United States Patent [19]

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[11] **3,724,631**

[45] **Apr. 3, 1973**

[54] **PRINTER WITH HELICALLY ARRANGED TYPE DIVIDED INTO AXIALLY OFFSET GROUP**

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[22] Filed: **Jan. 15, 1971**

[21] Appl. No.: **106,850**

[52] **U.S. Cl.**.....**197/49,** 101/93 C, 197/18

[51] **Int. Cl.**.....**B41j 1/22,** B41j 1/32

[58] **Field of Search** 101/93; 197/55, 49, 18

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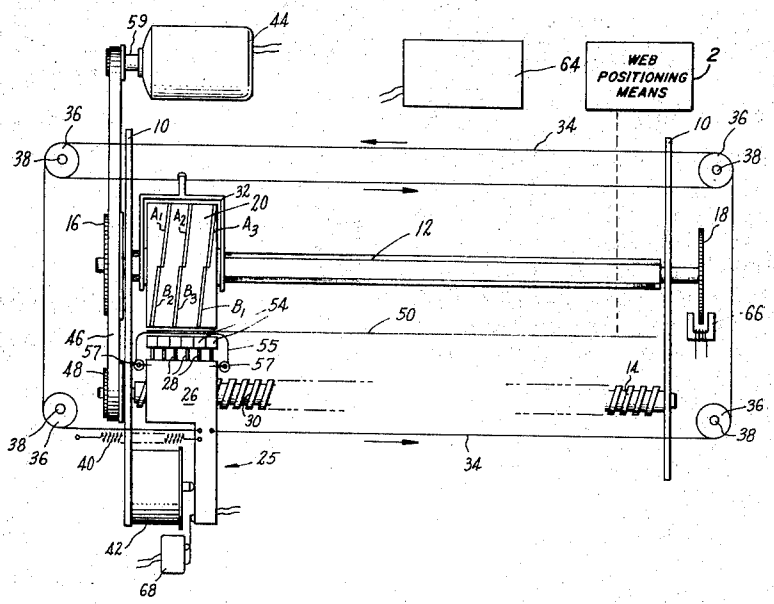
[57] **ABSTRACT**

An electronic printer employs a character drum on which the elements are arranged along helical paths, and are divided into a plurality of discrete, axially offset character groups. An impact member is aligned with each of the character groups, and enables printing during concurrent rotation of the drum and axial movement of both the drum and the hammers synchronously past the object to be printed.

