United States Patent

[11] **3,599,772**

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[45] Patented **Aug. 17, 1971**
[73] Assignee **The Singer Company**

[54] **SINUOUS FONT ARRANGEMENT FOR A PRINTING MEANS**
9 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** ..... **197/49,** 101/93 C
[51] **Int. Cl.** **B41j 1/32**
[50] **Field of Search** ..... 197/49, 55, 18; 101/93 C

[56] **References Cited**

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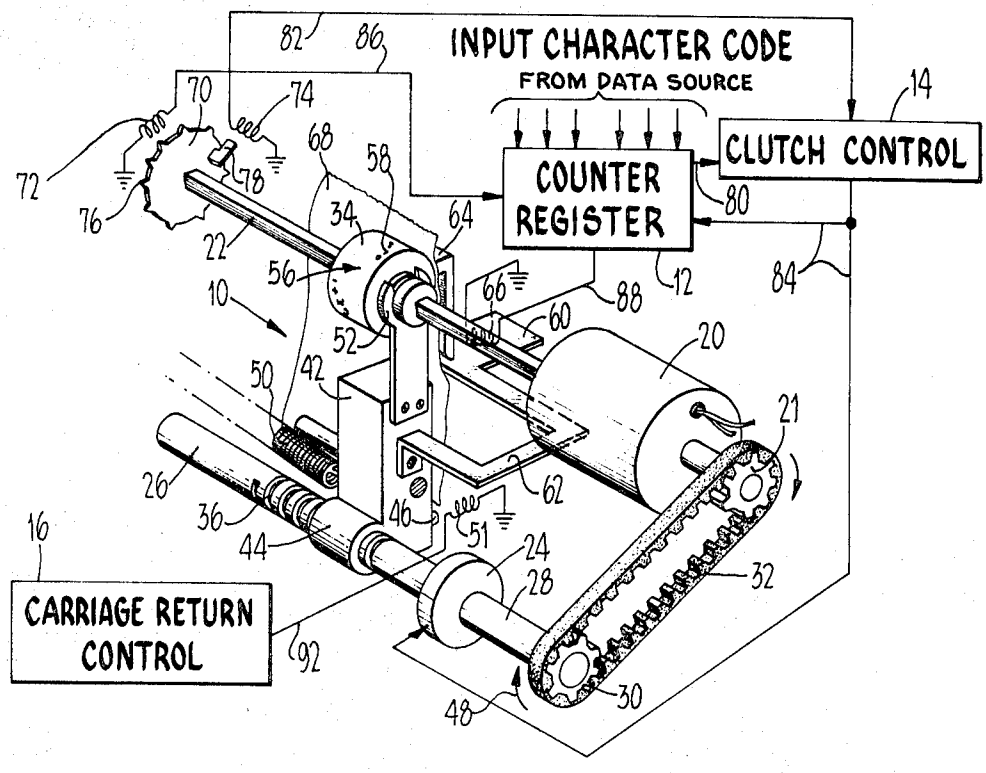
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ABSTRACT: A font wheel having a plurality of character types arranged in a sinuous pattern is mounted for continuous rotation about its axis and for intermittent translation along its axis adjacent a sheet of paper on which selected characters are to be printed in a row along the axial direction of translation. A one-revolution selectively operated clutch connects a motive power source to a drive screw for intermittently translating the font wheel along its rotation axis. A print hammer disposed behind the paper travels axially with the font wheel and is driven toward the paper and font wheel at selective times to cause printing of selected characters in response to input data and font wheel position signals.



