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(54) Selective density printing using dot matrix print heads in fixed spatial relation.

(57) The dot matrix printer comprises a plurality of print heads with each print head printing a portion of the line. In order to obtain quality print, alternate print head (54) are horizontally aligned with respect to one another so that the dots of one of the two alternate print heads prints dots between previously printed dots of the other of the alternate print heads. The heads would be controlled to print over two portions of the line whereby quality printed dot matrix characters would result.

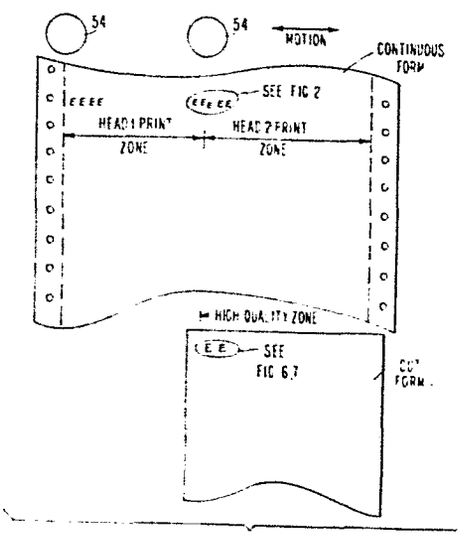

FIG.5

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SELECTIVE DENSITY PRINTING USING DOT MATRIX PRINT HEADS IN FIXED SPATIAL RELATION

Description

This invention relates to dot matrix printers and, more particularly, to selectively varying the dot density and print quality.

In order to achieve quality or "pretty" printed characters, one relies upon a relatively smooth character contour in addition to a high contrast (black/white) ratio between character and the recording medium. Where a character is formed on a medium from a matrix of dots produced by a wire matrix print head through a ribbon, the contrast ratio is a function of the dot density. In this regard, character contour or smoothness is a function of the overlap relationship among the dots especially in the vertical direction.

Martin, et al., US-A-4,010,835 issued 8 March 1977, describes a wire matrix print head arranged to provide two different printing arrays. In a first embodiment, the print wires are contained in two guides, one of which can be translationally displaced in a vertical direction from the other guide which is held in a fixed position. In a second embodiment, the wires are arranged in a single wire guide rotatable about an axis which is perpendicular to the document and parallel to the print wires. Further, in this patent the print head is translated horizontally from left to right to print across a line on a document. Printing is effected by the impact of selected pluralities of print wires, each of which is provided with a separate actuator arranged so that when the actuator is energized, the associated print wire is driven forward to impact the paper. An inked ribbon is interposed between the document (recording medium) and the print wires. The impact of the print wire on the ribbon causes a dot to be printed at a selected point on the document. By energizing combinations of actuators, combinations of print wires can be imprinted corresponding to a selected character.

In the prior art, it has been customary to fabricate a single vertical wire column print head with wires bent along a portion of their extent. This bend creates a long wire path subject to breakage and friction. Replacement of wires in such a head is not feasible. In contrast, a relatively never-fail print head may be fashioned from wires being laid in a diagonal rather than column array.

Reference should be made to US-A-4,284,001, issued 18 August 1981 showing a wire matrix printer having a plurality of print heads in which the wires are positioned in slanted relationship. In this arrangement, it is possible for a slant head to be involved with two or more characters. The overlapping of the slant heads and dotted character matrices creates a complex mapping relationship between both the data points and the print wire matrix.

US-A-4,284,363, issued 18 August 1981, describes a dot matrix tilting print head assembly in which the print head is rotatably mounted and framed. The dot matrix print head has its wires actuated to cause dots to be printed on the recording medium while the print head is laterally moved across the medium, the centers of the dots being separated by a given distance. In order to improve print quality, there is involved the insertion of dots between previously printed dots by controlling the rotation.

The technical problem solved by this invention is to vary the density within printed dot matrix characters by selectively overstriking the same medium position with the same character or a portion thereof positionally offset in at least one direction without requiring that the medium be moved or complex rotational head motion be involved. The solution involves partitioning each print line extent into several zones and assigning print heads to the counterpart zones; positioning the heads in fixed vertical offset relation to each other; and selectively causing each head to imprint the medium within its zone for low density and to overstrike a

designated position within another zone with a predetermined character or portion thereof for high density.

