United States Patent

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[73] Assignee **The Singer Company**
Continuation of application Ser. No. 724,880, Apr. 29, 1968, now abandoned. This application July 22, 1970, Ser. No. 64,036

[54] **PRINTING MEANS WITH PLURAL HELICAL SETS OF TYPE**
7 Claims, 3 Drawing Figs.

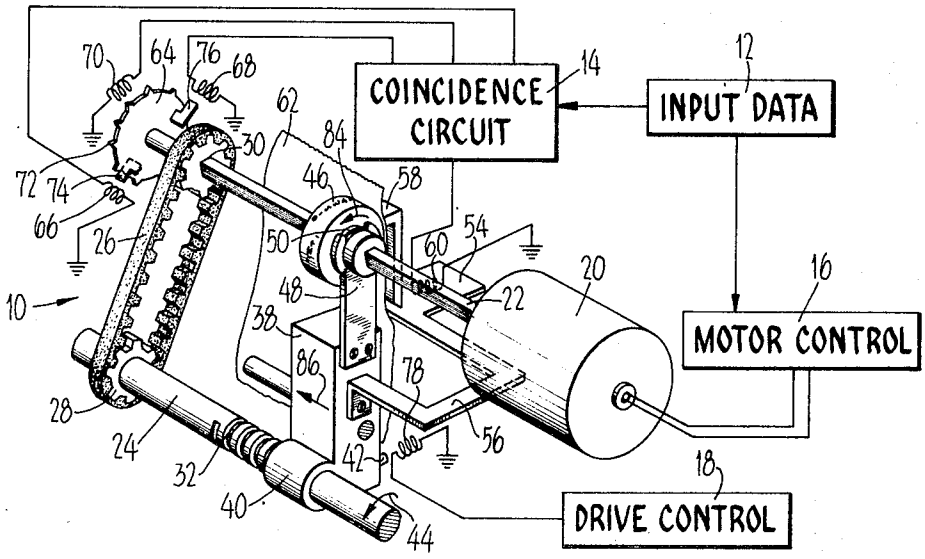
[52] **U.S. Cl.** **197/49,** 101/93
[51] **Int. Cl.** **B41j 1/32**
[50] **Field of Search** 197/49, 55; 101/93

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ABSTRACT: A font wheel having a plurality of character types arranged in predetermined groups of helixlike patterns is mounted for continuous rotation about its axis and for continuous 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 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. Horizontal spacing between adjacent printed characters is dependent upon groups of character types included in the selected character to be printed.