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SHEET 1 OF 2

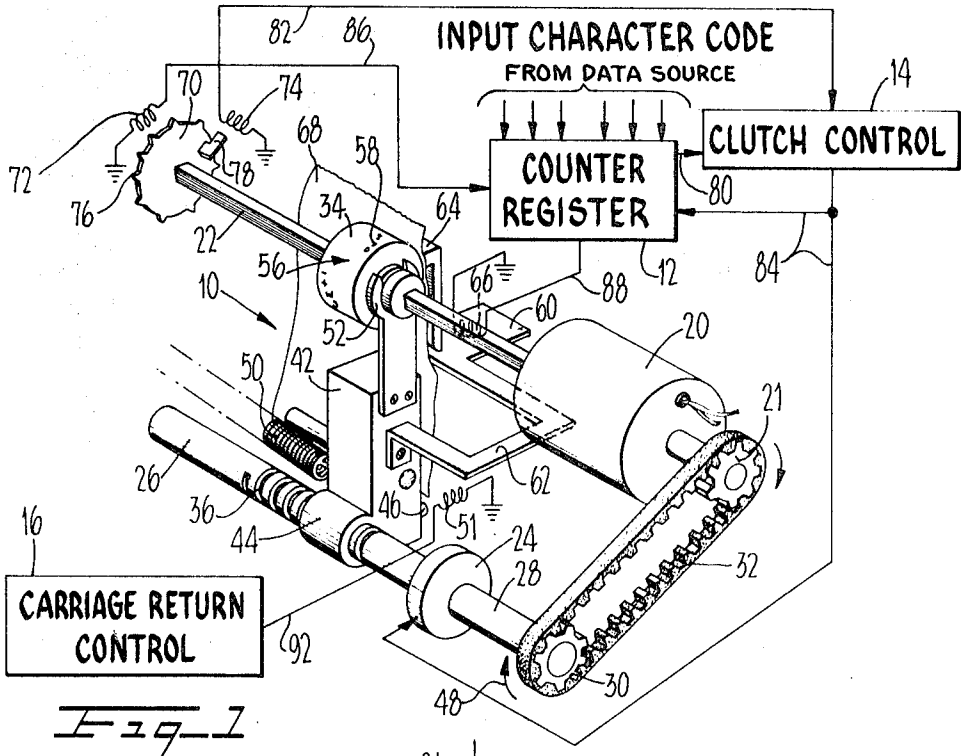


Fig. 1

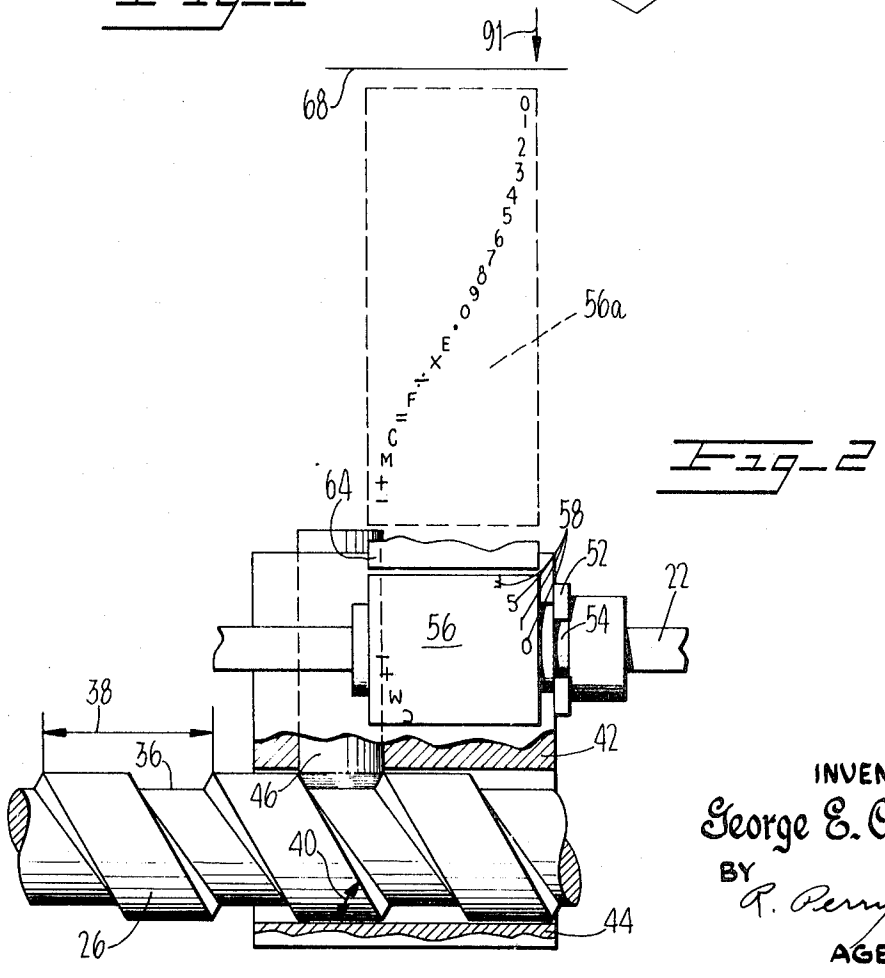


Fig. 2

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