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Ambrosio

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[54] **PRINTER WITH PRINT WHEELS HAVING CODED PERFORATIONS FOR SELECTIVE POSITIONING**

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[52] **U.S. Cl.** **101/93.29,** 197/18, 101/110

[51] **Int. Cl.** **B41j 7/34**

[58] **Field of Search** ..... 101/93 C, 95, 99, 45, 110, 101/111, 269; 197/18; 250/219

[56] **References Cited**

UNITED STATES PATENTS

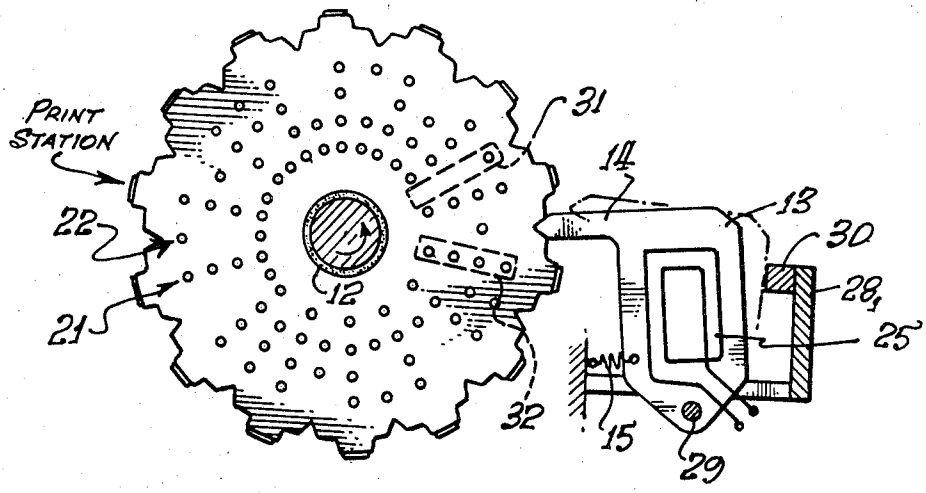
3,229,626	1/1966	Arps	101/93 C
3,334,237	8/1967	Dodsworth et al.	250/219
3,613,574	10/1971	Longcoy	101/110 X
3,669,016	6/1972	Kittel	101/110 X
3,673,957	7/1972	Guzak	101/93 C

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Assistant Examiner—Edward M. Coven
Attorney, Agent, or Firm—Lindenberg, Freilich, Wasserman, Rosen & Fernandez

[57] **ABSTRACT**

A printer is disclosed wherein the print wheels are positioned individually to desired symbols through coding provided in the form of perforations in the print wheels themselves. After individually positioning the print wheels, one at a time in sequence, by sensing the code perforations in a turning wheel through sensing perforations in all other wheels held stationary, a print roller is driven over the selected symbols.