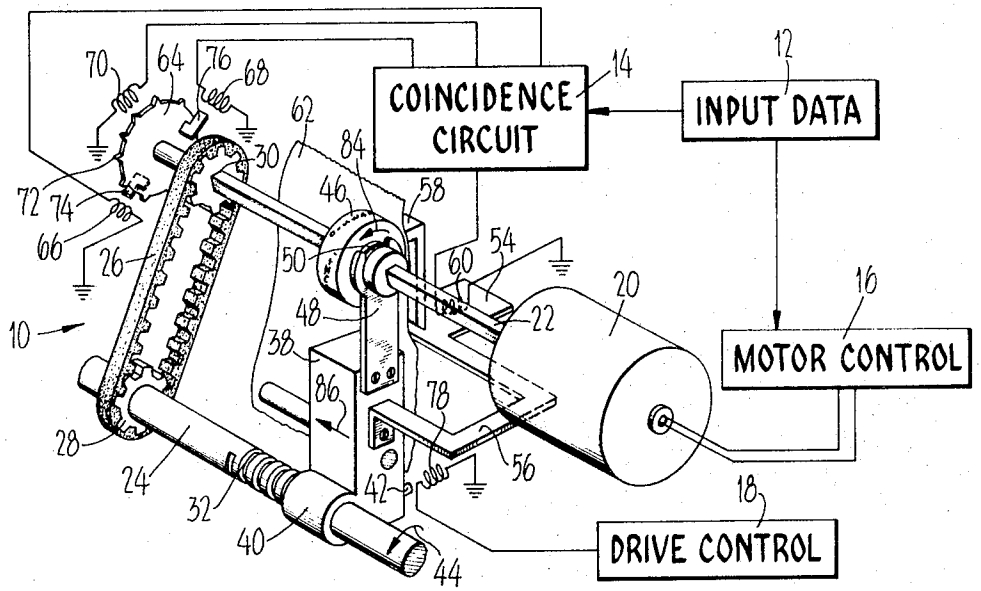


Fig_1

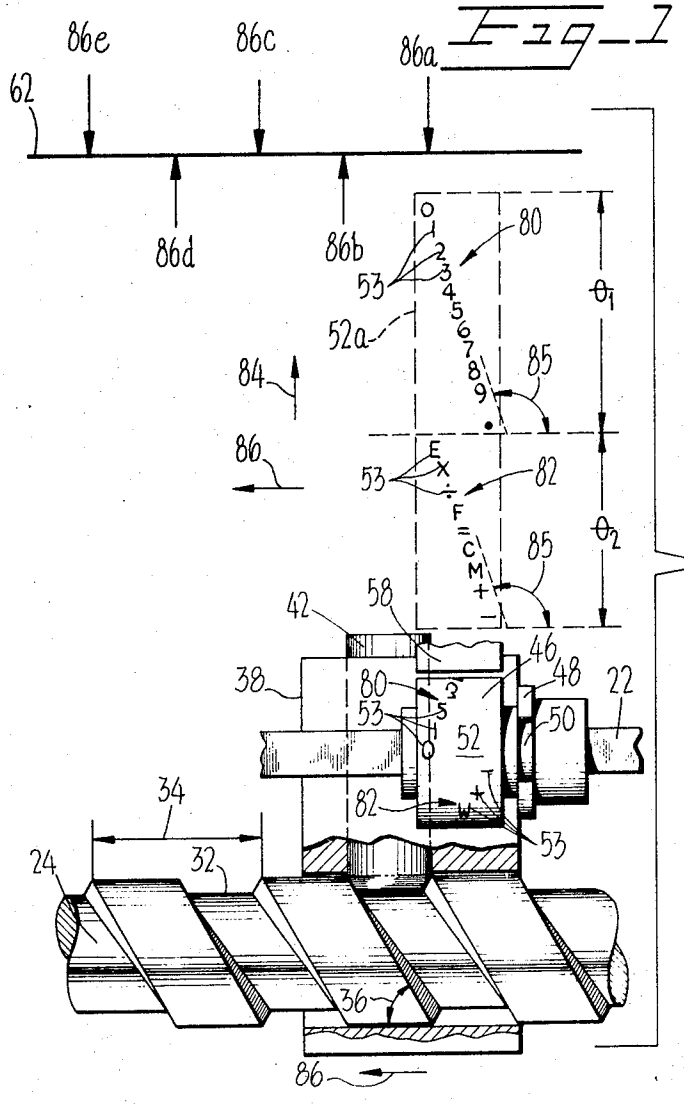


Fig_2

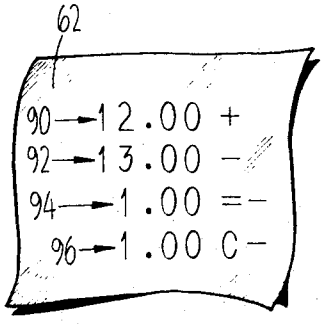


Fig_3

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PRINTING MEANS WITH PLURAL HELICAL SETS OF TYPE

This application is a continuation of Ser. No. 724,880 filed Apr. 29, 1968, and now abandoned.

BACKGROUND, FIELD OF INVENTION

This invention pertains to a high-speed printing system and more particularly concerns a font wheel for use in a variable character spacing printing system.

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, or has been, 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, there has been a demand for devices which can transform electrical signals 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., now U.S. Pat. No. 3,526,306, for Inking Device and assigned to the same assignee as the present invention.

The high-speed on-the-fly printer having character types arranged in a one-turn helix pattern is especially advantageous in that the major mechanical parts are in continuous motion during printing of a line on paper, thus obviating undesirable vibration, noise, and time-consuming start-stop motions.

