

[54] INK JET PRINTING APPARATUS WITH
LINE SWEEP AND INCREMENTAL
PRINTING FACILITIES[75] Inventors: **Raymond L. Fowler; James D. Hill;**
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Corporation, Armonk, N.Y.[22] Filed: **Dec. 11, 1972**[21] Appl. No.: **313,919**[52] U.S. Cl. **197/1 R, 197/19, 197/66,**
346/75[51] Int. Cl. **G01d 15/18**[58] Field of Search **101/DIG. 13; 346/75, 140;**
197/1 R, 19, 60, 62, 63-66, 68, 86, 85, 94,
88; 178/6.6 R

[56]

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[57]

ABSTRACT

An ink jet printing apparatus is described having facilities for printing information in character locations, (boxes) each character location comprising a plurality of vertical columns of drop locations, and a number of characters comprising a line of information. Structures and circuits are included for insuring correct location of information within the character boxes and also providing for one mode in which characters are printed continuously line-by-line and another mode in which characters are printed incrementally character-by-character. During incremental printing, as well as the first character in a line or group of characters, provision is made for re-bounding the printhead back into the box of the character just printed, that is, prior to the next character box to be printed to insure that when the printhead starts up again for the next character that all drop components for that character, including any located in the immediate vicinity of the character boundary, are properly placed during printing.