10 Claims, 6 Drawing Figures



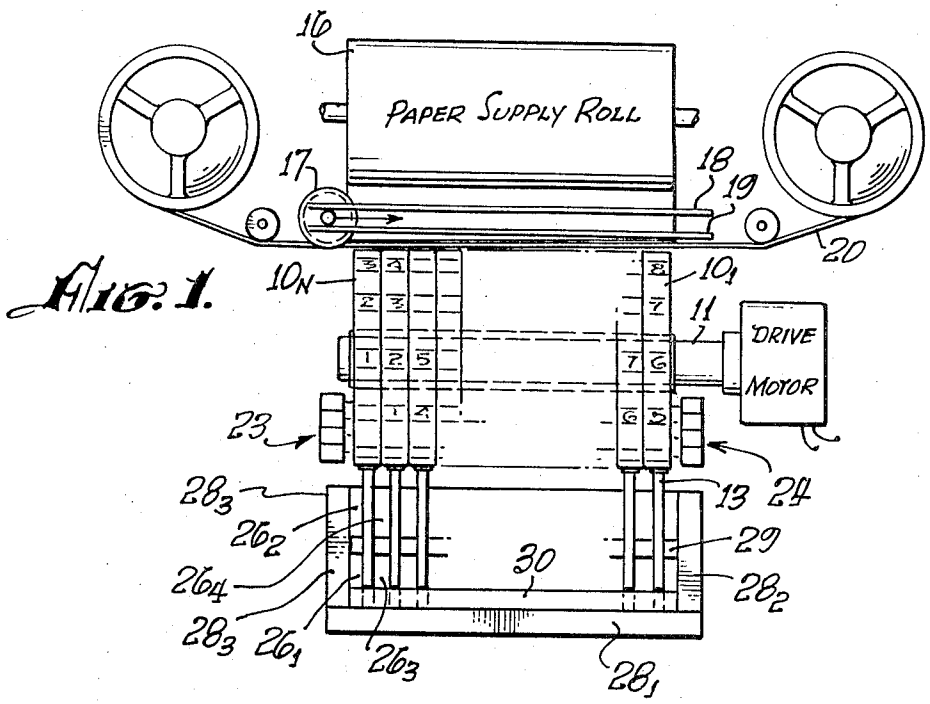


FIG. 1.

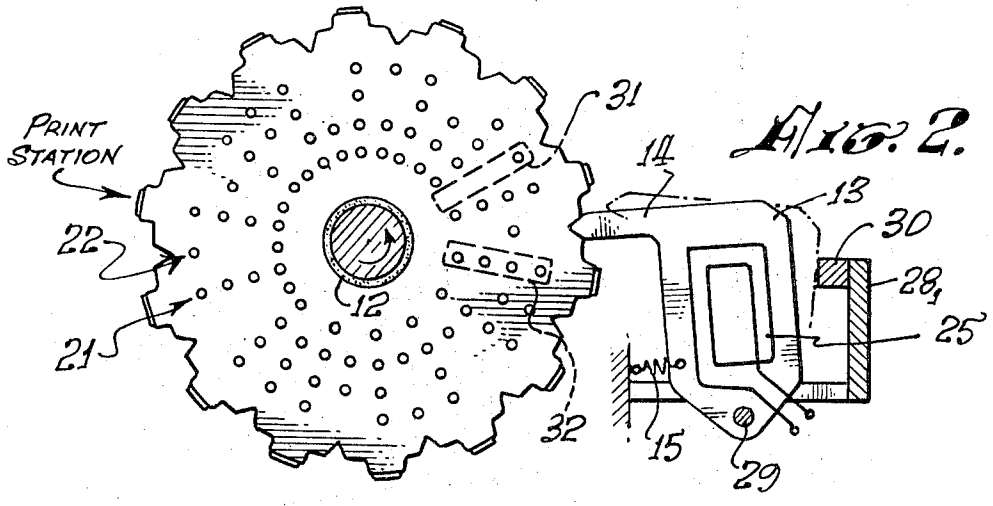


FIG. 2.

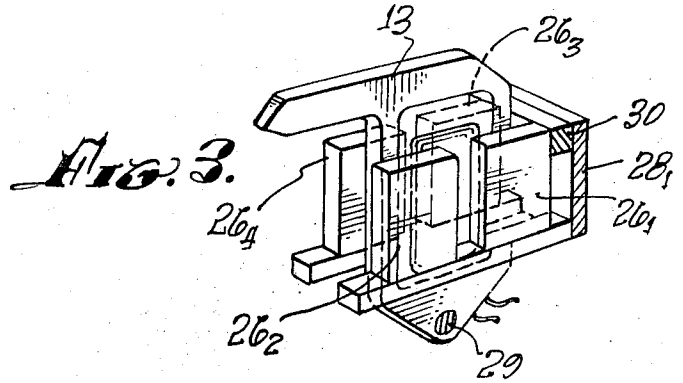


FIG. 3.

Fig. 4.

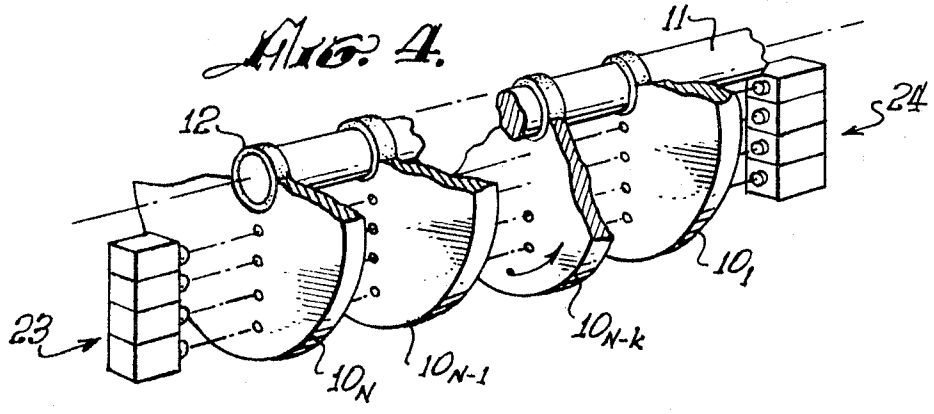

11
12
24
23
10_1
10_{N-k}
10_{N-1}
10_N

Fig. 5.