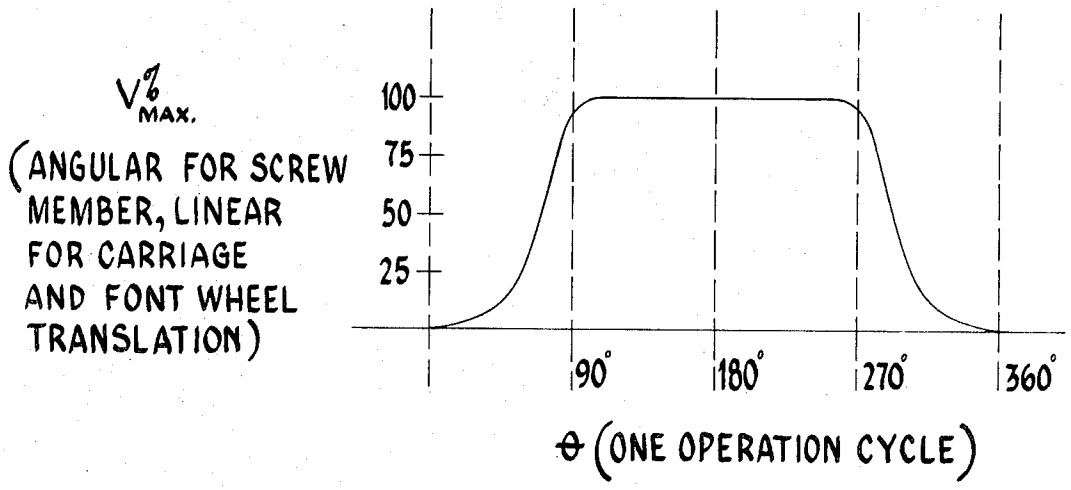

$V_{MAX.}^{\%}$
(ANGULAR FOR SCREW MEMBER, LINEAR FOR CARRIAGE AND FONT WHEEL TRANSLATION)
100
75
50
25
90°
180°
270°
360°
θ (ONE OPERATION CYCLE)