Significantly, the printer includes a plurality of print heads, each positioned to print a portion of the line and each including a plurality of wires which print dots separated by a given distance. Corresponding wires of one of the alternate print heads is horizontally aligned to print dots between printed dots of the other of the alternate print heads. A vertical displacement or offset of one-half character dot between overstriking pairs of heads yields aesthetically pleasing dot matrix characters. For low density, the half character dot displacement between the characters in the zones is not readily discernible to the eye. Advantageously, the only mechanical motion is the horizontal displacement of the preferably ganged print heads.

FIG. 1 is a simplified system diagram for a dot matrix printer system of the type within which the invention is contained;

FIG. 2 illustrates the printer console including the recording medium propagation path in relation to the print head mechanism;

FIG. 3 is a frontal view of the printer unit in the console shown in FIG. 2;

FIG. 4 illustrates four heads of nine-wire per head printing block.

FIG. 5 depicts the recording medium partitioned into print zones;

FIGS. 6 and 7 show the dot distribution in low and high density printing.

The wire matrix printer is substantially of the type described in US-A-4,284,001, issued August 18, 1981, which is incorporated by reference.

Referring now to FIG. 1, there is shown a representative system configuration including a host system 1, and a printer system 2. The printer system includes a control unit 3 and an attachment logic 4. Command and data signals are provided by the host system to printer control unit 3 by way of bus 5. Command and control signals are obtained from printer control unit 3 over the printer adapter 4 by way of bus 6. Status signals are supplied by the printer control unit 3 to host system 1 over bus 5. Typically, the host system applies sequences of commands and data to the printer and monitors status in return. Control unit 3 receives the commands, decodes them, checks for errors, and generates status information. Control unit 3 further regulates printing and spacing and includes local diagnostics. The adapter 4 executes decoded control unit commands, monitors all printer operations, actuates print wires, drives motors, senses printer emitters, and controls operator panel lights and switching circuitry. Also, the adapter controls the tractors, the ribbon drive, the print head carrier, the operator panel, and the printer sensors. It should be appreciated that the printer control unit 3 and adapter 4 incorporate one or more microprocessors for analyzing commands and data and to regulate operations.

FIGS. 2 and 3 illustrate components of the printer housed in console 10. Access panels or covers 11, 12, 13 keep a relatively clean industry environment. Top cover 11 has a window 14 enabling an operator to observe paper path movement during operation of the printer whenever the cover is closed. The recording medium is paper 15. It is obtained from a stored stack 16 and is fed into an upwardly or downwardly transversing paper path as seen in FIGS. 2 and 3 by way of a mechanical assembly 20 which includes one or more sets of tractors 90 and 91. A guide 28 moves the paper after printing to a takeup stack (not shown) positioned below the printing me-

chanism and to the rear of the console. The printer incorporates a print assembly 30 which is positioned in a horizontal relationship with respect to the medium 15 at a print station 32. The printer ribbon drive assembly 40 is located in closer proximity to the front of the printer. The printer control unit 3 and its associated microprocessors are situated behind the side cover 13.

A ribbon 41 is provided on one of the spools 42 or 43. Each ribbon box preferably contains a disposable ribbon shoe 46 mounted on spring attachment members 130 and 131 between print assembly 30 and the medium 15 in order to maintain ribbon 41 in proper alignment and to minimize ink smudging on the medium. The ribbon moves on a path in front of the print head around posts 125, 126, 127, and 128. Two motors drive ribbon 41 back and forth between spools 42 and 43. The printer control unit 3 detects ribbon jams and end of ribbon condition. A ribbon jam turns on an error indicator and stops printing.

The printer includes an operator panel 26 that consists of several operator control keys, two indicator lights, a power on/off switch, an operator panel display, and a density display.

Referring now to FIG. 4, print block 50 includes four groups of nine print wires 52 and associated actuator (not shown). Print block 50, print wires 52, and the print actuators are described in detail in European Patent Application No. 80105774.6, "Printer Subsystem With Microprocessor Control", filed on September 25, 1980. Each group of nine print wires 52 is referred to as a print head and is respectively designated heads 1 through 4. Each of the print wires 52 is, in turn, respectively numbered 1 through 9, vertically from top to bottom with wires 1 through 5 being on a first slanted path, such that adjacent wires 52 are separated horizontally by about (0.20 inches) and vertically by about 0,0042 cm (0.0167 inches). Any number of print heads may be used, such as for example two, four or seven.

