United States Patent [19]

Larsen et al.

[11] **3,900,094**

[45] **Aug. 19, 1975**

[54] **MATRIX PRINTER WITH OVERLAPPING PRINT DOTS**

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[73] Assignee: **LRC, Inc.,** Riverton, Wyo.

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[21] Appl. No.: **359,013**

[52] **U.S. Cl.** ..... **197/1 R;** 101/93.05

[51] **Int. Cl.** **B41j 3/04**

[58] **Field of Search** ..... 197/1; 101/93 C; 335/268

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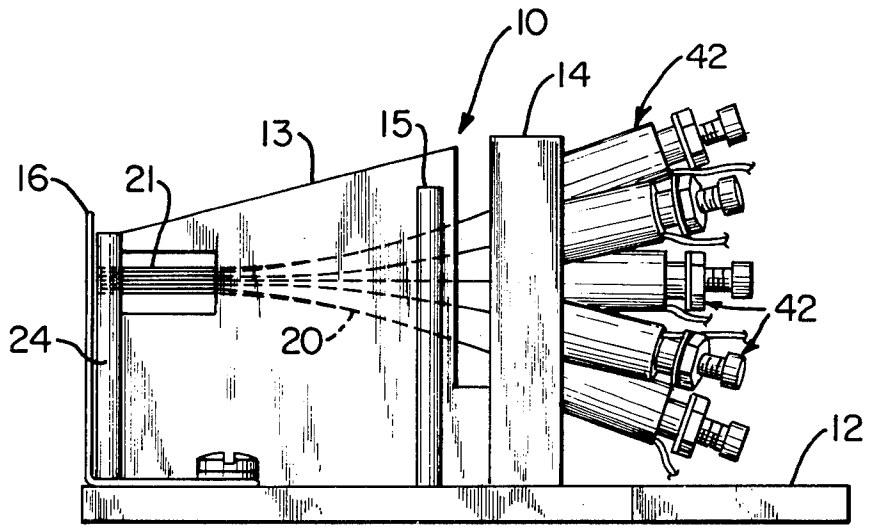
Primary Examiner—Edgar S. Burr
Assistant Examiner—R. T. Rader

[57] **ABSTRACT**

A matrix printer head apparatus and method of printing have been devised for high-speed printing operations in which impressions or dots formed on the print medium will overlap to form apparent solid lines. Overlapping of impressions or dots both in the horizontal and vertical directions in high-speed printing operations is accomplished by a novel and improved arrangement of the print elements and the manner in which the print elements are incrementally advanced and positively driven in forming each matrix.

