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[54] **MULTI-COLOR PRINTER UTILIZING ROTATING PRINT CYLINDER**

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[52] **U.S. Cl.** **101/102,** 101/336

[51] **Int. Cl.** **B41j 5/44**

[58] **Field of Search** ..... 101/93 C, 100, 101, 102, 101/175, 176, 193, 194, 196, 197, 198, 199, 336

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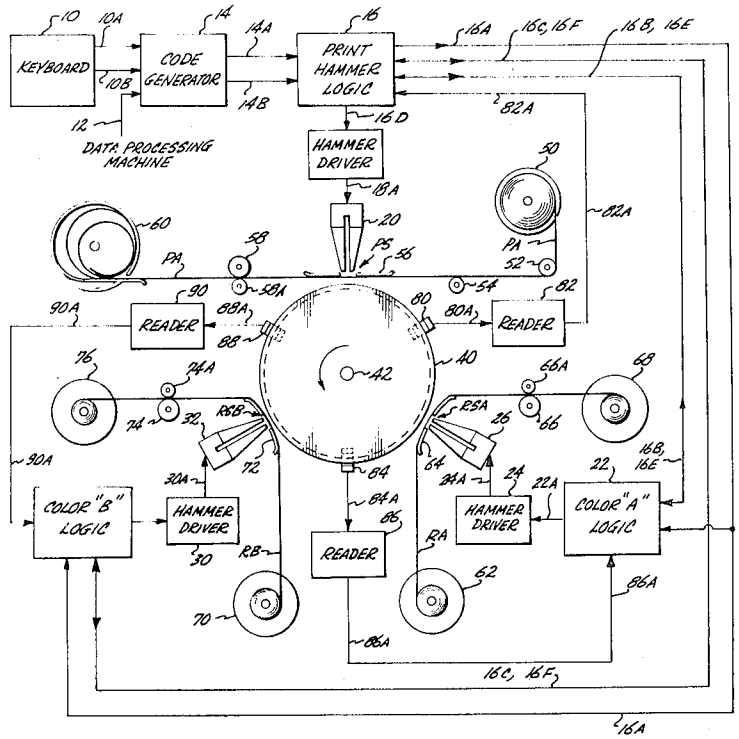
[57] **ABSTRACT**

A high speed printer capable of producing multi-color bar codes or the like upon paper or label stock without registration errors is disclosed. Ink is placed on selected characters located on a rotating print cylinder at a number of inking stations. Each inking station includes an ink source of a given color and a hammer controlled by a logic circuit for impacting the print cylinder. The ink on the cylinder is transferred to the paper or label stock at a single printing station including a hammer impacting the cylinder under control of a logic circuit. A synchronizing scheme for the printer is discussed, as are specific embodiments of the logic circuits.

