United States Patent [19]

Potter

[11] **3,919,933**

[45] **Nov. 18, 1975**

[54] **HIGH SPEED PRINTER**

[75] Inventor: **John T. Potter,** Locust Valley, N.Y.

[73] Assignee: **Potter Instrument Company, Inc.,** Plainview, N.Y.

[22] Filed: **Oct. 5, 1973**

[21] Appl. No.: **403,909**

[52] **U.S. Cl.** **101/93.32;** 101/93.02

[51] **Int. Cl.**[2] **B41J 9/42**

[58] **Field of Search** ..... 101/93 C, 111

[56] **References Cited**

UNITED STATES PATENTS

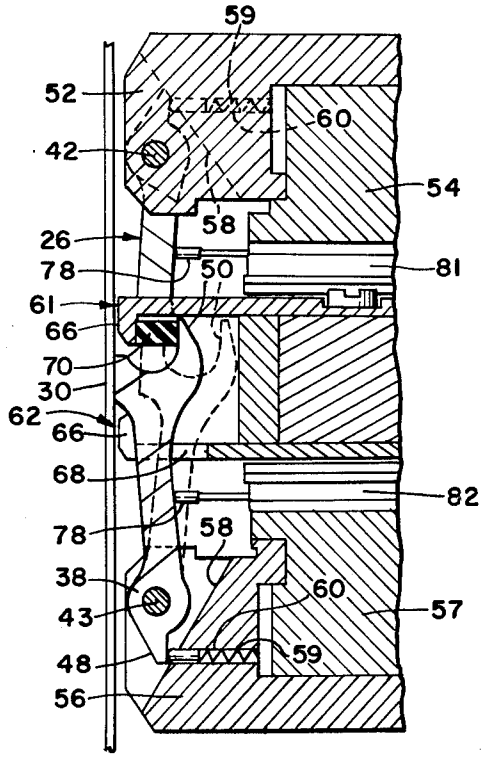
3,289,575	12/1966	Wassermann	101/93 C
3,301,177	1/1967	Shepard	101/93 C
3,418,928	12/1968	Ponzano	101/93 C
3,433,153	3/1969	Harrington et al.	101/93 C
3,585,927	6/1971	Burns et al.	101/93 C
3,605,611	9/1971	Konkel et al.	101/93 C
3,636,865	1/1972	Konkel et al.	101/93 C
3,640,217	2/1972	Drejza	101/93 C
3,715,978	2/1973	Raider	101/93 C

Primary Examiner—Clifford D. Crowder
Assistant Examiner—Edward M. Coven
Attorney, Agent, or Firm—Lane, Aitken, Dunner & Ziems

[57] **ABSTRACT**

A high speed, on-the-fly printer and method for operating same incorporating a type font having an increased number of character spaces for unit length of print line to increase printing speed for other established operating parameters. The printer has an unique hammer actuation assembly to facilitate the relatively small print character size without compromising hammer drive force.

6 Claims, 8 Drawing Figures



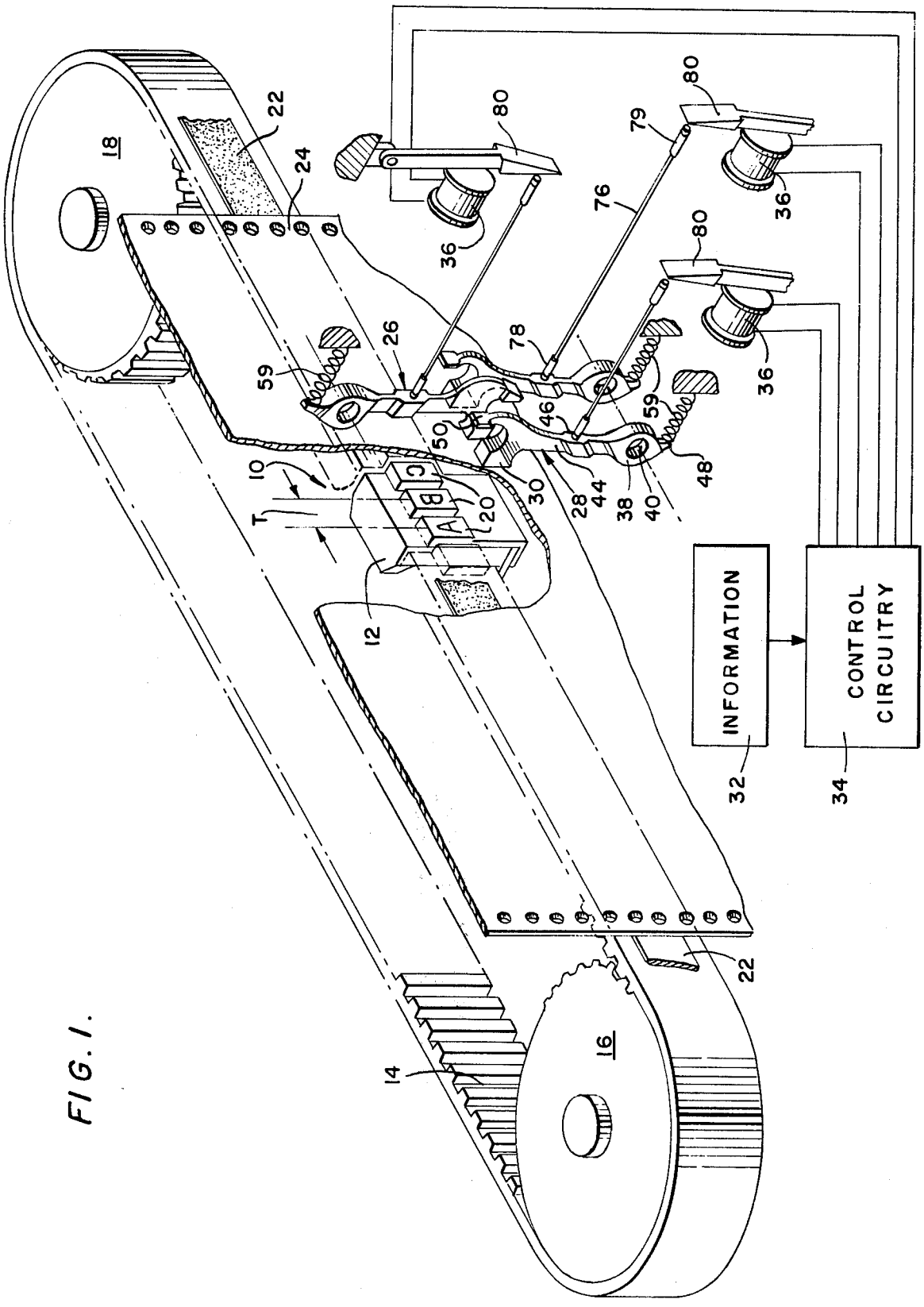

18
22
24
80
36
79
76
26
78
59
46
50
10
T
A
B
C
20
30
28
44
38
40
48
12
INFORMATION
CONTROL CIRCUITRY
32
34
14
16

FIG. 1.