14 Claims, 18 Drawing Figures



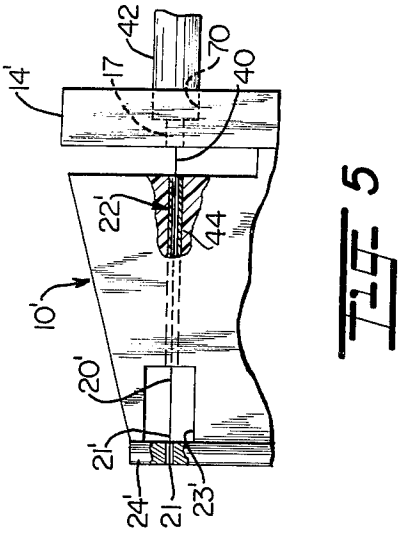


FIG. 5

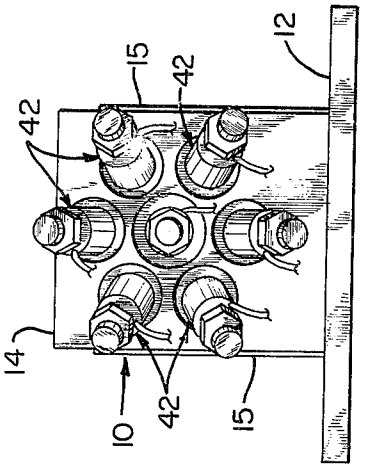


FIG. 2

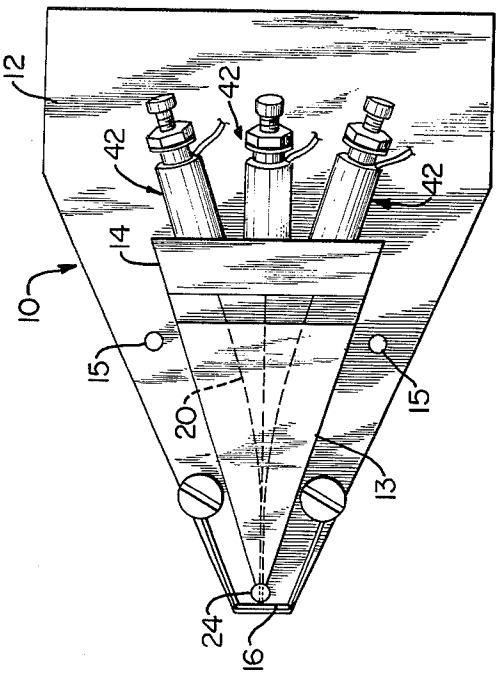


FIG. 3

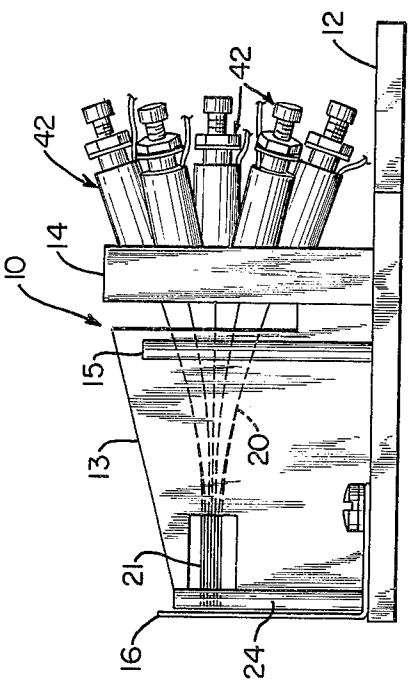
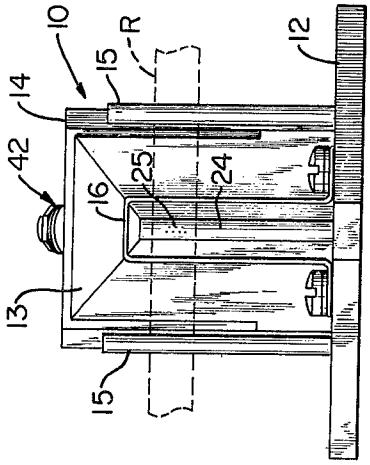


FIG. 1



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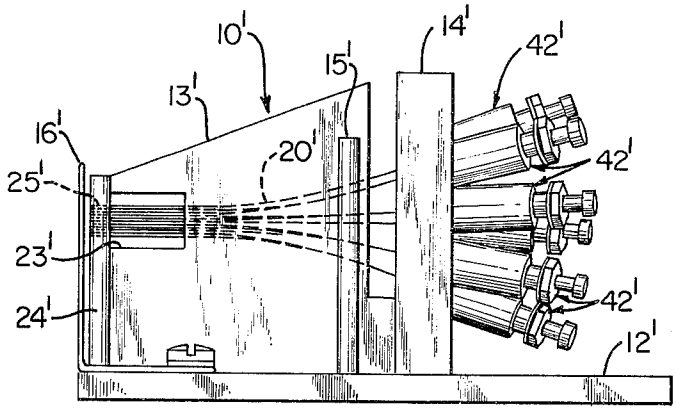