However, in the prior art, high-speed, on-the-fly printers having a continuously rotated, and continuously translated font wheel with character types arranged in a continuous one-turn 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.

However, in the printout of some numbers involved in calculations with a calculator, it is desirable to print a symbol such as, for example "+," or "−," or "=" alongside the number, yet have the symbol offset so that the printed symbol is more apparent visually and in order to obviate confusion between a numeral and a symbol that resemble each other such as, for example, a "C" (Clear register symbol) and an "0" (aught numeral).

With the characters arranged in a continuous single-turn helical pattern, it is impossible to effect such desired symbol offsetting without incorporating elaborate mechanical elements for back-spacing or advancing the font wheel from its normal continuous translating movement.

SUMMARY

The present invention is achieved, in one embodiment, by providing a continuously rotatable and continuously translatable font wheel with two separate sets of character types in separate helix arrangements; i.e., one set of character types extends in a helixlike arrangement for only a part of the circumferential extent of the wheel, while the other set of character types extends about the periphery of the wheel in a helixlike pattern that is not coextensive with the helixlike pattern of the first set of character types but does have the same pitch angle as the helixlike pattern of the first set of character types.

The first set of character types includes all the numerals 0–9 and period (.), while the second set of character types includes function symbols usually deemed desirable in a calculator printout, such as, for example, "+," "−," "E" (error or overflow), "=," "×," "," etc.

With such an arrangement of character types, numerals can be printed with a predetermined center-to-center spacing. However, a symbol (character from the other set of characters) will be printed with a center-to-center spacing from adjacent printed numerals that is different from the center-to-center spacing between two adjacent printed numerals. In this manner, the printed symbols are more visually prominent on the sheet of paper. Further, with the character-type arrangement of the present invention, a more compact smaller font wheel results, thereby providing less mass to be rotated and translated, hence reducing the amount of power required to operate the printer as compared with prior printing devices.

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

Another object is to provide in a printing apparatus simple means for printing characters with variable character-to-character spacing.

Yet another object of the present invention is to provide an improved font wheel for an on-the-fly 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 control illustration showing in simplified form a printer system embodying 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 showing a typical printout of numerals and function symbols made with the printer system of FIG. 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. 1, there is shown a high-speed, on-the-fly, printing system which incorporates a mechanical unit **10**, plus electrical and/or electronic control means shown generally as input data unit **12**, coincidence circuit **14**, motor control unit **16**, and drive control unit **18**.

The mechanical unit **10** includes an electric motor **20** to which a font wheel mounting and rotating shaft **22** is operatively coupled for continuous rotation when the motor is energized.

A carriage drive member or screw member **24** is suitably mounted for rotation about an axis parallel to the axis of shaft **22**. Interconnecting means, shown as toothed belt **26** and toothed pulleys **28** and **30**, provide for synchronous rotation of the screw member **24** with respect to rotation of the shaft

22. The synchronous relationship between rotation of shaft 22 and screw member 24 is a 1:1 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. The screw member 24 is formed with a helical groove 32 having a predetermined pitch which is shown by dimension arrow 34 (FIG. 2), helix angle or slope 36 (FIG. 2), and sense which is that of a right-handed screw.

A carriage 38 is suitably mounted for reciprocal movement in a path of travel parallel with the axes of rotation of shaft 22 and screw member 24. The lower forward portion 40 of the carriage is in surrounding relation with a portion of the screw member 24. A solenoid-actuated carriage drive pin 42 is mounted in the lower portion of the carriage for reciprocal movement into and out of a portion of groove 32 that passes through the screw surrounding carriage portion 40. It will be understood that with the screw member 24 rotating counterclockwise about its axis, as indicated by direction arrow 44, engagement of drive pin 42 into groove 32 will cause the carriage 38 to be driven from right-to-left (as viewed in FIGS. 1 and 2) which is the normal printing direction.

A biasing means, such as a spring (not shown) normally biases the carriage 38 in the rightward direction. Thus, when the drive pin 42 is retracted from engagement with the groove 32, the carriage will be returned to its rightward or home position.