10 Claims, 11 Drawing Figures

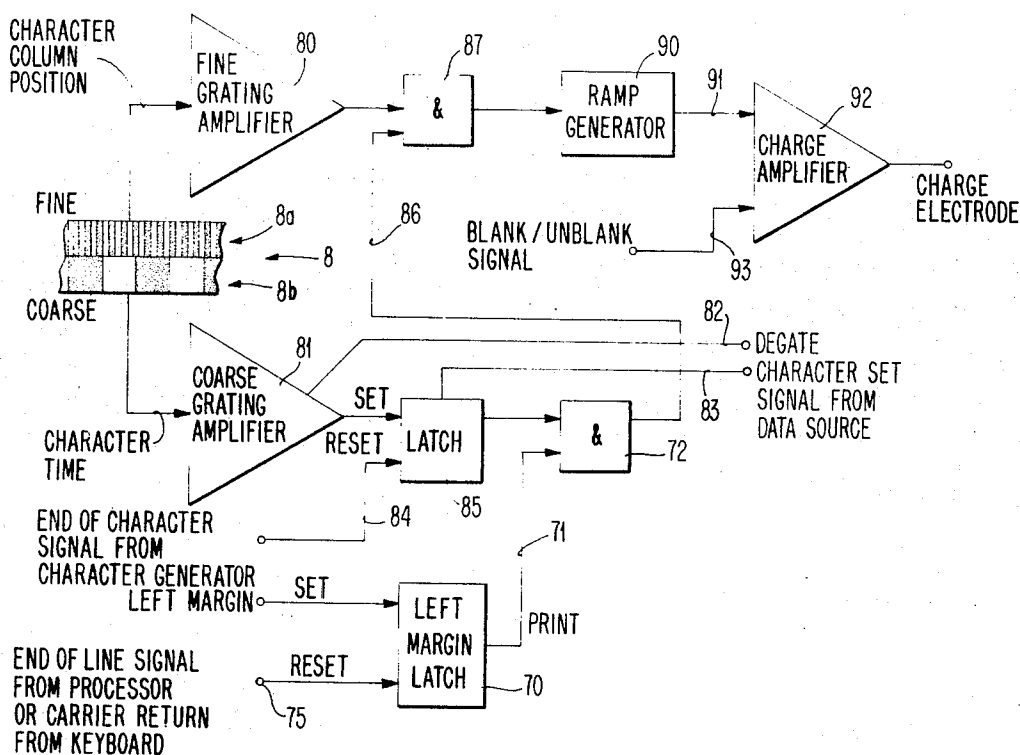


FIG. 1

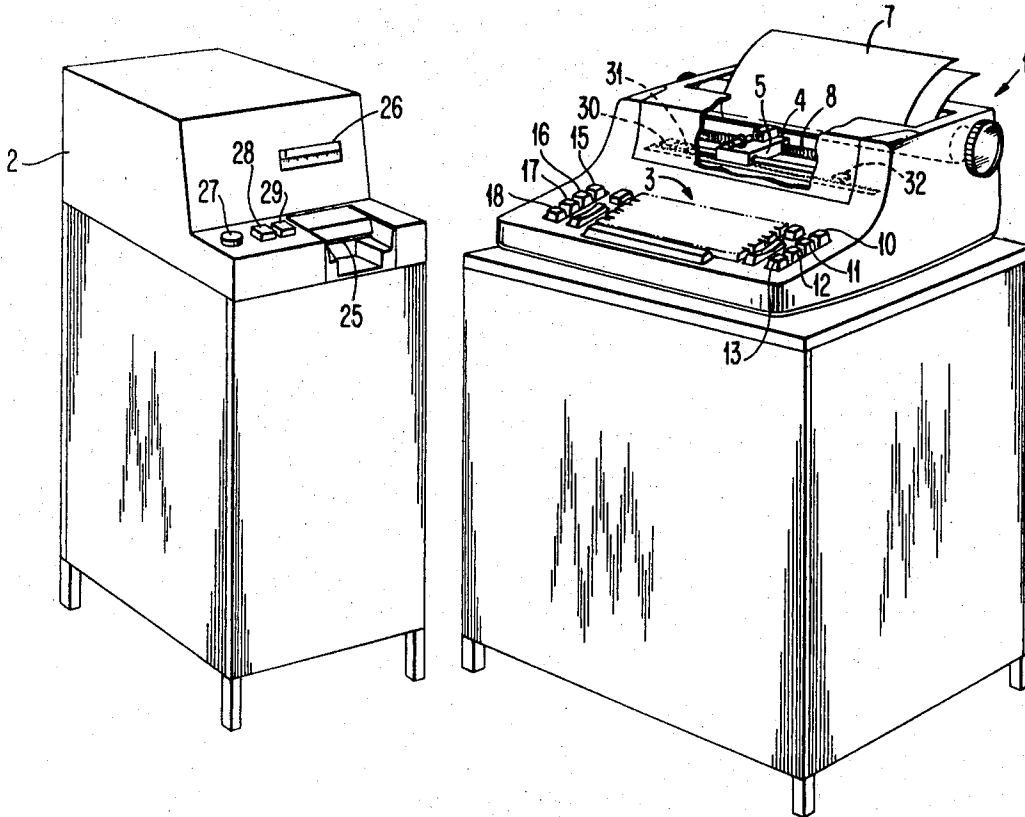


FIG. 2a

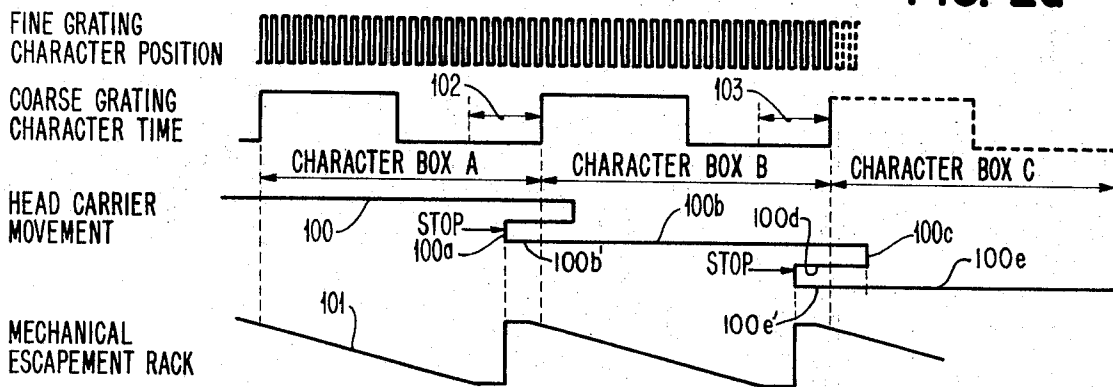
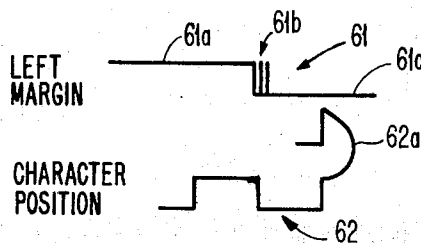


FIG. 2b



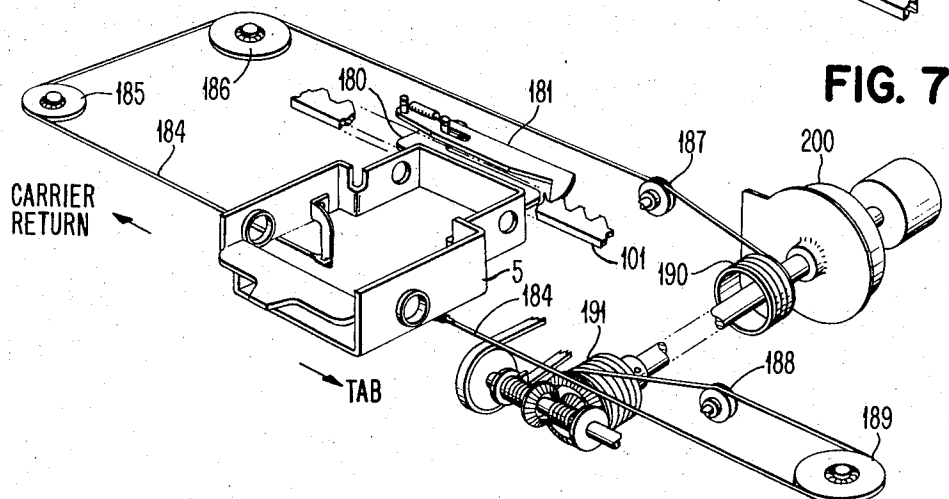
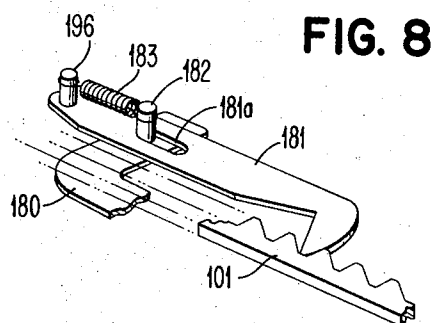
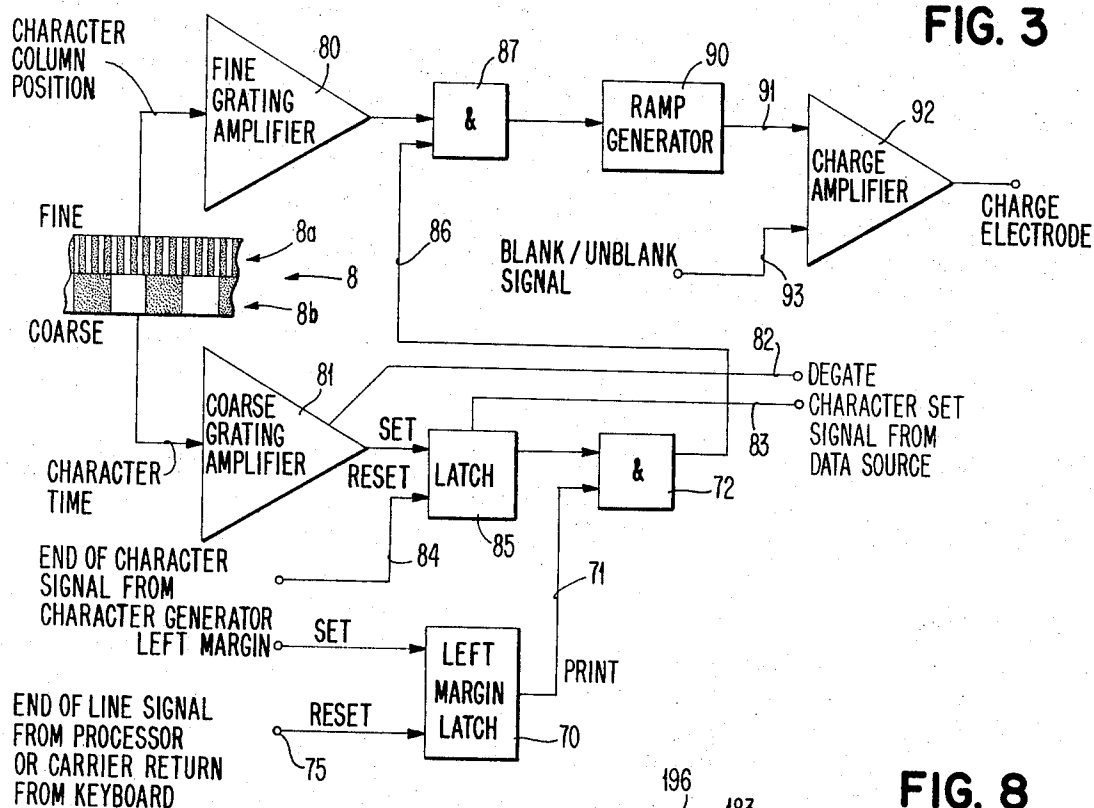