FIG 7

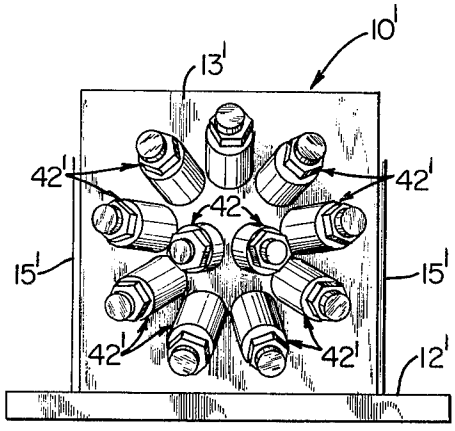

FIG 6

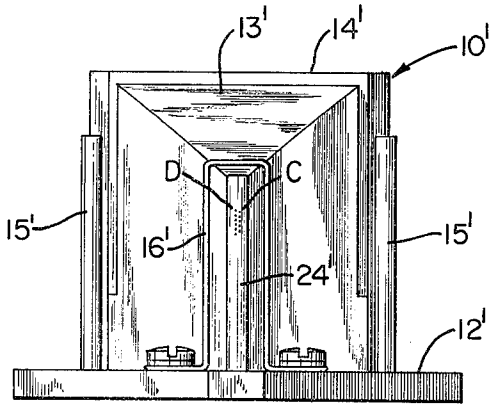

FIG 8

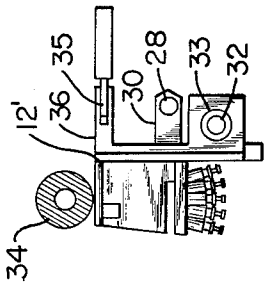

FIG. 10

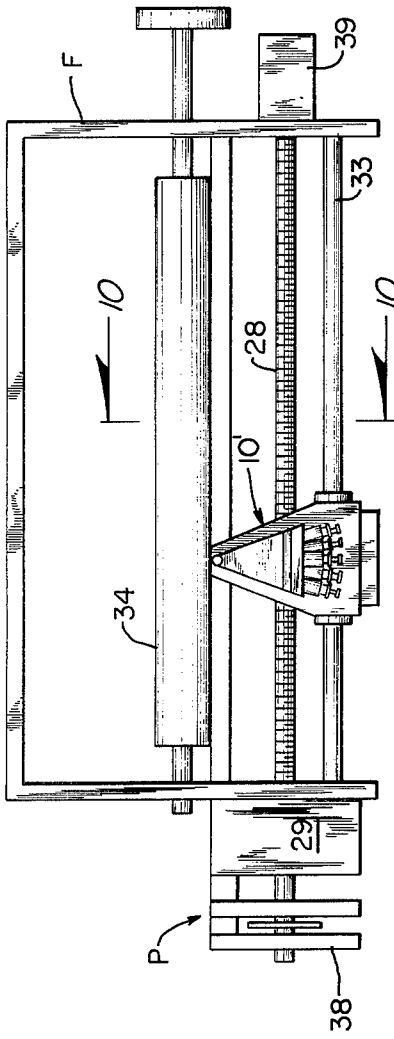

FIG. 9

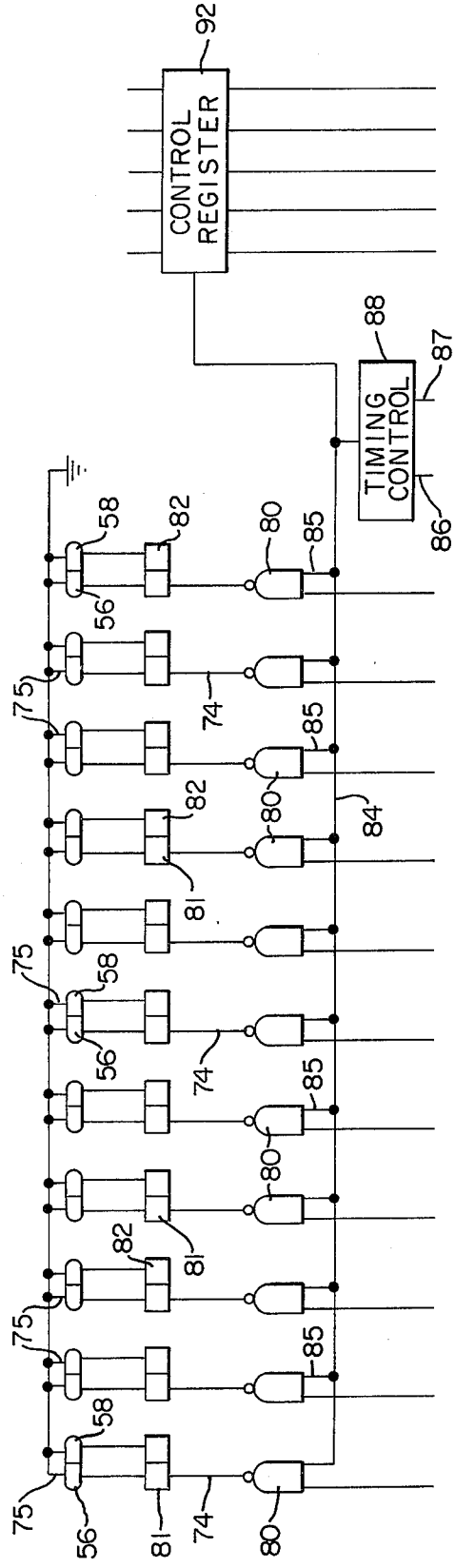

FIG. 12

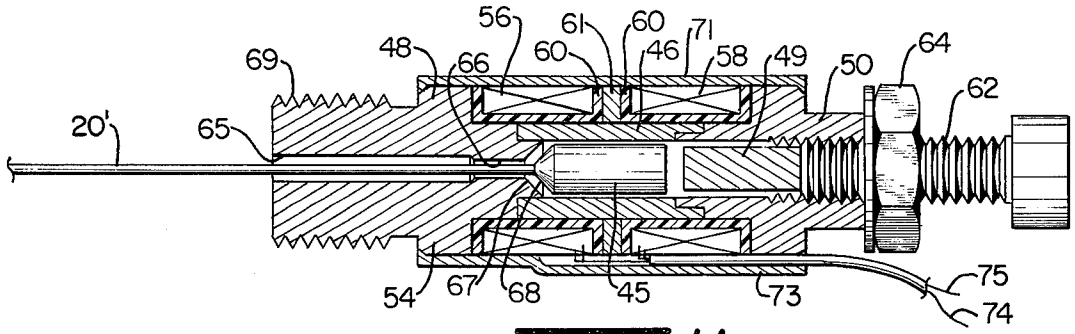

FIG. 11

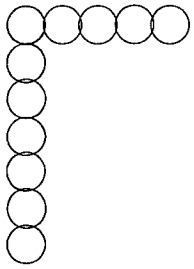

FIG. 13

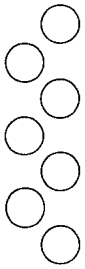

FIG. 14

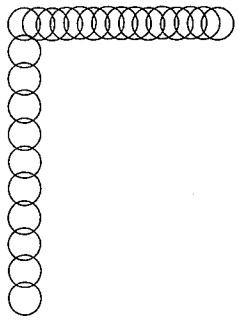

FIG. 16

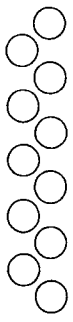

FIG. 17

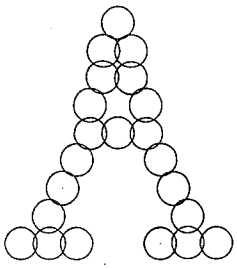

FIG. 18

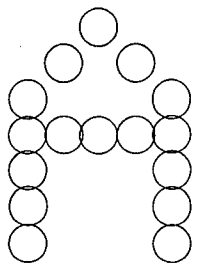

FIG. 15

MATRIX PRINTER WITH OVERLAPPING PRINT DOTS

BACKGROUND OF THE INVENTION

In matrix printing, the dot matrix employed in forming each character is defined by a predetermined number of dots or impressions arranged in a vertical plane or column and which are advanced to a predetermined number of laterally spaced positions. Thus, for example a 5 × 7 matrix is comprised of seven print elements each capable of forming a dot in a column, and each element being capable of being driven to impress a dot in each of five laterally spaced, incremental positions. The principal difficulties inherent in the so-called dot or wire printer are in forming legible characters without unduly reducing the printing rate, since the normal alignment of a series of wires in a single column will merely produce a series of spaced dots. Moreover, the dots formed in each column are laterally spaced from the next preceding column, so that in developing a character, spaces will appear between the dots both in the vertical and lateral directions.

Previously, it has been proposed to add print wires staggered with respect to the main column of print wires for the purpose of forming diagonal or curved lines in a character. In addition, it has been proposed to fire selected wires in a print head at alternate, laterally spaced half-positions; that is, to fire selected of the wires less than a full dot width apart so that the dots will overlap to some extent in the horizontal direction. Again the problem associated with these approaches in the past has been to achieve the desired overlap between adjacent dots whether in a vertical, horizontal or diagonal direction notwithstanding the physical separation between the print wires. In this respect, adjacent print wires are necessarily separated or spaced from the other owing to the fact that each wire must be capable of free independent movement without interference from the other wires and must be independently guided or supported in accurately driving into and away from the print medium.

