FIG. 1

```
+-------------------+-------------------+-------------------+
|                   |                   |                   |
| AREA 1            | AREA 2            | AREA 3            |
|                   |                   |                   |
|                   |                   |                   |
|                   |                   |                   |
|                   |                   |                   |
|                   |                   |                   |
+-------------------+-------------------+-------------------+

TYPE DRUM 11

PRINT HAMMERS 12

HAMMER CONTROL UNIT 13

SHIFT REGISTER 14

SWITCHES

12A  12B  12C

15A  15B  15C

E

120 COL

40 COL  40 COL  40 COL

Sheet 1 of 8

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TADASHI SUGIMOTO
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APPARATUS FOR LINE PRINTING

Tadashi Sugimoto, Kawasaki-shi, Japan, assignor to Fujitsu Limited, Kawasaki, Japan, a corporation of Japan

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3 Claims

ABSTRACT OF THE DISCLOSURE

A plurality of printing hammers of line printing apparatus are successively operated in groups to print groups of columns in succession. The number of columns in each of the groups is less than the total number of columns and is the same in each of the groups.

Description of the invention

The present invention relates to line printing. More particularly, the invention relates to a method and apparatus for line printing.

Line printers of known type utilize printing hammers and hammer actuating magnets. The hammer actuating magnets are controlled in operation, actuation or energization to control the operation of the hammers and thereby to control the printing. It is often desirable to increase the printing speed of the line printer, and there have been many different types of printing apparatus and printing methods. As the printing speed is increased and the performance enhanced, the cost of the apparatus increases. There are, however, small-sized electronic computers which utilize in their inputs and/or outputs small-sized low speed printers. The line printers utilizing the small-sized computers must be of low cost in order to raise the ratio of the performance of the equipment relative to its cost.

The principal object of the present invention is to provide a new and improved method and apparatus for line printing. The method and apparatus of the present invention for line printing are suitable for operation with small-sized computers. The apparatus of the present invention for line printing is of small size and of low cost and operates at low speed. The apparatus of the present invention for line printing is efficient, effective and reliable in operation. The apparatus of the present invention for line printing utilizes conventional known components and conventional known line printing equipment.

In accordance with the present invention, the method of line printing a plurality of columns comprises printing groups of columns in succession. The number of columns in each of the groups of columns is less than the total number of the plurality of columns. The number of columns in each of the groups of columns is the same. The groups of columns are printed in a line on a recording medium. The groups of columns in succession are recorded on the recording medium. The recording medium is fed to its next line. The groups of columns are printed in a line on a recording medium by printing only determined ones of the groups of columns to be printed, bypassing the others of the groups of columns not to be printed and feeding the recording medium to its next line at free points of time.

In accordance with the present invention, line printing apparatus comprises printing apparatus for printing a plurality of columns. The printing means includes a plurality of printing hammers. Hammer control apparatus controls the operation of the printing apparatus to successively operate the plurality of printing hammers in groups to print groups of columns in succession.

The hammer control apparatus comprises a plurality of hammer-controlling electromagnets each controlling a corresponding one of the printing hammers. Switches are interposed between the electromagnets and a power supply source for selectively switching one group of electromagnets at a time to the power supply source. Each group of electromagnets is the same as each group of corresponding printing hammers. The switches are a plurality of semiconductor controlled rectifiers and the number of semiconductor controlled rectifiers is the same as the number of the groups.

In order that the present invention may be readily carried into effect, it will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic block diagram illustrating the principle of operation of the apparatus of the present invention and the method of the present invention;

FIG. 2 is a circuit diagram illustrating the operation of the apparatus of the present invention and the method of the present invention;

FIG. 3 is a block diagram of an embodiment of the apparatus of the present invention;

FIGS. 4A and 4B are time charts illustrating the operation of the embodiment of FIG. 3;

FIG. 5 is a block diagram of a modification of the apparatus of the present invention;

FIGS. 6A and 6B are time charts illustrating the operation of the modification of FIG. 5;

FIG. 7 is a schematic side view of an embodiment of a line printer;

FIG. 8 is a perspective view of a type wheel;

FIG. 9 is a developed view of the type surface of a type wheel; and

FIG. 10 is an illustration of the printed data on the printing paper.