FIG. 4a

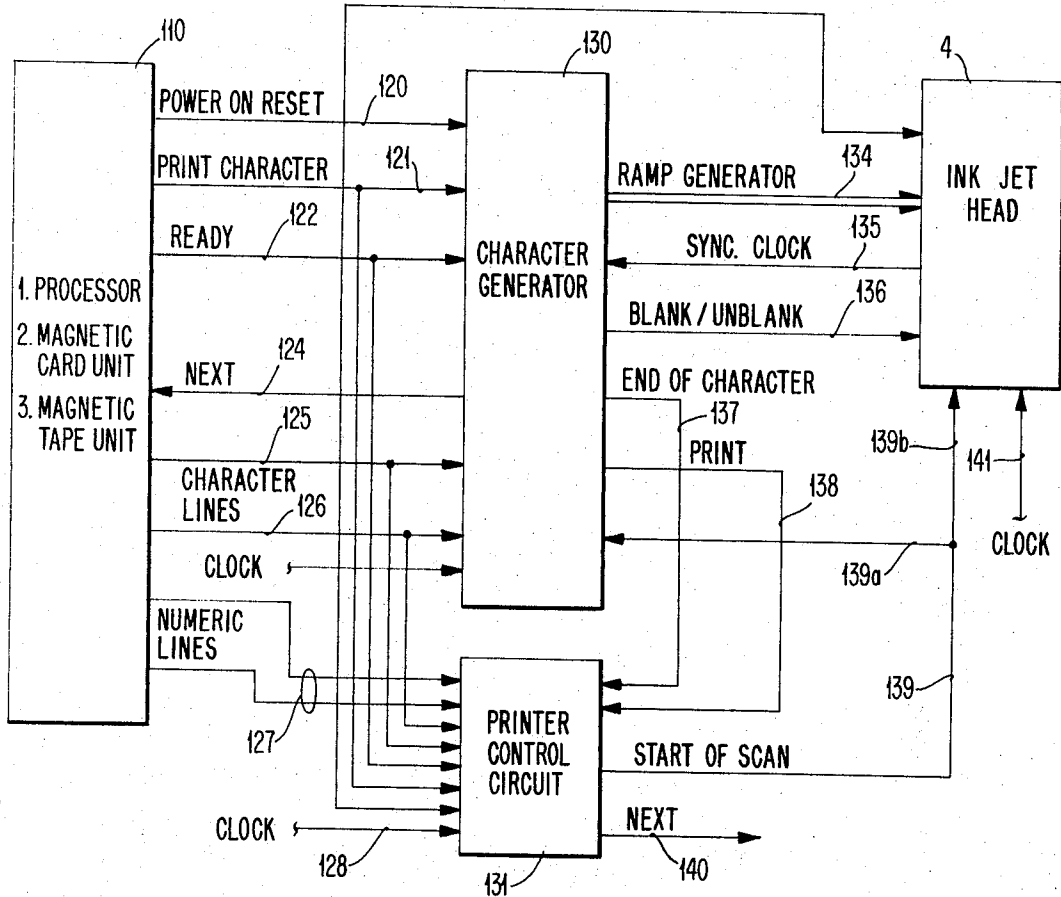


FIG. 4b

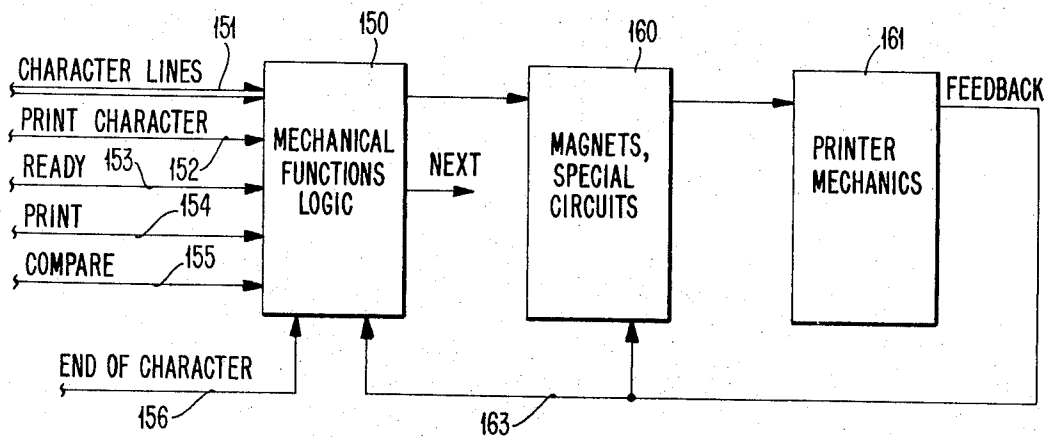


FIG. 5

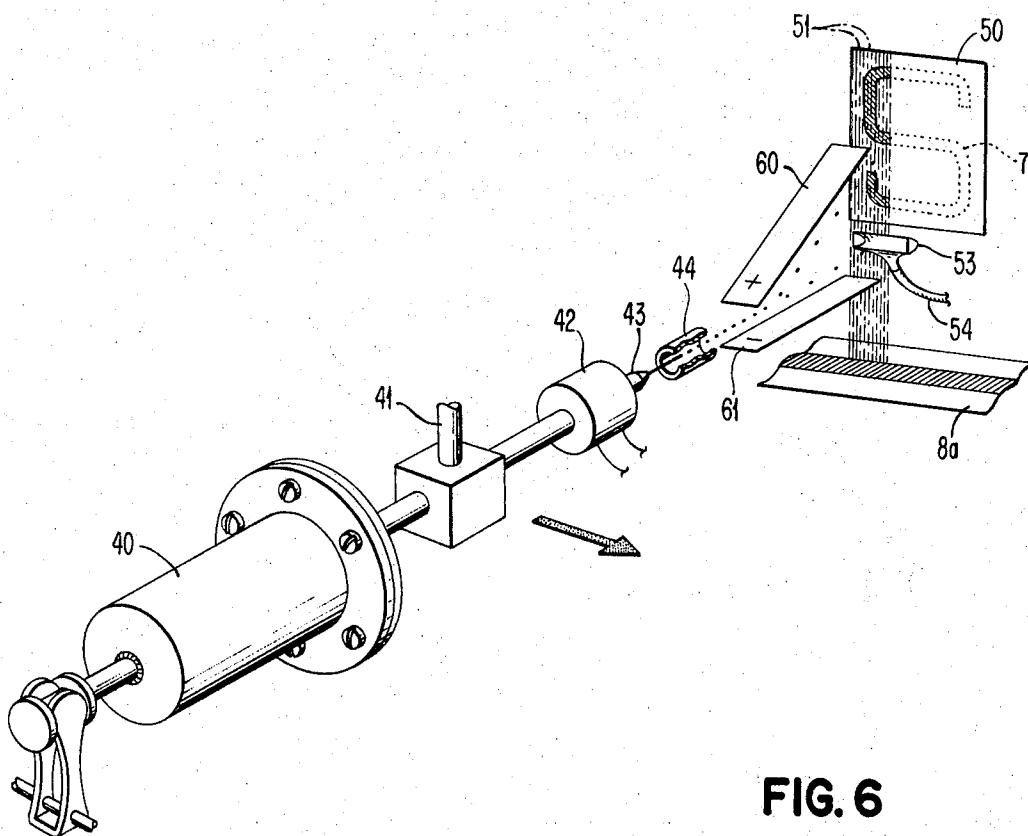
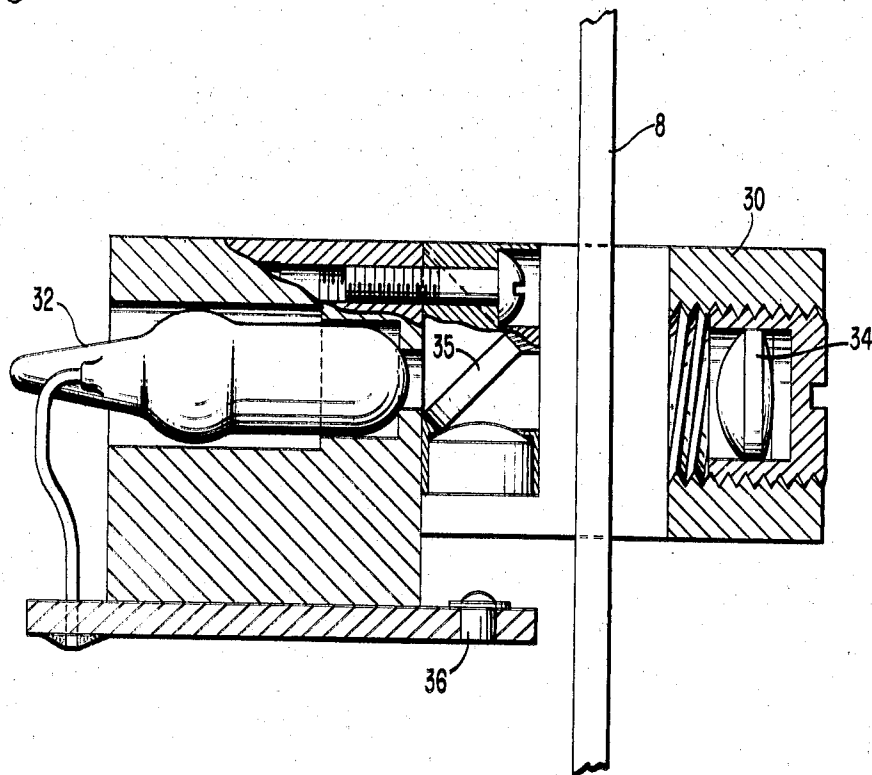
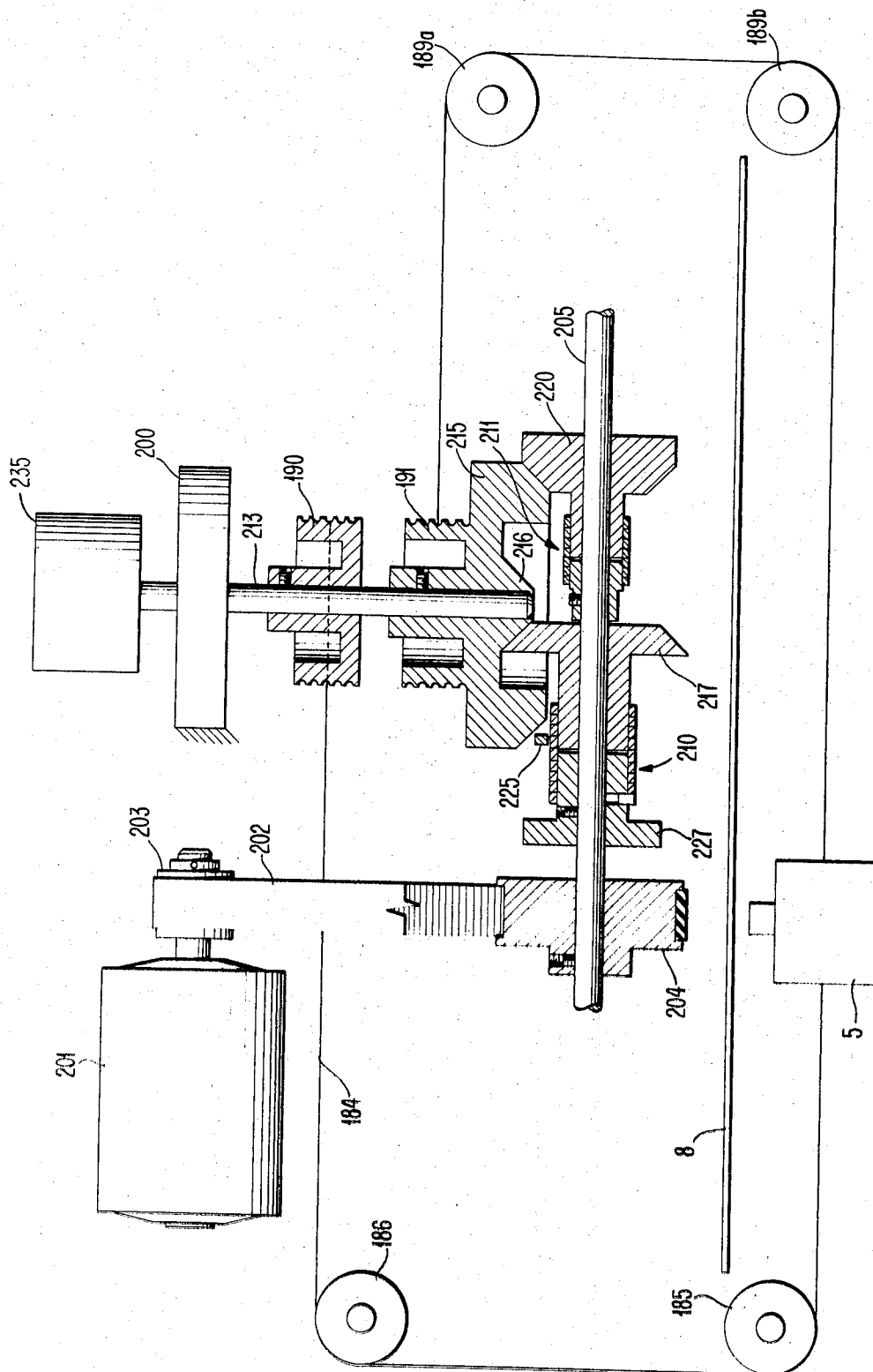


FIG. 6





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INK JET PRINTING APPARATUS WITH LINE SWEEP AND INCREMENTAL PRINTING FACILITIES

RELATED PATENT APPLICATION

U.S. patent application Ser. No. 313,886 filed Dec. 11, 1972, entitled "Ink Jet Printing Apparatus with Overrun of Printhead to Insure Better Visibility and Counter Control of Printing Locations", having J. W. Woods, et al., as inventors, and assigned to the same assignee as the present application.