SUMMARY

In accordance with the present invention, there has been devised a wire or matrix printer in which the impression or print elements on the print wires are arranged in off-set vertical columns, the print elements in one column being laterally offset less than a full dot width apart from adjacent print elements of the other column and spaced or offset equally between the next two adjacent print elements. The print head carrying the print elements is incrementally advanced between laterally spaced positions less than a full dot width apart, corresponding to the horizontal spacing between columns of the print elements. In this way, when selected print elements in each column are driven to make an impression on the print medium, dots formed by each column will overlap adjacent dots already formed by the preceding column. Thus, at each position of the print head, selected print elements in each column are successively driven or fired, incrementally advanced to the next position, and again successively fired or driven so that elements of the trailing column will make vertically aligned, overlapping impressions on those impressions made by the elements of the leading column. Again, in order to obtain the desired horizontal overlap, the incremental movement of the print head in a lateral or horizontal direction is just less than the width of the dot formed. As a result, both horizontal and vertical overlapping relation can be achieved between the dots resulting in the formation of apparent solid lines in each character formed.

High-speed printing can be achieved either by incrementally advancing the print head at a constant velocity or by controlled acceleration and deceleration through each matrix or given distance interval. The preferred form of motor control positioner for advancing the print head is set forth and described in detail in copending application for patent filed 25, Apr., 1974, Ser. No. 464,153 for DC MOTOR POSITION CONTROLLER, owned by the assignee of this invention and as such forms no part of the present invention. Moreover, a unique manner of driving and sequencing print elements is provided in accordance with the present invention: Each print wire is positively driven both in the forward and return directions, and reverse driving of elements in each column is triggered by the end of the time interval for driving the elements forwardly in that column. Accuracy and speed of printing are greatly enhanced by the construction and arrangement of the print wires in a way such that the print wires are disposed for advancement in closely spaced parallel relation without interference or contact with one another.

The above and other objects, advantages and features of the present invention will become more readily appreciated and understood from the following detailed description of a preferred form of invention when taken in conjunction with the accompanying drawings, in which:

DRAWING DESCRIPTION

FIG. 1 is a side elevational view of one embodiment illustrating a seven-wire print head in accordance with the present invention.

FIG. 2 is an end view of the seven-wire print head shown in FIG. 1 and showing the trailing ends and circular array of the print members employed in the head.

FIG. 3 is a top plan view of the print head shown in FIG. 1.

FIG. 4 is a front end view of the print head shown in FIG. 1.

FIG. 5 is a view partially in section showing extension of one of the print members through the printer head block from the mounting plate into the front guide post.

FIG. 6 is an end view of a modified form of printer head and illustrating the arrangement of print members in an eleven-wire printer head.

FIG. 7 is a side elevational view of the eleven-wire printer shown in FIG. 6.

FIG. 8 is a front end view of an eleven-wire printer head and illustrating the disposition of the print elements for movement through the front guide posts into contact with the print medium.

FIG. 9 is a top plan view in somewhat schematic form illustrating the disposition and arrangement of elements in an eleven-wire printer head for a printer apparatus.

FIG. 10 is a side view of the printer apparatus illustrated in FIG. 9.

FIG. 11 is a cross-sectional view in detail of a preferred form of print member and actuator assembly for

utilization in either form of printer head as illustrated in FIGS. 1 to 10.

FIG. 12 is a block diagram schematically showing a printer control circuit in an eleven-wire printer head.

FIG. 13 illustrates on an enlarged scale the formation of a column of dots in a 5 × 7 print matrix.

FIG. 14 illustrates on an enlarged scale the arrangement of dots formed from the print elements in a seven-wire printer head as illustrated in FIGS. 1 to 5.

FIG. 15 shows an example of an upper case letter formed in a 5 × 7 print matrix.

FIG. 16 illustrates on an enlarged scale the dot formation in an 11 × 15 print matrix.

FIG. 17 illustrates the disposition of print elements in an eleven-wire printer on enlarged scale employed in the formation of an 11 × 15 print matrix; and

FIG. 18 illustrates formation of upper case letters in an 11 × 15 print matrix.

DESCRIPTION OF A PREFERRED FORM

Referring in detail to the drawings, one embodiment of the printer head of the present invention is illustrated in FIGS. 1 to 5 in which a seven-wire printer head 10 is broadly comprised of a base support 12 for a printer head block 13 and a rearwardly spaced mounting plate 14. Vertically extending ribbon guide posts 15 are mounted on the base support on opposite sides of the printer head 13, and a front ribbon guide wire 16 is disposed in front of the printer head block to cooperate with the guide posts 15 in feeding a conventional print or typing ribbon R across the front of the printer head as represented in dotted form in FIG. 4. A series of seven print members 20 in the form of elongated rods or wires converge forwardly from the mounting plate 14 through bores or apertures 22 formed in the printer head block 13, and the bores communicate with a common recess 23 at the leading end of the printer head block 13. A print wire guide post 24 extends vertically of the front edge of the printer head block 13 directly behind the ribbon guide wire 16 and is provided with a series of seven closely spaced apertures 25 arranged in offset relation to one another to guide and serve as bearings for the leading ends 21 of the print wires 20. As will be hereinafter described in more detail, the apertures 25 are divided into two columns of apertures, there being three spaced apertures in column A and a series of four spaced apertures in column B, the latter being offset less than a full dot width apart from the dots formed by the print wires in column A. The leading ends 21 of the print wires define the print elements which are selectively driven in a manner to be described through the closely spaced apertures 25 in the guide post 24 into the typing ribbon to form an impression upon paper or other print medium.