FIG. 2.

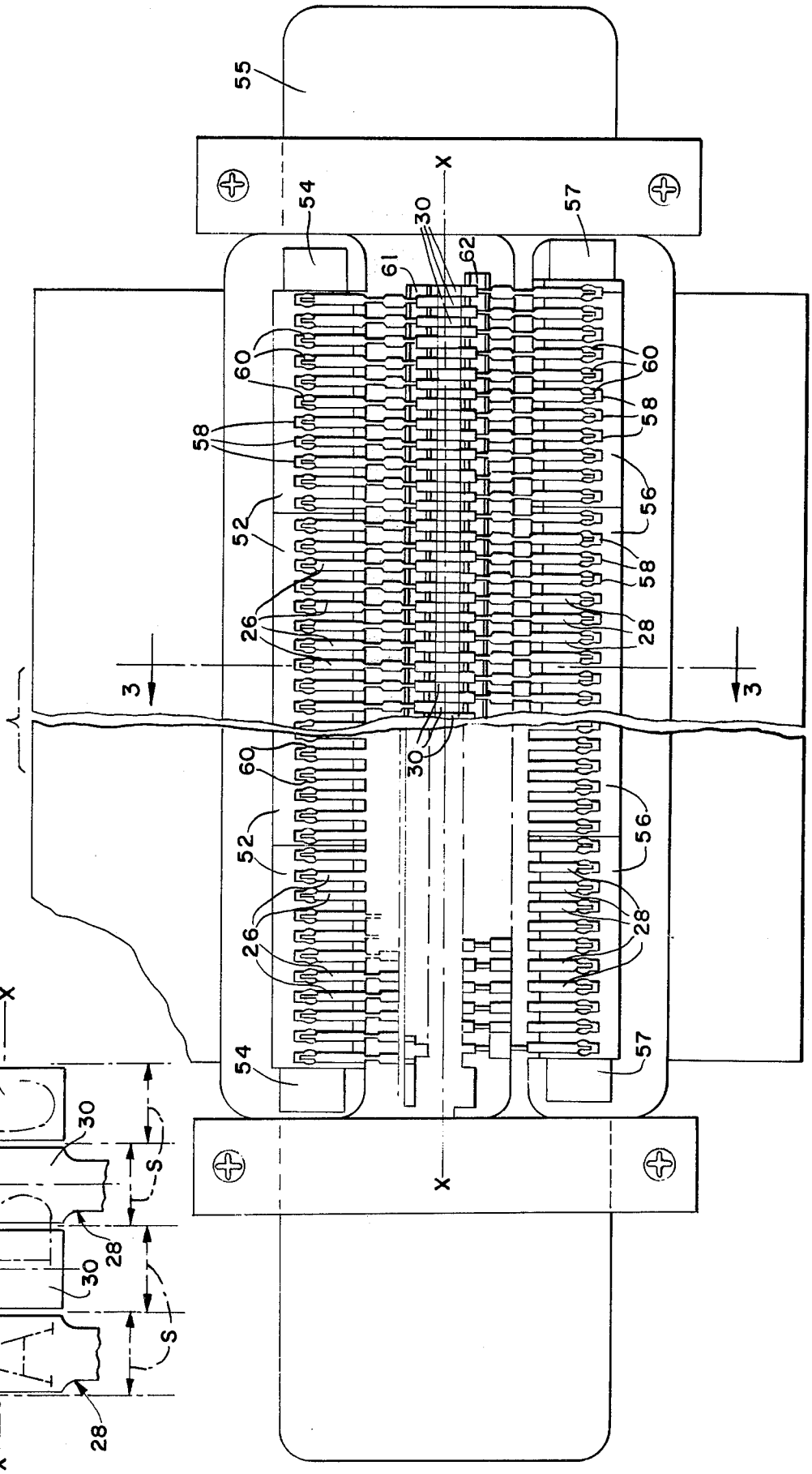

55
54
30
X
57
61
62
60
58
56
52
26
28
3
3
54
57
X

FIG. 2A.

30
X
30
26
S
28
30
H
T
S
28
X

FIG. 3.