As shown in FIG. 5, a vertical or slant matrix printer having two heads 54 in gang relationship each of which are normally assigned to a predetermined zone along a print line extent. In low density printing, the gang heads 54 would be positioned to the left of the first character to be printed and incrementally moved left to right until the heads were positioned just to the right of the last character to be printed upon that line. At this point, the medium would be advanced so that the gang heads could be actuated for printing purposes in a right to left direction for the next print line. The use of multiple heads and zones increases print speed because the heads are driven in parallel over a shorter distance.

Referring now to FIG. 6, there is shown the detail of the normal low vertical density printing within the zonal boundaries. Typically, a head will print dot matrix characters having 0,5mm (.020 inch) spacing therebetween horizontally and 0,42mm (.0167 inches) vertically. The other head is vertically offset. The amount of vertical offset is 0,21mm (.00833 inches). This is a half a dot character spacing. FIG. 7 shows the detail of high quality printing in which the horizontal dot spacing is 0,25mm (.010 inches) and the vertical dot spacing in any vertical row is 0,21mm (.00833 inches). Where it is desired to write a line of quality printing left to right, the ganged heads are positioned such that the right most head is to the left of the first character. Assuming the right most head is vertically displaced lower than the left head, a character as shown in the right most E in FIG. 7 would be first laid out all along the print extent while the second or left most head would overstrike each character position with the same character in the same order but offset vertically upwards to achieve the vertical and horizontal print density shown in FIG. 7. The ganged print head movement would continue until the left most head was positioned to the right of the last character at the right end of the line to be printed. The print rate for quality printing is 1/n of the draft printing, where n is the number of ganged heads.

Significantly, the ganged relationship among the heads is not mandatory, although it does obviate problems of maintaining synchronism of data and position. It will be further understood by those skilled in the art that the alternate print heads are horizontally aligned with respect to one another so that the dots of one of the two alternate print heads imprints dots between previously printed dots of the other of the alternate print heads. The heads are controlled in the quality print mode to print over two portions of the line whereby quality printed dot matrix characters result. By controllably printing in the draft mode, the print quality is of sparse density.

It will be further understood by those skilled in this art that various other changes in the form and details may be made therein without departing from the spirit and scope of the invention.

CLAIMS

1. A method for varying the density within printed dot matrix characters by selectively overstriking the same print medium position with the same character or portion thereof positionally offset in at least one direction, characterized by the steps of:

partitioning each recording medium print line extent into n zones and assigning n print heads to counterpart zones;

positioning the n heads in vertical offset relation from each other; and

selectively causing each head to imprint the medium within its zone for low density and to overstrike a designated position within another zone with a predetermined character for high density.

2. A method according to claim 1 whereby the positioning step further includes the step of maintaining a vertical offset among selected pairs of heads to be within one-half dot character overlap relation.

3. Wire matrix printer for printing a line of characters on a record medium, said printer having a plurality of print heads, each positioned to print a portion of the line and each including a plurality of wires which print dots separated by a given distance, characterized by:

corresponding wires of one of the alternate print heads being horizontally aligned to print dots between printed dots of the other of the alternate print heads; and

said printer including control means for selecting whether each print head is to print in either one or two portions of said line of characters.

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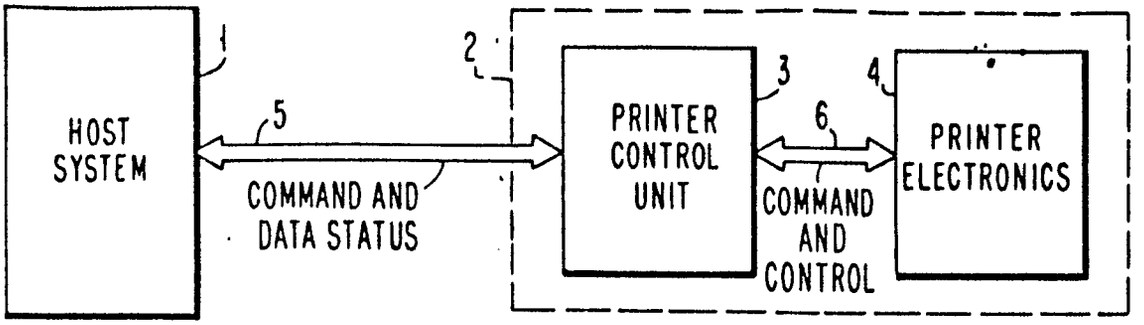