7 Claims, 5 Drawing Figures



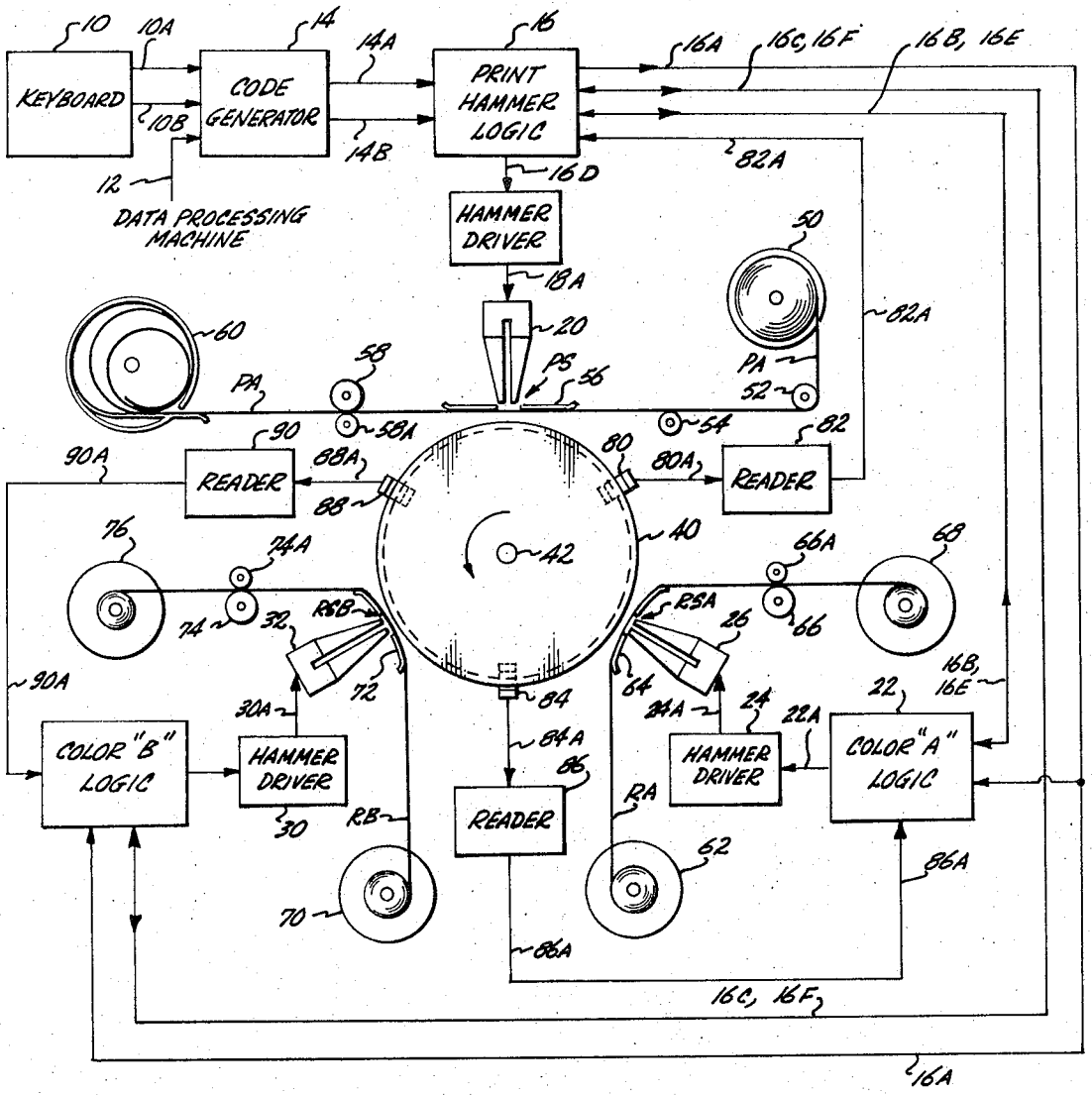

KEYBOARD
CODE GENERATOR
PRINT HAMMER LOGIC
DATA PROCESSING MACHINE
HAMMER DRIVER
READER
READER
COLOR "B" LOGIC
HAMMER DRIVER
READER
HAMMER DRIVER
COLOR "A" LOGIC
10
10A
10B
12
14
14A
14B
16
16A
16C, 16F
16B, 16E
16D
18A
20
PS
50
52
54
56
58
58A
60
62
64
66
66A
68
70
72
74
74A
76
80
80A
82
82A
84
84A
86
86A
88
88A
90
90A
22
22A
24
24A
26
30
30A
40
42
RA
RB
RSA
RSB
PA
16C, 16F
16A

Fig. 1.

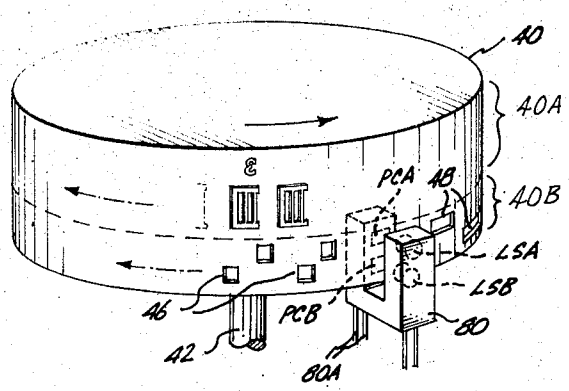

40
40A
40B
PCA
48
LSA
LSB
46
PCB
42
80
80A

Fig. 2.