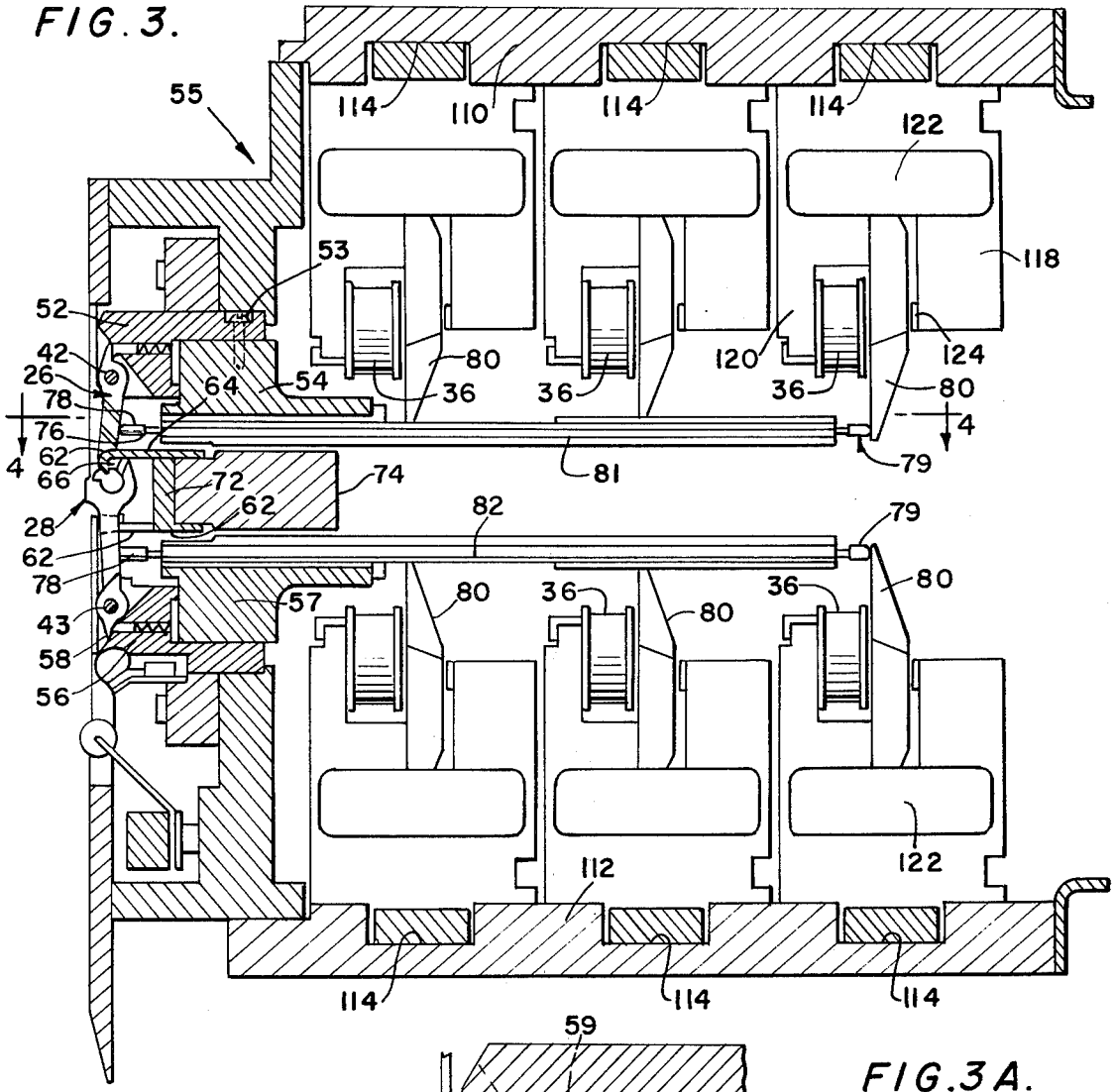

55
114
110
114
114
122
118
53
52
42
26
78
76
62
66
64
54
80
36
36
36
120
124
80
4
4
72
74
81
79
28
62
82
79
62
78
80
36
36
80
43
57
80
58
56
112
122
114
114
114

FIG. 3A.

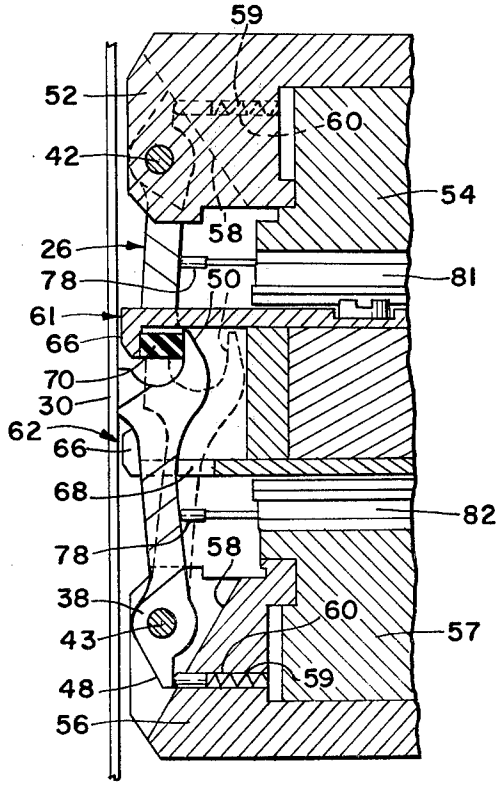

59
52
60
42
54
58
26
78
50
81
61
66
70
30
62
66
68
82
78
58
38
60
43
57
48
59
56

FIG. 4.

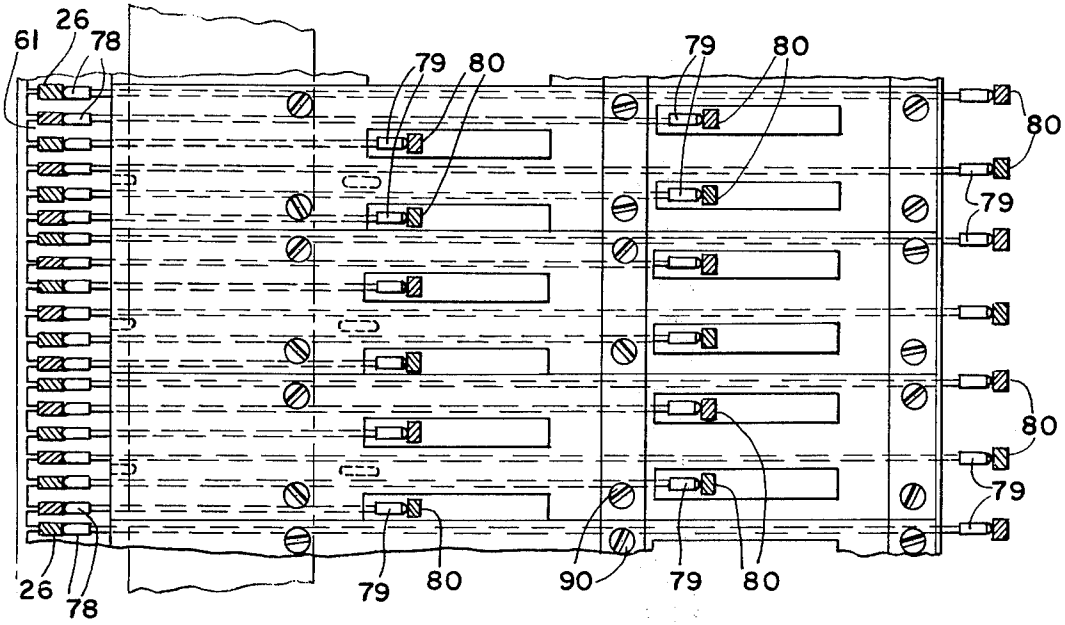


FIG. 5.

