Nov. 17, 1964 C. F. WEST ETAL 3,157,115

PRINTING MECHANISM

Filed Dec. 3, 1962 2 Sheets-Sheet 1

FIG. 3

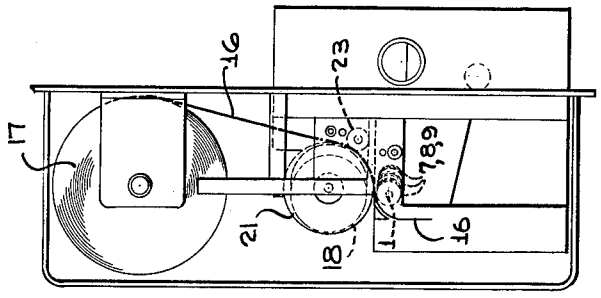


FIG. 2

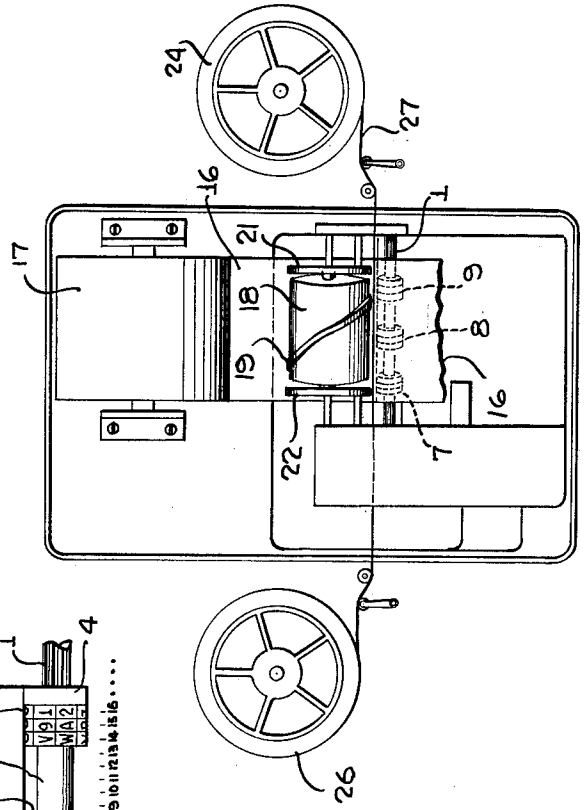
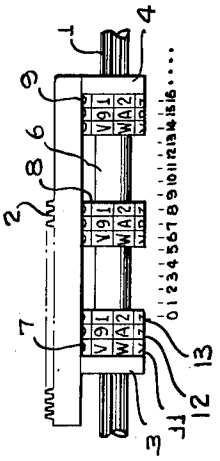