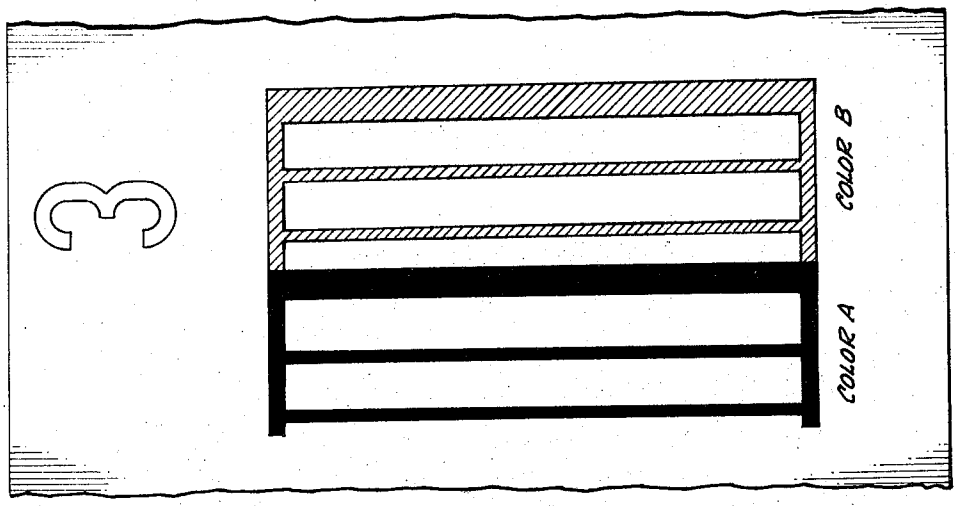


Fig. 5.

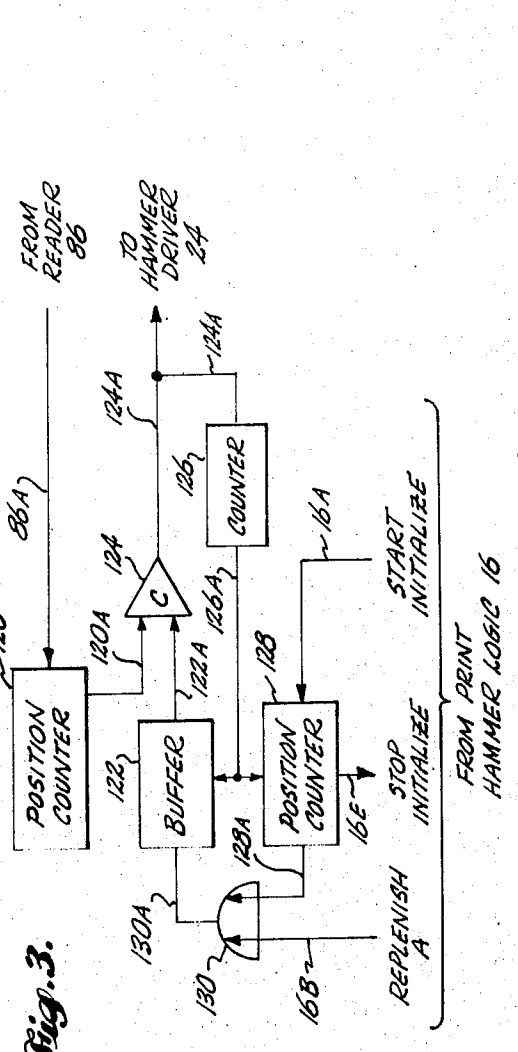


Fig. 3.