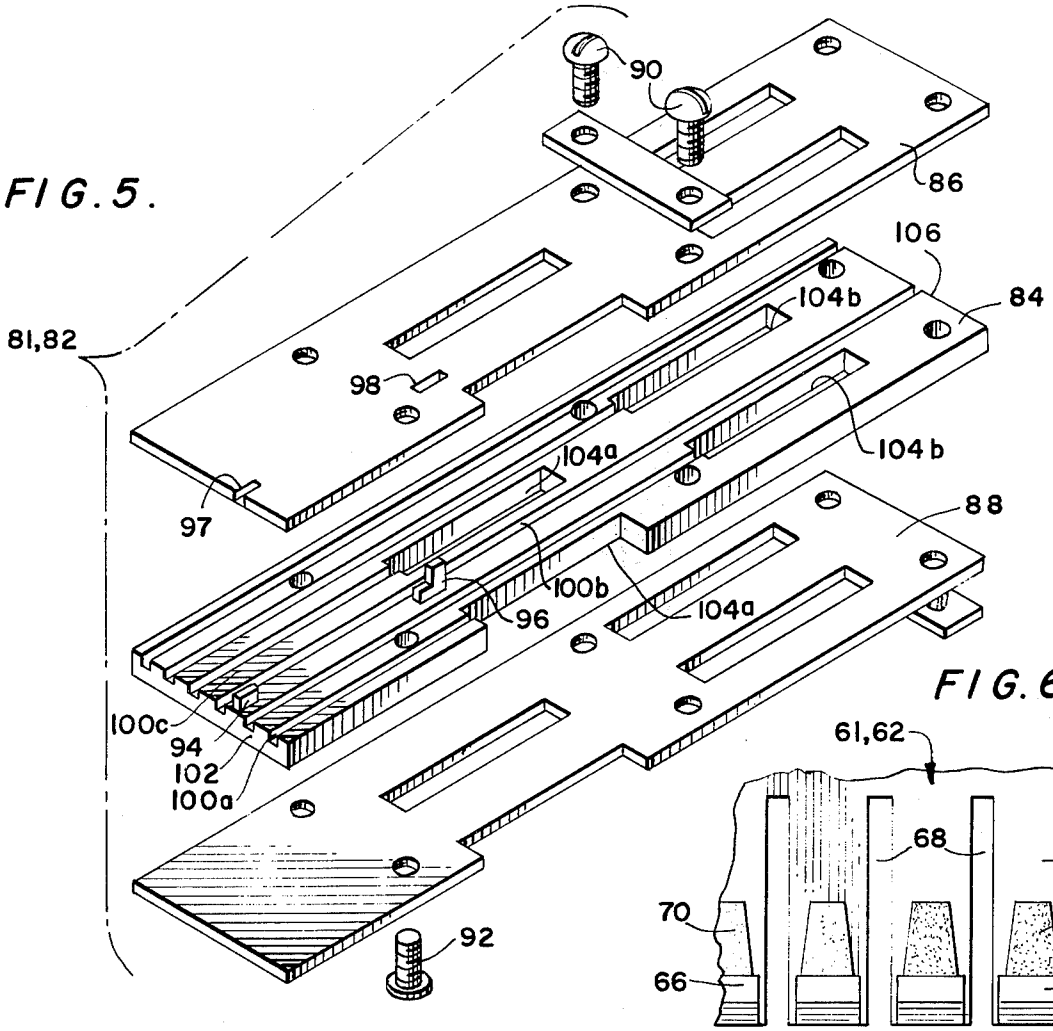


FIG. 6.

HIGH SPEED PRINTER

BACKGROUND OF THE INVENTION

This invention relates to methods and apparatus for high speed printing and more particularly, it concerns improvements in high-speed, on-the-fly line chain printers for use in computer systems as well as unique methods for operating such printers to improve speed and reduce paper consumption.

High speed printers are used extensively in computer systems to provide a readable printed record of computer processed information. Such printers conventionally employ a continuously moving type font selectively synchronized with a linear bank of electromagnetically operated print hammers located on the opposite side of paper to be printed and a ribbon from the type font. In the printing operation, a hammer assigned to a particular character position is activated at an appropriate time to strike the paper and push it against a ribbon and the particular character on the type font as the latter passes the position of the hammer. Upon completion of each printed line, the paper is advanced for printing the next succeeding line. Two basic types of such high speed, on-the-fly printers have been employed; that is, (1) drum printers in which the characters of the type font are carried on the periphery of a continuously rotating drum thus to be located on the drum in printing columns and and struck by the appropriate hammers at the intersection of such columns and a line and (2) chain printers in which the type font is carried by an endless belt or chain, the characters moving in individual lines to be struck at the intersection of such line and a column by the appropriate hammer.

The principal objection to drum printers is that because the type character slugs are moving vertically in relation to the hammers, the slightest measure of improper synchronization between the hammers and the type slug characters will result in vertical misalignment of the characters printed on the paper. Such misalignment is readily detectable and objectionable to one reading the printed copy. On the other hand, in chain printers, because the type font moves in a linear path parallel to the hammer bank and the lines to be printed, the same measure of non-synchronization will result only in a non-detectable slight irregularity of spacing between the printed characters. In light of this enhanced quality or legibility of printed matter, high speed, on-the-fly chain printers are very much in demand.

Inasmuch as the speed of the computer system with which such printers are used is virtually unlimited, the time required to print out processed information remains a predominant limitation on overall system speed. In the context of printer operation, ultimate speed must be measured in terms of number of characters printed per unit time, a factor which depends primarily on the amount of time required to print a single line in the present state of the art. In this respect, it is noted that the increment of time required to shift the paper web between successive printing lines is unproductive time in terms of actually printing characters. For this reason, it is conventional practice in the art to use relatively wide paper, for example, 14–⅞inches which, with side margins for drive sprocket holes and the like will accommodate 132 characters per line, using 10 character spaces per inch. Such paper is usually supplied in continuous, accordion fold form, perforated and folded at 11 inch intervals in what has been heretofore an effort to optimize printing speed and manageability of printed material.

The speed at which each line is printed by a chain printer is theoretically governed by the length of time required to advance a complete font of print over the length of the line. In the past, many diverse types of print font carriers have been developed in an effort to advance a font of type characters throughout the length of the line to be printed in the shortest possible time. Irrespective of the print font carrier employed, such factors as mechanical friction and resulting heat, and accuracy of type slug travel in terms of linearity and spacing, for example, have had a limiting effect on the linear velocity at which a type font may be advanced along the line to be printed. Although various types of chain printers have been operated in the past at speeds of between 1,000 and 2,000 lines per minute, each line conventionally including 132 character spaces, the capacity of the computer system to operate at much higher speeds indicates a need for higher printer speeds.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, the overall printing speed of an on-the-fly chain printer is materially increased over that of such printers heretofore available by reducing at least the lateral dimension of print character spaces to the size of conventional text book print, thereby to reduce the distance through which a linear type font of printing characters must travel to print a line with a given number of such character spaces. Specifically, the lateral dimension of each character space is selected to provide 14 to 16 such spaces per linear inch, the printing operation at each such space being effected by an individual hammer constituting one of a linear bank of such hammers uniquely assembled for individual electromagnetic actuation.