FIG. 1 illustrates the principle of operation of the apparatus of the present invention. The components of FIG. 1 may comprise any suitable components known in the art for performing the indicated functions. A type drum 11 is rotatably mounted and may comprise, for example, 120 columns. Print hammers 12 are mounted in operative proximity with the type drum 11 and function to print 120 columns in a known manner.

A hammer control unit 13 is electrically connected to the electromagnets of the print hammers 12. The hammer control unit 13 functions to operate, actuate or energize 40 print hammers at a time to thereby print 40 columns. A shift register 14 is electrically connected to the hammer control unit 13 and functions to store 40 bits of control data or information.

In the apparatus of FIG. 1, although the type drum 11 is divided into three equal areas 1, 2 and 3, each being a cylindrical surface area equal to one-third the cylindrical surface area of said drum, said drum may be divided into any suitable number of equal cylindrical surface areas. The number of print hammers 12, and therefore columns printed under the control of the hammer control unit 13, controlled by said hammer control unit, corresponds to the number of equal areas into which the drum 11 is divided. The shift register 14 stores a number of bits of control data equal to the number of columns printed at one time under the control of the hammer control unit 13.

In accordance with the present invention, each group of hammer-controlling electromagnets is driven or controlled in succession by the hammer control unit 13. Thus, in accordance with the method of the present invention, a number of columns equal to the total number of columns of the type drum 11 divided by n, is first printed by
the hammer control unit 13, the next succeeding equal number of columns is next printed under control of the hammer control unit 13, and so on, until all the columns of the type drum are printed. For purposes of illustration, the area of the type drum 11 is divided into three equal areas, so that n=3, and the 120 columns of said type drum are divided into three equal groups of 40 columns each. The 17-1 area of the type drum 11 is first printed under the control of the hammer control unit 13, the 40 columns of area 2 of said type drum are then printed under the control of said hammer control unit, and the 40 columns of area 3 of said type drum are then printed under the control of said hammer control unit. During each printing of the columns of an area of the type drum 11, said type drum is rotated or driven in a suitable manner by suitable known apparatus, not shown in the figures.

During the printing operation, the printing paper or recording medium, not shown in FIG. 1, which is interposed between the print hammer and the type drum 11, remains in the same position, whereas said type drum rotates three times for the printing of a single line. In order to print the 40 columns of area 1 of the type drum 11, a switch 15A is closed, either manually or automatically, to close a circuit between the hammer control unit 13, the first group 12A of 40 print hammers and a source of voltage E. In order to print the 40 columns of area 2 of the type drum 11, a switch 15B is closed, either manually or automatically, to close a circuit between the hammer control unit 13, the second group 12B of 40 print hammers and the source of voltage E. In order to print the 40 columns of area 3 of the type drum 11, a switch 15C is closed, either manually or automatically, to close a circuit between the hammer control unit 13, the third group 12C of 40 print hammers and the source of voltage E. The switches 15A, 15B and 15C is closed at a time, and said switches are operated in sequence.

FIG. 2 illustrates the operation of the hammer-controlling electromagnets under the control of the hammer control unit 13. In FIG. 2, the hammer-controlling electromagnets are not all illustrated, but are indicated only by the first and last of each group of said electromagnets. Thus, in FIG. 2, the hammer-controlling electromagnets of the first of the three groups of said electromagnets are represented by the first electromagnet 16-1 and the last of said electromagnets 16-h. In the present example, h equals 40. The hammer-controlling electromagnets of the second of the three groups of said electromagnets are represented by one first electromagnet 17-1 and the last of said electromagnets 17-h. The hammer-controlling electromagnets of the third of the three groups of said electromagnets are represented by the first electromagnet 18-1 and the last of said electromagnets 18-h.

The hammer control unit 13 is indicated principally in block form. However, a first control transistor 19-1 and a last control transistor 19-h are shown as included in the hammer control unit 13 in order to enhance the description of the operation shown in each of the control transistors 19-1 to 19-h of the hammer control unit 13 controls a corresponding one of the hammer-controlling electromagnets of each of the n groups of said electromagnets. Thus, the control transistor 19-1 is connected in series with the first hammer-controlling electromagnet 16-1, 17-1 and 18-1 of each of the three groups of said electromagnets. The control transistor 19-h is connected in series with the last hammer-controlling electromagnets 16-h, 17-h and 18-h of each of the three groups of said electromagnets.