FIG. 1



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FIG. 4

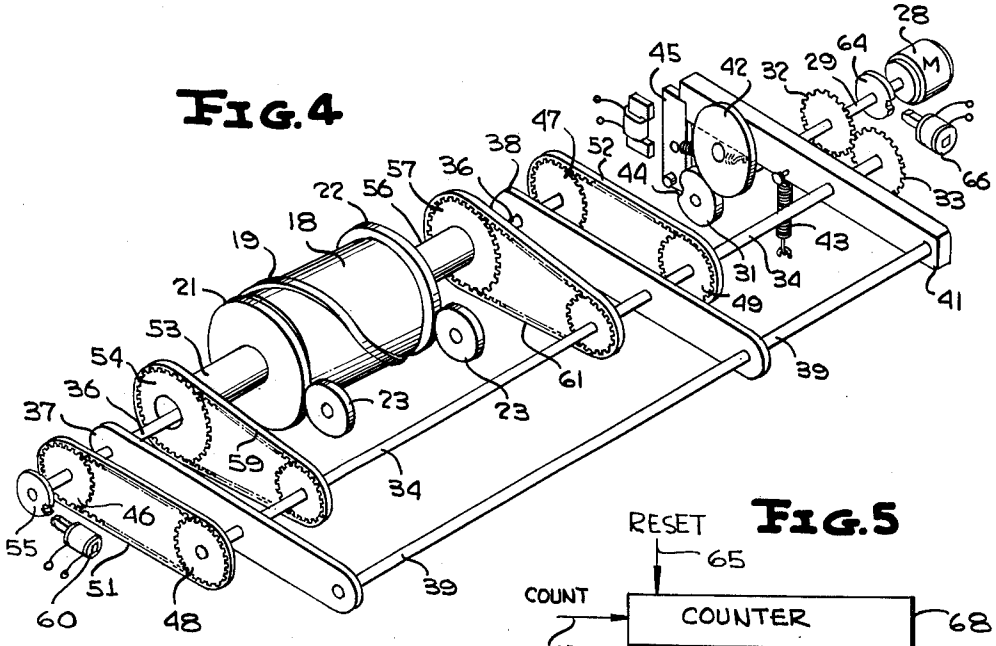


FIG. 5

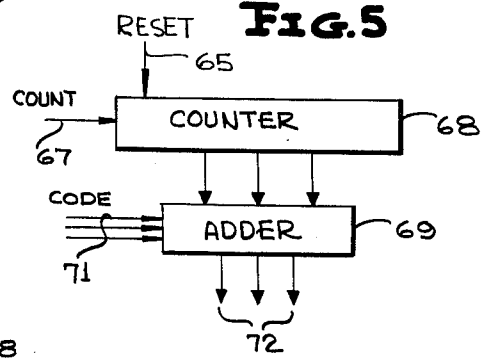


FIG. 6

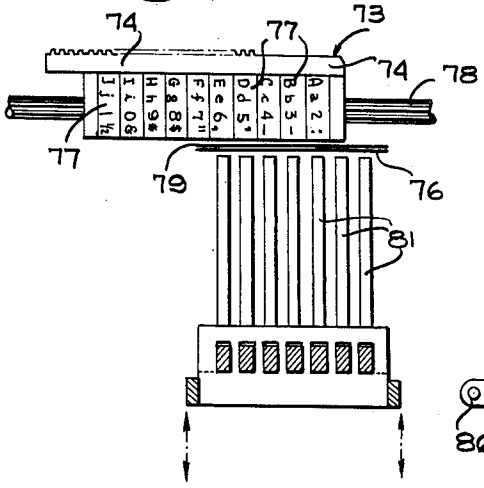
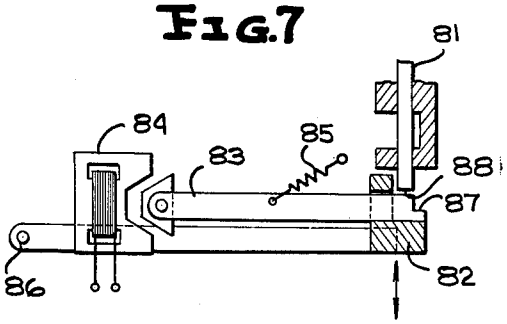


FIG. 7



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United States Patent Office 3,157,115
Patented Nov. 17, 1964

3,157,115

PRINTING MECHANISM

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Filed Dec. 3, 1962, Ser. No. 242,853
11 Claims. (Cl. 101—93)

The present invention relates to printing mechanisms and more particularly to a mechanism for printing multiple columns or lines of information.

In recent years, it has become common practice to record instrumentation data in columnar form by means of columnar tabulators which print in fifteen to twenty adjacent columns. Due to inherent speed limitations of the present columnar printers, simultaneous readings taken from instruments or other sources of information are normally transmitted in parallel to the printer for parallel recording. Such parallel transmission and recording involves expensive and bulky cabling as well as repetitive volumes of electronic control circuits.

In accordance with the present invention, there is provided a columnar printer which can accept serial data and print this data character-by-character at high speeds in the various columns selected. Although the concept is not restricted to high speed printing, the apparatus is capable of printing at speeds of 100 characters per second and therefore may record twenty columns of data five times each second.

The apparatus of the present invention depends upon the availability of a long-life, printing mechanism which can position a print drum or matrix in both rotation and translation at unusually high speeds. Such a device is available in the form of the mechanism disclosed in the co-pending patent application of John H. MacNeill, James E. Bellinger, Jr. and Thomas G. Holmes, Serial No. 116,524, filed June 12, 1961 for Medium Speed Serial Printer, now U.S. Patent No. 3,089,413, and assigned to the same assignee as the present invention. The application discloses a mechanism for positioning the print drum to one of eight positions in both rotation and translation for selecting and printing one of 64 characters. The apparatus is useful in any situation where a continuous single line of printing is desired. In order to achieve both translation and rotation of the print drum, the drum is axially slidable on a splined shaft. Rotation of the shaft produces rotation of the drum. A rack gear, associated with a pinion, is secured to the drum so that upon rotation of the pinion the drum is translated along the splined shaft. A three-bit binary code is employed to control rotation of the drum and a corresponding three-bit code is employed to control translation of the drum along the splined shaft. The mechanisms for producing this movement, as previously indicated, form the subject matter of the aforesaid application and are pertinent herein only to the extent that they disclose a type of mechanism capable of producing the movement of a drum at the speeds which are contemplated herein. Other mechanisms which are capable of producing the same type of control on a drum mechanism may be employed in the apparatus forming the subject matter of the present invention.