The longitudinal extent of shaft 22 is, in cross section, square shaped. A disclike font wheel 46 is mounted on the shaft 22 such that the font wheel rotates with the shaft and is slidable axially along the shaft.

A yokelike font wheel sliding member 48 is secured to the carriage 38 and extends upward into engagement with a narrow groove 50 on one side of the font wheel. Thus, as the carriage 38 is moved back and forth as described above, the yoke member acts on the font wheel to cause a like amount of movement in a path of travel parallel with the axes of rotation of the shaft 22 and screw member 24.

The radially outer periphery 52 of the font wheel 46 contains a plurality of character or printing types 53 spaced thereabout in patterns which will be described in more detail below.

A print hammer support platform 54 is disposed rearwardly (as viewed in FIG. 1) of the font wheel 46 and is secured to the carriage by appropriate means such as U-shaped bracket 56, for movement with the carriage. A print hammer 58 and actuating solenoid 60 is mounted on the carriage. Upon electrical energization of the solenoid 60, the print hammer 58 is caused to rapidly move forward toward a location on the periphery of the font wheel.

Ordinarily, a sheet of paper 62 is positioned between the font wheel 46 and the print hammer 58. 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 64 which rotates with the shaft 22 and, of course, rotates with the font wheel 46. A plurality of sensor means shown as inductance coils 66, 68, and 70 cooperate with character identification means shown as teeth 72 and tabs 74 and 76 to transmit a set of electrical signals to the coincidence circuit 14, which signals precisely define or identify the particular character type that is in printing position opposite the print hammer 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 72 and inductance coils shown in FIG. 1 are illustrative only.

Electrical signals indicative of the character to be printed in each printing position is furnished from the input data source 12 to the coincidence circuit 14. Thus, when the character-type identifying signals furnished from the sensor means match the character indicative signals from the input data source 12, the coincidence circuit 14 detects this fact and transmits an electrical signal to the print hammer solenoid 60, thereby causing printing of the desired character on the paper 62.

New data is then furnished from the input data source 12 as the character wheel 46 continues to rotate and advance to the left so that the next character will be printed to the left of the previously printed character.

In the preferred embodiment, an electrical signal is transmitted from the input data source 12 to the motor control 16 whenever it is desired to start a printing sequence. The motor 20 is thus energized and causes rotation of the shaft 22, which, in turn, causes synchronized rotation of font wheel 46 and screw member 24. The drive pin is normally disengaged from the groove 32 at the time the motor is turned on.

At some point in the first revolution of the screw member 24, the right-hand beginning point of the groove 32 will be in line or adjacent with the drive pin 42; sensor means (not shown but indicated by drive control 18) energizes a drive pin solenoid 78 which moves the drive pin into engagement with the groove 32 as best shown in FIG. 2. Thus, the font wheel 46 will be driven from right to left as it rotates.

Assuming that the screw member 24 is rotated at the same speed as the shaft 22 (a 1:1 gear ratio), one revolution of the screw member 24 (and thus one revolution of the font wheel) will cause the font wheel 46 to move from right to left by a distance equal to the pitch length 34 of the screw member 24. This pitch length 34 is and will hereafter be referred to as one unit column-to-column spacing. Thus, during each revolution of the screw member 24 (and font wheel 46), the font wheel will be advanced or translated axially through one unit column-to-column space.

The character types on the font wheel's periphery 52 are arranged into two groups or sets, the first set 80 comprising the numerals 0 through 9, plus the decimal point (.), and the second set 82 comprising the special symbol "E" (error or overflow), "×" (multiplication), "" (division), "F" (first number entered), "=" (equal or answer) "C" (Clear), "M" (contents of memory), "+" (addition), and "−" (subtraction) as best shown in FIG. 2. In FIG. 2, the periphery 52 of the font wheel is shown in dotted lines 52*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 comprising each set 80 and 82 are offset from adjacent character types of the set with respect to the axis of rotation of the font wheel by a predetermined amount. The arrangement or pattern of axial offsetting is in the manner of a helix having a sense (left-hand screw sense) opposite to the sense of the groove 32 (a right-hand screw sense) of the screw member 24 and having the same pitch, if extended for a full turn, as the pitch 34 of the screw member. This is additionally illustrated in FIG. 2 wherein the helix angle 85 of the helical pattern of character sets 80 and 82 is the supplement of the helix angle 36 of screw member 32.