From the standpoint of structural arrangement, the invention is embodied in a high-speed chain printer employing a print chain in which a plurality of printing slugs are carried on an elastomeric timing belt, each slug carrying a plurality of type characters as shown generally in U.S. Pat. No. 3,621,778 issued to D. J. Ripple et al on Nov. 23, 1971. A novel hammer bank assembly is provided to cooperate with such a print chain, the hammer bank employing an individual hammer corresponding to each printing character space. Individual mounts for the relatively small hammers as well as a measure of space accommodation for a complete electrogmagnetic firing assembly for each hammer is provided by supporting and actuating alternate hammers from opposite sides of a common print line, thus to provide upper and lower tiers of hammers which are interlaced in the sense that impacting hammer heads of both tiers are aligned with the print line. The interlacing of hammers in this manner also enables the use of a precision machined slotted guide and abutment snubbing bar, one for each tier of hammers, and which enables precise control over the movement of each hammer head on actuation.

The measure of space accommodation for individual and independent hammer firing assemblies provided by the interlaced arrangement of hammers is further enhanced through the use of low inertia push rod interconnections between the hammers and solenoid actuators. More particularly, encased and freely floating

piano wire push rods are arranged in upper and lower tiers corresponding respectively to the upper and lower hammer tiers. The lengths of the wires are staged so that three rows of solenoid actuators may be employed in each tier, the rows extending parallel to the print line. By virtue of this arrangement, adjacent solenoid actuators in each row constitute the actuator for each sixth hammer. Hence, the electromagnetic power available for actuation of each hammer is not compromised by the reduced size and spacing of the hammers.

Among the principal objecives of the present invention are, therefore: the provision of high-speed, on-the-fly printing method and apparatus by which the speed particularly of chain-type on-the-fly printers is significantly increased over the printing speed of such printers heretofore available; the provision of such a printing method and apparatus which results in both improved printing speed and in conservation of paper or other printing medium; the provision of an improved impact hammer assembly for high-speed, on-the-fly printers of the type used in computer systems; the provision of such an impact hammer assembly which maximizes the electromagnetic force available for firing each hammer for a small physical size and spacing of the hammers; and the provision of such an impact hammer assembly incorporating precision guide and/or snubbing means for each hammer.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description to follow taken in conjunction with the accompanying drawings in which like parts are designated by like reference numerals.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective, partially schematic view illustrating the general organization of the chain printer of this invention;

FIG. **2** is a front elevation illustrating the hammer bank assembly of the present invention;

FIG. **2A** is a greatly enlarged front elevation illustrating a portion of the hammer bank illustrated in FIG. **2** with chain carried type characters superimposed thereon in phantom lines;

FIG. **3** is an enlarged fragmentary cross-section taken on line **3—3** of FIG. **2;**

FIG. **3A** is a still further enlarged fragmentary cross-section taken on line **3—3** of FIG. **2;**

FIG. **4** is a fragmentary cross-section taken on line **4—4** of FIG. **3;**

FIG. **5** is an exploded perspective view illustrating the hammer actuating push rod support assembly for the printer of the present invention; and

FIG. **6** is an enlarged fragmentary plan view illustrating the hammer guide and abutment stop mechanism of the apparatus of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. **1** of the drawings, a chain printer embodying the present invention is generally shown to employ a print chain of the type described in the aforementioned U.S. Pat. No. 3,621,778 and generally designated by the reference numeral **10.** Accordingly, the print chain incudes a plurality of multicharacter type slugs **12** carried on an endless timing belt **14** trained about rotatably driven gears **16** and **18.** As shown, each type slug **12** carries on its front face three raised characters **20,** the lateral center to center spacing of each character on the chain being designated by the reference letter T and discussed in more detail below. Although only three such type characters are shown in FIG. **1** of the drawings, it will be appreciated by those familiar with the high-speed printing art that the print chain will include one or more fonts of the type characters around the complete length of the endless belt **14,** each font containing one of each character to be printed. Typically, a font might include forty-eight characters representing the 26 letters of the English alphabet, ten numerals and twelve miscellaneous symbols including punctuation marks and the like.

Also in accordance with conventional practice, an ink ribbon **22** is positioned between the type characters **20** and a print receiving medium conventionally in the form of a continuous paper web **24.** On the opposite side of the paper web and ribbon from the type characters **20** is positioned a linear bank of hammers **26, 28** each having a head **30** adapted to be advanced against the paper **24,** the ribbon **22** and the type characters **20** so that the paper **24** will receive a printed image of the type character struck by any one of the several hammer heads. Conventional operation of such printers involves the feeding of information by a computer designated by the reference numeral **32** to control circuitry **34** of the printer operative to fire any one of a plurality of actuating solenoids **36** to cause a particular hammer to impact the paper, the ribbon, and the type character through linkage means to be described in more detail below. The control circuitry **34** of the printer also incorporates means for correlating the precise location of each type character **20** precisely with the location of any one of the hammer heads **30** at all times while the chain **10** is being driven continuously at high linear velocities. Inasmuch as one hammer head **30** is provided for each character space along a line to be printed on the paper web **24,** printing of a particular character at a specific character space along the line involves an impacting of the hammer head corresponding to that space at the instant the type character desired to be printed passes that space. Since a complete printing capability requires a facility for any one of the type characters **20** to be impressed against the paper at any character space position along the length of a line to be printed on the paper, the shortest time in which a line can be printed is the time required for a complete font of the type characters **20** to traverse the line. An important feature of the present invention results from a foreshortening of the character space width which in turn results in a corresponding foreshortening of a font of such characters as well as a foreshortening of the length of the line printed on the paper web **24,** assuming a given number of character spaces per line.

To provide a clear understanding of the interrelation of the hammer heads **30,** the chain carried type characters **20,** and a line of printed characters on the web **24,** reference is made to FIG. **2A** of the drawings in which these items are schematically superimposed. Specifically, the width of each printed character space is designated by the reference letters S, such printed character spaces being adjacent to one another in each line to be printed. The hammer heads **30** on the respective hammers **26** and **28** are disposed on a common horizontal center line X—X which corresponds to the location of the line to be printed on the web **24** during the time such line is printed. The center-to-center spacing of the hammer heads **30** is designated by the reference letter H. Inasmuch as one hammer is provided for each

printed character space, the dimension H is equal to the dimension S or the width of the character space. The center-to-center spacing of the type characters **20** carried on the chain **10** is designated in FIG. **2A** by the reference letter T and is larger than either of the dimensions S or H. Specifically, the dimension T exceeds the dimension H by a multiple known in the high-speed printing art as the "aspect ratio", the multiple typically being 1.5. The reason for the aspect ratio is that because the paper web **24** and ribbon **22** are moved against an individual type character **20** on the chain **10** by the individual hammer heads **30,** a spacing of the type characters **20** on the chain equal to the spacing of the hammers and the printed character spaces S is likely to cause "ghosting" which is an unwanted partial printing of the type character adjacent to the one intended to be impacted by a particular hammer.