11 Claims, 7 Drawing Figures



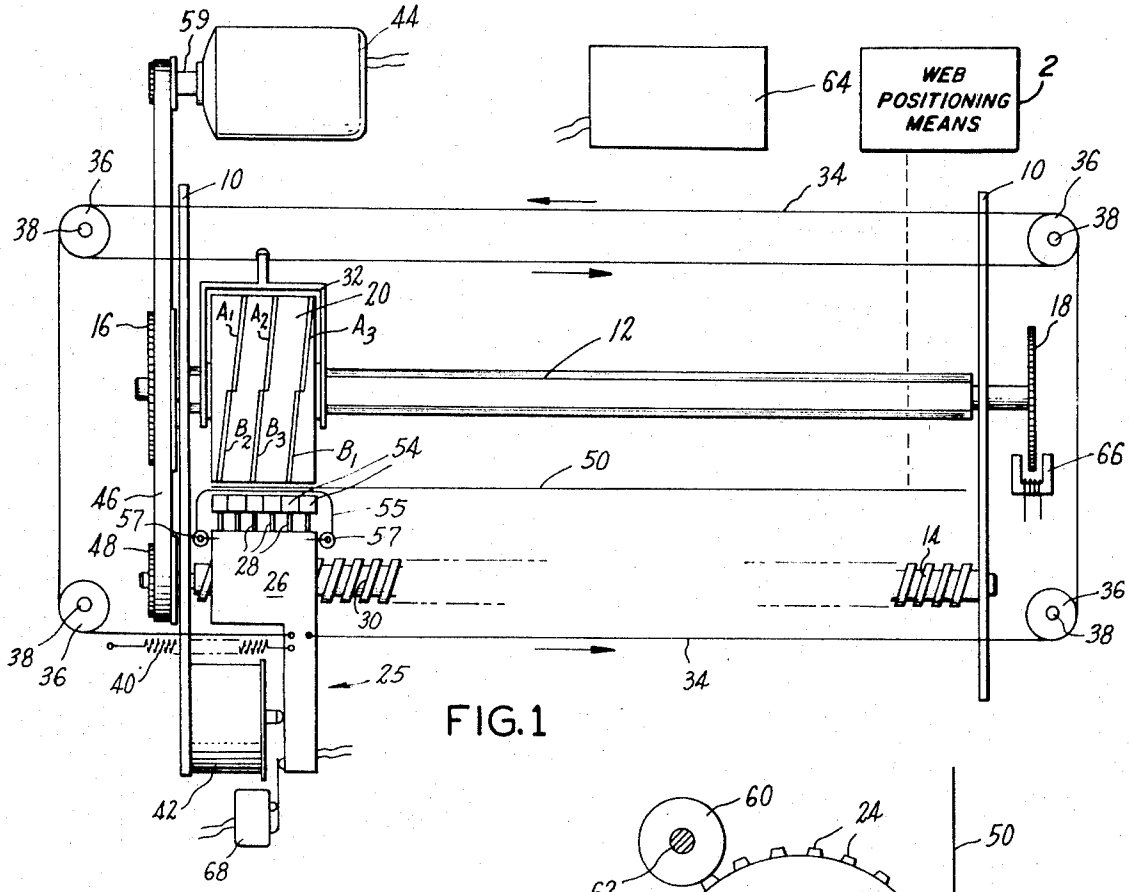


FIG. 1

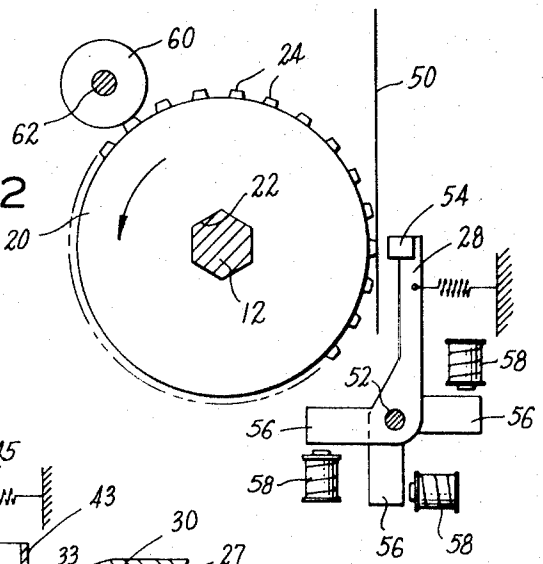


FIG. 2

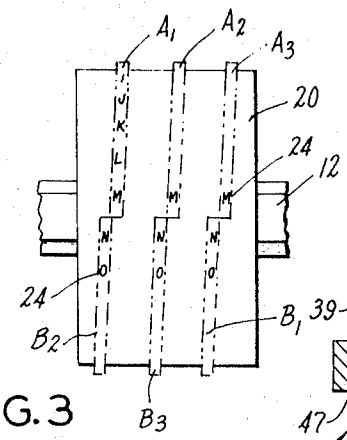


FIG. 3

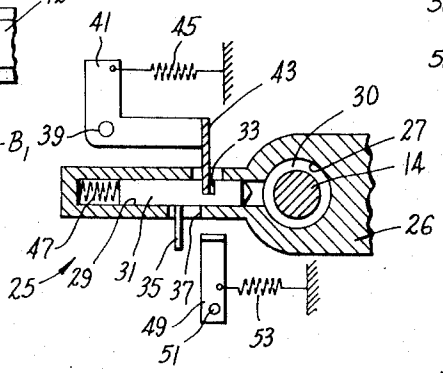


FIG. 4

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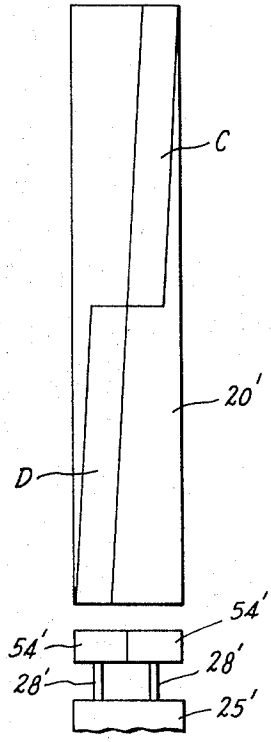