Fig. 3

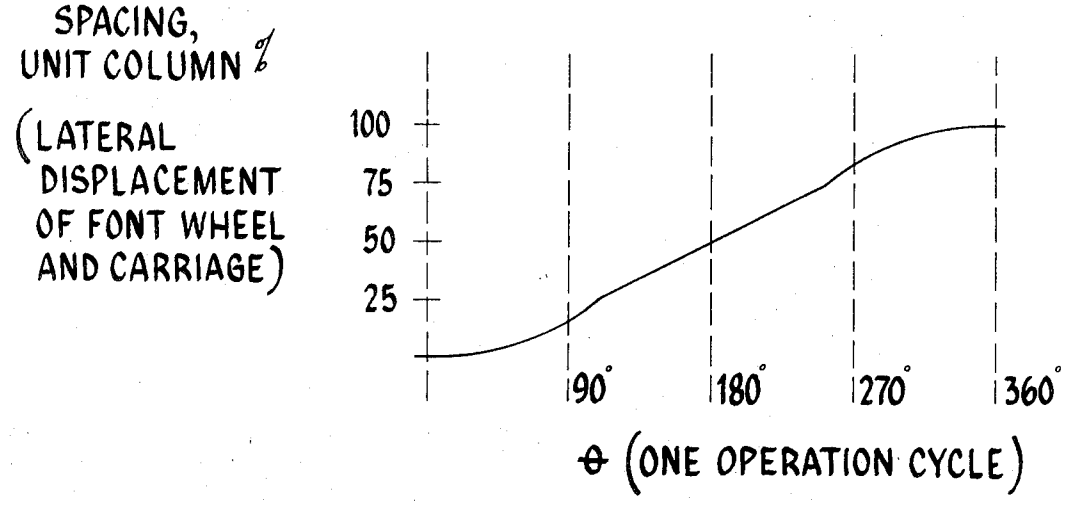

SPACING, UNIT COLUMN %
(LATERAL DISPLACEMENT OF FONT WHEEL AND CARRIAGE)
100
75
50
25
90°
180°
270°
360°
θ (ONE OPERATION CYCLE)

Fig. 4

SINUOUS FONT ARRANGEMENT FOR A PRINTING MEANS

BACKGROUND, FIELD OF INVENTION

This invention pertains to a high-speed printing system and more particularly concerns a font wheel for use in a constant character spacing printing system which receives data asynchronously.

BACKGROUND, PRIOR ART

Printing devices responsive to input data are useful in the mechanical and electronic data processing art as a means for providing permanent, easily readable records of data that is, has been, or is to be operated upon by the data processing mechanism.

With the advent of electronic data processors, or calculators, and high-speed electrical data signal generation and transmission, as found, for example, in high-speed paper tape and magnetic tape handling systems, and remote terminal devices, there has been a demand for devices which can transform electrical signal or codes into permanent meaningful human-readable form at very rapid rates. One form of device which is directed toward achieving these objectives is a high-speed printer that incorporates a font wheel having a plurality of character types arranged about its periphery in a one-turn helix pattern. The font wheel is continuously rotated about its axis, which axis is disposed parallel with the direction of the line or row area of a paper sheet on which printing is to occur. While the font wheel is continuously rotated about its axis, it is translated or moved axially along its axis in such a manner that for each one revolution of the font wheel, each character type is brought into printing position adjacent the same spot or location on the paper that is to receive a character impression (or no character impression in the event that a space is to appear at such location in the completed line). The translation of the font wheel axially along its axis is best achieved by means of a screw having a thread whose pitch is equal to the pitch of the helix pattern of the character types on the font wheel. One example of such a translating mechanism is shown and described in detail in U.S. Pat. No. 3,356,199 for "Printer Having Type Disk Rotatable in a Plane Parallel to the Printing Line," by L. P. Robinson, issued Dec. 5, 1967 and assigned to the same assignee as the present application. Another example is shown in U.S. application Ser. No. 650,501, filed June 30, 1967 by A. F. Marion et al. for "Inking Device" now U.S. Pat. No. 3,526,309 issued Sept. 1, 1970 and assigned to the same assignee as the present invention.

In the prior art, high-speed, on-the-fly printers having a continuously rotated, and continuously translated font wheel with character types arranged in one-turn pure helical pattern, each of the characters printed in adjacent columns or locations on the paper inherently, are spaced apart equally from each other. For example, each letter in a word is spaced from adjacent letters by equal amounts as measured from letter-center to letter-center. The same is true when printing a succession of numerals forming a multidigit number.

With the characters arranged in a continuous single turn pure helical pattern, input data must be supplied to the printing mechanism in synchronism with translational movement of the font wheel along its rotation axis. In other words, the data must be available at regular recurring time intervals.

However, in certain types of printing devices, the input data is not available at precise regular intervals. For example, in a manually operable keyboard, such as a typewriter, actuation of the keys of a human operator occurs in highly irregular time sequence, and thus coded data representative of the character keys struck manually is furnished in an irregular or asynchronous manner.