The increased printing speed resulting from the practice of the present invention without changing other printing operating parameters such as the aspect ratio or the linear velocity of the print chain **10** may now be appreciated. Traditionally, chain printers have employed approximately ten character spaces per printed line inch thus requiring 4.8 times 1.5 (the aspect ratio) or 7.2 inches of chain length for each forty-eight character type font. By reducing the character spacing S to conventional text book size on the order to 14 to 16 character spaces per inch of 15 characters per inch, for example, the same type font occupies a length on the chain **10** of 4.8 inches. It will be appreciated therefore that the length of time required for a forty-eight character type font to traverse each hammer in a chain printer operating in accordance with the present invention where fifteen character spaces are provided for each linear inch is less than the traditional chain printer by a factor of one third where are all other operating parameters remain constant. Stated differently, the time of print font traverse is reduced to provide a printing speed increase of 50% as compared with prior chain printers.

The reduction of character space width and resulting increase printing speed is attainable in substantial measure as a result of a novel hammer bank assembly depicted schematically in FIG. **1** and illustrated in more detail in FIGS. **2–6** of the drawings. As shown most clearly in FIGS. **1–3** of the drawings, each of the hammers **26, 28** is identically constructed to include a pivot boss **38** at one end and having a bearing aperture **40** for receiving a pivot pin **42** or **43.** An arm or body portion **44** extends from the pivot boss **38** to the hammer head **30** and is provided with an enlarged push rod abutment **46** intermediate its length. A return spring tang **48** projects from the pivot boss **38** in a direction opposite from the arm **44.** A portion of the arm **44** extends rearwardly and beyond the head **30** as an abutment tang **50.**

As shown most clearly in FIGS. **1** and **2,** the hammers **26** are pivoted from the pivot pin **42** carried by an upper hammer pivot block **52** fixedly secured to such as by screws **53** to an upper mounting bar **54** forming part of a frame **55.** As such, the hammers **26** depend from the upper mounting bar **52** as an upper tier of hammers. The hammers **28** constitute a lower tier of hammers and are pivoted from the pin **43** in generally upstanding relation from a lower pivot block **56** similarly secured to a lower mounting bar **57.** The heads **30** of both tiers of hammers **26** and **28** converge on the common print line X—X (FIG. **2**) with the hammers **26** in the upper tier occupying alternate character space locations with the hammers **28** in the lower tier. The hammers **26** are thus "interlaced" with the hammers **28.**

As shown most clearly in FIGS. **2, 3** and **3A,** the print blocks **52** and **56** are precision formed to nest against the mounting bars **54** and **57** respectively and further, several such pivot blocks, each supporting multiple hammers **26, 28** are mounted in side-by-side relation along the length of each mounting bar. Also the pivot boss **38** of each hammer is received in one of multiple, uniformly spaced machined slots **58** having respective lateral dimensions or widths to receive the hammer bosses with close tolerances and thus support the hammers for movement in single pivot planes. The hammers **26** and **28** are biased to a retracted position by helical compression springs **59** contained in appropriate borings **60** in the base of each slot **58** of the respective pivot blocks **52** and **56.**

Movement of each hammer from its retracted position to its impacting or striking position is both further guided and limited by upper and lower snubbing bars designated generally by the reference numerals **61** and **62,** respectively and shown most clearly in FIGS. **3** and **6** of the drawings. Each of the snubbing bars is of L-shaped cross-sectional configuration to establish an elongated horizontal leg or base plate portion **64** and a relatively short vertical leg portion **66.** A series of precisely machined slots **68** extend through the leg portion **66** into the base portion **64** and are dimensioned to receive the portion of the hammer arm **44** between the push rod abutment **46** and the head **30.** The configuration of each snubbing bar, therefore, may be likened to that of a comb having teeth separated by the slots **68** as seen in FIG. **6** of the drawings. Secured on the inside surface of each vertical leg **66** is an abutment cushion **70** for engagement by the abutment tangs **50** on the respective hammers **26** and **28.** Specifically, and as shown in FIG. **3** of the drawings, the lower snubbing bar **62** is oriented along the length of the hammer bank such that the slots **68** therein are aligned to receive the lower tier of hammers **28.** Similarly, the upper snubbing bar **61** is oriented so that the slots in the upper bar receive the upper tier of hammers **26.** Because of the interlaced organization of the upper and lower tiers of hammers, the abutment pads **70** in the upper guide bar **61,** being located intermediate the slots **68,** will be in a position to be engaged by the abutment tangs **50** on the lower tier of hammers **28.** In like manner, the abutment stops or cushions **70** on the lower snubbing bars **62** are positioned to be engaged by the abutment tangs **50** on the upper tier of the hammers **26.** Using the comb analogy in describing the arrangement of the upper and lower snubbing bars **61** and **62,** it will be apparent that the teeth of the upper comb are positioned opposite the slot of the lower comb and vice versa, the abutment stops **70** being on the inner surfaces of the teeth. The retracted or rearwardmost position of the hammers **26** and **28** is established by a common cushion block **72** secured between the upper and lower snubbing bars **61** and **62** as shown in FIG. **3** of the drawings. Thus it will be seen that in spite of the relative small size of the hammers **26** and **28,** positive control is effected for the movement of each individual hammer by the relatively simple organization of the guide bars **61** and **62** together with the return stop block **72,** all of which are adaptable to precision forming by readily available manufacturing techniques. Further, these components are readily supported on a central mounting bar **74** ex-

tending the length of the frame **55** and located centrally between the hammer mounting bars **54** and **57.**

As above indicated, the drive solenoids **36** are actuated during printing on command by the control circuitry **34** to advance the hammers **26** and **28** forwardly at impact velocities until the abutment tangs **50** engage the abutment pads **70,** at which time the face of the hammer head **30** will impress the paper **24** and ribbon **22** against a selected type carrier **20.** The solenoids **36** therefore, which must be equal in number to the number of hammers **26** and **28,** must also be sufficiently large in size to develop an adequate electromagnetic force to effect this substantially instantaneous movement of the hammers against the paper, the ribbon and the type characters while the latter are travelling at high linear velocity in a direction normal to hammer movement. The manner in which the spacial requirements for adequately powerful solenoids is met, as well as the structural organization by which the solenoids are driveably connected to each of the closely spaced and relatively small hammers **26** and **28** in accordance with this invention, may be understood by reference to FIGS. **1** and **3–5** of the drawings. In addition to a solenoid **36,** associated with each hammer **26** and **28** is a low-inertia push rod **76** preferrably formed of piano wire and having plungers **78** and **79** at opposite ends. The push rods are supported in an assembly to be described in more detail below such that the plunger **78** at the forward end thereof is positioned to engage the plunger abutment **46** on each hammer whereas the rear plunger **79** is adapted to be engaged by a solenoid actuated striker **80** also to be described.