FIG. 5

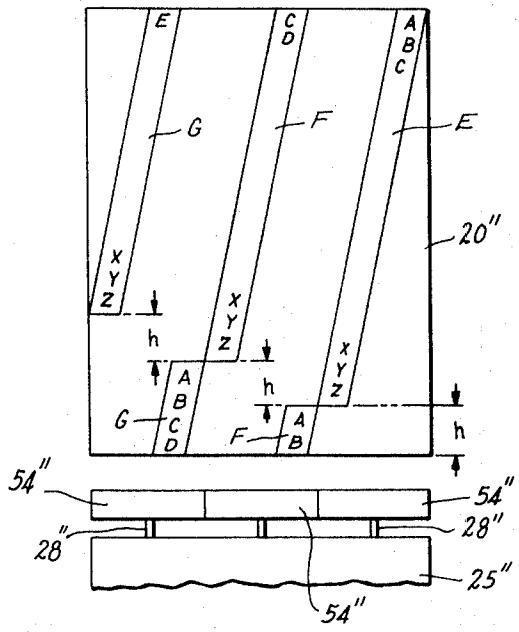

FIG. 6

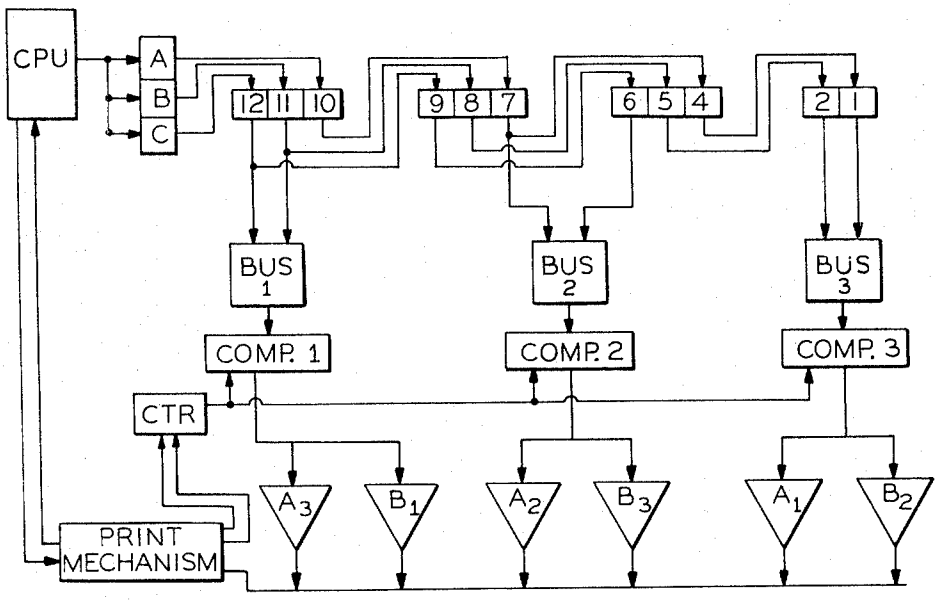

FIG. 7

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PRINTER WITH HELICALLY ARRANGED TYPE DIVIDED INTO AXIALLY OFFSET GROUP

BACKGROUND OF THE INVENTION

In many instances, the maximum value is not realized in currently available computer, mini-computer, telecommunication, and other similar systems due to the inappropriateness or inadequacy of the output unit employed therein. Although high speed printers are available, their cost is often prohibitive or at least difficult to justify, particularly in situations in which the output capacity that they provide greatly exceeds the overall capacity of the system. Moreover, such printers tend to be inappropriate for use in applications in which human memory and reading capacities are involved. On the other hand, in contemporary mini-computer systems the presently available low speed printers often constitute the most limiting factor, and tend to militate against efficient operation.

Accordingly, it is the primary object of the present invention to provide a medium speed electronic printer that is relatively inexpensive to produce.

A more specific object is to provide such a printer that is capable of printing at least 30 characters per second, preferably about 60 – 90 and most desirably about 80 – 120 characters per second.

It is also an object of the invention to provide a printer that is especially suited for use in mini-computer systems, both in terms of output capacity and also in terms of cost.

Another object is to provide a full character impact printer having, in addition to the foregoing advantages, the capability of producing a desirable final copy format.

It has now been found that the foregoing and related objects can be readily attained in an electronic character printer comprising a frame having means thereon for positioning an object to be printed along a linear printing path, and a character drum mounted on the frame for concurrent movement along the linear path and rotation about an axis parallel thereto. The drum has a multiplicity of character elements arranged about the circumference thereof and along helical paths, which elements are divided into a plurality of discrete, axially offset character sets each comprised of a plurality of discrete axially off-set character groups each provided by a multiplicity of character elements. The printer also includes a plurality of impact members mounted on the frame for synchronous movement along the linear path with the character drum. Each of the impact members cooperates with one of the character groups and is of a width substantially equal to the axial length encompassed by one of the character groups, and is aligned therewith to permit contact to be effected between any character element thereof and the object, for printing during such concurrent movement and rotation. The printer has means for continuously rotating the character drum and for moving the character drum and impact members along the linear path; means is also provided for dynamically indicating the angular relationship between the character elements of each of the groups and the impact member associated therewith. Means responsive to an electronic input signal representative of matter to be printed is also provided for actuating the impact members when a desired character for printing is aligned therewith, as

indicated by the indicating means, and the actuating means actuates the impact members independently of one another and such that the impact members cooperating with those groups of characters which are axially aligned along the circumference of the drum are actuated prior to actuation of the impact members cooperating with the character groups spaced circumferentially therefrom.

In accordance with one embodiment, the character groups are substantially identical and each of them constitutes a character set. The angle of the helical paths, the character group off-set distance, and the rates of rotation and linear movement are interrelated in such a manner that the character elements of each of the groups sweep past only $1/n$ of the number of columns to be printed on the object, where n represents the number of character groups. In addition, each of the character sets extends incompletely about the drum circumference to provide circumferential spacing between the first and last character elements thereof.