REFERENCES OF INTEREST

The following U.S. patents are of general interest: Rossetto, et al., U.S. Pat. No. 25,354; Stabler, U.S. Pat. No. 2,656,106; Woodhead, U.S. Pat. No. 2,954,860; Sims, U.S. Pat. No. 3,297,124; Locklar, et al., U.S. Pat. No. 3,260,340; Jones, et al., U.S. Pat. No. 3,512,137; Hayes, et al., U.S. Pat. No. 3,494,550.

The following IBM publications are of interest:

"Reed Switch Contact Block" authors, R. L. Burdick, et al., IBM Technical Disclosure Bulletin, October 1966, page 512.

"Toggle and Momentary Reed Console Switch Assembly", authors, L. F. Dorius, et al., IBM Technical Disclosure Bulletin, May 1967, pages 1702 and 1703.

The following IBM Customer Engineering Manuals are of interest:

"Selectric" Printer Instruction Manual, January, 1966, Form NO. 241-5032.

"Selectric" Typewriter, Service Manual, November, 1970, Form No. 241-5615.

"Selectric" II Typewriter, Service Manual Supplement, Form No. 241-5615 (Supplement).

Magnetic Card "Selectric" Typewriter, Self Teach Course Summary, July, 1969, Form No. 241-5581.

Magnetic Card "Selectric" Typewriter, Self Teach Instruction Manual, Vol. II, June, 1969, Form No. 241-5580.

Parts Catalog, Magnetic Card "Selectric" Typewriter, August, 1969, Form No. 241-5584.

Pictorial Reference/Adjustment Manual, Magnetic Card "Selectric" Typewriter, July, 1969, Form No. 241-5593.

BACKGROUND OF THE INVENTION AND PRIOR ART

The Rossetto patent describes photocomposing apparatus making use of a grating for determination of character increments. The Stabler patent describes a shaft position indicator for recognizing direction of rotation of a shaft and having an associated counting means. The Woodhead patent describes a counter for keeping track of printer position.

The Sims patent describes a power typing system incorporating an IBM "Selectric" printer with an associated magnetic tape storage unit with recording and reading facilities. Line readjustment capabilities are also described. The Locklar, et al., patent describes an apparatus similar to the Sims system with provision for selection of information on a character, word, and line basis. The Jones, et al., patent describes an automatic typing system incorporating an IBM "Selectric" Typewriter together with an associated magnetic card stor-

age unit having recording and reading facilities. The Hayes patent describes an electrical keyboard unit.

The Burdick, et al., and Dorius, et al., publications describe Reed Switch Assemblies.

The various IBM Customer Engineering Manuals describe the "Selectric" printer, the "Selectric" Model II printer, and the "Selectric" printer and magnetic card unit in the IBM MC/ST.

SUMMARY OF THE INVENTION

The ink jet printing system described herein is designed to operate both in line and incremental modes. During line printing, the carrier, on which are mounted the ink jet hardware and optical sensor, is moved from left to right at a reasonably constant speed not exceeding 10 inches per second and has a high carrier return speed of 40-50 inches per second. In the incremental mode, a clock spring and escapement rack allows the carrier to stop at 0.100 inch intervals while it moves from the left to the right side of the machine. Tab, Backspace and platen Index capabilities are also included. An electrical switch allows the machine to be operated in either mode of printing.

Ink drops are formed at a high frequency such as 100 kilohertz and propelled from a nozzle at a high speed, and are directed toward a document to be printed with suitable placement of drops to form character matrices, such matrix comprising a predetermined number of vertical columns of drops, such as 24 and each column comprising a plurality of drops, such as 40.

A raster scan is used to print the characters. Deflection of ink drops in the vertical direction is by electrostatic action, while deflection in the horizontal direction is primarily by mechanical motion. In order to reduce the requirements on the velocity control of the mechanical motion of the head which generates the stream, a fine grating is used having a line to define each vertical column of drops. Where printing is continuous and the stream motion is in a constant direction, this grating is sufficient. However, since the head must start and stop the fine grating is supplemented by a second grating which has one line for each character position. If the head is stopped short of a character line, then the line can be used to indicate to the electronics when to start printing the related character (i.e. when to look at the fine grating). This allows the mechanism greater freedom in where the head stops.

The system described here is operable on an incremental character-by-character basis wherein characters are defined by character boundaries, individual characters having components close to the boundaries and incorporates facilities automatically operable to position the printhead prior to the starting boundary of a character to be printed to insure proper placement of components.

OBJECTS

The primary object of the present invention is to provide ink jet printing apparatus having both line printing and incremental modes of operation.

A further object of the present invention is to provide a grating-sensor arrangement for keeping track of character and drop column locations during printing.

Another object of the present invention is to provide structures for producing continuous line sweeping action or incremental character-by-character spacing and printing, as required.

A still further object of the present invention is to provide an ink jet printing system having facilities for accurate and complete placement of character components.

The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of the preferred embodiment of the invention as illustrated in the accompanying drawings.

DRAWINGS

In the drawings:

FIG. 1 illustrates an ink jet printing system incorporating a printer and having an associated magnetic card recording/reproducing unit with both line printing and character-by-character printing facilities.

FIG. 2a illustrates various pulse waveforms provided for in the system of FIG. 1, together with carrier motions encountered during incremental printing. FIG. 2b is a supplementary waveform showing a left margin signal.

FIG. 3 illustrates a coarse and fine grating and associated circuits for controlling printing of information and charging of drops.

FIG. 4a is a block diagram of the ink jet printing apparatus of FIG. 1 showing a number of significant control lines and suitable data sources. FIG. 4b is a block diagram illustrating some of the printer mechanical signals involved.

FIG. 5 illustrates structures in the ink jet printer head assembly with associated grating.

FIG. 6 illustrates a sensor assembly useful with the grating shown in FIG. 5.

FIG. 7 illustrates various drive mechanisms for producing movement of the ink jet carrier in the tab direction or in the carrier return direction, as required.