FIG.1

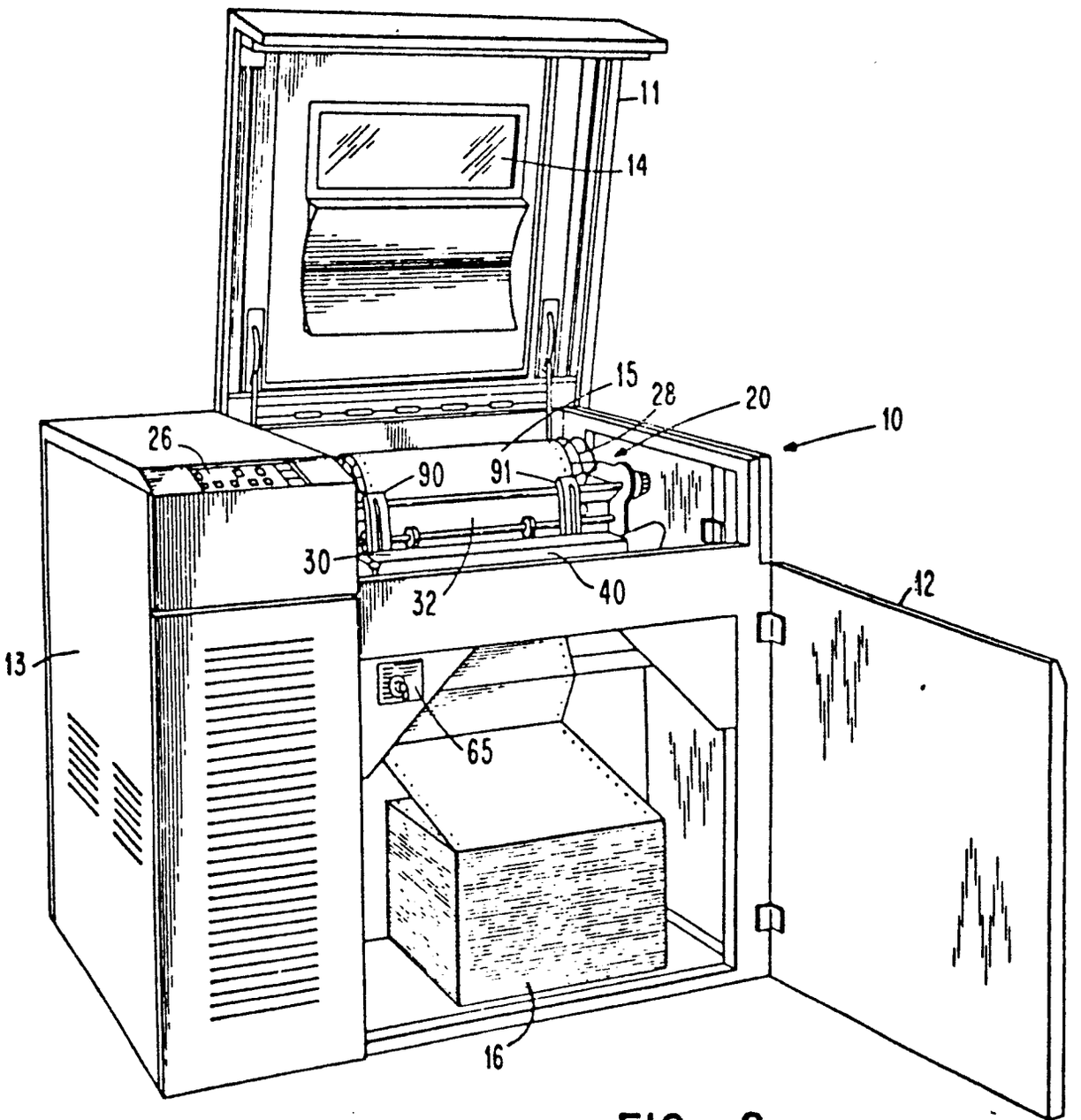


FIG. 2

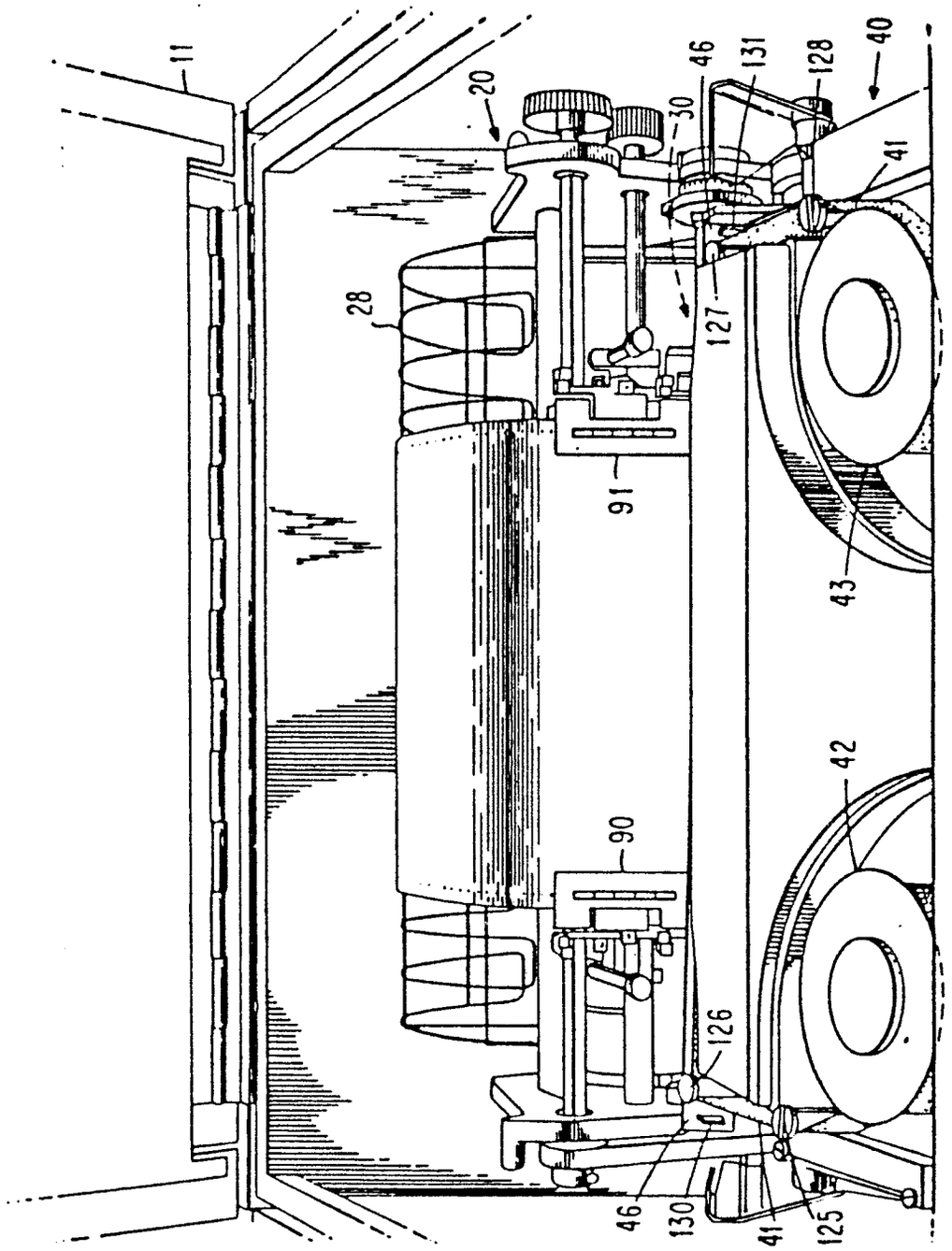


FIG.3

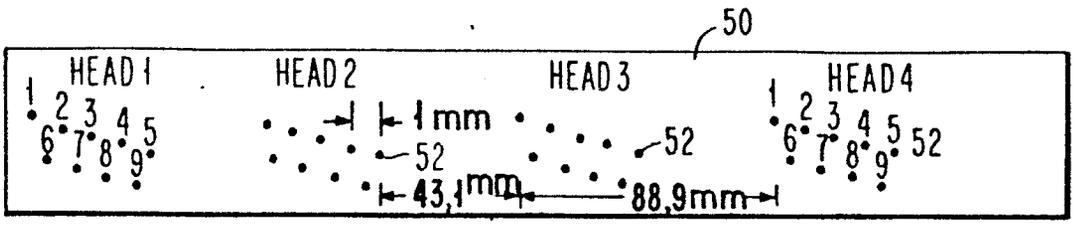