Alternatively, a pair of character groups may provide a single character set, as a result of which the set will have two impact members associated with it. Preferably, the drum has a plurality of character sets thereon with the character groups arranged sequentially about the circumference thereof. In such a case, the angle of the helical paths, the character group off-set distance, and the rates of rotation and linear movement are so interrelated as to cause the character elements of each of the sets to sweep past only $1/n$ of the total number of columns to be printed on the object, n representing the number of character sets on the drum. Most desirably, three character sets and six of impact members are provided. The drum is advantageously substantially free of axial and circumferential spacing between the last character element of one of the groups and the first character element of another of the groups to which it is adjacent. Generally, a character set will contain 64 alphanumeric characters, and the printer will additionally include means furnishing ink to the object at the locations of contact with character elements.

In accordance with the method of the invention, an object to be printed is positioned along a linear printing path, and a character drum is concurrently moved along the linear path and continuously rotated about an axis parallel thereto. The drum is provided with a multiplicity of character elements arranged about its circumference and along helical paths, and the elements are divided into a plurality of discrete, axially offset character groups. A plurality of impact members are moved synchronously with the drum along the linear path and with the object therebetween. Each of the impact members is of a width substantially equal to the axial length encompassed by one of the character groups, and is aligned therewith to permit contact to be effected between any character element thereof and the object. The relationship between the character elements of each of the groups and the impact member associated therewith is dynamically detected, and an electronic signal representative thereof is generated. An electronic input signal representative of the matter to be printed is also generated, and the detecting signal and input signal are compared. The impact members are independently and non-sequentially activated in response to the signal comparison during such concur-

rent movement and rotation, thereby effecting contact of the object and the character elements to reproduce the matter thereon. Preferably, contact of 60 – 90 character elements per second is effected with the object, and most desirably the rate of contact is 80 – 120 character elements per second.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a printer embodying the present invention;

FIG. 2 is a side elevational view of a character drum, printing hammers and inking roll which may be utilized in the type of printer illustrated in FIG. 1, and drawn to a scale that is slightly enlarged therefrom;

FIG. 3 is a front elevational view of the character drum of FIG. 1, drawn to a slightly enlarged scale to more clearly illustrate the character element arrangement thereon;

FIG. 4 is a fragmentary sectional view to an enlarged scale of an engagement mechanism for the printer carriage assembly;

FIG. 5 is a schematic view of the developed surface of a second drum providing a single character set, and of a pair of cooperating printing hammers employed therewith, drawn to an enlarged scale;

FIG. 6 is a schematic view of another developed drum surface and of printing hammers used therewith, the drum providing three discrete character sets that are axially offset from one another and have circumferential spacing between the first and the last elements thereof; and

FIG. 7 is a schematic view of an electronic logic design appropriate for use in the printer of FIG. 1.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Turning now in detail to FIG. 1 of the appended drawings, therein illustrated is a printer mechanism embodying the present invention and having a chassis providing side elements **10** between which are journalled a hexagonal shaft **12** and a worm shaft **14**, parallel thereto. The hexagonal shaft **12** has a pulley **16** secured near one end and a timing wheel **18** at the opposite end thereof, and a character drum **20**,having a hexagonal axial passageway **22** therethrough, is slidably mounted on the shaft **12** between the side elements **10** of the chassis. The drum **20** has a multiplicity of character elements **24** arranged along helical paths in six discrete axially offset groups A_1, B_1, A_2, B_2, A_3 and B_3, as is best seen in FIG. 3 and will be more fully described hereinafter.

A hammer carriage assembly, generally designated by the numeral **25**, is mounted upon the worm shaft **14** and includes a housing **26** supporting a multiplicity of hammers **28** therein. As is seen in FIG. **4**, which illustrates a mechanism by which the carriage assembly **25** may engage the worm shaft **14**, the housing **26** has a transverse bore **27** for the worm shaft **14**, and an intersecting perpendicular bore **29** in which is seated a slidable pin **31**. The upper surface of the pin **31** has a transverse notch **33** formed therein, and a short stud **35** projects downwardly from the pin **31** through an opening **37** in the housing **26**. Pivotably mounted above the pin **31** on an axle **39** is a pawl **41** having a nose portion **43** that is urged by sprint **45** into engagement in the notch **33** of the pin **31**, thus maintaining the pin **31** in retracted position against the force of coil spring **47** positioned therebehind. As will be apparent, pivoting the pawl **41** in a counter clockwise direction will disengage the nose portion **43** and permit spring **47** to thrust pin **31** into driving engagement in the groove **30** of the worm shaft **14**. Disengagement of the pin **31** from shaft **14** is effected by pivoting the resetting arm **49** on the shaft **51** against the force of spring **53**. This causes the arm **49** to bear against the stud **35** and return the pin **31** to a position for reengagement of the nose portion **43** in the notch **33**.