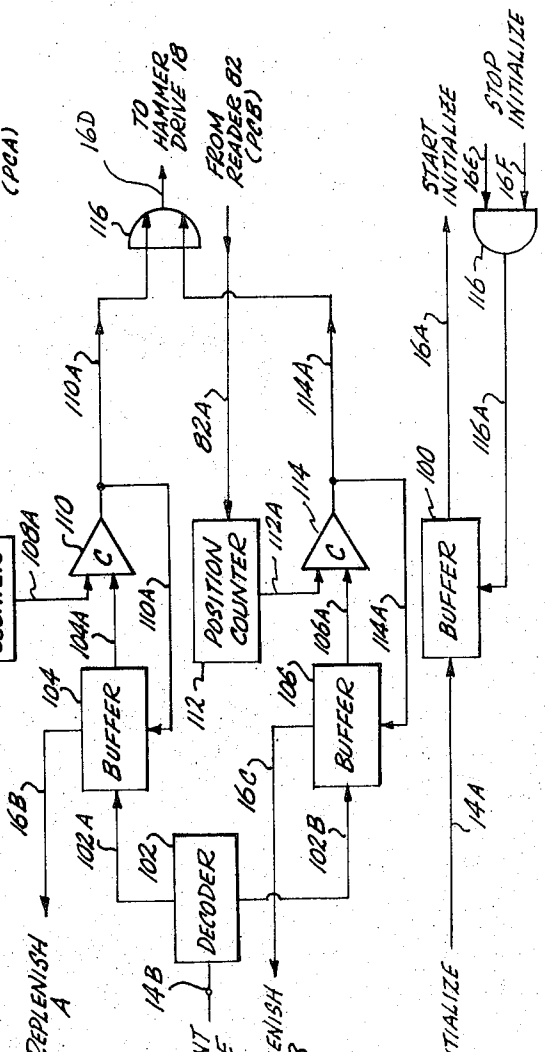


Fig. 4.

MULTI-COLOR PRINTER UTILIZING ROTATING PRINT CYLINDER

FIELD OF THE INVENTION

This invention generally relates to printing machines utilizing a rotating print cylinder and more particularly, to such a machine for providing multi-color printing of code and alphanumeric characters.

BACKGROUND OF THE INVENTION

Merchandising establishments increasingly are requiring more sophisticated tools for store management and control. Automated store control systems, which may be used for inventory control, records of purchase orders, records of payment, investments, returns, and so forth, generally include a central data processing system into which information regarding store transactions, merchandise quantities, and so forth, is provided. This input information may be entered into the system either manually or automatically. In the latter case, a merchandise ticket attached to an article has placed thereon a code which is both machine and human readable.

One machine-readable code that has been implemented in merchandising applications is that known as a bar code which comprises a series of parallel lines or bars. In a bar code, the spacing between the bars or the relative bar width carries the coded information. Many types of bar codes are known to the prior art, and each type has certain advantages and disadvantages in specific applications. One type that seems particularly advantageous for merchandising applications is that class of code utilizing multiple color bars, in which coded information is contained in the transition from one color bar to another. The multi-color bar code has a superior information-carrying capability to the single color bar codes.

The multi-color bar code has not found widespread acceptance, however, primarily because of the difficulty of accurately printing such a code. That is, the superior information-carrying capability of the multi-color bar code is realized only if precise registration is obtained between adjacent bars of different color. In the prior art, it has been thought necessary to print this code by the use of a plurality of separate printing stations, one for each color of the code. As a result, misregistration between adjacent bars of different color is inherent, and careful precautions must be taken in the design and maintenance of the printer to assure that accurate and precise codes are being reproduced. Furthermore, the added printing stations increase the cost and decrease the reliability of the printer.

It is therefore an object of this invention to provide a multi-color printer, for bar codes or the like, which utilizes but a single print station so as to substantially eliminate misregistration errors in the reproduction of a printed code. It is another object of this invention to provide a printer which allows for rapid, accurate and precise multi-color imprinting of bar codes.

It is yet a further object of this invention to provide a printer capable of multi-color code reproduction at a cost comparable to that of single-color code reproduction.

SUMMARY OF THE INVENTION

The foregoing objects and others are realized, briefly, by providing, in a printer, a print cylinder having located on a face thereof a plurality of sets of raised alpha-numeric and machine-readable code characters, at least one set being provided for each color of the code, a plurality of inking stations located in proximity to said print cylinder face for selectively inking each character of a set with its corresponding color, and a separate print station located in proximity to said print cylinder face for selectively impacting the print cylinder to transfer the ink onto a print medium.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can perhaps best be understood by reference to the following portion of the specification, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a combined schematic and block diagram illustrating a preferred embodiment of the multi-color printer;

FIG. **2** is a pictorial diagram illustrating a typical print cylinder and an associated reading head;

FIG. **3** is a block diagram illustrating an embodiment of the color "A" hammer logic in FIG. **1**;

FIG. **4** is a block diagram illustrating an embodiment of the print hammer logic in FIG. **1**; and

FIG. **5** is a pictorial diagram illustrating a typical multi-color bar code.