Rotation of the font wheel in the counterclockwise direction results in movement of the character types past or adjacent the paper 62 in the printing location (print hammer position) in the direction of arrow 84, while at the same time, the print wheel is moved axially in the direction of arrow 86.

Thus, it will be understood that rotation of the font wheel 46 through an angle that includes each character type of the first

set 80 will result in placement of successive ones of the first set 80's character types at the same printing location 86a, with respect to the paper.

It can be further understood that completing one revolution of the font wheel 46 will result in placement of the first character type (the "0" character type) at a succeeding printing location 86c. Then rotation of the font wheel through the angle θ_1 will result in placement of successive ones of the first set 80's character types at the same succeeding printing location 86c. It will be noted that the distance between successive printing locations associated with the first set 80 is equal to the pitch 34 of screw member 24 and such printing locations are predetermined by the axial position of the font wheel 46 at the time the first character type of the first set 80 is first in printing position adjacent the paper when the printing sequence begins.

It is shown in FIG. 2 that the helixlike pattern of the second set 82 of character types is not coextensive with the helixlike pattern of the first set 80; instead, the helixlike pattern of the second set is axially offset from the first set in the direction of axial movement of the font wheel. It can be understood that the last character type of the first set 80 (here the decimal point) is moved past the first printing location 86a, the first character type of the second set 82 (here the symbol "E") will be adjacent the paper, and opposite the print hammer 58, at a printing location 86b. Then, as the font wheel rotates through the angle θ_2, all of the character types of the second set will be moved past or adjacent the printing location 86b. It can further be understood that when the font wheel is rotated through one revolution as measured from the first character type of the second set 82 (here the symbol "E") being adjacent the paper at printing location 86b, the first symbol ('-'E") of the second set will be at printing location 86d. The distance between printing locations 86b and 86d is the same as the distance between printing locations 86a and 86c and is, of course, equal to the pitch 34 of the screw member 24.

It can be understood from FIG. 2 that the printing location of a character type from the second set 82 is spaced from adjacent printing locations for character types of the first set by distance less than the aforementioned one unit column-to-column spacing (pitch distance 34). For example, from the above-described structure and operation, if the distance from printing location 86b to printing location 86a is equal to the axial distance from the center of character "E" and the character "." (decimal point), while the distance from printing location 86b to printing location 86c is the axial distance from the center of character "—" to the center of character "0.

From the above, it can be appreciated that characters from the first set may be printed adjacent to each other with normal one unit column-to-column spacing, while characters of the second set may be printed adjacent each other with the same one unit column-to-column spacing, and characters from different sets may be printed adjacent each other with less than normal one unit column-to-column spacing or with more than one unit column-to-column spacing which is not an integral multiple of the normal one unit column-to-column spacing. 0."

As shown in FIG. 3, a typical subtraction problem printout on paper 62 is shown followed by the printout of a clear operation as performed in a calculator utilizing the present invention. At the top portion of the paper 62 in FIG. 3, there is shown a minuend 90 with a plus symbol (+) printed to the right of the number. It is to be noted that the plus symbol (+) is displaced to the right of the minuend by less than normal one unit column-to-column spacing but is not spaced a full one unit column-to-column space from the number.

The same holds true for the minus symbol (−) of the subtrahend 92.

The answer, difference, or remainder 94 is indicated as an arithmetic answer by the equal symbol (=) appearing to the right of the answer number and spaced from the answer number by the same spacing as that of the plus (+) and minus (−) symbols. However, it is to be noted that since the absolute value of the subtrahend is, in this example, greater than the absolute value of the minuend, the answer has a minus or negative value. This minus value of the answer is indicated by the minus symbol (−) to the right of the equal symbol (=). But, the minus symbol (−) and the equal symbol (=) are spaced from each other by the normal one unit column-to-column spacing.