A yoke **32** embraces the drum **20**, and is secured to the carriage housing **26** by a flexible drive cable **34**. The cable **34** is supported upon the chassis by four pulleys **36** which in turn are rotatably mounted upon corner posts **38**. A coil spring **40** biases the carriage assembly **25** toward the left end of the chassis as depicted in FIG. **1**, and a dashpot or shock absorber **42** is affixed upon the side element **10** adjacent to that end to prevent damaging impact upon return of the carriage assembly **25** under the force of the spring **40**. The printer also includes an electric motor **44** from the shaft **59** of which power is transmitted through a belt **46** to the hexagonal shaft **12** and the worm shaft **14** through the pulleys **16**, **48** on the ends thereof, respectively.

Energization of the motor **44** causes the worm shaft **14** and the hexagonal shaft **12** (and consequently the drum **20**) to rotate continuously. To commence printing, engagement between the carriage assembly **25** and the rotating worm shaft **14** is effected by release of the pin **31** in the manner described, which follows the groove **30** and thus causes axial movement of the assembly **25** from left to right in FIG. **1**. Through the cable **34** and yoke **32**, the drum **20** moves axially with the carriage assembly **25** at precisely the same rate, and continuous rotation of the drum sequentially presents the character elements **24** thereon to the associated hammers **28** for printing, as will subsequently be described in detail. When the farthest extent of the carriage assembly **25** and drum **20** has been attained (near the right end of the printer) the resetting arm **49** is actuated to disengage the pin **31** and permit the spring **40** to return the mechanisms to the home position near the left end.

FIG. **2** shows one inking arrangement and best illustrates the individual raised character elements **24** of the printer. The paper **50** is positioned by conventional web positioning means **2** between the drum **20** and the hammers **28** which are aligned on a common axle **52** for pivotal movement toward the paper **50** and drum **20**. The hammers **28** have enlarged heads **54**, and foot portions **56** made of magnetic material and angularly offset relative to the axle **52** to best accommodate the magnetic coils **58** by which the hammers **28** are actuated. An inking roll **60** is rotatably mounted upon a shaft **62** that is parallel to shafts **12** and **52**, and the roll **60** moves with the drum **20** and contacts the character elements **24** to provide ink thereto for transfer upon impact. It will be appreciated that this arrangement for inking would not be very appropriate with the mechanism shown in FIG. **1** because printing would thereby be produced from right to left on the page. With the particular printer illustrated, it is preferable to

supply an inking ribbon **55** from spools **57** and convey it between the hammers **28** and paper **50**. The impressions are thereby transferred from the drum **20** through the rear of the paper **50** for reproduction on the front surface thereof.

With further specific reference to FIG. **1**, it is seen that each of the enlarged heads or impact members **54** of the hammers **28** is substantially equal in width to the axial portion of the drum **20** that is covered by the character group (e.g. A_1, A_2, A_3, B_1, B_2, or B_3) that is associated with it; i.e., each head **54** is about one-sixth of the total length of the drum **20**. As a result, each head **54** is capable of contacting all elements **24** of the character group with which it is aligned, and only those elements.

Appropriately interconnected (in a manner not shown) with the other elements of the printer is a schematically represented electronic logic system **64**, used for information input and printout control. Normally, the electronic system **64** will cooperate with a computer or other central printing unit providing data input thereto, and the logic design will be more fully described hereinafter.

The timing wheel **18** on the end of the hexagonal shaft **12** is provided with reference marks or strobes (not shown) indicative of the position of each of the character elements **24** on the drum **20**. The wheel may also have marks for other purposes, such as to enable tabulation of total revolutions of the drum for carriage return control and the like, or a second timing wheel may be provided for that purpose. The wheel **18** passes through the field of a magnetic pickup head **66**, which is connected to the system **64**, to generate a signal for actuation of the hammers **28** when the character required in a particular column of the paper **50** is aligned therewith (as indicated by the signal from head **66**). It will be appreciated that other means for detecting the relationship between the character elements **24** and the hammers **28** or heads **54** may be substituted, such as the optical code disk devices known in the art. It will also be appreciated that the arrangement of character elements **24** illustrated in FIG. **3** simplifies the timing wheel configuration since like elements of each character set are aligned and may all therefore be indicated by a single reference mark; however, other character arrangements may be employed advantageously. The limit switch **68** is actuated by the carriage assembly **25** in the "home" position thereof, to permit the transfer of data through the electronic system **64** and the other parts of the printer.