The series connection of the corresponding control transistors of the hammer control unit 13 and the corresponding hammer-controlling electromagnets is through corresponding diodes which prevent a current flow in the opposite direction. Thus, the collector electrode of the control transistor 19-1 is connected in common to one end of the winding of each of the electromagnets 16-1, 17-1 and 18-1 via a common lead 21, leads 22, 23 and 24 and corresponding diodes 25, 26 and 27. The diode 25 is connected in the lead 22 with its anode connected to the common lead 21 and with its cathode connected to the aforementioned end of the winding of the electromagnet 16-1. The diode 26 is connected in the lead 23 with its anode connected to the common lead 21 and with its cathode connected to the aforementioned end of the winding of the electromagnet 16-1. The diode 27 is connected in the lead 24 with its anode connected to the common lead 21 and with its cathode connected to the aforementioned end of the winding of the electromagnets 16-1.

The emitter electrode of the control transistor 19-1 is connected to ground via a lead 28. The collector electrode of the control transistor 19-h is connected in common to one end of the winding of each of the electromagnets 16-h, 17-h and 18-h via a common lead 29, leads 31, 32 and 33 and corresponding diodes 34, 35 and 36. The diode 34 is connected in the lead 31 with its anode connected to the common lead 29 and with its cathode connected to the aforementioned end of the winding of the electromagnet 16-h. The diode 35 is connected in the lead 32 with its anode connected to the common lead 29 and with its cathode connected to the aforementioned end of the winding of the electromagnet 17-h. The diode 36 is connected in the lead 33 with its anode connected to the common lead 29 and with its cathode connected to the aforementioned end of the winding of the electromagnet 18-h. The emitter electrode of the control transistor 19-h is connected to ground via a lead 37. The emitter electrode of each of the 40 control transistors 19-1 to 19-h of the hammer control unit 13 is connected to one terminal of an electrical power supply E via a common lead 38 and a lead 39. The other terminal of the power source E is connected in common to the cathode of each of three semiconductor controlled rectifiers or SCR's 41A, 41B and 41C via a common lead 42 and leads 43, 44 and 45 respectively. The anode of the first SCR 41A is connected in common to the other end of the winding of each of the hammer-controlling electromagnets 16-1 to 16-h of the first group of said electromagnets via a common lead 46 and branch leads 47-1 to 47-h, respectively. The anode of the second SCR 41B is connected in common to the other end of the winding of each of the hammer-controlling electromagnets 17-1 to 17-h of the second group of said electromagnets via a common lead 48 and branch leads 49-1 to 49-h, respectively. The anode of the third SCR 41C is connected in common to the other end of the winding of each of the hammer-controlling electromagnets 18-1 to 18-h of the third group of said electromagnets via a common lead 51 and branch leads 52-1 to 52-h, respectively.

Each of the hammer-controlling electromagnets is shunted by a clamping diode. Thus, a clamping diode 53 is shunted across the hammer-controlling electromagnet 16-1. A clamping diode 54 is shunted across the hammer-controlling electromagnet 17-1. A clamping diode 55 is shunted across the hammer-controlling electromagnet 18-1. A clamping diode 56 is shunted across the hammer-controlling electromagnet 16-h. A clamping diode 57 is shunted across the hammer-controlling electromagnet 17-h. A clamping diode 58 is shunted across the hammer-controlling electromagnet 18-h. Each of the first, second and third SCR's 41A, 41B and 51C may comprise any suitable SCR known in the art, such as, for example, those described in considerable detail in the Silicon Controlled Rectifier Manual, third edition, 1964, General Electric Company, Auburn, N.Y. Each SCR includes a gate or control electrode which is utilized to control the conductive condition of such SCR.

A switching control transistor 59 is connected in the common ground line 38. The emitter electrode of the switching control transistor 59 is connected to the ground terminal of the electrical power source E and the col-
lector electrode of said switching control transistor is connected in common via a lead $61$, a control resistor $62$, and leads $64$ and $65$, to the anodes of coupling diodes $66A$, $66B$, and $66C$, respectively.

The cathode of the first coupling diode $66A$ is connected to the lead $46$ and to the anode of the first SCR $41A$ via a lead $67$. The cathode of the second coupling diode $66B$ is connected to the lead $48$ and to the anode of the second SCR $41B$ via a lead $68$. The cathode of the third coupling diode $66C$ is connected to the lead $51$ and to the anode of the third SCR $41C$ via a lead $69$.