50
HEAD 1
HEAD 2
HEAD 3
HEAD 4
1
2
3
4
5
6
7
8
9
1 mm
52
43,1 mm
88,9mm

FIG.4

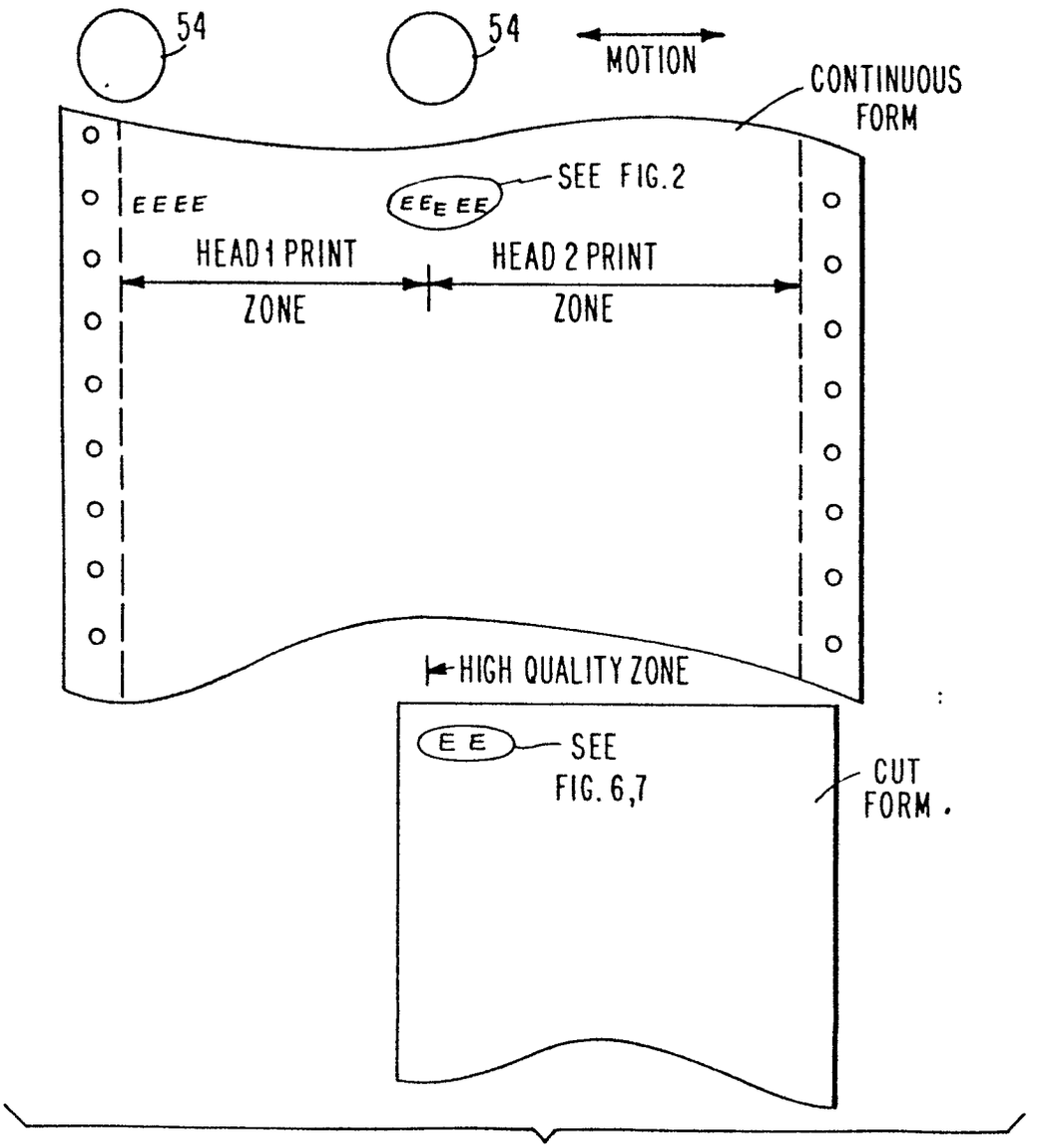
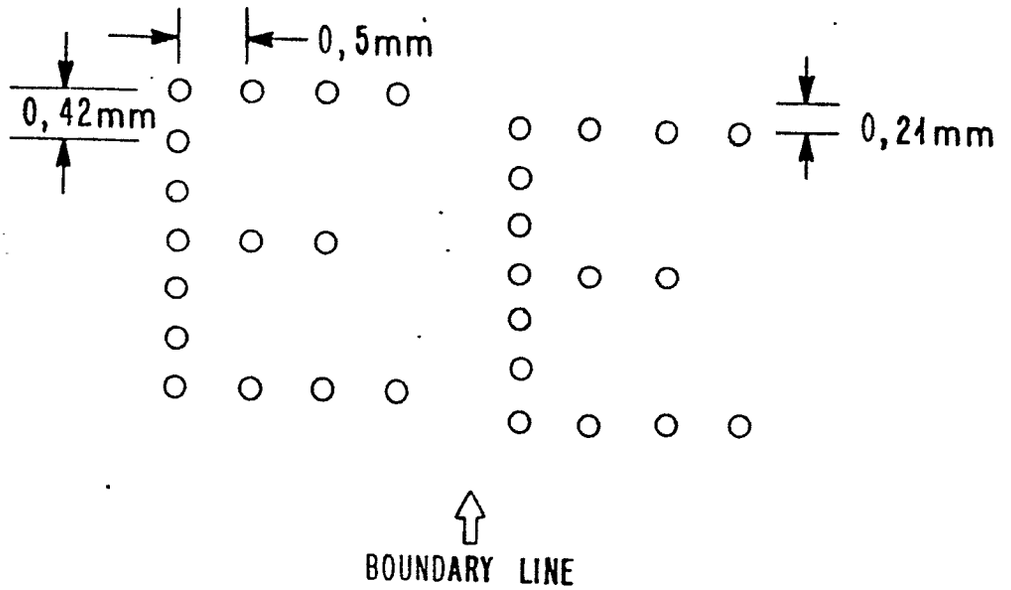