As depicted in FIG. **1**, the drum **20** rotates upwardly into the page of drawings while it moves axially from left to right. To compensate for the axial movement, it is necessary that the character elements **24** be arranged along a path that extends helically in the direction opposite to forward progression of the drum **20**. This allows all elements of each character group to pass the same points across the page, and it will be appreciated that the proper helical angle is a function of the axial and rotational rates, and of the character group spacing. If movement was intermittent or at varying rates, the elements would have to be arranged along paths of different configurations for proper compensation.

As has been mentioned, the drum **20** employed in FIGS. **1 – 3** has six separate character groups (namely A_1, A_2, A_3, B_1, B_2 and B_3), each of which is associated with a single hammer **28**. Each of the pairs of groups A_1 and B_1, A_2 and B_2, and A_3 and B_3 constitutes a single alphanumeric series (normally of 64 or 96 characters) to provide three complete character sets on the drum **20**, the groups A_1 and B_1 being positioned to sweep every third column on the page (e.g., columns **2, 5, 8, 11** . . .) the groups A_2 and B_2 sweeping subsequent columns (e.g., **1, 4, 7, 10** . . .) and A_3 and B_3 sweeping the remaining columns (e.g., **3, 6, 9, 12** . . .). In this manner a full alphanumeric character set is presented to each column of the page as the drum **20** progresses thereacross, and the speed of printing can be greatly increased because each of the sets need pass only one third of the columns. Moreover, due to the division of each set into two axially offset groups, the speed is further increased by elimination of any delay due to hammer responsiveness and cycle times. Thus, by so dividing the character sets the equivalent of 180° of blank space is provided for the resetting of each of the hammers between impacts, which is more than adequate recycle time, in the present state of the art. Although it might appear that even greater printing rates could be attained by dividing the sets into more than two groups, such is not the case in practice. The resultant speeds require very high rates of drum rotation, which in turn would impose intolerable centrifugal forces thereon. Secondly, although the contact time of the paper, character elements, and impact heads is very brief, unduly high speeds cause significant relative movement at the moment of contact, producing smudging and loss of definition in the printed characters. In FIG. **5**, a developed (i.e., showing the full 360° circumferential surface) drum **20'** having only two character groups C, D is illustrated, the groups C and D constituting a single alphanumeric series. The carriage **25'** supports two hammers **28'**, each of which has an impact head **54'** spanning the axial length of the character group with which it is aligned. Although this embodiment does not offer the full scope of benefits previously discussed, the printing speeds attainable are considerably in excess of those that would be possible using a drum having the character set arranged along a single, continuous (not offset) helical path and associated with only one hammer. Thus the recycle time for the hammer must be accounted for in the latter instance, and although the lag is brief it imposes a significant limitation upon printing speeds. It will be appreciated that other character configurations than those illustrated may be employed in accordance with the instant invention, such as configurations providing two or four complete character sets about the drum circumference.

FIG. **6** illustrates another embodiment of the invention wherein the developed drum **20''** has three axially offset character sets E, F and G thereon, cooperating with a carriage assembly **25''** having three hammers **28''** and associated impact heads **54''**. The provision of a plurality of character sets in accordance herewith permits increased printing rates because only a fraction of the total number of columns must be covered by each set. However, since only one hammer **28''** cooperates with each set of characters, the cycle time of the hammers must be considered, thus rendering this arrangement less desirable than that illustrated in

FIGS. 1 – 3 wherein both a plurality of character sets and also offset character groups comprising half a set are employed. Resetting time is accounted for in this embodiment by providing circumferential spaces *h* between the first character (A) and the last character (Z) in each alphanumeric set E, F and G. The worst possible case with such an arrangement would require the letter Z to be printed in one column, and immediately thereafter the letter A to be printed in the next; the space h provides a relief period for hammer resetting, making such an operation possible at the high speeds that are attainable due to the use of plural character sets.

It should be understood that operation of the printer herein described requires that the hammers be capable of independent and arbitrary or non-sequential actuation, since the character to be printed in a particular column will be presented thereto without regard to the position of the column relative to those in the same vicinity. To permit operation in such a manner, the computer, data terminal, telecommunication system or other central printing unit must be employed with logic design capable of producing such results. FIG. 7 of the drawings schematically illustrates an appropriate design for use with the printer of FIGS. 1 – 3.

Actuation of the limit switch (**68** in FIG. 1) permits initial communication to occur between the printer and data supplier or central processing unit (CPU in FIG. 7). Upon every revolution of the drum **20** the print mechanism, through the timing wheel **18** and pickup head **66**, signals or flags the CPU of its availability for data input. The CPU thereupon serially transmits data, a character code at a time, to the input buffer registers A, B and C. Assuming, for example, the matter to be printed to be the word "prints," the p code would go to register A, the r code to register B, and the *i* code to register C (hereafter only the letters themselves, rather than their codes, will be referred to). Upon transmission of the third character, the flag signal is removed to terminate data inflow.