A switching control unit $71$ controls the conductive condition of the switching control transistor $59$ and of each of the SCR's $41A$, $41B$ and $41C$. The switching control unit $71$ is thus connected to and provides a control signal to the base electrode of the switching control transistor $59$ via a lead $72$ and to the control electrode of each of the SCR's $41A$, $41B$ and $41C$ via leads $70A$, $70B$ and $70C$, respectively.

A computer $81$ (FIG. 3) is connected to an input of the switching control unit $71$ via a lead $99$ (FIG. 3) and to an input of a collator $95$ (FIG. 3) via a lead $97$ (FIG. 3). The connection and relation of the computer $81$, the switching control unit $71$ and the collator $95$ are described with reference to FIG. 3. The output of the collator is connected to an input of the shift register $14$ (FIG. 1) via a lead $103$ (FIG. 3). The shift register $14$ is connected to and provides a control signal to the base electrode of each of the control transistors $19-1$ to $19-h$ via a corresponding one of leads $73-1$ to $73-h$, respectively.

The printing operation is controlled either manually or automatically such as, for example, via prerecorded programs through the computer $81$ and the switching control unit $71$ and the collator $95$ and shift register $14$. Although each of the SCR's or thyristors $41A$, $41B$ and $41C$ is switched to its conductive or ON condition by a sufficient current in its control electrode, the potential of its anode must be positive and higher in magnitude than that of its cathode. Each of the SCR's $41A$, $41B$ and $41C$ is switched to its non-conductive or OFF condition by decreasing the potential of the anode to a magnitude below that of the cathode.

The switching control unit $71$, under the control of the computer $81$, first switches the switching control transistor $59$ to its conductive or ON condition. When the switching control transistor $59$ is in its conductive condition, it maintains the potential of the anodes of the SCR's $41A$, $41B$ and $41C$ positive and at a higher magnitude than that of the cathodes thereof and said SCR's can be switched ON by a sufficient current supplied to the control electrodes thereof. When the switching control transistor $59$ is in its non-conductive condition, the potential of the anodes of the SCR's $41A$, $41B$ and $41C$ becomes equal to that of the cathodes thereof and said SCR's cannot be switched ON, but are, rather switched OFF.

As illustrated in FIG. 4A, the computer $81$ supplies, via the switching control unit $71$ and the leads $70A$, $70B$ and $70C$, successive switching signals to the control electrodes of the CSR's $41A$, $41B$ and $41C$. When a switching signal is supplied to the control electrode of the first SCR $41A$, it provides sufficient current to the control electrode of said first SCR to switch said SCR to its conductive or ON condition. The computer $81$, via the collator $95$ and the shift register $14$, then switches the control transistors $19-1$ to $19-h$ to their conductive or ON condition, thereby closing an energizing circuit to the power source $E$ for the hammer-controlling electromagnets $16-1$ to $16-h$ through the first SCR $41A$. This operation is then repeated for each of the second and third anodes of the type drum $11$ (FIG. 1) by the switching of the second and third SCR's $41B$ and $41C$ to their conductive conditions.

When the printing of the first area of the type drum $11$ is completed, the second SCR $41B$ is switched to its conductive condition in the aforesaid manner and the hammer-controlling electromagnets $17-1$ to $17-h$ of the second group of said electromagnets are energized and cause the printing of the second area of the type drum $11$. Since only one of the three SCR's is energized or fired at one time, only one of said SCR's is in its conductive condition at one time, so that only one of the first, second and third areas $1$, $2$ and $3$ is printed at one time. Upon completion of the second area of the type drum $11$, the third SCR $41C$ is switched to its conductive condition and energizes the hammer-controlling electromagnets $18-1$ to $18-h$ in the aforesaid manner to print the third area of said type drum $11$.

In the embodiment of the apparatus of FIG. 3, a computer $81$ is directly connected to the line printer $82$ without the interposition of a buffer memory unit. In the modification of FIG. 5, however, a buffer memory unit is interposed between the computer $81$ and the line printer. The same components of FIGS. 3 and 5 are indicated by the same reference numerals therein. FIGS. 4A and 4B are time charts illustrating the operation of the embodiment of FIG. 3.