FIG. 8 illustrates a mechanism for obtaining startup prior to the printing of each character.

FIG. 9 is a top elevation of driving mechanisms for the printer of FIG. 1 illustrating some of the same elements previously shown in FIG. 7.

DETAILED DESCRIPTION

FIG. 1 illustrates an ink jet printing system incorporating a typewriter 1 with an associated magnetic card recording/reproducing unit 2. Card unit 2 is shown for convenience only since by inspection of FIG. 4a, it is apparent that other kinds of storage units, recording/reproducing units, and the like, may be used in the system. Typewriter 1 has the usual keyboard 3 which preferably is of the electrical type referred to in some of the IBM Customer Engineering Manuals listed previously. It may also be of the type described in the Hayes, et al., patent. Printer 1 incorporates an ink jet head assembly 4 arranged for travelling movement from left to right (and conversely) adjacent a document 7 to be printed. Assembly 4 has an ink drop nozzle and an associated grating 8 with an upper incremental column location scale and a lower character scale as shown in greater detail in FIG. 3. Printer 1 may be provided with various control buttons 10, 11, 12 and 13 for automatic, line, word, and character printing, respectively. Other key-buttons 15-18 concern mode selection, that is, line printing or character printing, playback, adjust, and skip, respectively.

Reference is made to the various "Selectric" typewriter manuals referred to previously for description of

other keyboard facilities and other features of the printer. The magnetic card unit 2 has a load slot 25 and a track indicator 26. Also provided on unit 2 is a card eject button 27, a track stepdown button 28 and a track stepup button 29 for relocating the scanning transducer with respect to the various tracks on the card. Reference is made to the various magnetic card manuals and the Jones, et al., patent for a description of facilities in the card unit. It is understood, of course, that other kinds of storage facilities, card units, tape units, processors, and the like can be substituted for unit 2 including as an example, the magnetic tape unit set forth in the Sims and Locklar, et al., patents.

Printer 1 incorporates a left margin reed switch 30, a drop carrier return reed switch 31 and a right margin reed switch 32. These may be of the type set forth in the Burdick, et al., and Dorius, et al., publications.

FIG. 2a illustrates various mechanical movements encountered in the system of FIG. 1 during movement of head assembly 4 adjacent document 7, while FIG. 3 represents circuitry for deriving the pulses from the fine and coarse grating 8. FIG. 2b illustrates a left margin signal 61 with portion 61a representing closure of switch 30 indicative of the left margin zone, portion 61b indicating transfer of switch 30 and portion 61c indicating printing zone. Signal 61 is combined with character signal 62 from portion 8b of grating 8 to control printing of the first character. Portion 62a reflects overrun of the grating in an incremental mode.

With mode keybutton 15 in line mode, head assembly 4 moves from the left of margin switch 30 to the right across document 7 to print characters in a continuous fashion. At the end of each line, a carrier return operation is performed as determined by the location of the switch 32, FIG. 1, or as a result of a line ending code from the data source, and head assembly 4 returns beyond the left margin at switch location 30.

Mounted on head assembly 4 for translational movement adjacent grating 8 is a sensor assembly such as that shown in FIG. 6. This comprises a supporting structure 30 incorporating a lamp 32 arranged to direct light thru grating 8 to a reflecting lens 34. Light is then returned for reflection at 90° by mirror 35 to a photo-sensor pickup 36 for development of the pulses such as those illustrated in FIG. 2a referred to a fine grating pulses and coarse grating pulses, respectively. It will be understood that two photo-sensor assemblies such as that shown in FIG. 6 would ordinarily be included in the nozzle assembly 4 in order to sense the two sets of marks on grating 8.

Referring to FIG. 5, various structures incorporated in head assembly 4 are illustrated. This includes a pump 40 for directing ink from an ink supply conduit 41 on demand as a crystal 42 is energized, that is, pulsed at high frequencies. The rate of impulsing crystal 42 may be in the range of 100 kiloHertz for example. Ink drops are emitted from nozzle 43 and pass through a charge electrode 44 for variable charging in accordance with the output of a charge amplifier to achieve deflection of the drops in a column an amount representing the vertical height of the drop location in any given character. As illustrated, the letter capital S designated 50 comprises a number of vertical columns 51. The printing is such that a sequence of drops forming vertical columns, each column comprising a plurality of drops, such as 40 in number, is propelled from nozzle 43 toward document 7 for the printing of the character in-

volved. If drops are not required for printing, they are directed to a gutter 53 for passage by means of a conduit 54 back to the ink supply, customarily. A pair of deflection plates 60 and 61 is positioned in the path of travel of the drops leaving the charge electrode 44. A constant high potential is applied across plates 60 and 61 and this in cooperation with the variable charge on the individual drops determines the amount of deflection as the drops are directed toward document 7. Grating 8a in this instance is shown as being positioned horizontally rather than vertically as in FIG. 1, but the positioning is immaterial.

As indicated, the individual characters are located within character boxes comprising perhaps 40 drop locations in height and 24 drop locations in width, that is, 24 columns wide.

If it is assumed that printer 1 is in a line mode and the system is in a playback mode, appropriate positioning of a card, not shown, results in card unit 2 furnishing signals to the printer 1 to determine the printing of characters. During a line printing mode, head assembly 1 leaves the left margin which results in setting the left margin latch 70, FIG. 3. An output indicating "print" is provided from latch 70 on line 71 to And circuit 72 and remains at an up level until an end of line signal is received from card unit 2 on line 75. As head assembly 4 moves adjacent grating 8, signals are provided to amplifier circuits 80 and 81 from the respective portions 8a and 8b of grating 8. In order to handle various printing situations, portion 8a of grating 8 has marks thereon indicative of column locations in the individual characters. In the case illustrated, the column lines are provided at 240 per inch in portion 8a. During a line sweep mode, portion 8b of grating is not used. Amplifier 81 is degated by a signal on line 82 and character latch 85 is set by a signal on line 83. Latch 85 is reset at the end of a character by a signal on line 84. Character position and width are determined strictly by character generator 130, FIG. 4a, to allow for proportionally spaced characters, if desired. An advantage is that there is no requirement to maintain the velocity of head 4 constant.

In a typical situation, portion 8b of grating 8 has lines engraved thereon to indicate each character location encountered by head assembly 4 as it traverses document 7 during printing.