The preferred disposition of the actuator assemblies in the mounting plate 14 is illustrated in FIG. 3 for the seven-wire printer head 10. In the seven-wire printer head 10 six actuator assemblies 42 are arranged in a circular array 60° apart equally spaced about a central actuator assembly 42. The print wire 20 for the central actuator assembly 42 will extend horizontally through the printer head block, while the print wires for the outer circular array of actuator assemblies will converge forwardly along a low gradual line of curvature through the printer head block into the common recess.

An eleven-wire print head 10' is illustrated in FIGS. 6 to 8 and which is generally characterized by forming a denser matrix than the seven-wire print head just described. The basic construction and arrangement of the print head 10' is the same as the seven-wire, and like elements are correspondingly enumerated by prime numbers. As shown, the eleven-wire print head 10' includes a base support 12' for printer head block 13' and the upstanding mounting plate 14'. Ribbon guide posts 15' extend upwardly from the base support on opposite sides of the printer head block 13' to cooperate with the ribbon guide wire 16' in front of the printer head block in feeding a conventional print or typing ribbon, not shown, across the front of the printer head 10'. In the eleven-wire print head, a series of eleven print wires 20' extend forwardly from the mounting plate 14' through apertures 22' in the printer head block 13' and through the common recess 23' at the leading end of the printer head block 13' for extension through the apertures 25' in the guide post 24'. As best seen from FIG. 8, the guide post 24' is provided with two columns C and D of the apertures 25', there being five in column C and six vertically offset or staggered apertures in column D; and again, the apertures in column D are offset horizontally from those in column C less than a full dot width apart.

Referring to FIGS. 9 and 10, the mounting and disposition of the printer head 10' is shown somewhat schematically with respect to a printer apparatus P; and although it is illustrated specifically with respect to the eleven-wire printer head it will be apparent that the same manner of mounting and disposition could be employed and adopted for the seven-wire printer head 10. As shown, the printer head 10' is advanced horizontally across the printer mechanism by a motor drive which as represented is made up of a drive screw 28 mounted in a frame F and rotated by motor drive represented at 29, and the rotating drive screw 28 passes through a nut 30 which is affixed to the underside of the base support 12 of the printer head 10'. The base support 12' also has a guide bushing 32 journaled on a support rod 33, the latter traversing the width of the platen 34. Another upright bearing 35 is received in a slotted bar 36 at the forward end of the base support 12'. Preferably, motor drive 29 is a reversible variable speed DC motor, the speed of which is controlled by a photo timing disk 38 through motor position control circuitry as described in said copending patent application for MOTOR POSITION CONTROLLER. The motor position controller generally functions to control the speed and direction of advancement of the printer head 10 across the platen and of course to incrementally stop the printer head at each laterally spaced position, with the aid of a detent motor or brake represented at 39, in printing each character.

There is now considered in more detail the construction and arrangement of a print member 20 which is adaptable either for a seven- or eleven-wire printer, but as hereinafter described is specifically in relation to the eleven-wire print head 10'. As shown in FIGS. 5 and 11, each of the print members 20' includes a thin, flexible wire portion 40 which terminates in an impression element or surface 21 at its leading end and has a wire actuator assembly 42 at its trailing end which is disposed in the mounting plate 14'. Preferably, the flexible wire portion 40 extends through a thin-walled tube 44 which is composed of a low coefficient of friction

material such as Nylon and forms a liner in each of the apertures **22**. The tubular line **44** extends beyond the leading end of each aperture into the central common recess **23'**, and the trailing end projects beyond the block **13'** through a bore **17** in the mounting plate **14'** for attachment to the actuator assembly **42** in a manner to be described.

Each actuator assembly **42** has an armature **45** affixed to the trailing end **41** of each print wire **20'** and the armature **45** is disposed for slidable, axial reciprocation within a cylindrical bearing **46** between a front anvil or stop **48** and a rear anvil **49**. The rear anvil is surrounded by a rear cap **50** which has an external cylindrical shoulder **52**; and similarly the front anvil **48** has an external cylindrical shoulder **54** with the shoulders **52** and **54** between them defining an annular recess for insertion of front and rear drive coils **56** and **58**, respectively. The coils **56** and **58** are each insulated by a plastic bobbin **60** and are axially spaced apart by an annular washer **61**. The coils are aligned in outer concentric relation to the front and rear ends of the armature **45** to selectively energize and drive the armature and attached print wire **20'** forwardly and rearwardly in making an impression on the paper.

It will be seen that the rear anvil **49** is of solid cylindrical configuration and forms a forward axial extension of a stroke adjusting screw **62** which is threaded into the rear cap **50** and is adjustably locked in place by a lock nut **64**. The front anvil **48** is of hollow cylindrical configuration to provide a central bore **65** and a reduced rearward end portion **66**. The portion **66** is provided with a flared extremity **67** surrounding the rearward end of the bore and which corresponds to the taper of the leading end surface **68** of the armature **45**. The leading end **69** of the front anvil **48** is externally threaded for threaded insertion into an opening **70** in the mounting plate **14**.

An outer shell **71** is disposed in surrounding relation to the shoulders **52** and **54** as well as the front and rear drive coils **56** and **58** of the actuator assembly, and the shell includes a raised portion **73** which permits insertion of a set of leads for the front coil **56** and for the rear coil **58**, including a positive lead **74** and a ground lead **75** to each coil.