In FIG. 3, the line printer $82$ comprises the type drum $11$ (FIG. 1), the print hammers $12$ (FIG. 1), and the hammer-controlling electromagnets $83$ which include the electromagnets $16-1$ to $16-h$, $17-1$ to $17-h$ and $18-1$ to $18-h$ (FIG. 2). The line printer $82$ also includes the hammer control unit $13$ and the shift register $14$ (FIG. 1). A recording medium or printing paper $84$ is interposed between the type drum $11$ and the print hammers $12$ and is driven or moved by any suitable means (not shown in the figures). The line printer also includes a diode circuit $85$ which includes the various diodes such as, for example, the diodes $25$, $26$, $27$, $34$, $35$ and $36$ (FIG. 2) and an SCR circuit $86$ which includes the first, second and third SCR's $41A$, $41B$ and $41C$ (FIG. 2). The switching control unit $71$ (FIG. 2) is connected to the SCR circuit $86$.

A type code and time pulse generator $87$ is coupled to the type drum $11$ for rotation with said type drum. The output or time pulses of the generator $87$ are supplied to the input of a time pulse detector $88$ via a lead $89$ and to the input of an amplifier $91$ via the lead $89$ and a lead $92$. The output of the amplifier $91$ is supplied to the input of a type code register $93$ via a lead $94$ and the output of said register is supplied to an input of a collator $95$ via a lead $96$. Another input of the collator $95$ is supplied, via a lead $97$, by the computer $81$.

The output of the detector $88$ is applied to an input of the switching control unit $71$ via a lead $98$. Another input of the switching control unit $71$ is supplied by the computer $81$ via a lead $99$. An output of the switching control unit $71$ is connected to the hammer control unit $13$ via a lead $101$ and to an input of the shift register $14$ via a lead $102$. The output of the collator $95$ is supplied to another input of the shift register $14$ via a lead $103$. The output of the shift register $14$ is supplied to an input of the hammer control unit $13$ via a lead $104$. The output of the hammer control unit $13$ is supplied via a lead $105$ and the diode circuit $85$ to the hammer-controlling electromagnets $83$. The diode circuit $85$ is connected to an output of the switching control unit $71$ via a lead $106$, the SCR circuit $86$ and a lead $107$.

FIGS. 4A and 4B illustrate the basic printing operation of the apparatus of the embodiment of FIG. 3. In each of FIGS. 4A and 4B, each of the line segments extends in the direction of the abscissa, which represents time. FIG. 4A illustrates the printing of one line having 120 columns.

There are four basic orders involved in the printing of one line of 120 columns, as illustrated in FIG. 4A. The four basic orders include the three printing orders $P_1$, $P_2$ and $P_3$ for the corresponding areas $1$, $2$ and $3$, of the type drum $11$ (FIG. 1), respectively. The fourth basic order is the feeding order $F_1$ for the recording medium or paper $84$ (FIG. 3).
The computer 81 provides the first printing order P1 for the printing of the first area 1 of the type drum 11 (FIG. 1) in the switching control unit 71 via the lead 99 (FIG. 3) or the shift register 86 (FIG. 3) to its conductive condition. The initial control signal supplied by the computer 81 simultaneously starts the printing cycle R1 and said computer provides the printing information.

The type code corresponding to the type on the type drum 11 (FIG. 1) is indicated by the type code and time pulse generator 87 of FIG. 3 and is stored in the type code register 93 after amplification by the amplifier 91 (FIG. 3). The type code stored in the register 93 is collated in the collator 95 with the printing information supplied by the computer 81 via the lead 97 and the result of the collation is stored in the shift register 14 (FIG. 3). Upon the completion of the collation of 40 columns the hammer control unit 13 is triggered by the next time pulse from the type code and time pulse generator 87 and the result of the collation of the 40 columns is printed. The aforesaid operation completes the printing of one letter. The printing of the 40 columns of area 1 of the type drum 11 (FIG. 1) is completed when all of the 64 letters of the type drum 4A have been printed by the aforesaid operation commencing with the initiation of the transfer of printing information and concluding with the printing.

When the first area 1 of the type drum 11 (FIG. 1) has been completely printed, the computer 81 (FIG. 3) provides the second printing order P2 (FIG. 4A) for the printing of the second area 2 of said type drum. The second SCR 41B (FIG. 2) of SCR 41A having been switched to its non-conductive condition upon the supply of the second printing order P2 to the switching control unit 71 (FIG. 3). The second area 2 of the type drum 11 (FIG. 1) is then printed in the same manner as the first area 1 via the 99 drum. Upon completion of the printing of the area 2 of the type drum 11, the third area 3 of said type drum (FIG. 1) is then printed in the same manner as the areas 1 and 2, under the control of the third printing order P3 from the computer 81. When the printing of the third area 3 of the type drum 11 (FIG. 1) is completed, the printing of a single line is completed. The computer 81 (FIG. 3) then provides the paper feeding order F1 and the paper is fed or moved to its next line position by suitable apparatus (not shown in the figures). The printing is then completed upon the completion of the feeding or moving of the printing paper 84 (FIG. 3) in response to the paper feeding order F1.