Therefore, some means must be provided for utilizing the advantages of the helical font arrangements on a continuously rotated font wheel in a printing device wherein input data is only available in an asynchronous manner.

SUMMARY

The present invention is achieved, in one embodiment, by providing a continuously rotatable but intermittently translatable font wheel having character types disposed thereon in a distorted arrangement; i.e., the character types extend in a sinuous arrangement.

A one-revolution clutch intermittently, when desired, couples a source of continuously energized rotative power to a helically grooved font wheel advancing means for spacing or translating the font wheel to the next adjacent printing location.

However, since the velocity of the print wheel is continuous in the angular direction, but varies in the lateral direction as it is accelerated and decelerated, the character types are arranged in a sinuous pattern about the circumference of the type wheel to compensate for the difference in lateral velocity and thus take advantage of a continuously rotatably, laterally moving font wheel in a printing apparatus wherein input data is available asynchronously.

It is therefore an object of the present invention to provide an improved printing apparatus.

Yet another object of the present invention is to provide an improved font wheel for an on-the-fly asynchronously operated printer.

The features of novelty that are considered characteristic of this invention are set forth with particularity in the appended claims. The organization and method of operation of the invention may best be understood from the following description when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a combined mechanical and electrical control illustration showing in simplified form a printer system of the present invention;

FIG. **2** is an illustration demonstrating the arrangement of character types on a font wheel according to the present invention;

FIG. **3** is an illustration of a typical lateral velocity graph or waveform of the font wheel of the present invention; and

FIG. **4** is an illustration demonstrating the lateral movement or displacement of the font wheel of the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. **1**, there is shown a high-speed, on-the-fly, asynchronous printing system which incorporates a mechanical unit **10**, plus electrical and/or electronic control means shown generally as counter/register unit **12**, clutch control **14**, and carriage return control unit **16**.

The mechanical unit **10** includes an electric motor **20** to which a font wheel mounting and rotating shaft **22** is operatively coupled at one end thereof for continuous rotation when the motor is energized. A toothed pulley **21** is operatively coupled to the opposite end of the motor for transmitting continuous rotative power to a one-revolution clutch **24**.

A carriage drive member or screw member **26** is suitably mounted for rotation about an axis parallel to the axis of shaft **22**. The right-hand end of screw member **26** is coupled to an output shaft of one-revolution clutch **24**. The input shaft **28** of the one-revolution clutch has attached thereto a toothed pulley **30**. Interconnecting means, shown as toothed belt **32** provides for continuous synchronous rotation of the input shaft **28** of the clutch with respect to rotation of the shaft **22**. The synchronous relationship between rotation of shaft **22** and input shaft **28** is a one-to-one relationship in this described embodiment. However, it will be apparent that other ratios may be provided that are compatible with the operating requirements of the remainder of the structural elements to be described below.

Upon triggering of the one-revolution clutch **24**, the screw member **26** will be caused to make one complete revolution. However, the angular speed of the screw member **26** during its one revolution varies, the best demonstrated in FIG. **3**, due to

the fact that it takes time to accelerate the screw from zero angular velocity to its maximum constant angular velocity, and to decelerate the screw from its maximum constant angular velocity back to zero velocity.

As demonstrated in FIG. 3, acceleration takes place from 0° to about 90° during one cycle of operation, constant velocity occurs from about 90° to about 270° of an operation cycle, and deceleration takes place from about 270° to 360° of the operation cycle. The varying angular velocity portions of the rotation of the screw member **26** effect a varying lateral velocity of the continuously rotatable-type font wheel **34** as described more fully below.

The screw member **26** is formed with a helical groove **36** having a predetermined pitch, which is shown by dimension arrow **38** (FIG. 2), helix angle or slope **40** (FIG. 2), and sense which is that of a right-handed screw.