Each of the guide tubes **44** terminate at the rear end of the printer head block **13'** and extends forwardly through the printer head block to terminate at its opposite end at the common recess **23'** as described. In this way, the flexible wire **40** follows a line of gradual curvature through the printer head block and beyond the leading end of the tube **44** so as to extend horizontally through the recess into the apertures in the guide post **24**. Forward advancement of the print element of each print wire through the guide post **24'** in making an impression upon the paper or other print medium is caused by energization of the front drive coil **56**, and the extent of advancement is regulated by the spacing between the leading tapered end **68** of the armature **45** and the flared extremity **67** of the front anvil. Conversely, return movement of the wire away from the front anvil **54** is effected by the rear drive coil **58**, and the armature is driven rearwardly until it abuts the rear anvil **49**. Disposition of the rear anvil **52** with respect to the armature **45** is regulated by the stroke-adjusting screw **62**.

As shown in FIG. **6**, in the eleven-wire printer nine actuator assemblies **42'** are disposed in a circle at equally spaced intervals 40° apart, and two actuator assemblies **42'** are disposed in side-by-side relation within the circle. In this form, the print wires **20'** for the inner or centermost assemblies **42** are directed through the mounting plate **14'** and printer head block **13'** along a very low degree of curvature while those in the outer circular array will extend along a greater degree of curvature. Again however the print wires **20'** will extend through the recess **23'** into the guide posts **24'** in a horizontal direction so that their movement will be on a line of travel directly normal to the print medium. As a result, the centermost print wires will be slightly shorter than the outer circular print wires in order that their print elements will extend the same distance into the guide posts **24'**. The circular arrangement of the print wires **20'** and actuator assemblies **42** with one or more disposed in the center is advantageous for establishing the lowest possible curvature of the print wires through the printer head block **13'** for the greatest number of wires **20'** in printing while affording the necessary space between the actuator assemblies **42**. Preferably the guide post **24** or **24'** is of a material different than that of the print wires **20** or **20'** so that the walls of the apertures **23** or **23'** will minimize wear on the flexible print wires **20** or **20'**. For instance, the wires may be composed of stainless steel and the guide post of brass, and the apertures will define separate bearings for the passage of the print wires therethrough. Accordingly, the guide post serves the important function of maintaining accurate alignment between the leading ends **21** or **21'** of the wires and interference-free movement as they are driven at a high rate of speed by the actuator assemblies.

FIG. **12** diagrammatically illustrates a preferred form of print control circuit for controlling forward and reverse drive of each print wire **20'** in an eleven-wire printer. As previously noted, two sets of leads **74** and **75** extend to each of the drive coils **56** and **58**, including a ground lead **75** and the other lead **74** applying a positive energizing signal to a forward or reverse drive coil **56** or **58**. The forward drive lead **74** extends from the output of a data gate through a monostable multivibrator **81** to the forward drive coil **56**. Whenever a gate **80** is activated, the associated single shot or monostable multivibrator **81** is set for a predetermined time interval to apply an energizing signal to the forward drive coil **56**. The end or trailing edge of that time interval will cause another monostable multivibrator or single shot **82** to be fired over a predetermined time interval to apply an energizing signal to the reverse drive coil **58**. Accordingly, the forward drive coil **56** will be energized over a predetermined time interval in driving the print wire **20'** into the paper, at the end of which time interval the other single shot **82** will be activated to drive the print wire **20'** in a reverse direction away from the paper in preparation for the next signal.

Each data gate **80** for a print wire **20'** is enabled by the presence of a timing control signal from a timing control gate circuit represented at **88** over the common input line **84** to each of the gates and a data signal applied over line **85** to each of the gates **80** from a computer, not shown. Typically, the computer or other information source will enter a command over line **86** to the input line **84** to ascertain that the printer is ready to print. If the printer is in condition to print, clock pulses from the photo timing disk **38** are applied over input **87** and the timing control line **84** to the inputs of

the data gates **80**, at which time those gates with data signals from the computer will be enabled to drive or fire selected ones of the single shots **81** in one of the columns C and D in order to drive the print wires **20'** selected in that column into the print medium. Those print wires **20'** caused to advance into the print medium are then reversed by the reverse drive coils **58** under the control of the single shots **81**, and the printer head **10'** is advanced to the next incremental position at which the apertures of column C are aligned with the column of print just formed, as described, by column D. The photo disk **38** is correlated with this movement to direct a signal to the timing control indicating that the printer head **10'** has reached its next incremental position for printing; and in the presence of a signal from a photo disk **38** and from the computer to command printing of the next information, the data gates **80** will be enabled to selectively activate the print wires in column C and drive them forwardly into the print medium.

As further represented in FIG. **12**, the timing control will suitably regulate other operations of the printer and for example be applied to register **92** to regulate various functions of the motor drive including direction of movement, speed, and various functional operations of the printer such as return, backspace and space.

Referring to FIGS. **16** to **18**, if all of the print wires in column D were caused to print and, sequentially at the next incremental position, all of the print wires **20'** in column C were caused to print in overlapping relation to the dots or impressions formed by column D it would result in a continuous line of overlapping dots, as shown in the lefthand column. In an 11 × 15 matrix as illustrated in FIGS. **16** to **18**, each column of print elements would be advanced incrementally through 15 positions. Thus as illustrated along the top row of dots, the uppermost print element could be fired fifteen times to produce an overlapping row of dots as shown. The same is true of each of the print wires in both columns C and D so that substantial overlap is attained both in vertical and horizontal directions.

For each incremental advancement of the printer head across the matrix, each column of print elements is sequentially fired and of course the print wires in each column are simultaneously fired. In other words, the selected print wires in column D are simultaneously fired followed by simultaneous firing of selected print wires in column C, after which the printer head is advanced to the next incremental position.

In establishing time intervals for the single shots, it is found that the time interval for the drive coil may be slightly greater than that for the return or rear drive coil, since driving in the reverse direction is aided somewhat by the rebound of the print wire away from the paper. For instance, the time interval for the forward drive coil may be established at 300 microseconds and the time interval for the reverse drive coil set at 275 microseconds.

For the purposes of comparison, the overlapping relationship between dots formed in a 5 × 7 matrix is illustrated in FIGS. **13** to **15** for a seven-wire print head. In this case, the dots preferably are larger in area than those formed by the eleven-wire printer and overlap between dots either in the horizontal or vertical direction. For instance in a standard 5 × 7 matrix in which the height is 0.102 inches, the distance between centers of dots of a diameter of 0.015 inches may be on the order of 0.0145 inches in a seven-wire head. In an 11 × 15 matrix wherein the height is 0.125 inches, the distance between centers of the dots may be approximately 0.011 inches, and the diameter of each dot is 0.014 inches. Formation of the letter A by each matrix as described in shown in FIGS. **15** and **18**, respectively.

In the forms shown, the motor drive **28** typically may be a printed circuit motor, such as, the DC printed circuit motor manufactured by Photo Circuits Corporation of Glen Cove, N. Y. In a conventional manner, the photo-timing disk is keyed to the motor drive shaft with a series of slots on the outer periphery which are advanced between a light source and a pair of photo diodes to produce a given number of timing pulses according to the speed of rotation of the motor.

It is therefore to be understood from the foregoing that various changes and variations may be adopted in the method and apparatus of the present invention without departing from the spirit and scope thereof as defined by the appended claims.

What is claimed is:

1. A matrix printer head comprising in combination:

a plurality of print members having impression elements arranged in adjacent columns and disposed in confronting relation to a print medium, the impression elements in one column being offset vertically and laterally with respect to the impression elements in an adjacent column, said impression elements adapted to impress a matrix of dots to form each character on the print medium,

print member drive means for sequentially driving selected of the print members in each column to advance their impression elements forwardly into contact with the print medium whereby the dots formed in one column are vertically and laterally offset with respect to dots formed by the next adjacent impression elements of the adjacent column, and

printer head advancing means for incrementally advancing said printer head in a direction laterally of the print medium to a succession of incremental positions in forming each character, the distance between incremental positions corresponding to the spacing between adjacent columns of said impression elements, said print member drive means sequentially driving selected of the print members in each column at each incremental position whereby the dots formed by driving selected of said print members in one column by said print member drive means will partially overlap and be vertically aligned with the next adjacent dots previously formed by driving of the print members of the adjacent preceding column at that incremental position, so that characters having apparent solid lines are formed by the matrix of dots when the printer head has been successively advanced through a series of incremental positions in forming each character.

2. A matrix printer head according to claim **1** including timing means between said print member drive means for the print members in each column to sequentially drive the print members in one column a predetermined time interval after driving the print members of the other column into contact with the print medium at each incremental position.

3. A matrix printer head according to claim **1**, said drive means for each print member including forward

drive means for driving each print member to advance the impression elements into contact with the print medium, and reverse drive means for positively driving each print member and associated impression elements away from the print medium.

4. A matrix printer head according to claim 1 wherein the impression elements are arranged in a pair of spaced adjacent columns, one column of impression elements being offset less than a full dot width apart from the impression elements in the other column.

5. A matrix printer head according to claim 1 wherein the impression elements in each column are laterally offset less than a full dot width apart, and said impression elements in one column are spaced equal distances between adjacent impression elements in the other column.

6. A matrix printer head according to claim 5, said impression elements in the adjacent columns being operative to form an overlapping series of dots vertically along each column printed in a matrix and an overlapping series of dots horizontally and diagonally between columns as said print members are successively advanced to each incremental position and selected of said impression elements are sequentially advanced into contact with the print medium.

7. A matrix printer head according to claim 1 wherein said print members include a plurality of elongated flexible print wires, each of the print wires having a leading end terminating in an impression element at one end and a trailing end portion at the opposite end, said print member drive means having actuator assemblies at the trailing ends of said print wires, each actuator assembly including an armature at the trailing end of each print wire, electromagnetic forward drive means adjacent to the forward end of each armature operative to energize said armature to drive each said print wire in a forward direction, electromagnetic reverse drive means aligned adjacent to the rearward end of said armature operative to energize said armature to positively drive each said print wire in the reverse direction, and timer means for successively energizing said electromagnetic forward and reverse drive means of each actuator assembly to positively advance and retract said print wires toward and away from the print medium, respectively.

8. A matrix printer head according to claim 7, said actuator assemblies including at least one centrally disposed actuator assembly and a plurality of actuator assemblies arranged in a circle about the central actuator assembly, said print wires converging forwardly from the trailing end portions and the leading ends of said print wires extending horizontally in closely spaced, parallel relation to one another.

9. In a matrix printer head adapted for impressing a matrix of dots to form each character on a printing medium, the combination comprising:

a plurality of elongated, axially movable print members each provided with a leading end portion having an impression surface at its leading terminal end and a trailing end portion including an actuator assembly, there being at least one actuator assembly disposed centrally with respect to the other actuator assemblies, and the other actuator assemblies disposed in a circle at equally spaced circumferential intervals in surrounding relation to the centrally disposed actuator assembly, each actuator assembly including positive forward and reverse drive means at opposite ends thereof and means for successively energizing said forward and reverse drive means, said print members converging forwardly from said actuator assemblies and terminating in leading end portions which extend in spaced parallel relation to one another, and

a guide post provided with a series of closely spaced apertures arranged in spaced adjacent columns to receive and guide the leading ends of said print members for movement toward and away from the print medium, actuator control means associated with said forward and reverse drive means for sequentially driving selected of the print members in each column to advance their impression elements forwardly into contact with the print medium whereby the dots formed by one column of print members will touch the next adjacent impression elements of the adjacent column, printer head advancing means for incrementally advancing said printer head in a direction laterally of the print medium to a succession of incremental positions in forming each character whereby the dots formed by driving selected print members of said actuator control means in one column will touch and be vertically aligned with the next adjacent dots of the preceding series of dots formed by the adjacent column of print members at incremental positions whereby characters having apparent solid lines are formed by the matrix of dots when the printer head has been successively advanced through a series of incremental positions.