The time chart of FIG. 4B illustrates another arrangement of printing orders in the apparatus of FIG. 3. In the arrangement of printing orders illustrated in FIG. 4B, the computer 81 provides the first printing order P1. The first printing order P1 is then followed by a repetition of the first printing order P1. After the completion of the printing of the first area 1 of the type drum 11 (FIG. 1), the third paper feeding order F3 is supplied. The third paper feeding order F3 is followed by the second printing order P2.

The basic printing cycle of the apparatus of FIG. 3, illustrated in FIG. 4B, avoids unnecessary printing time in the event of slippage in the printing of the first area 1 of the type drum 11 since it involves feeding the paper twice (F1 and F2) so that said paper is moved two lines, printing the first area 1 (R1) and feeding the paper by one line (F3) and printing the second area 2 (R2), and so on, as shown in FIG. 4B. In a conventional line printing operation, where the printing and feeding are controlled by a single order, the printing time for the second and third areas 2 and 3 of the type drum 11 (FIG. 1) is wasted if only the first area 1 is actually printed. Furthermore, in such conventional line printer operation, the structure of the line printer is complex. In accordance with the method of the present invention, there are four independent orders which need not be in any particular succession with relation to each other, so that areas which are not to be printed are not ordered to be printed by corresponding printing orders. Thus, the next succeeding printing order is provided for an area 2 to be printed, so that there is no printing time wasted and high speed processing is accomplished.

In the modification of FIG. 5, a buffer memory in the form of a core memory, or other suitable memory device, is included in the line printer apparatus. Thus, in the modification of FIG. 5, an output of the switching control unit 71 is connected to the input of a core memory 111 via a lead 112, an inhibitor 113 and a lead 114. The output of the core memory 111 is connected to the input of a shift register 115 via a lead 116. An output of the shift register 115 is connected to a second input of the collator 95 via a lead 117 and to an input of the switching control unit 71 via a lead 117 and a lead 118. As shown in FIG. 6A, a complete printing cycle R is accomplished by three rotations of the type drum 11 (FIG. 1). The printing information is provided by the computer 81 and the first printing order for printing the first area 1 of the type drum 11 (FIG. 1) is supplied by said computer. Both the printing information and the printing orders are supplied by the computer 81 to the switching control unit 71 and are stored in core memory 11.

When the printing information for one column has been completely transferred to the core memory 111, the line printer is in effect disconnected from the computer 81. When the first printing order P1 has been provided, the line printer initiates the printing cycle R (FIG. 6A). The line printer thus first provides the first printing subcycle S1 by printing the first area 1 of the type drum 11 (FIG. 6A), that is, the stored contents of the core memory 111 are read out via the shift register 115 and are collated by the collator 95 with the type codes and are printed for the first 40 columns after the typing of the 64 letters. The line printer then provides the second printing subcycle S2 (FIG. 6A) by printing the second area 2 of the type drum 11. Upon completion of the second printing subcycle S2, the line printer provides the third printing subcycle S3 by printing the third area 3 of the type drum 11 (FIG. 1).

The printing of the third area of the type drum 11 (FIG. 1) is completed after said type drum has rotated three times. One line is completed upon the completion of the feeding or moving of the printing paper 84 (FIG. 1) in response to the paper feeding order F1.

The time chart of FIG. 6B illustrates another arrangement of printing orders in the apparatus of FIG. 3.

The printing of the type drum 11 (FIG. 1) is completed after said type drum has rotated three times. One line is completed upon the completion of the feeding or moving of the printing paper 84 (FIG. 1) in response to the paper feeding order F1.

The printing of the third area of the type drum 11 (FIG. 1) is completed after said type drum has rotated three times. One line is completed upon the completion of the feeding or moving of the printing paper 84 (FIG. 1) in response to the paper feeding order F1.

The printing of the third area of the type drum 11 (FIG. 1) is completed after said type drum has rotated three times. One line is completed upon the completion of the feeding or moving of the printing paper 84 (FIG. 1) in response to the paper feeding order F1.