DESCRIPTION OF A PREFERRED EMBODIMENT

With reference now to FIG. **1**, input signals representing desired characters to be imprinted may be obtained either from a keyboard **10** or from a data processing machine, not illustrated. These input signals are provided by keyboard **10** on lines **10A** and **10B**, and by the data processing machine on line **12**, and supplied to a code generator **14**. In response, code generator **14** provides output control and code signals on lines **14A**, **14B** to a print hammer logic circuit **16**.

As will be described in more detail hereinafter, print hammer logic circuit **16** provides a plurality of control signals on lines **16A**, **16B**, **16C**, **16E**, and **16F**, to a color A logic circuit **22** and a color B logic circuit **28**. In addition, print hammer logic circuit **16** provides an output signal on line **16D** to a hammer driver **18** which in turn provides a driving signal on a line **18A** to a print hammer **20**.

Likewise, color A logic circuit **22** provides an output signal on a line **22A** which is converted by hammer driver **24** to a drive signal on line **24A** to actuate a ribbon hammer **26**, and a color B logic circuit **28** provides an output signal on line **28A** which is converted by hammer driver **30** into a drive signal on line **30A** to actuate a ribbon hammer **32**.

Hammers **20**, **26** and **32** are arranged for actuation along separate radii of a print cylinder **40** which is rotatable in a counterclockwise direction about a shaft **42**. The material to be imprinted is known hereinafter as paper PA but should be understood to comprise paper tape, label stock including a plurality of individual die-cut labels contained on a release backing strip, card stock, or the like. In the embodiment of FIG. **1**, the paper PA is taken from a supply reel **50** and is passed around a roller **52**. The paper is driven by a drive capstan **58** co-acting with a pinch roller **58A** over a roller **54** and past a guide **56** which, together with hammer **20** and print cylinder **40**, defines a print station PS. It should be noted that the paper PA passes be-

tween the hammer 20 and the print cylinder 40. After imprinting, the paper PA is supplied to a take-up mechanism 60 wherein it is coiled.

In a similar manner, a ribbon RA is drawn from a supply reel 62 over a guide 64 by a capstan 66 co-acting with a pinch roller 66A, and thence on to a take-up reel 68. The guide 64, together with a ribbon hammer 26 and a print cylinder 40, define an ink station RSA. A ribbon RB is drawn from a supply reel 70 over a guide 72 by a drive capstan 74 co-acting with a pinch roller 74A, and thence on to a take-up reel 76. Guide 72, together with ribbon hammer 32 and print cylinder 40, define an ink station RSB.

Ribbons RA and RB may be of an identical type, that is, a one-time carbon ribbon, a re-inkable ribbon, or the like, and differ only in their ink colors.

To synchronize the operation of the hammers 20, 26 and 32 with the rotation of the print cylinder 40, various reading means are utilized. In particular, a first light source-light detector means 80 provides signals on line 80A to a first reader 82 which in turn supplies timing and synchronizing signals on line 82A to print hammer logic 16. Light source-light detector means 80 is positioned in advance of print station PS, given a counterclockwise rotation of print cylinder 40. Likewise, a second light source-light detector 84 supplies signals on line 84A to a reader 86 which in turn supplies timing and synchronizing signals on line 86A to color A logic circuit 22, and a third light source-light detector 88 supplies signals on line 88A to a reader 90 which in turn supplies timing and synchronizing signals on line 90A to color B logic circuit 28.

In FIG. 2, the make-up of a typical print cylinder 40 and the light source-light detector 80 are shown in more detail. The peripheral surface of print cylinder 40 is divided into an upper portion 40A and lower portion 40B. In portion 40A, a plurality of embossed bar code characters are located, as are a plurality of alpha-numeric characters which are positioned directly above certain ones of the bar code characters. The specific font of bar code that is utilized is not important to the invention, the only requirement being that the font be compatible with a multi-color code. The code characters, and their associated alpha-numeric characters, if any, are arranged into two sets. The first set comprises those characters which are to be utilized to imprint a character in color A, and the second set comprises those characters which are to be utilized to imprint a character in the color B. A reproduction of the characters imprinted on the paper PA using the characters of FIG. 2 is seen in FIG. 5. It can be seen that the characters alternate in set around the periphery of the print cylinder 40; however, this arrangement is not necessary to successful implementation of the invention.