The setting of latch 85 in conjunction with And circuit 72 provides gating for one input of And circuit 87 on line 86. The other input occurs from amplifier 80 when each fine mark is sensed in portion 8a of grating 8. Thereupon, ramp generator 90 is activated to provide a sloped signal on line 91 to charge amplifier 92 which drives the charge electrode 44 previously discussed in connection with FIG. 5. As indicated, the charge exerted on charge electrode 44 determines at what drop location a drop will ultimately arrive within a given column of drops in the character box on document 7. If no drop is required, that is, it is to be directed to gutter 53, FIG. 5, then a blank signal on line 93 to amplifier circuit 92 results in no charge on the drop and it lands in gutter 53. An unblank signal on line 93 enables amplifier 92 to charge the particular drop occurring at that time from nozzle 43 with a voltage representative of the drop location to which it is directed on document 7.

INCREMENTAL MODE, CHARACTER-BY-CHARACTER PRINTING

FIG. 2a illustrates some of the conditions occurring during incremental printing, that is, on a character-by-character basis. The movement of the carrier is indicated by line 100 in relation to a mechanical escapement rack 101 to be described in greater detail later. The coarse grating indicates individual character boxes as shown in FIG. 2a. It is assumed that an incremental mode has been selected by depression of keybutton 15 on printer 1, FIG. 1. Then appropriate signals are provided to enable printing of the character and development of signals from the portions 8a and 8b of grating 8. During incremental character printing by head 4 adjacent document 7, detection of a character mark in portion 8b initiates an output from amplifier 81 to set latch 85 and the action of the circuit in FIG. 3 is essentially as previously described.

Mechanisms are provided that will be discussed shortly for relatively moving the carrier backwardly in relation to the start of a character box to insure the proper placement of drops close to the character box boundary. This is indicated, as an example, by portion 100a of line 100 in FIG. 2a. Typically this increment amounts to 0.020 inch. When a character is to be printed then the carrier is released to move as indicated by portion 100b of line 100, further comprising a start up interval 100b', FIG. 2a, and some slight overrun occurs as shown by portion 100c past the character box and into the next character box. The mechanisms are such that the carrier is returned into the character box just printed as shown by portion 100d of line 100. Thus, the carrier is positioned prior to but in readiness for printing of the next character in the subsequent character box. This is indicated by line portion 100e, further comprising start up interval 100e'.

It may be arranged that if printing of character box A in FIG. 2a is in progress, receipt of the character signals for character box B during the interval 102 will enable the continued release of the escapement mechanisms and carrier 4 will then sweep on through character box B performing the printing of that character, as well. Thus, the over-shooting and backspacing to achieve start-up is not required in that case. The same thing applies during the printing of character box B. If the signal is received during the interval 103, then printing can proceed immediately into character box C without any stopping of the carrier 4.

SYSTEM BLOCK DIAGRAM

FIG. 4a is a system block diagram incorporating a data source 110, such as a processor, card unit, tape unit, or the like and having various control lines 120-128 interconnected with a character generator box 130 and printer control circuits 131. Other lines 134-141 interconnect the character generator 130 and printer control circuit 131 with the head assembly 4.

In FIG. 4b the logic 150 representing various mechanical functions has inputs on lines 151-156 providing control for various operational circuits 160 and ultimately to the printer mechanisms 161 with various feedback signals on lines 163.

CARRIER TRANSPORT MECHANISMS

FIGS. 7-9 illustrate various mechanisms incorporated in printer 1 for facilitating movement of head as-

sembly 4 on carrier 5. Connected by a bracket 180 to carrier 5 is an escapement pawl assembly including an escapement pawl 181 mounted for engagement with the escapement rack 101 previously referred to in connection with FIG. 2a.

Reference is made to the various "Selectric" type-writer manuals referred to previously, since many of the structures illustrated in FIGS. 7-8 are somewhat comparable to the structures shown in those manuals. Attached to carrier 5 is a cable 184 routed on pulleys 185-189 and coupled to a rear cord drum 190 and a front cord drum 191. Two pulleys 189a and 189b are shown in place of the pulleys 188 and 189 in FIG. 9. The principles of operation are the same.

As in the "Selectric" printers, a main spring 200 provides driving force to move carrier 5 in the tab direction from left to right in FIGS. 7 and 9. A motor 201, FIG. 9 provides driving force by a belt 202 and pulleys 203 and 204 to a drive shaft 205 in order to move carrier 5 in the carrier return direction, that is from right to left, and also to wind up main spring 200 in readiness for a subsequent movement of carrier 5 from left to right. Several spring clutches 210 and 211 are provided in the mechanism, more fully illustrated in FIG. 9. Positioned on the forward end of shaft 213 associated with main spring 200 is a face gear 215 having an associated small gear 216 cooperating with a floating carrier return gear 217 arranged for coupling with spring clutch 210. Face gear 215 has an associated tab governor gear 220 that also floats on shaft 205.

For line printing, pawl 181 is released from escapement rack 101 thereby enabling main spring 200 to drive carrier 5 by means of cable 184 and cord drums 190 and 191. Face gear 215 and associated governor gear 220 together with frictionally coupled clutch 211 and centrifugal governor 235 prevents the carrier from going faster than the operational shaft 205.

At the end of each line, when carrier return is required, the carrier return shoe 225 is engaged against spring clutch 210 by mechanisms not shown thereby coupling the drive from shaft 205 through hub 227 which is fixed to shaft 205 through clutch 210 and by way of the carrier return gear 217 and gear 216 to reverse the rotation of shaft 213, associated cord drums 190 and 191 and thereby to reverse the direction of cable 184 in order to move carrier 5 from right to left in the printer.

During incremental, that is, character-by-character printing, pawl 181 is released from rack 101 just long enough for movement of carrier 5 one character location to the right. Prior to the completion of the movement of a complete character, pawl 181 moves back into position for engagement with the next tooth on rack 101. This can be seen in FIG. 8. Associated with bracket 180 is a pin 182 riding in an elongated slot 181a in pawl 181. A spring 183 is connected between pin 182 and pin 196 that is mounted on the left most extremity of pawl 181. Slot 181a enables engagement of pawl 181 but results in an over-shoot of carrier 5 past the character location as illustrated by portion 100c in FIG. 2a. Main spring 200 tends to pull the entire carrier assembly to the right by means of cable 184. However, spring 183 is somewhat stronger than main spring 200 and immediately after the over-shoot represented by portion 100c in 2a, spring 183 pulls bracket 180 and associated carrier 5 rearwardly, that is to the left as indicated by line 100d, FIG. 2a, into the charac-

ter box just printed and thereby, the carrier is located a sufficient distance back of the next character to be printed. Thus, the carrier 5 does not have to stop precisely at the boundary of the character not to be printed, such as character box C, FIG. 2a.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a printing apparatus having provision for successively incrementally printing individual characters in predefined character locations on a receiving member by a printhead, each of said characters comprising components that are printed between and including a character starting position and a character termination position, a method for insuring that all components of a character to be printed are properly printed within its respective character location, said apparatus being operable to print all components of each individual character during a single character print cycle, each said print cycle comprising first, second and third cycle portions, comprising:

1. during the first cycle portion of each said print cycle relatively moving said receiving member and said printhead from a position prior to the starting position of a character to be printed, said printhead having facilities for printing and being operable to print the components of each individual character during the relative movement in said first cycle portion;
2. during the second cycle portion of each individual character print cycle, overbounding said printhead past the termination position of said individual character into the next succeeding character location to insure the printing of all components of said individual character prior to and including said termination position; and
3. during the third cycle portion of each individual character print cycle, invariably re-bounding and stopping said printhead back prior to the starting position of the individual character to be printed in the next character print cycle to be printed to thereby insure that a start-up interval exists prior to the starting position of the next character to be printed.