The mechanisms described above are basically strip printers in that they are employed to print a single line of information along a continuous strip. The purpose

of the apparatus of the present invention is to convert a mechanism of this type into a columnar, line, or multiple-line printer. Basic to either embodiment of the invention to be described herein is the ability to cause a printing hammer or its equivalent, to be at the proper location to produce printing in the selected column or line. Several apparatus for achieving this result are described subsequently and employ in one instance a rotating drum having a raised helix serving as the print hammer and in a second a plurality of aligned hammers selectively actuated by an interposer arrangement.

In accordance with a first embodiment of the present invention, there is provided a columnar printer capable of operating at 100 characters per second. The basic apparatus may provide from eight to twenty-four symbols in from twenty-four to twenty-two columns, respectively. The type drum is divided into three, equally-spaced, coaxial, drum elements, each element containing the same character information. The drum elements are secured one to the other so as to be both translated and rotated as a unit. Each drum element is provided with eight, circumferentially-spaced faces so that a three bit code is required to produce positioning in the rotational sense. The coded information supplied to the code magnets to effect rotation of the drum is unaltered by the system of the present invention. The information supplied to the code magnets for producing translation of the drum elements is altered by a number equal to the position of the column in which the particular character is to be printed relative to the, for instance, lefthandmost column of the apparatus. Thus, if it is desired to have a first drum element print in the zero (left hand) column, the translation code received is supplied unaltered to the code magnets. The second unit of information received has a "one" added thereto so that the "home" position of the drum, in the translatory sense, is shifted one position to the right. The print hammer is also shifted to this new position by the means previously described. Generation of the column shift numeral is achieved by adding one to a counter after each printing operation. The count thus stored is added to the incoming code in a suitable electronic adder before application to the code magnets. In the specific example under consideration, the counter has a maximum count equal to the number of characters about each band of the drum; that is, 8. Upon the counter receiving its 8th input pulse, it reverts to zero and nothing is added to the character code. The original or "home" position of the drum is re-established but the print hammer has now moved to the region of the second drum element, so that printing occurs in the 8th column. As printing proceeds printing is transferred to the third drum element and subsequently is transferred to the second drum element and subsequently is transferred back to the first drum element as translation across the page is completed.

It is apparent that paper feed and ribbon feed mechanisms must be provided, the ribbon feed mechanism being completely conventional and the paper feed mechanism being also a conventional ratchet feed, or, as will be indicated subsequently, a slow speed pinch roller feed. In the latter, the print drum is slightly skewed relative to the paper, which permits a continuous but slow movement of the paper to produce a straight line of printing across the paper. Such an arrangement permits slow and continuous paper movement, and is far superior to

an arrangement where the paper must be rapidly moved an entire line between printing of successive lines.

The apparatus described above permits printing in 24 columns but does not require the drum to be translated more than 8 columns. This is achieved by employing three identical drum elements and shifting the home position of the drum through a predetermined count. By adding an additional band to each drum element, the number of characters which may be printed is increased by 8 and the number of columns in which printing may occur is decreased by one. Each additional band adds 8 characters and decreases the number of columns by 1.

A multiple line strip printer may also be provided in accordance with the present invention. Shifting of the "home" position of the drum is again employed but now line-by-line. Specifically, drum translation is vertical to the direction of movement of the strip of paper upon which printing is to occur. The characters in a single column are printed, one in each line, successively. The paper is then shifted one line or character space and printing again occurs on each successive line. This procedure continues until the entire message is printed. In order to achieve printing in this manner, the entire message is received and properly sorted so that the characters can be presented to the apparatus in the appropriate order. The concept of adding the count of one for each character printed either may be again carried over so that the home position of the drum is shifted down one line each time a character is printed until the last line to be accommodated has a character applied thereto, at which time the counter overflows, returns to its zero count and the drum returns to its home zero position; or the drum's home position may be supplied to the adder concurrently with delivery of the code for the character to be printed.

It is an object of the present invention to provide a printing mechanism employing a strip printer modified to provide either multiple column or multiple line printing.

It is another object of the present invention to provide a relatively high speed columnar or multiple line printer utilizing a single character positioning mechanism.

It is yet another object of the present invention to provide a relatively high speed columnar printing mechanism which is long lived, rugged and in which the number of characters available may be increased by multiplies of 8 without materially affecting the number of columns available for printing.

It is still another object of the present invention to provide a columnar, line, or multiple line printer employing a system for shifting the home position of a printing drum to correspond with the next column or line to be printed and to synchronously shift a print hammer with the shift of the home position.

It is an object of the present invention to provide a feed paper for a columnar printer in which the paper is fed at slow speed during printing of each character and the print drum is skewed with respect to the paper so that the lines are straight across the paper.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of several specific embodiments thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a front view of the printing drum employed in one embodiment of the present invention;

FIGURE 2 is a front view of the printing mechanism of the present invention;

FIGURE 3 is a side view of the apparatus of FIGURE 2;

FIGURE 4 is a perspective view of the drive mechanism for the paper feed, hammer advance and hammer actuating elements of the present invention;

FIGURE 5 is a schematic block diagram of a portion of the electrical control apparatus of the invention;

FIGURE 6 is a view in elevation of the print drum and hammer mechanism of a second embodiment of the invention; and

FIGURE 7 is a side view of the hammer control mechanism employed with the apparatus of FIGURE 6.

Referring specifically to FIGURE 1 of the accompanying drawings, there is illustrated a drum mechanism utilized in the apparatus of the present invention. The drum mechanism is mounted on a spline shaft 1 adapted to be rotated in accordance with information to be printed by the mechanism of the invention. The mechanism is further provided with a rack gear 2 adapted to be translated parallel to the axis of the shaft 1 also in accordance with the material to be printed. The rack gear has two downwardly depending arms 3 and 4 disposed about the shaft 1 but not engaged therewith. Apertures in the members 3 and 4 receive the shaft 1 and are sufficiently large not to interfere with or be affected by rotation of the shaft. Positioned between the arms 3 and 4 is an interiorly splined spool 6 which engages the splines of shaft 1 and is translated by translatory movement of the arms 3 and 4 and is rotated by the shaft 1. Rigidly mounted on the spool 6 are three drum elements 7, 8 and 9. In the specific arrangement illustrated, each drum element 7, 8 and 9 constitutes 3 bands of characters 11, 12 and 13 with eight characters in each band.

In FIGURE 1, disposed below the physical arrangement described above are the numbers zero through 16 indicating 17 of the 22 columns in which printed information may be displayed by operation of the apparatus. Normally, the so-called zero column, which is the first lefthand column, is disposed below or in alignment with the band 13 of the drum element 7. The corresponding band 13 of the drum element 8 is aligned with the eight column and the band 13 of the drum element 9 is aligned with the 16 column. Any one of the eight different characters on the band 13 of the head element 7 may be displayed in the columns zero through 7, while any of the characters in the band 13 of the drum element 8 may be displayed in the columns 8 through 15 and so on. Considering for the moment only one band per drum element, (band 13), no code is required for movement of the drum element relative to the selected column although the drum element must be moved to accomplish printing in the various columns. A code is required to control the rotation of the shaft 1 so that the proper one of eight facets on the drum element 7 is presented to the zero column. After a printing operation has occurred in the zero column, the home position of the drum elements is shifted right so that the band 13 now has its home position over the one column. After that printing operation, the band 13 is again indexed so that its home position is over column 2 and so on until the band has been positioned over all eight columns available thereto. Thereafter, printing is taken up by the drum element 8 and after it has traversed its eight allowable columns the drum element 9 takes over and prints the remaining columns provided.

The system described has been based on the assumption that any particular drum head is employed in a maximum of eight columns. This is not essential to the operation of the system but it is convenient for purposes of explanation. The method of operation with three bands per head as illustrated in FIGURE 1 is now considered. In such an arrangement, the band containing the character to be printed is selected by a three bit binary code. Indexing of the drum elements so that their home positions are shifted to the various columns in sequence is accomplished by adding to the code for selecting the band 11, 12 or 13 a number indicating the column in which the information is to be printed. For instance, and reference is made to the table below, if printing is to occur in column 0, the column code is zero and if the symbol code is also zero; that is, the printed character appears in the band 13, then a code indicating the binary number zero is applied to the control mechanism of the rack gear 2.

If on the other hand, the information is to be printed in the second column which has a column code 1, and the symbol code is again 0; that is, the character to be printed is in the band 13, then the code supplied to control mechanisms is a binary 1. Continuing, if the symbol to be printed appears in band 13 and printing is to occur in the fifth column, the column code is 100 and the code fed to the control mechanism is 100 so that the rack gear is indexed four print positions or column positions to the right as viewed in FIGURE 1. The mechanism for acquiring the column indexing information will be described in more detail subsequently. If now the symbol to be printed is in band 12; the symbol code is one and to that must be added the column code to produce the printed code.

TABLE

Column Code	Symbol Code	Printing Code
0	0	0
0	1	1
0	10	10
1	0	1
1	1	10
1	10	11
10	0	10
10	1	11
10	10	100
100	0	100
111	1	000
111	10	001

As previously indicated, an eight stage counter is employed to record the column in which printing is occurring. When the column code plus the symbol code exceed the count of seven, the counter returns to zero and the machine code is therefore a zero. Referring specifically to the case where the symbol code is 1 and the column code is 7, this indicating the eighth column or the column indicated by the numeral 7 in FIGURE 1, the addition of the two codes produces a count of eight, which in the eight count binary counter is represented by the count of zero. Thus, the machine code is a zero and the entire mechanism is indexed to the home position with the band 13 of the column 7 over the zero column. At this time, however, the band 12 of the drum element 8 is positioned over the column 7 and the proper printing symbol is printed since the symbol code 1 indicates a desire to print a character in the band 12 regardless of which drum is employed. A similar occurrence takes place when the symbol to be printed is in the band 11 of the head element 7, for instance. The symbol code for the band 11 is a binary 2 and if the column in which printing is to occur is the sixth or seventh the counter overflows and returns to a zero or a one count. If the count is zero which indicates the sixth column, then the drum element 8 has its band 11 positioned over the column 6 and proper printing occurs. Similarly, if the column code was 7 then all of the heads are indexed one position to the right which places the band 8 of the drum element 11 over the column 7 and proper printing again occurs. The same interchange occurs relative to the drum elements 8 and 9. It is essential, of course, that the print hammer at all times be properly indexed relative to the column to be printed. This matter will be discussed subsequently.

The number of symbols that may be printed with any particular arrangement is limited by the number of facets provided on a particular drum element. If a drum element has only a single band and eight facets then only eight symbols may be printed in twenty-four different columns. If two bands are employed, sixteen characters may be printed but printing can occur in only twenty-three different columns and so on. In the particular arrangement illustrated, three bands are employed which

provide printing of twenty-four characters in twenty-two columns. It will be noted that, in effect, the formula for determining the number of columns in which printing may occur is the number of stages in the counter times the number of print heads less the difference between one and the number of bands per drum element.

Referring now specifically to FIGURES 2 through 4, there is illustrated a columnar printing mechanism utilizing the concepts and arrangements described in FIGURE 1. The three drum elements 7, 8 and 9 are positionable along the splined shaft 1 by the mechanism illustrated in FIGURE 1 and are disposed under a length of paper 16 fed from a roll 17 and under a drum 18. The drum 18 constitutes the hammer mechanism of the present invention and includes a raised, narrow helical spiral 19 providing what is known in the facsimile art as a "lawn mower." The drum 18 is rotated at a rate such that there is one revolution of the drum for the interval allocated to the printing in one complete line on the paper 16, a line comprising twenty-two to twenty-four columns depending upon the specific arrangement employed. In the arrangement illustrated, since there are three bands of print for each drum element, printing can occur in twenty-two columns. The paper is withdrawn from the roll 17 by means of a set of pinch rolls comprising rollers 21 and 22 disposed on opposite sides of the drum 18 and therefore positioned in front of the paper and pinch rolls 23 which are on the opposite side of the paper 16 and in alignment with the pinch rolls 21 and 22. Only one pinch roll 23 is illustrated in FIGURE 3. Driving energy is applied to the pinch rolls 21 and 22 and they are rotated at such a rate that the paper 16 is advanced the equivalent of one line; that is, is moved vertically as viewed in FIGURES 2 and 3 a distance equal to the spacing between the horizontal lines of the vertical columns, during the interval required for the drum 18 to rotate one full revolution. The type is skewed relative to the paper 16; that is, the shaft 1 is skewed slightly with respect to the paper's edge such that the copy produced maintains proper horizontal registration with the moving paper. This design permits a portion of the last line printed to be visible and also permits a gradual feed of the paper rather than gross feeding of an entire line at the end of each line of printing. Due to the use of gradual rather than gross feeding, there is substantially no lost time due to paper feed. Thus, if twenty-two charcters are to be printed the paper is moved vertically as viewed in the figures of the drawings 1/22 of a line between each printing interval. This may be easily accomplished.

The printing mechanism, per se, is the drum 18 with the raised helix 19 formed thereon. As the helix 19 rotates, the position of the helix relative to the print heads 7 through 9 moves horizontally across the page as viewed in FIGURE 2. When it is desired to print information the drum 19 is moved downwardly so that the raised helix 19 contacts the paper at the point of intersection between the helix and the drum head and this point moves horizontally across the page as the drum is rotated. A ribbon feed mechanism is provided which is synchronized with the operation of the machine and comprises a first ribbon spool 24 and a second ribbon spool 26 and a ribbon 27 threaded between the two and passing between the drum 18 and the paper 16. Thus, the character to be printed appears on the visible surface of the paper in FIGURE 2 with the character being applied from the underside of the paper and the printing occurring on the visible or top side of the paper.

The driving mechanisms for the apparatus are illustrated in FIGURE 4. An electric motor 28 drives a shaft 29 corresponding to shaft 3 in FIGURE 1 of the aforesaid copending application. A cam 31 is mounted on the shaft 29 to effect actuation of the print hammer or drum 18, the cam 31 corresponding to the cam 104 in FIGURE 1 of the aforesaid application. The shaft 29 also drives the type drum positioning mechanism if the mechanism

is that described in the aforesaid application. A gear 32 secured to the shaft 29 and drives a second gear 33 through a gear reduction ratio of 22 to 1 in the present case. The gear 33 is mounted on a shaft 34 which as will be described subsequently is employed to rotate the drum 18. The 22 to 1 ratio is employed since the drum is to be rotated one revolution for every 22 actuations of the print hammer or drum 18, there being 22 columns per line. The print drum 18 is secured to a shaft 36 supported between a pair of arms 37 and 38. The arms 37 and 38 are pivoted about the shaft 34 and are secured to a further shaft 39 on the side of the shaft 34 remote from the shaft 36. The shaft 39 at its right end, as viewed in FIGURE 4, is secured to an arm or link 41 which extends to the left as viewed in FIGURE 4 and is pivoted about the shaft 34. The arm 41 carries a cam follower wheel 42 which engages the surface of the cam 31. The cam 31 is provided with a notch or indentation 44 and the wheel 42 is biased by spring 43 to follow the contours of the wheel 31. Upon rotation of the shaft 29 and therefore the cam 31, the arm 41 is pivoted counterclockwise about the shaft 34 once each revolution of shaft 29 due to the wheel 42 following the indentation 44 in the cam wheel 31. This produces upward movement, as viewed in FIGURE 4, of the shaft 39 which causes the arms 37 and 38 to be pivoted counterclockwise thereby lowering the drum 18 so that the helix 19 engages the ribbon 27 and paper 16 and presses it against the selected character of the print head. Printing may be prevented by a latch arm 45. The arm 45 is normally positioned under link 41 so that the link 41 may not rotate about shaft 34. If printing is desired electromagnet 50 is energized, pulls arm 45 out of the way and permits link 41 to rotate.

The drum 18 is rotated by producing rotation of the shaft 36 which is accomplished by driving the shaft 36 from the shaft 34. Toothed wheels 46 and 47 are provided on opposite ends of the shaft 36 and corresponding toothed wheels 48 and 49 are secured to the shaft 34. Toothed belts 51 and 52 extend respectively between the pulleys 46 and 48 on the one hand and 47 and 49 on the other hand. Since a 22 to 1 reduction ratio was used between the gears 32 and 33, the coupling provided by the toothed belt and pulley arrangements should be 1 to 1. Of course, if some other gear reduction ratio is desired between the gears 32 and 33 the final proper ratio may be obtained by employing pulleys 46 and 48 for instance of such a different size as to provide the desired reduction.

As previously indicated, pinch rolls 21 and 22 are disposed on opposite sides of the drum 18, closely adjacent thereto. The pinch roll 21 is supported on a hollow stub shaft 53 journalled in a suitable bearing (not illustrated) and carrying a toothed pulley 54 on the end thereof opposite from the roller 21. The inner diameter of the shaft 53 is sufficiently large that the shaft 36 may pass therethrough and move through the angle necessary to produce printing by means of movement of the drum 18 through the action of cam 42. The shaft 36 is at a slight angle, in the embodiment approximately 5 degrees, with respect to shaft 53 so that the drum 18 is aligned with the type drum shaft 1. The inner diameters of shafts 53 and 56 must also be large enough to accept the skew of shaft 36. The paper drive pinch roll 22 is supported on a shaft 56 which is similar to shaft 53 in that it is also hollow and the shaft 36 passes therethrough. The hollow shaft 56 carries a toothed pulley 57 thereon and the toothed pulleys 54 and 57 are driven by means of toothed belts 59 and 61 respectively. The belts 59 and 61 are in turn driven by pulleys mounted on the shaft 34. Since the paper feed is considerably slower than the peripheral velocity of the rotating drum 18, a rather large gear reduction ratio is employed between the shaft 34 and the hollow stub shafts 53 and 56. The paper is held against the paper drive wheels 21 and 22 by means of pinch roll 23 as previously indicated.

There is also connected to the shaft 29, a wheel 64 of magnetic material having a notch formed therein. The notch is sensed by a variable reluctance pickup 66 so that an electrical impulse is produced for each revolution of the shaft 29. This impulse is employed to synchronize the magnet 50 and may also be employed in the column counting mechanism to be described.

Also attached to shaft 36 is a notched disc 55 with a variable reluctance pickup 60. The notch is disc 55 is sensed by pickup 60 to produce an electrical pulse just before the print drum 18 is positioned to commence printing of each line.

Referring now to FIGURE 5 of the accompanying drawings, there is illustrated the electrical circuits for generating the input code to the control magnets which control translation of the rack 2 which in turn controls the positioning of the type drum. The output signals from reluctance pickup 60 are fed into the reset terminal 65. This zero's the circuits before printing commences. The electrical impulses produced by the variable reluctance pickup 66, one for each actuation of the hammer drum 18, are then applied via a lead 67 to the three stage binary counter 68. The counter 68 counts from 0 to 7 and then returns to zero so that the counting procedure is continuous. The output code generated by the counter 68 is applied in parallel to an adder circuit 69 to which is also supplied, via parallel leads 71, the code from an outside information source indicating the letter to be printed. The information from the counter 68 and the leads 71 is added in the adder 69 and applied via output leads 72 in parallel to the various code control magnets of the printing mechanism. These may correspond to the magnets 33, 39 and 40 of FIGURE 1 of the aforesaid copending application.

As previously indicated, the apparatus of the present invention may also be utilized as a line printing mechanism. Referring now to FIGURES 6 and 7 there is illustrated a line printing apparatus employing a print drum mechanism generally designated by the reference numeral 73. The drum 73 comprises a rack gear 74 adapted to be driven by a pinion, not illustrated, to appropriately position the head mechanism 73 relative to a strip paper 76 to which characters are to be applied. The drum mechanism further comprises, as illustrated, ten bands 77 of characters in which all of the characters arranged in the head are different from all other characters. Each band 77 contains 8 characters and therefore, as will be shown, the apparatus is capable of printing eighty distinct characters. The bands 77 are rotatable with a splined shaft 78, as in the previous illustrations, to produce selection of the characters about the bands. The apparatus is adapted to print in seven different lines and in this embodiment of this invention several different print hammers are employed. The strip of paper 76 moves perpendicularly to the page of the drawing and therefore the print mechanism 73 translates perpendicularly to the longitudinal axis of the paper strip. As in the prior mechanism a ribbon 79 is disposed between the paper and the print drum, and seven print hammers 81 are arrayed below the paper 76. Seven distinct print hammers are employed, one for each line to be printed, so that it is not necessary to move the hammer mechanism. The hammers are selected by an interposer arrangement such as the type described in U.S. Patent 2,962,208 to MacNeill et al. A modified portion of this mechanism is reproduced for purposes of illustration only. The hammer selection mechanism includes a bail 82 which is vertically reciprocable, actually rotatable about shaft 86. The hammers 81 are arrayed in a vertical direction each in alignment with a different row to be printed on the paper and are disposed above a set of interposers 83 which extend into the bail 82. The position of the interposers is controlled by magnets 84. If the magnets are de-energized springs 85 cause the interposer to be extended such that a portion 88 having a maximum height is disposed under the hammer 81. When the bail is moved vertically the interposer engages the under side

of the hammer, moves it upwardly and causes it to engage the paper and ribbon and press them against the print drum. If the interposer is withdrawn by energization of the magnet 84, then its portion 87 of minimum vertical height is disposed under the hammer 81 and does not engage the hammer upon upward movement of the bail. In this case, the hammer does not produce printing. The hammers 81 either may be selected by signals supplied with the code to be printed, or from signals supplied from the counter (such as counter 68) so that as the line to be printed moves down the paper, the proper hammer is selected.

The positioning of the print head 73 is done again as in the manner of the apparatus of FIGURE 1 and more particularly a counter records the number of cycles so that the home position of the head mechanism 73 is moved, for instance, to the left each time the material for a particular line has been printed. In this case, however, since ten bands are employed, a sixteen count adder; that is, a four stage binary adder is required. This provides the ten positions of the drum plus the six shifted positions relative to the home position. The count or code indicating which of the ten bands of the drum contain the character to be printed is added to the count indicating the line to be printed so as to provide a final output to the control mechanism for final positioning of the head in translation.

As indicated above, the data is printed in up to seven lines and all symbols in one column are first printed. The paper is then shifted and the characters in column 2 of the seven lines are printed, etc. This arrangement permits incremental stepping of the paper rather than stepping it through a full line and then having to bring the entire strip back to the starting position such as is done with the normal carriage return on a drum cover just about all of the normal characters on a typewriter including upper and lower case letters and therefore the printer is available which does not require upper and lower shifts, carriage returns, etc. Also again using the skew system the paper may be fed continuously during the successive line printings. An advantage to the type of print mechanism employed in this latter arrangement over that of the arrangement of FIGURES 2 3 and 4 is that impact printing is not employed. Instead the pushing action which is normally available from a print or punch bail type of motion is employed. Therefore, the mechanism is longer-lived and more silent. Of course, the helix type of print hammer may be employed in this latter apparatus as the interposer type could be employed in the apparatus of FIGURES 2, 3 and 4. In this latter instance however the use of a 22 interposer and print hammer arrangement does become expensive.