To identify the character sets to the printer and to provide the aforementioned timing and synchronizing signals, a plurality of timing apertures are provided in portion 40B. The timing apertures are arranged in an upper channel and a lower channel, an aperture 44 in the upper channel being associated with each character in the first set, and an aperture 46 in the lower channel being associated with each character in the second set. At the beginning of each set, each channel in portion 40B has located therein an elongated, synchronizing aperture 48. Each character in the set is then identified by counting the number of timing apertures in a channel between its position on the print cylinder 40 and synchronizing aperture 48.

The aforesaid synchronizing and timing signals are obtained from the portion 40B by the light source-light detector 80 which includes two light sources LSA, LSB and two corresponding photocells PCA, PCB for the upper and lower channels, respectively. Passage by detector 80 of a synchronizing aperture 48 and a timing aperture 44 causes a synchronizing signal and a timing signal to be produced in the corresponding channel's photocell.

The light source-light detectors 84 and 88 are similar in structure to that of light source-light detector 80, with the exception that only one channel is sensed.

The operation of the printer may be briefly summarized as follows. When the machine is started initially, appropriate signals are provided through print hammer logic 16 to both color A logic circuit 22 and color B logic circuit 28. As a result, circuits 22 and 28 operate under control of the synchronizing and timing signals provided by their respective readers 82, 90, to cause the hammers 26, 32 to be actuated at the appropriate times so as to place ink of color A upon all the alpha-numeric and code characters in the first set, and to place ink of color B upon all the alpha-numeric and code characters in the second set of color B. During this time, the print cylinder 40 is continuously rotating at a relatively high speed. When an input signal representing a desired character from either keyboard 10 or the data processing machine on line 12 is received by code generator 14, appropriate signals designating the character and its color are transmitted to print hammer logic 16. Accordingly, the print hammer logic circuit 16, utilizing and synchronizing and timing signals provided by its reader 82, causes hammer 20 to be actuated by an appropriate time so as to imprint the desired character on the proper PA. Immediately after the hammer 20 has been actuated, a signal is provided by print hammer logic circuit 16 to either color A logic circuit 22 or color B logic circuit 28 so that the character which has been imprinted is replenished with ink by actuation of the respective hammers 26 or 32 at its next passage of the ink stations RSA or RSB.

Suitable means, not illustrated, are provided to synchronize the movements of the paper PA and the ribbons RA, RB with the hammer actuations. Such means form no part of the present invention and could be conventionally implemented. However, it is preferable that the paper PA, and ribbons RA and RB be stationary in the region of print station PS and ink stations RSA and RSB at the time of hammer actuation.

In the conventional multi-color code printer, a plurality of print stations are utilized, one for each color of the code, wherein both the material which is to be imprinted and a ribbon of a desired color are drawn between the actuating hammer and the character bearing device or print cylinder. Because two separate print stations are thus utilized, misregistration between the printed characters of different colors exists. The invention avoids this misregistration by first placing ink of desired colors to be imprinted on desired characters at a plurality of separate locations, one for each color to be imprinted, then carries out all imprinting at a single print station.

Further details of the invention, together with additional advantages, will be realized from consideration

of a specific embodiment of the logic circuits **16, 22** and **28,** and their functional operation.

When the machine is first started, code generator **14** provides an Initialize signal on line **14A** to print hammer logic circuit **16.** With a specific reference now to FIG. **4,** this Initialize signal is stored in a buffer **100** and transmitted via line **16A** as a Start Initialize signal to logic circuits **22** and **28.** With reference now to FIG. **3,** which illustrates logic circuit **22,** the Start Initialize signal on line **16A** enables a position counter **128** which provides an output signal to a buffer **122,** via line **128A** and OR gate **130,** and line **130A** denoting the position of a first character in the set of color A. The output signal from counter **128** is preferably a digital number representing the number of timing apertures between the position of the desired character and the position of the channel's synchronizing aperture **48.**

The synchronizing and timing signals from reader **86** are also supplied to a second position counter **120** having *m* positions wherein *m* = the number of characters in the first set. Position counter **120** is reset by the synchronizing signal at the start of the first set and is thereafter stepped by each timing signal on line **86A.** Therefore, position counter **120** contains a digital number representing the actual character on the print cylinder **40** that is in position to be inked at ink station, RSA.