As shown in FIGS. **3–5,** the push rods **76** are supported in upper and lower tiers for actuation respectively of the upper and lower tiers of hammers **26** and **28** by a series of adjacent plate assemblies **81** and **82** cantilevered rearwardly from the upper and lower mounting bars **54** and **57,** respectively. Each such mounting plate assembly, as seen most clearly in FIG. **5,** includes a grooved plate **84,** a cover plate **86** and a support plate, all of such plates being secured together in overlying coextensive relation by screws **90.** The assembly of plates **84, 86** and **88** is further secured by mounting screws **92** which extend through the three plates and into the respective hammer mounting bars **54** and **57** to secure the cantilevered support of the plate assemblies **81** and **82** in the manner illustrated in FIG. **3.** To locate the plate assemblies **81** and **82** precisely in relation to the hammers, the surfaces of the upper and lower mounting bars **54** and **57** are provided with accurately machine positioning grooves (not shown). The plate **84,** as seen in FIGS. **4** and **5** of the drawings, is provided with a pair of locating lugs **94** and **96** which, when assembled, extend upwardly through cut-outs **97** and **98** in the cover plate **86** to engage in the mounting plate grooves and thus position each of the push rod supporting plate assemblies **81** and **82.**

The plate **84** is provided with equally spaced push rod receiving grooves **100***a*, **100***b* and **100***c* which differ only in length or in the distance they extend from the front edge **102** of the plate. It will be appreciated that in the assembled supporting plates **81** and **82,** the grooves **100** as well as the push rods **76** therein will be enclosed by the cover plate **86** so that the push rods are supported along their length in Bowden wire fashion. The push rods **76** as may be seen in FIGS. **3** and **4** for example, are also of three different lengths in correspondence to the lengths of the grooves **100***a*, **100***b* and **100***c*. Each of the grooves **100***a* and **100***b* terminate at their rearward end in elongated slots **104***a* and **104***b*, respectively whereas the grooves **100***c* extend through the rear end **106** of the plate **84.** The lengths of the push rod **76** correspond to the lengths of the grooves **100***a*, **100***b* and **100***c* such that the rear striker plunger **79** on each third push rod will be located respectively in the slots **104***a*, **104***b* and behind the rear end of the plate **106.** Thus, the striker plungers **79** in each tier of push rods are aligned in three rows extending in a direction parallel to the hammers. Because of the interlaced upper and lower tiers of hammers **26** and **28** and corresponding upper and lower tiers of push rods, the lateral spacing between each push rod in each tier, or the lateral spacing between the grooves **100,** is twice the center to center distance between hammers. By staging the lengths of the push rods in the manner aforementioned, the rear plunger on each push rod to be engaged by striker **80** is spaced at three times the distance each push rod is spaced or six times the center to center distance between hammers. Correspondingly, the lateral space available for each solenoid **36** is six times the spacing between hammers.

The physical arrangement of the solenoids **36** in the printer may be understood by reference to FIGS. **3** and **4** of the drawings. As shown in FIG. **3,** the chassis **55** incorporates a pair of upper and lower rearwardly extending plates **110** and **112** preferably perforated for the circulation of cooling air therethrough. Each of the plates **110** and **112** are formed with three inwardly facing grooves **114** extending in parallel with the line of hammers **26** and **28** and spaced correspondingly to the spacing of the three rows of striker plungers **79** on the push rods **76.** The grooves **114** receive spacer bars **116** on which a plurality of solenoid actuating assemblies **118** are mounted. Each of the solenoid actuating assemblies **118** includes a vertically oriented bracket **120** supporting a solenoid **36** in operative relation to a corresponding striker **80.** The strikers are pivoted from axes **122** and operate between the confronting end face of each solenoid **36** and a return stop **124** on the bracket **120.** The end of the strikers **80** engage the striker plungers **79** on the push rods as shown.

In operation, the paper web is incrementally advanced and printed line by line, the printing of each line being effected by the appropriate hammer head **30** striking the paper and ribbon **22** against a particular print character as that character flies by the hammer. Although this operation, in itself, is well-known in the operation of chain printers, the time required to print each line in accordance with the present invention is significantly reduced by the reduction of the character spacing S and the corresponding reduction in the distance each character **20** must be moved in the overall printing operation.

Hammer striking actuation is initiated by the control circuitry **34** to energize a solenoid **36** at the precise time interval such that the corresponding hammer head **30** moves against the selected type character **20** as it moves past the space occupied by the hammer head. Upon energization, the solenoid fires the associated striker **80** against the plunger **79** to move the corresponding push rod **76** axially against the boss **46** on the hammer **26, 28** to pivot the hammer against the bias of the return spring **59** until the tang **50** engages the cushion **70** aligned therewith. Return of the hammer and the push rod is effected by the spring **59.** This essentially instantaneous movement of the push rod and

hammer is possible largely because of the free axial support of the push rods **76** in the supports **81, 82** and the low inertia of both the push rods and the hammers. Moreover, there is not detectable difference in the operation of hammers actuated by push rods supported in the relatively long grooves **100***c* as compared with those relatively short push rods in the grooves **100***a*.

Thus it will be seen that as a result of the present invention, an improved high-speed printing method and apparatus is provided by which the above mentioned objects are completely fulfilled. It will be apparent to those skilled in the art that various modifications and/or changes can be made in the invention as described herein without in any way departing from the true spirit and scope of the present invention. It is expressly intended therefore that the foregoing description is illustrative of preferred embodiments only, not limiting, and that the true spirit and scope of the present invention be determined by reference to the appended claims.