A carriage **42** is suitably mounted for reciprocal movement in a path of travel parallel with the axes of rotation of shaft **22** and screw member **26**. The lower forward portion **44** of the carriage is in surrounding relation with a portion of the screw member **26**. A solenoid actuated carriage drive pin **46** is mounted in the lower portion of the carriage for reciprocal movement into and out of a portion of groove **36** that passes through the screw surrounding forward carriage portion **44**. It will be understood that with the screw member **26** rotating clockwise about its axis, as indicated by direction arrow **48**, and drive pin **46** engaged within groove **36**, the carriage **42** will be driven from left-to-right (as viewed in FIGS. **1** and **2**) which is the normal printing direction for the described embodiment.

A biasing means, such as a spring **50** normally biases the carriage **42** in the leftward direction. Thus, when the drive pin **46** is retracted from engagement with the groove **36** by energization of drive pin solenoid **51**, the carriage will be returned to its leftward or home position.

The shaft **22** is, in cross section, square shaped. A circular or disclike font wheel **34** is mounted on the shaft **22** such that the font wheel rotates the shaft and is slidable axially along the shaft.

A yokelike font wheel translating member **52** is secured to the carriage **42** and extends upward into engagement with a narrow groove **54** (shown best in FIG. **2**) on one side of the font wheel. Thus, as the carriage **42** is moved back and forth as described above, the yoke member acts on the font wheel to cause a like amount of movement or translation in a path of travel parallel with the axes of rotation of the shaft **22** and screw member **26**.

The radially outer periphery **56** of the font wheel **34** contains a plurality of character or printing types **58** spaced thereabout in a sinuous pattern, which will be described in more detail below, in connection with FIG. **2**.

A print hammer support platform **60** is disposed rearwardly (as viewed in FIG. **1**) of the font wheel **34** and is secured to the carriage **42** by appropriate means such as U-shaped bracket **62**, for movement with the carriage. A print hammer **64** and actuating solenoid **66** is mounted on the support platform. Upon electrical energization of the solenoid **66**, the print hammer **64** is caused to rapidly move forward toward a location on the periphery of the font wheel.

Ordinarily, a sheet of paper **68** is positioned between the font wheel **34** and the print hammer **64**. Thus, when the print hammer is energized, as mentioned above, it rapidly and firmly engages the rear side or surface of the paper and urges a small area of the front surface of the paper into firm engagement with a character type on the periphery of the font wheel. Ink contained on the character type (by means not shown here, but fully disclosed in the aforementioned U.S. application, Ser. No. 650,501) is thus transferred to the paper and a character is thus printed on the paper.

The particular character that is printed and its printing location on the paper will now be described. At the left end portion of the shaft **22**, there is secured a character timing or identification wheel **70** which rotates with the shaft **22** and, of course, rotates with the font wheel **34**. Sensor means, shown as inductance coils **72** and **74** cooperate with character identification means shown as teeth **76** and tab **78** to transmit a set of electrical signals to the counter/register unit **12** and clutch control unit **14**, which signals precisely define or identify the particular character type that is in printing position opposite the print hammer **64** as the shaft **22** is rotated. It will be apparent to one skilled in the art that there are various ways of identifying the character type on a rotational font wheel that is in printing position; for example, photoelectric sensors may be utilized in conjunction with a timing wheel. The toothed wheel **70** and inductance coils shown in FIG. **1** are illustrative only.

Sets of electrical character code signals or data indicative of the individual character to be printed in each printing position are furnished asynchronously from an input data source such as a typewriter keyboard (not shown) to the counter/register unit **12**. The counter/register unit **12** includes a set of data detection gates which will transmit a data received signal over a lead **80** to the clutch control unit **14**. The clutch control is conditioned by a data received signal on lead **80** to respond to the next indexing or home signal on a lead **82**. The indexing or home signal is generated as the index or home tab **78** passes by the associated inductance coil **74**. The clutch control responds to the presence of the above-mentioned signal on leads **80** and **82** by transmitting an electrical clutch operate and counter/register count-enable signal via a lead **84** to the one-revolution clutch **24** and the counter/register unit **12**.