2. In a marking apparatus having provision for successively incrementally printing individual symbols in predefined symbol locations on a receiving member by a printhead, each of said symbols comprising columns of markings that are printed between and including a symbol starting column position and a symbol termination column position, a method for insuring that all components of a symbol to be printed are properly printed within its respective symbol location, said apparatus being operable to print all components of each individual symbol during a single symbol print cycle, each said print cycle comprising first, second and third cycle portions, comprising:

1. during the first cycle portion of each said print cycle, relatively moving said receiving surface and said symbol printhead from a position prior to the starting position of a character to be printed, said printhead having facilities for printing and being operable to print the columnar components of each

individual symbol during said relative movement in said first cycle portion;

2. during the second cycle portion of each individual symbol print cycle, overbounding said printhead past the termination position of said individual symbol into the next succeeding symbol location to insure the printing of all columnar of said individual symbol components in said individual symbol prior to and including said termination position; and
3. during the third cycle portion of each individual symbol print cycle, invariably re-bounding and stopping said printhead back prior to the starting position of the individual symbol to be printed in the next symbol print cycle to thereby insure that a start-up interval exists prior to the starting columnar position of the next symbol to be printed.

3. Marking apparatus for successively printing individual symbols in predefined symbol locations, each of said symbols comprising columns of marking components that are printed between and including a symbol starting columnar position and a symbol termination columnar position, an arrangement for insuring that all components of a symbol to be printed are properly printed within its respective symbol location, said apparatus being operable to print all components of each individual symbol during a single symbol print cycle each said print cycle comprising first, second and third cycle portions, comprising:

1. means for position a document for printing;
2. printhead means mounted for movement adjacent said document for selectively forming, propelling, charging and deflecting marking components toward said document;
3. moving means operable during the first cycle portion of each said print cycle for relatively moving said document and said printhead means from a position prior to the starting position of the symbol to be printed in order to print a symbol on said document during said relative movement;
4. overbound means interconnected with said moving means and operable during the second cycle portion of each individual symbol print cycle for overbounding said printhead means past the termination position of said individual symbol into the next succeeding symbol location to insure the printing of all columnar marking components of said individual symbol prior to and including said termination position; and
5. re-bound means interconnected with said moving means and operable during the third cycle portion of each said print cycle, following the overbounding of said printhead means for re-bounding and stopping said printhead means back prior to the starting position of the individual symbol to be printed in the next symbol print cycle to thereby insure that a start-up interval exists prior to the starting columnar position of the next symbol to be printed.

4. Ink jet apparatus for successively printing individual characters in predefined character locations, each of said characters comprising marking components that are printed between and including a character starting position and a character termination position, an arrangement for insuring that all components of a character to be printed are properly printed within its respective character locations, said apparatus being operable

to print all components of each individual character during a single symbol print cycle, each said print cycle comprising first, second and third cycle portions, comprising:

1. means for positioning a document for printing;
 2. printhead means mounted adjacent said document for selectively forming, propelling, charging and deflecting marking components toward said document;
 3. moving means operable during the first cycle portion of each said print cycle for relatively moving said document and said printhead means from a position prior to the starting position of the character to be printed in order to print a character on said document during said relative movement;
 4. overbound means interconnected with said moving means and operable during the second cycle portion of each individual character print cycle for overbounding said printhead means past the termination position of said individual character into the next succeeding character location to insure the printing of all marking components of said individual character prior to and including said termination position; and
 5. re-bound means interconnected with said moving means and operable during the third cycle portion of each said print cycle, following the overbounding of said printhead means for re-bounding and stopping said printhead means back prior to the starting position of the individual character to be printed in the next character print cycle to thereby insure that a start-up interval exists prior to the starting position of the next character to be printed.
5. The apparatus of claim 4, further comprising:
6. means for relatively moving said document and said printhead means on a continuing basis in order to print at least two characters in succession;
 7. degate means interconnected with said overbound means and said rebound means, said degate means being operable to recognize occurrence of at least two characters to degate said overbound and said rebound means to prevent operation of said overbound and said re-bound means between said characters; and
 8. gating means interconnected with said overbound means and said rebound means, said gating means being operable to recognize the last character in a series to be printed to initiate operation of said overbound and re-bound means, whereby overbounding and re-bounding occur only with respect to the last character printed in a series of characters.
6. The apparatus of claim 4 wherein said marking components are arranged in a plurality of columnar locations for each character printed, and further comprising:
6. grating means, said grating means comprising markings arranged in first and second sets, the first set defining character locations and the second set defining columnar locations in each character; and
 7. means interconnected with said grating means for maintaining the location of characters and columns during printing operations, as well as during said overbounding and re-bounding operations.

7. The apparatus of claim 6, wherein said grating means defines a coarse grating defining character locations and a fine grating defining columnar locations, and further comprising:

8. a coarse sensor means and a fine sensor means, respectively arranged for sensing said coarse and fine gratings, each sensor means providing signal representative of the location of characters and columns relative to the respective grating associated with each said sensor means during relative movement in said apparatus; and

9. means responsive to signals from said respective sensor means for controlling printing of characters and columnar components of said characters.

8. The apparatus of claim 4, further comprising:

6. escapement means for controlling incremental movement of said printhead means relative to said document, said escapement means incorporating a pawl element having an elongated slot, and said escapement means further incorporating a pin element mounted for engagement with said slot in said

pawl element, and said pawl element further having a fixed pin element thereon; and

7. resilient means interconnected between said pin elements for establishing said overbound and rebound actions when engagement of said printhead means with said escapement means occurs during printing.

9. The apparatus of claim 4, further comprising:

6. first timing means providing signals for defining character locations during printing;

7. second timing means providing signals for defining marking component locations during printing; and

8. means responsive to signals from said first and second timing means for controlling printing of characters and marking components thereof.

10. The apparatus of claim 9, further comprising:

9. a data source, said data source providing signals to said first timing means for controlling the locations of characters.

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