I claim:

1. A high-speed, on-the-fly chain printer comprising:

means supporting a linear font of printing characters for continuous movement in a linear path parallel to a line to be printed on a flexible print receiving medium;

a linear bank of individually actuatable hammers, each hammer being operable to strike the print receiving medium against any one of said printing characters as same passes such hammer on-the-fly, there being at least fourteen of said printing characters and at least fourteen of said hammers for each linear inch of said font and said bank, respectively;

including independent actuating means for operating each of said hammers;

wherein said actuating means comprises a plurality of low inertia push rods each having a hammer end for engaging each of said hammers and an opposite striker end, means supporting said push rods intermediate said ends in at least one common plane for independent free axial movement in the direction of hammer striking movement, the axes of said push rods thereby being in parallel spaced interrelation, said push rods in said one common plane also being of at least three different lengths and arranged so that the hammer ends of all push rods are laterally aligned and so that the striker ends of each third push rod are in lateral alignment, and drive means to engage the striker end of each of said push rods, said drive means being arranged in three lateral rows spaced at increments from the line of said hammer bank by a distance corresponding to the lengths of said push rods, the center to center distance between each drive means in each row being three times the spacing between push rods in said common plane;

wherein said linear bank of hammers comprises interlaced upper and lower hammer tiers, the hammers in said upper tier having heads depending from a common upper pivotal axis and the hammers in said lower tier having heads upstanding from a common lower pivotal axis, the heads of said upper and lower hammer tiers being successively alternated in said linear bank so that the center to center spacing between the hammers in each tier is twice that of like spacing in said bank, said push rods also being arranged in upper and lower planar tiers to engage the respective hammers in said hammer tiers intermediate said heads and said common pivot axes, whereby the spacing of said push rods in each of said planar tiers is also twice the center to center spacing between said hammer heads in said linear bank;

and comprising snubbing means for limiting striking movement of said hammers towards said printing characters, said snubbing means comprising means defining an abutment surface spaced beyond the head end of each of said hammers, each of said hammers having an abutment tang projecting beyond and presented behind said head thereby to engage said abutment surface upon actuation of said hammers;

wherein said snubbing means comprises upper and lower bars each being formed having slots to receive portions of said hammers between the heads thereof and said pivotal axes respectively, said abutment surface for engagement by said tangs on said upper tier hammers being located between said slots on said lower bar and said abutment surface for engagement by said tangs on said lower tier hammers being located between said slots on said upper bar.

2. A hammer supporting and actuating apparatus for high-speed, on-the-fly printers adapted to print at least fourteen character spaces in each inch of printed line, said apparatus comprising;

a linear bank of hammers, each of said hammers having a head dimensioned to cover the area of each such character space;

means for supporting said hammers in upper and lower hammer tiers, the heads of said upper hammer tier being interlaced and laterally aligned with the heads of said lower hammer tier;

independent means for actuating each of said hammers to advance said heads from a retracted inactive position to an extended striking position, said actuating means comprising,

upper and lower tiers of linear push rods each having a hammer end and a striker end, said push rods being of three different lengths and arranged so that the striker end of each third rod in each tier is laterally aligned in one of three rows whereas the hammer ends of all push rods are laterally aligned,

a solenoid operated striker for each of said push rods, and

means for supporting said strikers in upper and lower tiers and in three rows in each tier corresponding to the rows established by the striker end of each third push rod;

wherein said means for supporting said hammers includes upper and lower pivotal supports for said upper and lower hammer tiers respectively, and including further, snubber means for cushioning movement of said hammers to said striker postion;

and wherein said hammers each include an abutment tang projecting beyond and behind said head and wherein said snubber bars are formed having slots to receive the hammers of said respective upper and lower tiers, said cushioning means being located between said slots in a position to be engaged by the hammers received in slots of the other one of said bars.

3. A hammer supporting and actuating apparatus for high-speed, on-the-fly printers adapted to print at least

14 character spaces in each inch of printed line, said apparatus comprising:

a linear bank of hammers, each of said hammers having a head dimensioned to cover the area of each such character space;

means for supporting said hammers in upper and lower hammer tiers, the heads of said upper hammer tier being interlaced and laterally aligned with the heads of said lower hammer tier;

independent means for actuating each of said hammers to advance said heads from a retracted inactive position to an extended striking position and;

snubber means for cushioning movement of said hammers to said striking position, said snubber means comprising upper and lower snubber bars each having slots to receive the hammers of said upper and lower hammer tiers respectively and each also having cushioned stops between said slots for engagement by the hammers of said lower and upper hammer tiers respectively.

4. The apparatus recited in claim **3** wherein said snubber bars are of L-shaped configuration in a cross-sectional plane normal to the line of said hammer bank thereby to establish a horizontal mounting leg portion and a vertical abutment leg portion, said slots extending through said abutment leg portion and into said mounting leg portion.

5. The apparatus recited in claim **4** wherein said cushion stops comprise elastomeric cushions bonded to the inside of said abutment leg portions.

6. In a high-speed on-the-fly chain printer comprising in combination;

an endless timing belt carrying a plurality of contiguous character slugs;

means for moving said belt at a predetermined speed to progress said character slugs along a printing line;

a plurality of printing hammers arranged along said printing line and in opposition to said character slugs;

means for supporting a flexible print receiving medium between said slugs and said hammers;

the improvement which comprises:

means for pivoting alternate hammers on an axis parallel to and above said printing line;

means for pivoting the remaining hammers on an axis parallel to and below said printing line;

hammer actuating magnets arranged in parallel rows three deep and actuating said hammers through three different lengths of push rods to actuate said upper pivoted hammers and similar but inverted magnets and corresponding push rods for actuating said lower pivoted hammers;

means including upper and lower combs comprising teeth and slots, the teeth of the upper comb being positioned opposite the slots of the lower comb, the slots in the upper comb being adapted to guide the upper pivoted hammers along planes perpendicular to said printing line, the slots in the lower comb being adapted to guide the lower pivoted hammers along planes perpendicular to said printing line;

wherein each of said hammers includes an abutment means and the inner surfaces of said teeth of said combs carry elastomeric snubbing means;

and wherein the abutment means of said upper pivoted hammers are adapted to strike the snubbing means carried by the teeth of the lower comb and the abutment means of said lower pivoted hammers are adapted to strike the snubbing means carried by the teeth of the upper comb.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,919,933 Dated November 18, 1975

Inventor(s) John T. Potter et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet Item [75] should read

-- Inventors: John T. Potter, Locust Valley;
John Tschinkel, Great Neck, and
Henry Stalzer, Floral Park, N. Y. --.

Signed and Sealed this

Second Day of November 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks