printing elements selected by said selection means as energizing signals.

8. A printer as set forth in claim **7** wherein said readout means includes an up-down counter arranged to read out said control signals from said memory means, signal generating means, means for applying output signals from said signal generating means to said up-down counter to be counted thereby and means for controlling the counting direction of said up-down counter during the counting of the output signals from said signal generating means and means for applying count signals stored in said up-down counter means to said memory means to readout said control signals from said memory means in response to said count signals whereby said control signals from said memory means are read out in either a first sequence during an up counting operation of said counter or a second sequence during a down counting operation of said counter.

9. A printer as set forth in claim **4** wherein said energizing means includes a memory means for storing control signals for said print elements and readout means arranged to read out said control signals from said memory means as energizing signals for application to the printing elements selected by said selection means.

10. A printer as set forth in claim **9** wherein said readout means includes an up-down counter arranged to read out said control signals from said memory means, signal generating means, means for applying output signals from said signal generating means to said up-down counter to be counted thereby and means for controlling the counting direction of said up-down counter during the counting of the output signals from said signal generating means and means for applying count signals stored in said up-down counter means to said memory means to readout said control signals from said memory means in response to said count signals whereby said control signals from said memory means are read out in either a first sequence during an up counting operation of said counter or a second sequence during a down counting operation of said counter.

* * * * *