A reference mark on the timing wheel **18** (which, along with the shafts **12** and **14** and the drum **20** is continuously rotating) actuates the engagement mechanism of the carriage assembly and causes it and the drum **20** to be driven axially thereby. A subsequent mark effects a shift of the data in registers A, B and C to shift registers **10, 11** and **12** respectively, placing *p* in **10**, *r* in **11** and *i* in **12**. At this point, the character elements (*a* – *m*) in the group designated A_3 begin to sweep through the third column location on the page. Rotation of the timing wheel **18** generates pulses which are counted and stored in a six bit counter (CTR.) to indicate the presence of each character element as it becomes available for printing in column **3**. During the first half (180°) of the drum revolution the content of the CTR is compared with that of shift register **12** in the first comparator (COMP. 1). Since, in fact the character i is present in both register **1** and the counter (representative of an A character group), a signal is generated to activate solenoid A_3 and its associated hammer **28** to print the character in column **3** of the page. During the second half of the first revolution of the drum the character group B_1 (containing elements *n* – *z*) sweeps the second column location and BUS 1 switches the comparison in COMP. 1 to the CTR content and that of shift register **11**. Since,once again, both the register compared and the counter (now representative of a B character group) contain a common character (i.e., *r*) solenoid B_1 is activated to print with the proper hammer **28** in column **2**. Thus, after the first complete revolution the page bears the characters "*ri.*"

While this was happening, the previously mentioned flag is set and three more characters are stored in the buffer registers; i.e., *n* is stored in A, *t* is stored in B and *s* is stored in C, after which the flow of data is terminated. A reference strobe generated between the first and second revolutions shifts any remaining data in registers **10, 11** and **12** to registers **7, 8** and **9** respectively, and the data in the buffer registers to shift registers **10, 11** and **12** in the manner previously described. As a result, during the second revolution of the drum characters *p*, *n*, *t* and *s* are in registers **7, 10, 11** and **12** respectively, registers **8** and **9** being vacant since the characters *r* and *i* were printed during the first revolution. During the first half of the second revolution character groups A_3 and A_1 sweep columns **6** and **1** respectively, the counter accumulates characters *a* – *m* and comparators **1** and **2** compare the contents of shift registers **12** and **7** respectively. Since these registers contain only B group characters (i.e. in the latter half of the alphabet) no match is found and no printing occurs. However, during the second half revolution, while character group B_1 sweeps column **5**, the counter accumulates the B group characters and comparator **1** finds the character t in register **11**; accordingly, solenoid B_1 activates its associated hammer **28** and prints the character *t* in column **5**.

At the beginning of the third revolution the data has been shifted so that *p*, *n* and *s* are in registers **4, 7** and **9**, registers **10, 11** and **12** being vacant because the matter to be printed has been fully transmitted. During this revolution comparisons are made as hereinbefore described while groups A_3, B_1, A_2 and B_3 sweep columns **9, 8, 4** and **3**, respectively; no matches are found, and no printing therefore occurs. On the fourth revolution the data is shifted to place *p* in register **1** and *n* and *s* in registers **4** and **6**. During the second half revolution, while groups B_3 and B_2 sweep columns **6** and **1** respectively, matches are found by both comparators **2** and **3**. As a result, the characters p and s are printed in columns **1** and **6**, and the page contains the characters "*prits.*" Thereafter, the character *n* shifts to register **1** and, while group B_2 passes column **4** a match causes the final character to be printed to complete the word.

The logic system will vary depending upon the number of character groups, the arrangement thereof and other factors to provide the proper firing order. Normally it will also include circuitry for carriage return, which may continuously monitor register A to detect the code for carriage return, which in turn may be generated by the counter after sensing an appropriate number of drum revolutions. Upon detecting such a code, a signal is generated to activate the release arm **49**, to disengage the pin **31** from the shaft **14** and permit the spring **40** to return the carriage **25**. In addition, another detector may detect a line feed code at the input, and fire a paper advance solenoid (not shown) to permit printing of a subsequent line. Such circuitry should be appropriately designed to prevent

data flow when undesired, such as during carriage return, or to permit over-printing by delaying paper advance.

Although it is believed that the foregoing detailed description will enable those skilled in the art to readily practice the invention, perhaps it should be noted that the optimum overall dimensions for the type of character drum illustrated in FIGS. 1 – 3 are believed to be about 2.6 inches in diameter and 1.5 inches in width (axial length). These dimensions are thought to result in a weight/mass to volume ratio that is particularly desirable in a rotating drum of such configuration for a number of reasons, including the elimination of the need for an extensive and costly bearing set for absorption of hammer impact shock during printing. The drum impact surfaces are preferably plated with a hard metal such as chromium to enhance durability. However, an outstanding benefit attendant to the unique design features of the present printer, which minimize rotational speeds, "g" loadings and torques, is the potential for use of non-ferrous materials, which can often conveniently and inexpensively be molded.