The clutch **24** responds to the signal on lead **84** by causing power from continuously rotating pulley **30** to be coupled to screw member **26** for a period of time necessary to effect one revolution only of the screw member. The one-revolution of the screw member takes place with a velocity pattern described previously and shown in FIG. **3**. This one-revolution of the screw member effects lateral movement of the carriage **42** and axial movement of the font wheel **34** one column or print position to the right, as viewed in FIGS. **1** and **2**, with a velocity pattern like that described for the screw member and also shown in FIG. **3**. The font wheel is moved axially from left to right across the paper **68** by a distance equal to the pitch **38** of the screw member as the screw member makes one revolution, as described above.

The counter/register unit **12** is also conditioned by the aforementioned electrical signal on lead **84** for accepting and counting in a decreasing or increasing mode, as desired, as will be apparent to those skilled in the art to which the present invention pertains, the series of character type representative signals generated in inductance coil **72** and transmitted via lead **86**. When the counter/register is counted down (or up) to zero contents, an electrical character type print signal is generated in the counter/register unit and transmitted via lead **88** to the print hammer solenoid **66**. The pring hammer solenoid is energized, thereby driving the print hammer forward to press the paper **68** into firm rapid engagement with the one selected print character type **58** that is in printing position **91** (FIG. **2**) at the time.

A new set of character input data may then be furnished from the input data source at some later asynchronous time for printing the next character.

The character types **58** are disposed on the font wheel's periphery **56** in a modified helical arrangement best described as sinuous, as shown in FIG. **2**. In FIG. **2**, the periphery **56** of the font wheel is shown in dotted lines **56***a* as it would appear if it were "unrolled" and laid out flat. Then the observer is looking at the periphery in the direction radially outward from the center of the wheel; this is for the purpose of more readily showing the principles of the present invention.

The individual character types **58** are offset axially from adjacent character types by predetermined amounts not all equal. The arrangement or pattern of axial offsetting is in a sinuous manner to compensate for the variable velocity pattern or lateral translation of the font wheel as it is moved one column space during printing operation of each character.

Each of the character types **58** are spaced circumferentially from adjacent types by equal angles or distances. Thus, with the 20 character types shown by way of example in FIG. **2**, the character types **58** are each spaced 18° from adjacent character types. It will be apparent that any desired number of character types may be disposed about the circumference of the font wheel and spaced from adjacent types by the appropriate distance or angle.

However, as shown in FIG. **4**, the lateral displacement of the font wheel during rightward movement of one revolution (360°) of the font wheel is not a constant or straight-line function of the angular movement of the font wheel. For example, during the acceleration phase which extends from 0° to about 90°, the lateral displacement of the font wheel is not as great for a unit angular change in rotation of the font wheel as the lateral displacement that takes place per unit angular movement of the font wheel during the constant velocity lateral movement phase which extends from about 90° to about 270°. A like situation occurs in the deceleration phase which extends from about 270° to 360°. As shown in FIG. **4**, the chart or graph of the lateral displacement of the font wheel appears sinuous. Thus, it will be apparent that in order to provide that each character type **58** be located at the same printing position **91** during an entire single constant velocity rotation of the font wheel as it is moved laterally one column space **38** with a varying velocity as shown in FIG. **3**, the characters **58** must be arranged axially about the font wheel so as to compensate for such varying lateral displacement. Such compensating pattern or arrangement is sinuous as shown in FIG. **2** and such sinuous arrangement is directly related to the sinuous graph of FIG. **4**.

Thus, it will be understood that rotation of the font wheel **34** through 360° will result in placement of successive ones of the character types **58** at the same printing location **91**.

From the foregoing, it will be apparent that printing of the next character, defined by the next set of data signals received in counter/register **12**, will cause printing of such next successive character in a new printing location to the right of the former printing location. Such successive printing locations are, of course, spaced by distance equal to space **38**. When the extreme right-hand end of a printing line is reached, the carriage return control **16** recognizes such fact as, for example, by actuation of a microswitch (not shown) and generates a signal over lead **92**, thereby energizing solenoid **51**, pulling pin **46** out of engagement with helical groove **36** of screw member **26**, thus permitting the force of spring **50** to return the carriage **42** to the extreme left position. Further, advancing means may be included to move the paper **68** upwardly or downwardly, if desired, one printing line. When the carriage **42** returns to its leftmost position, the carriage return control appropriately recognizes such fact and deenergizes solenoid **51**, thereby permitting pin **46** to be once again engaged with the helical groove **36** of screw member **26**. Other appropriate means for returning the carriage may be utilized as will be apparent to those skilled in the art to which the present invention pertains.