Alternative to the arrangement illustrated in FIGURES 6 and 7, the printer may be employed to print 88 symbols on six lines, 96 symbols on five lines, 104 symbols on four lines and so on, each increment of eight being achieved by adding one band to the apparatus. It was previously indicated that positioning of up to eight bands may be controlled by three bit codes which provides a count of zero through seven. The addition of one further code bit and its associated mechanism to the print head control mechanism expands the total number of positionable bands to sixteen. Of course, the larger the number of bands and the larger the number of columns in which printing occurs, the greater becomes the inertia of the mechanism, thereby requiring a reduction in the print speed.

The principles of the apparatus of the two embodiments thus far described may be combined to provide in effect a page printer. Thus, the drum head with the large number of bands in which all bands carry different symbols as in the second embodiment of the invention, and the positioning mechanism for positioning a series of such drums across a page, as illustrated in the first embodiment of the invention may be combined so as to provide, for example, up to 128 different characters printed across a page of normal typewriter width. This mechanism is slower than any of those illustrated thus far due to inertia involved in producing a rigid support for a series of drums traversing a full width page. However, printing at between 35 and 50 characters per second may still be achieved with this mechanism. In addition, the skew arrangement for paper feed again permits saving the time normally lost in performing carriage return operations.

While we have described and illustrated several specific embodiments of our invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What we claim is:

1. In a printing mechanism, a print member having "X" number of print locations extending longitudinally thereof wherein X is at least one; means for establishing an initial print position for said print member; means for moving said print member along its longitudinal axis; a recycling means for generating a displacement code designating the desired print position relative to said initial print position, said recycling means generating a maximum displacement code and, after a printing operation, employing such maximum displacement code, said recycling means generating a displacement code designating said initial print position; means for generating a final code by combining said displacement code with a code representing the one of said "X" number of print locations which is to be adjacent the region where printing is to occur; and means for applying said final code to said means for moving said print member, said means for moving transporting said print member from a prior print position directly to the new print position.

2. In a printing mechanism, a print member having "X" number of print locations extending longitudinally thereof wherein X is at least one; means for establishing an initial print position for said print member; means for moving said print member along its longitudinal axis; a recycling means for generating a displacement code designating the desired print position relative to said initial print position, said recycling means generating a maximum displacement code of (X−1) and, after a printing operation, employing such maximum displacement code, said recycling means generating a displacement code designating said initial print position; means for generating a final code by combining said displacement code with a code representing the one of said "X" number of print locations which is to be adjacent the region where printing is to occur; and means for applying said final code to said means for moving said print member, said means for moving transporting said print member from a prior print position directly to the new print position.

3. The combination according to claim 2 further comprising a print hammer mechanism, means for passing indicia receiving material between said member and said hammer mechanism, means for selectively actuating said hammer mechanism and means for maintaining said hammer mechanism in alignment with the selected print position.

4. The combination according to claim 3 wherein said material is moved along a path skewed a predetermined small amount relative to the perpendicular to the longitudinal axis of said print member, the skewing being such relative to speed of movement of the material and the interval between printing of indicia that the indicia are aligned in a row across the material.

5. The combination according to claim 2 wherein said means for generating generates a maximum displacement code equal to $X-1$.

6. The combination according to claim 5 wherein there are provided a number "Y" of axially aligned print members each including X number of circumferential bands of indicia with each band having the same indicia formed thereon, said recycling means establishing a number of initial print positions equal to the number of print members.

7. The combination according to claim 6 further comprising means for rotating said print members about their axes to select one of said indicia in said band.

8. The combination according to claim 6 wherein said recycling means in combination with said means for moving establishes a number of print positions axially of said print members equal to $YZ-(X-1)$ where Z is the number of indicia per band.

9. The combination according to claim 4 wherein said indicia are arranged in circular bands so as to be read parallel to the direction of movement of said material and wherein said paper is advanced by an increment equal to the spacing between lines of each indicia after a predetermined number of printing cycles equal to the number of different indicia provided in said bands.

10. The combination according to claim 4 wherein said hammer mechanism comprises a drum having an axis

parallel to the axis of said print member, a single turn raised helix of material formed about the peripheral of said drum and means for rotating said drum such that said helix advances a print position for each printing cycle.

11. The combination according to claim 4 wherein said hammer mechanism comprises a plurality of individual hammers arranged in the row aligned with the axis of said print member and each located adjacent a different print position and means for selectively actuating said hammer mechanisms including means for selectively actuating said hammers one at a time.

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