Thus, it can be seen that the present invention attains the primary object thereof, namely the provision of a novel medium speed electronic printer that is relatively inexpensive to produce. Furthermore, the printer is capable of printing at least 30 characters per second, and of printing at the preferred and most desirable rates of 60 – 90 and 80 – 120 characters per second, respectively, thus overcoming limited throughput capability of prior art output devices and providing a printer that is especially suited for use in mini-computer systems. The invention provides a full character impact printer having, in addition to the foregoing advantages, the capability of producing a desirable final copy format, as well as providing a novel method of electronically printing at a medium rate, as is also an object of the invention.

Having thus described the invention, I claim:

1. In an electronic character printer, the combination comprising:

a. a frame having means thereon for positioning a web to be printed along a linear printing path;

b. a character drum mounted on said frame for concurrent movement along said linear path and rotation about an axis parallel thereto, said drum having a multiplicity of character elements arranged about the circumference thereof and along helical paths, said elements being divided into a plurality of discrete, axially offset character sets each comprised of a plurality of discrete, axially offset character groups each provided by a multiplicity of character elements, each of said character sets extending about substantially the entire circumference of said drum;

c. a multiplicity of impact members mounted on said frame for synchronous movement along said linear path with said character drum and equal in number to the total number of character groups cooperating therewith, each of said impact members being of a width substantially equal to the axial length encompassed by one of said character groups and being aligned therewith to permit contact to be effected between any character element thereof and the web, for printing during said concurrent movement and rotation;

d. means for continuously rotating said character drum;

e. means for moving said character drum and impact members along said linear path;

f. means for dynamically indicating the angular relationship of the character elements of each of said groups and said impact member associated therewith; and

g. means responsive to an electronic input signal representative of matter to be printed for actuating said impact members when a desired character for printing is aligned therewith, as indicated by said indicating means, said actuating means actuating said impact members independently of one another with the impact members cooperating with groups axially aligned along the length of said drum being actuated prior to actuation of impact members cooperating with groups spaced circumferentially therefrom.

2. The printer of claim 1 wherein said groups are substantially identical in the number and identity of characters; wherein the rates of rotation and linear movement are predetermined relative to the angle of said helical paths and the character group offset distance to cause the character elements of each of said groups to sweep past only $1/n$ of the number of columns to be printed on the web, where n represents the number of character sets; and wherein each of said groups extends incompletely about said drum circumference to provide circumferential spacing between the first and last character elements thereof.

3. The printer of claim 1 wherein a pair of said groups provides a single character set, said set thereby having two of said impact members associated therewith.

4. The printer of claim 3 wherein said character groups are arranged sequentially about the circumference of said drum, with the rates of rotation and linear movement being predetermined relative to the angle of said helical paths and the character group offset distance to cause the character elements of each of said sets to sweep past only $1/n$ of the total number of columns to be printed on the object, where n represents the number of character sets.

5. The printer of claim 4 wherein there are three of said character sets and six of said impact members.

6. The printer of claim 5 wherein the last character element of one of said groups and the first character element of another of said groups of its set and to which it is adjacent are axially offset but contiguous to avoid substantial spacing therebetween, and each of said groups occupies 180° of drum circumferential surface.

7. The printer of claim 3 wherein said character set contains 64 alphanumeric characters.

8. The printer of claim 1 additionally including means furnishing ink to the object at the locations of contact with said character elements.

9. In a printing method, the steps comprising:

a. positioning a web to be printed along a linear printing path;

b. providing a character drum having a multiplicity of character elements arranged about the circumference thereof and along helical paths, said elements being divided into a plurality of discrete, axially offset character sets each comprised of a plurality of discrete, axially offset character groups

each provided by a multiplicity of character elements, each of said character sets extending about substantially the entire circumference of said drum;

c. concurrently moving said character drum along said linear path while continuously rotating said drum about an axis parallel thereto,

d. moving a multiplicity of impact members synchronously with said drum along said linear path and with said object therebetween, each of said impact members cooperating with one of said groups and being of a width substantially equal to the axial length encompassed by one of said character groups and aligned therewith to permit contact to be effected between any character element thereof and said web;

e. dynamically detecting the relationship between the character elements of each of said groups and said impact member associated therewith and generating an electronic signal representative thereof;

f. generating an electronic input signal representative of matter to be printed;

g. comparing said detecting signal and said input signal; and

h. independently actuating said impact members in response to said signal comparison during said concurrent movement and rotation to effect contact of said web with said character elements to reproduce said matter on said web, said actuation during a single rotation of said drum being of the impact members cooperating with character groups axially aligned along the length of said drum prior to actuation of impact members cooperating with groups spaced circumferentially therefrom.

10. The method of claim **9** wherein said impact members are actuated at a rate to contact 60–90 of said character elements per second with said web.

11. The method of claim **9** wherein said impact members are actuated at a rate to contact 80–120 of said character elements per second with said web.

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