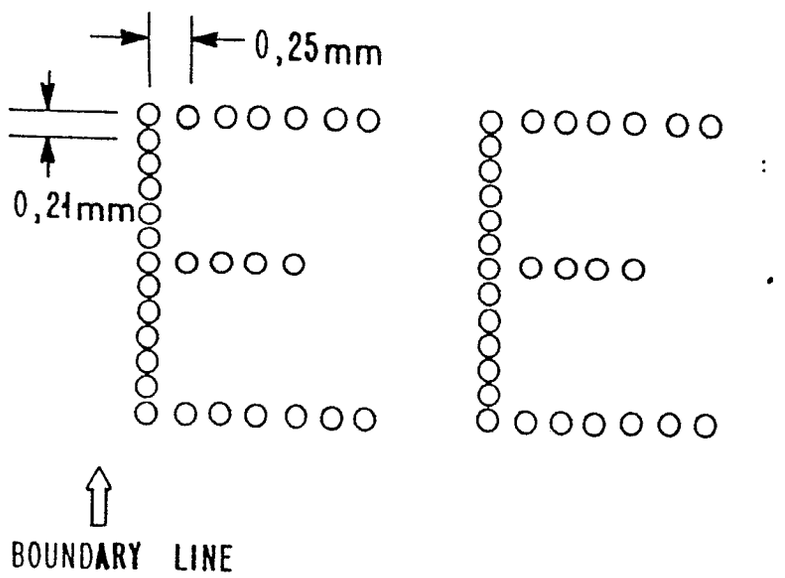

54
54
MOTION
CONTINUOUS FORM
SEE FIG.2
HEAD 1 PRINT ZONE
HEAD 2 PRINT ZONE
HIGH QUALITY ZONE
SEE FIG. 6,7
CUT FORM

FIG.5



DETAIL OF "NORMAL" LOW VERTICAL DENSITY PRINTING AT THE ZONAL BOUNDARY

FIG.6



DETAIL OF HIGH QUALITY PRINTING

FIG.7