The contents of position counter **120** and buffer **122** are supplied by lines **120A, 122A,** respectively, to a comparator **124.** When the contents of position counter **120** and buffer **122** are equal, comparator **124** provides an output signal on a line **124A** which appears as output signal **22A** controlling the actuation of the hammer **26.** As a result, ink of color A is placed on the desired character.

The output signal on line **124A** is also supplied to a counter **126** which has *n* positions, where *n* = the number of times that each character is to be inked before imprinting. In the simplest case, *n* = 1, however, due to the ink characteristics and other factors, it may be desirable to ink a character more than once before imprinting, so *n* may be greater than one.

If counter **126** has not counted *n* times, then comparator **124** provides an output signal on line **124A** to reink the character at the next time the counts in position counter **120** and buffer **122** are equal, which will usually occur upon the next revolution of cylinder **40.** When the character has been inked *n* times, counter **126** provides an output signal which clears buffer **122** and steps position counter **128** to its next position.

The inking cycle thus described is then repeated for the next character in the first set (of color A), as position counter **128** steps through the character positions in sequence. After position counter **128** has stepped to its last position, the signal on line **126A** from counter **126,** which signifies that the last character has been imprinted *n* times, clears buffer **122,** resets position counter **128** and causes a Stop Initialize signal to be transmitted on line **16E** to print hammer logic **16.**

Color B logic circuit **28** operates in an identical manner to apply ink to all the characters in the second set at this time. When inking is complete for color B, logic circuit **28** transmits a Stop Initialize signal on line **16F** to logic circuit **16.** When the Stop Initialize signals on lines **16E** and **16F** are both received by AND gate **116** (FIG. **4**), a signal is issued thereby on line **116A** to clear buffer **100** to terminate the initialization process.

To imprint a desired character in a desired color, code generator **14** supplies a Print Code signal on line **14B** to print hammer logic circuit **16.** With reference now to FIG. **4,** this print Code signal is supplied to a decoder **102,** which routes the signal either to a buffer **104** on a line **102A,** or to a buffer **106** on a line **102B,** depending on whether color A or color B is to be imprinted. Preferably, the signal stored in buffer **104** is in the form of a digital number representing the relative position in the set of the desired character with respect to the set's synchronizing aperture **48.** This signal is supplied on line **104A** to one input of comparator **110.**

An input signal to a position counter **108,** having m positions equal to the number of characters in the first set of color A, is provided by the synchronizing and timing signals present on a line **82A** from reader **82,** and specifically from photocell PCA therein. Position counter **108** is reset by the synchronizing aperture **48** in the upper channel of portion **40B** of print cylinder **40.** Therefore, the count in position counter **108,** which is supplied to comparator **110** on line **108A,** represents a specific character in the first set. When the counts in counter **108** and buffer **104** are equal, signifying that the desired character is in a position for imprinting, an output signal is provided on a line **110A** through an OR gate **116** to appear as the control signal on line **16D** to cause hammer **20** to be actuated.

The signal on line **110A** clears buffer **104** for the next desired character in that set and causes buffer **104** to transmit the previously stored signal via line **16B** as a Replenish A signal to color A logic circuit **22.** With specific reference now to FIG. **3,** the Replenish A signal is coupled through OR gate **130** to buffer **122,** and is provided to one input of the comparator **124** via a line **122A.** The second input to comparator **124** is obtained from position counter **120** via line **120A.** When the counts in position counter **120** and buffer **122** are equal, signifying that the desired character is in a proper position for reinking, an output signal is provided on line **124A** which causes the hammer **26** to reink the desired character. The output signal on line **124A** is also supplied to *n*-bit counter **126** which does not clear buffer **122** via line **126A** until the character has been re-inked *n* times.