The printing of the third area of the type drum 11 (FIG. 1) is completed after said type drum has rotated three times. One line is completed upon the completion of the feeding or moving of the printing paper 84 (FIG. 1) in response to the paper feeding order F1.
the core memory 111 for each column. The signal bits permit the supervision of the printing information and increase the printing speed by preventing the waste of printing time. The signal or flag bit and its application is described in Japanese patent application Ser. No. Tukugansho 39–27124, filed May 14, 1964.

The computer 81 supplies the first printing order P1 (FIG. 6B) to the switching control unit 71 (FIG. 5) and the printing information is also supplied to said switching control unit. At the same time a “0” signal is recorded as the flag bit of the column to be printed and a “1” signal is recorded in the other columns. The line printer then provides the entire printing cycle R by providing the printing subcycles S1, S2 and S3 (FIG. 6B) in sequence.

Upon the provision of the first subcycle S1, the first area 1, of 40 columns, of the type drum 11 (FIG. 1) is read out of the core memory 111 and is printed. The contents of the first area are read out of the core memory 111 and are collated with the type code by the collator 95, so that the columns of the first area are printed in accordance with the type code. The flag bit of the column printed is changed from “1” to “0” as the printing of each column is completed. Each time the information stored in the core memory 111 is read out, the flag bit is detected, and when all the flag bits of the group or area are detected as being “0,” the first printing subcycle S1 is completed and the second printing subcycle S2 is initiated. The second and third printing subcycles S2 and S3 then follow in the same manner as the first printing subcycle S1 (FIG. 6B).

The signal bit or flag bit control system utilized in conjunction with the core memory 111 thus completes a single printing subcycle within one rotation of the type drum 11 (FIG. 5), and when there is no printing information for an area, the only time utilized is that for reading out 40 columns of the core memory 111, which time is approximately 100 microseconds. The printing speed of the apparatus of FIG. 5 illustrated in FIG. 6B is thus twice that illustrated in FIG. 6A.

The flag bit or signal bit system for indicating the end of each printing subcycle of the printing cycle is described as one possible means for such indication. In actuality, any suitable detecting arrangement may be utilized such as, for example, counting systems or the like. Thus, the number of columns containing printing data or information may be counted in advance when the information is transferred to the switching control unit 71 (FIG. 5) and the number of columns printed may be counted each time a column is printed. The printing cycle for the printing of all the columns is then indicated as completed when the number of columns actually printed is the same as the number of columns counted in advance.

FIG. 7 shows a line printer for a hammer which may be utilized as each hammer of the apparatus of the present invention.

FIG. 8 shows a type wheel which may be utilized as the type wheel of the apparatus of the present invention.

FIG. 9 illustrates the type surface of a type wheel which may be utilized as the type wheel of the apparatus of the present invention.

FIG. 10 illustrates the data printed by the apparatus of the present invention on the printing paper of said apparatus. In FIG. 10, the horizontal spaces indicate thirty columns divided into three groups or areas of ten each. The vertical spaces indicate the type printing characters or numbers of the type wheel and comprise the numerals 0 to 9. The thirty columns are completely printed by the revolution of the type wheel three times.

FIGS. 7, 8 and 9 are FIGS. 1, 2 and 3, respectively, of United States Patent No. 3,322,063, issued May 30, 1967.

While the invention has been described by means of specific examples and in specific embodiments, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

1. Line printing apparatus, comprising printing means for printing a plurality of columns, said printing means including a plurality of printing hammers, hammer control means for controlling the operation of said printing means to successively operate said plurality of printing hammers in groups to print groups of columns in succession, the number of columns in each of the groups of columns being less than the total number of said plurality of columns, said hammer control means comprising a plurality of hammer-controlling electromagnets each controlling a corresponding one of said printing hammers, electrical power supply means and switching means interposed between said electromagnets and said power supply means for selectively switching one group of electromagnets at a time to said power supply means, each group of electromagnets being the same as each group of corresponding printing hammers.

2. Line printing apparatus as claimed in claim 1, wherein said switching means comprises a plurality of semiconductor controlled rectifiers interposed between said electromagnets and said power supply means for selectively switching one group of electromagnets at a time to said power supply means, and the number of said semiconductor controlled rectifiers is the same as the number of said groups.

3. Line printing apparatus as claimed in claim 2, wherein said hammer control means comprises switching control means connected to said semiconductor controlled rectifiers for controlling the conductive condition of each thereof.

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WILLIAM B. PENN, Primary Examiner.