Directly below the answer 94 is the typical printout 96 that results when the calculator's arithmetic register is cleared. The clear printout is the number that was in the arithmetic register just prior to clearing. The printout 96 is indicated to be the result of a clear operation, by the clear symbol (C) appearing to the right of the number and spaced from the number in the same manner as the plus symbol (+), the minus symbol (−), and the equal symbol (=). When the number in the arithmetic register is a negative number, the minus symbol (−) is printed to the right of the clear symbol (C) and spaced therefrom by the normal one unit column-to-column spacing. It can be seen from FIG. 3 that printing the symbol "C" in a position offset from the adjacent numeral "0" results in less confusion in reading the printout.

There has thus been shown and described a printing system utilizing a novel font wheel for providing variable character-to-character spacing without complex spacing mechanisms in a simple rapidly operated manner. From the above, it can be understood that by having two sets of character types in different helix arrangements the width of the font wheel is reduced to one-half what it would be if all the character types were on a single one-turn helix pattern. Such a reduced width font wheel requires less power to rotate.

While the principles of the invention have been made clear in the illustrative embodiments, there will be obvious to those skilled in the art, many modifications in structure, arrangement, proportions, the elements, materials, and components, used in the practice of the invention, and otherwise, which are adapted for specific environments and operating requirements, without departing from these principles. The appended claims are therefore intended to cover and embrace any such modifications within the limits only of the true spirit and scope of the invention.

What is claimed is:

1. In combination:

a cylindrical member having a substantially circular peripheral surface, said member being rotatable about the body axis of said cylinder;

a first set of character types disposed on said peripheral surface in a first pattern defined with respect to said axis by one-half turn of a first helix about said axis;

a second set of character types disposed on said peripheral surface in a second pattern defined with respect to said axis by one-half turn of a second helix about said axis;

said first pattern having a first end disposed at a first circumferential location and a first axial location with respect to the axis of rotation of said member, said first pattern having a second end disposed at a second circumferential location and a second axial location with respect to the axis of rotation of said member, said first and second circumferential locations of said first end and said second end, respectively, being circumferentially spaced from each other by about one-half turn about the axis of rotation of said member;

said second pattern having a first end disposed at a first circumferential location and a first axial location with respect to the axis of rotation of said member different from said first end of said first pattern, said second pattern having a second end disposed at a second circumferential location and a second axial location with respect to the axis of rotation of said member, said first and second circumferential locations of said first end and said second end, respectively, of said second pattern being circumferentially spaced from each other by about one-half turn about the axis of rotation of said member;

said first ends of said first and second patterns being circumferentially spaced from each other by about one-half turn about the axis of rotation of said member;

said second ends of said first and second patterns being circumferentially spaced from each other by about one-half turn about the axis of rotation of said member;

said first end and said second end of both said first pattern and said second pattern being axially spaced from each other with respect to the axis of rotation of said member.

2. The combination according to claim 1 wherein each of said helix patterns have the same helix angle.

3. An apparatus for printing characters on the surface of a sheet of paper, said apparatus comprising the combination of claim 1 and further including;

means for continuously rotating said member about said axis;

said axis being substantially parallel with the surface of the paper to be printed;

means for moving said member in a path of travel along said axis while said member is rotated about said axis;

means for urging said paper and selective ones of said character types into printing engagement with each other while said member is being rotated about said axis and moved along said axis.

4. The apparatus according to claim 3 wherein said first set of character types include types indicative of the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9; and wherein said second set of character types include types indicative of alphabetic characters.

5. The apparatus according to claim 3 wherein said means for moving said member along said axis includes;

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

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

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

6. The apparatus according to claim 5 wherein said first and second helix patterns have the same predetermined sense, opposite to the sense of said predetermined sense of said helical screw means groove.

7. The apparatus according to claim 5 wherein said first helix pattern, said second helix pattern, and said screw means groove have the same acute helix angle.

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