10. In a matrix printer head according to claim 9 including a common mounting plate for said actuator assemblies and printer head support means for guiding and supporting said print members for forward extension from said mounting plate through guide passages in said printer head support means, said guide post positioned at the leading end of said printer head support means.

11. In a matrix printer head according to claim 10, the guide passages of said printer head support means each having a low coefficient of friction tube lining the wall of said passage for extension of a print member therethrough, and the guide passages terminating in a common recess for extension of the leading ends of said print members therethrough.

12. In a matrix printer head according to claim 11, said print head support means including said guide post at the leading end thereof in front of the recess, said guide posts provided with apertures therein for reception of the leading ends of said print members.

13. In a matrix printer head according to claim 12, the apertures in said guide post each defining a bearing surface for high-speed movement of a print member therethrough without contacting the other print members.

14. A method of printing characters on a printing medium with a printer head having a series of print elements arranged in spaced adjacent columns comprising the steps of:

arranging the print elements of one column in vertically offset relation to the print elements of the next adjacent column,

selectively activating the print elements in one column to form vertically spaced impressions in a single column upon the print medium,

incrementally advancing the printer head to a position in which the print elements of the other column are aligned in the plane through the impressions formed by the print element of the one column, and

selectively activating the print elements of the other column to form impressions along the same column

of impressions formed by the one column, the vertical distance between adjacent offset print elements of the columns being such that the impressions formed by offset adjacent print elements in a single column will partially overlap to form an apparent solid line of print.

* * * * *

REEXAMINATION CERTIFICATE (674th)

United States Patent [19] [11] **B1 3,900,094**

Larsen et al. [45] Certificate Issued **May 5, 1987**

[54] **MATRIX PRINTER WITH OVERLAPPING PRINT DOTS**

[75] Inventors: **Raymond B. Larsen; Donald E. Holmes,** both of Riverton, Wyo.

[73] Assignee: **Eaton Corporation,** Cleveland, Ohio

Reexamination Request:
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Filed:	**May 10, 1973**

[51] **Int. Cl.**[4] **B41J 3/12;** B41J 3/04
[52] **U.S. Cl.** **400/124;** 101/93.05
[58] **Field of Search** ..... 400/118-121, 400/124; 101/93.04, 93.05, DIG. 13; 346/150, 151, 155-157, 162-164

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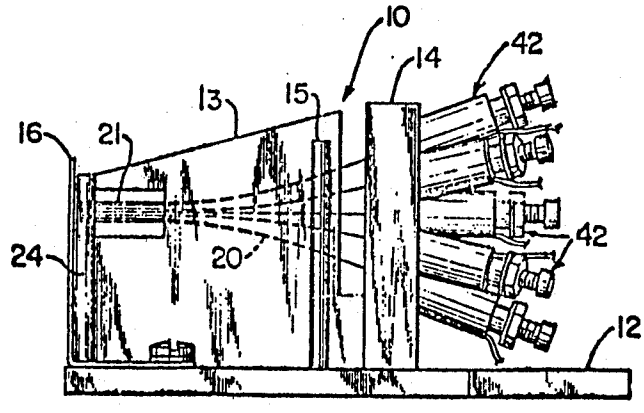
Primary Examiner—Paul T. Sewell

[57] **ABSTRACT**

A matrix printer head apparatus and method of printing have been devised for high-speed printing operations in which impressions or dots formed on the print medium will overlap to form apparent solid lines. Overlapping of impressions or dots both in the horizontal and vertical directions in high-speed printing operations is accomplished by a novel and improved arrangement of the print elements and the manner in which the print elements are incrementally advanced and positively driven in forming each matrix.



REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **9–14** is confirmed.

Claim **6** is cancelled.

Claim **1** is determined to be patentable as amended.

Claims **2–5**, **7** and **8**, dependent on an amended claim, are determined to be patentable.

1. A matrix printer head comprising in combination:

a plurality of print members having impression elements arranged in adjacent columns and disposed in confronting relation to a print medium, the impression elements in one column being offset vertically and laterally with respect to the impression elements in an adjacent column, said impression elements adapted to impress a matrix of dots to form each character on the print medium,

print member drive means for sequentially driving selected of the print members in each column to advance their impression elements forwardly into contact with the print medium whereby the dots formed in one column are vertically and laterally offset with respect to dots formed by the next adjacent impression elements of the adjacent column, [and]

printer head advancing means for incrementally advancing said printer head in a direction laterally of the print medium to a succession of incremental positions in forming each character, the distance between incremental positions corresponding to the spacing between adjacent columns of said impression elements, said print member drive means sequentially driving selected of the print members in each column at each incremental position whereby the dots formed by driving selected of said print members in one column by said print member drive means will partially overlap and be vertically aligned with the next adjacent dots previously formed by driving of the print members of the adjacent preceding column at that incremental position, so that characters, having apparent solid lines are formed by the matrix of dots when the printer head has been successively advanced through a series of incremental positions in forming each character, *and said impression elements in the adjacent columns being operative to form an overlapping series of dots vertically along each column printed in a matrix and an overlapping series of dots horizontally and diagonally between columns as said print members are successively advanced to each incremental position and selected of said impression elements are sequentially advanced into contact with the print medium.*

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