The operation for printing and re-inking a character in the second set is identical, with the exception that the Print Code signal is routed by decoder **102** to buffer **106** which in turn utilizes a comparator **114,** a *p*-bit counter **112,** wherein *p* = the number of characters in the second set (of color B), connecting leads **106A, 112A** and **114A,** reader **82,** and specifically photocell PCB, and color B logic circuit **28** to effect the desired operation.

While the invention therefore has been described with respect to a preferred embodiment thereof, it is to be clearly understood by those skilled in the art that it is not limited thereto, but rather is to be bounded only by the limits of the appended claims.

I claim:

1. A printing system providing for precise registration of characters when imprinted in multiple colors upon a print medium, comprising:

a. a print cylinder having a plurality of sets of raised characters located around a circumferential sur-

face thereof, one set of raised characters being provided for each color to be imprinted,

b. a plurality of inking stations located in proximity to said print cylinder, each of said inking stations including means for selectively inking the raised characters of one of said sets thereof on said circumferential surface with ink of a desired color in response to an inking control signal,

c. a printing station also located in proximity to said print cylinder, said printing station including means for selectively impacting the print medium against the characters in any of said plurality of sets on said circumferential surface in response to a print control signal,

d. timing means providing timing signals identifying the location of the characters in said plurality of sets relative to said printing station and to each of said plurality of inking stations,

e. code generator means providing an output signal representing a desired character to be imprinted and its color,

f. logic means responsive to said timing signals and to said output signal including means providing an inking control signal to one of said plurality of inking stations having ink of the desired color and including means providing a print control signal to said printing station.

2. A system as recited in claim **1,** wherein each of said sets of raised characters on said circumferential surface of said print cylinder includes a plurality of alpha-numeric characters and a plurality of machine-readable code characters.

3. A system as recited in claim **2,** wherein said plurality of machine-readable code characters in each set are in the form of a bar code.

4. A system as recited in claim **3,** wherein said plurality of alpha-numeric characters in each set are aligned with certain ones of said plurality of bar code characters.

5. A multi-color printer for coded characters, comprising:

a. a rotating print cylinder having located about its circumference a plurality of sets of said characters, one set being provided for each color to be imprinted, and a plurality of timing channels, each channel being provided for one of said plurality of sets and including means identifying each character in the set,

b. a plurality of inking stations which are located in proximity to said print cylinder, each of which includes an ink ribbon of a given color, means for maintaining said ink ribbon in proximity to said print cylinder circumference, and a member for impacting said ink ribbon against said print cylinder in response to an inking control signal,

c. a single print station also located in proximity to said print cylinder and including means for maintaining a print medium in proximity to said print cylinder circumference, and a member for impacting said print medium against said print cylinder in response to a print control signal,

d. timing means including a plurality of sensors, one sensor for each channel and providing an output timing signal in response to said identifying means therein,

e. code generator means providing an output signal denoting a desired character to be imprinted and its color,

f. a print logic means including first storage means response to said timing signals for registering the instantaneous location of each character in each set relative to said print station, and comparator means for comparing the color and desired character information contained in said output signal with the registration information in said storage means to provide said print control signal when a desired character in a desired set is in a position to be imprinted, and

g. a plurality of inking logic means, each of said inking logic means being associated with one of said inking stations and including second storage means responsive to said timing signals for registering the instantaneous location of each character in one of said sets relative to said inking station, and second comparator means for comparing the color and character information contained in said output signal with the registration information contained in said second storage means to provide said inking control signal when the desired character in its set is in a position to be inked.

6. A multi-color printer as recited in claim **5,** wherein:

a. said identifying means in each of said timing channels comprises a plurality of timing marks located about the circumference of said print cylinder, one timing mark being provided for each character,

b. said sensors providing a timing pulse for each of said timing marks,

c. said first storage means in said print logic means and said second storage means in each of said inking logic means comprises a position counter incremented by said timing pulses.

7. A multi-color printer as recited in claim **5,** further comprising a means providing an initialization signal, and wherein each of said inking logic means comprises means responsive to said initialization signal for supplying output signals to said second comparator means which successively denote all characters in a set so that all characters in the set are successively inked in response thereto.

* * * * *