From the foregoing description, it will be apparent that the present invention provides for printing of equally spaced characters by means of a continuously rotating font wheel having a varying velocity lateral movement where the information or data signals are available in an asynchronous or nonregular mode.

What I claim is:

1. An apparatus for printing characters on a surface of a print receiving medium, said apparatus comprising:

a font member having a substantially circular periphery and a plurality of character types disposed on said periphery, said font member being mounted for rotation about an axis, said types being equiangularly disposed from adjacent types about said axis;

means for continuously rotating said font member about said axis with a substantially constant angular velocity;

translating means for moving said font member axially along said axis a predetermined interval for each character to be printed with a compound velocity during each said interval, said compound velocity comprising an initial portion of increasing magnitude, an intermediate portion of substantially constant magnitude and a terminal portion of decreasing magnitude; and

control means for initiating operation of said translating means at the beginning of each said interval at a predetermined angular position of said font member;

the axial spacing of successive ones of said character types about said periphery of said font member being matched to the corresponding axial displacement of said font member per angular rotational displacement thereof so that each of said character types passes adjacent a predetermined point on said print receiving medium as said font wheel rotates and is moved axially during each said interval.

2. An apparatus according to claim **1** wherein there is further included first means for receiving a set of character indicative signals representative of selected ones of said character types on said font member; and

second means responsive to the receipt of a set of character indicative signals in said first means for initiating operation of said translating means at a predetermined angular position of said font member.

3. An apparatus according to claim **2** wherein said first means comprises a counter/register means for receiving a first set of character indicative signals at any time during rotation of said font member, said counter/register means generating a character received signal in response to receipt of said set of character indicative signals; and wherein said second means comprises means for generating a position indicative signal when said font member first rotates to said predetermined angular position subsequent to receipt of a set of character indicative signals in said counter/register means, and means responsive to the presence of both said character received signals and said position indicative signals for generating a translating means operating signal.

4. A printing apparatus according to claim **3** wherein there is further included third means for urging said print receiving medium and selective ones of said character types into printing engagement with each other while said font member is being rotated about said axis and moved axially;

said third means comprising means for generating a set of successive character-type representative signals as said font member rotates, successive ones of said character-type representative signals being indicative of an associated one of said character types of said font member being in operative printing position; and

means responsive to the occurrence of the character-type representative signal representing the character type on said font wheel that corresponds to the character represented by said first set of character indicative signals received in said counter/register means for effecting printing engagement between said print receiving medium and the character type in printing position.

5. The apparatus according to claim **1** wherein said translating means includes:

a screw means having a helical groove provided therein, said helical groove having a predetermined sense;

means for rotating said screw means in synchronism with rotation of said font member according to a predetermined ratio; and

means extending between said font member and said screw means for releasable engagement with said screw means, said releasable engagement means moving said font member in a first direction along said axis when in engagement with said screw means.

6. The apparatus of claim **5** wherein said means for rotating said screw includes a one revolution clutch.

7. The apparatus of claim **1** wherein said initial portion, said intermediate portion, and said terminal portion of said compound velocity each corresponds substantially to the 0°—90°, 90°—270°, and 270°—360° portion, respectively, of the rota-

tional cycle of said font member, relative to said predetermined angular position thereof.

8. The apparatus of claim 1 wherein the magnitude of said compound velocity at the beginning of said initial portion and at the end of said terminal portion is substantially zero.

9. The apparatus of claim 1 further including means for positioning said font member at an initial character print location prior to the operation of said translating means.