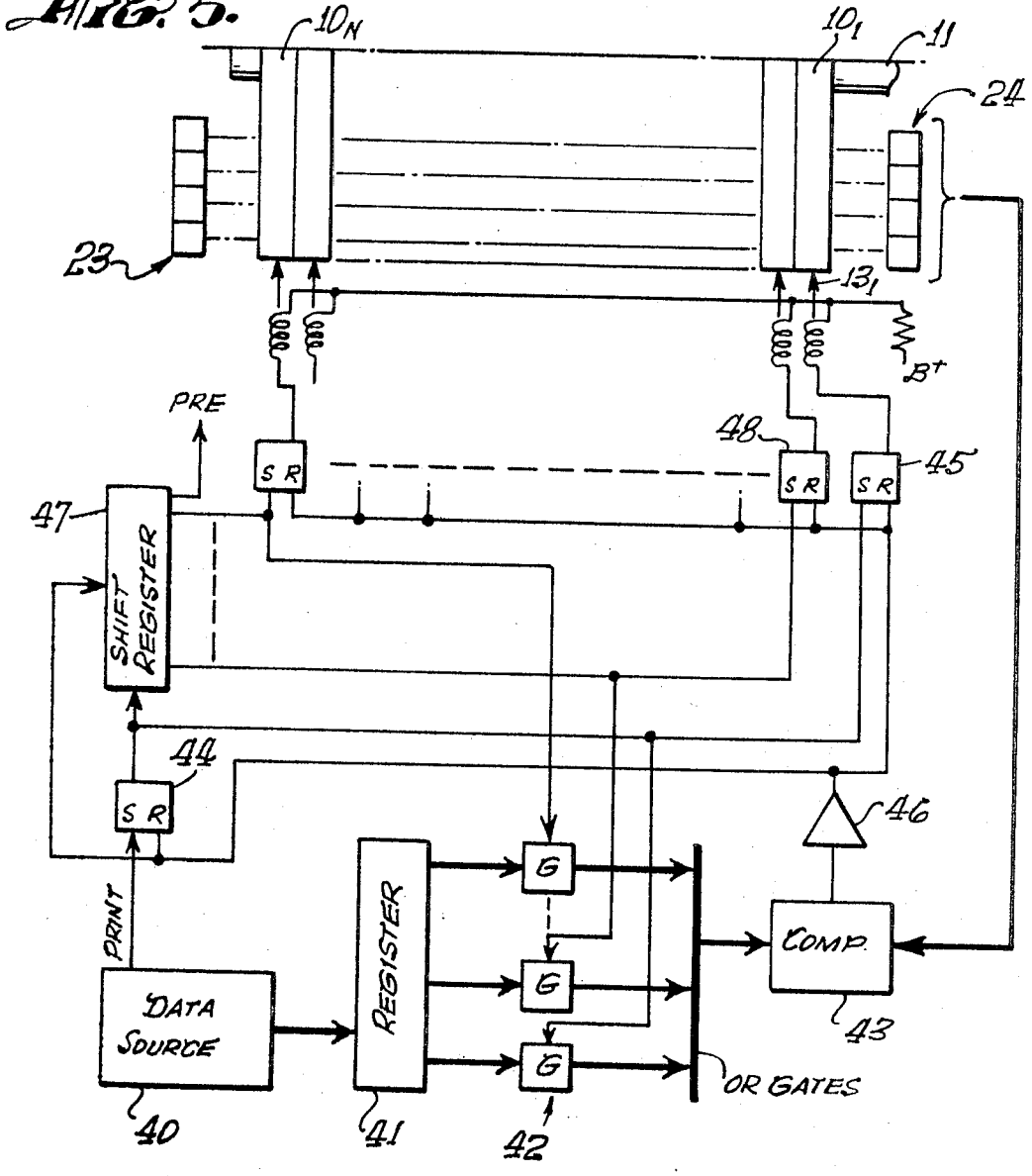
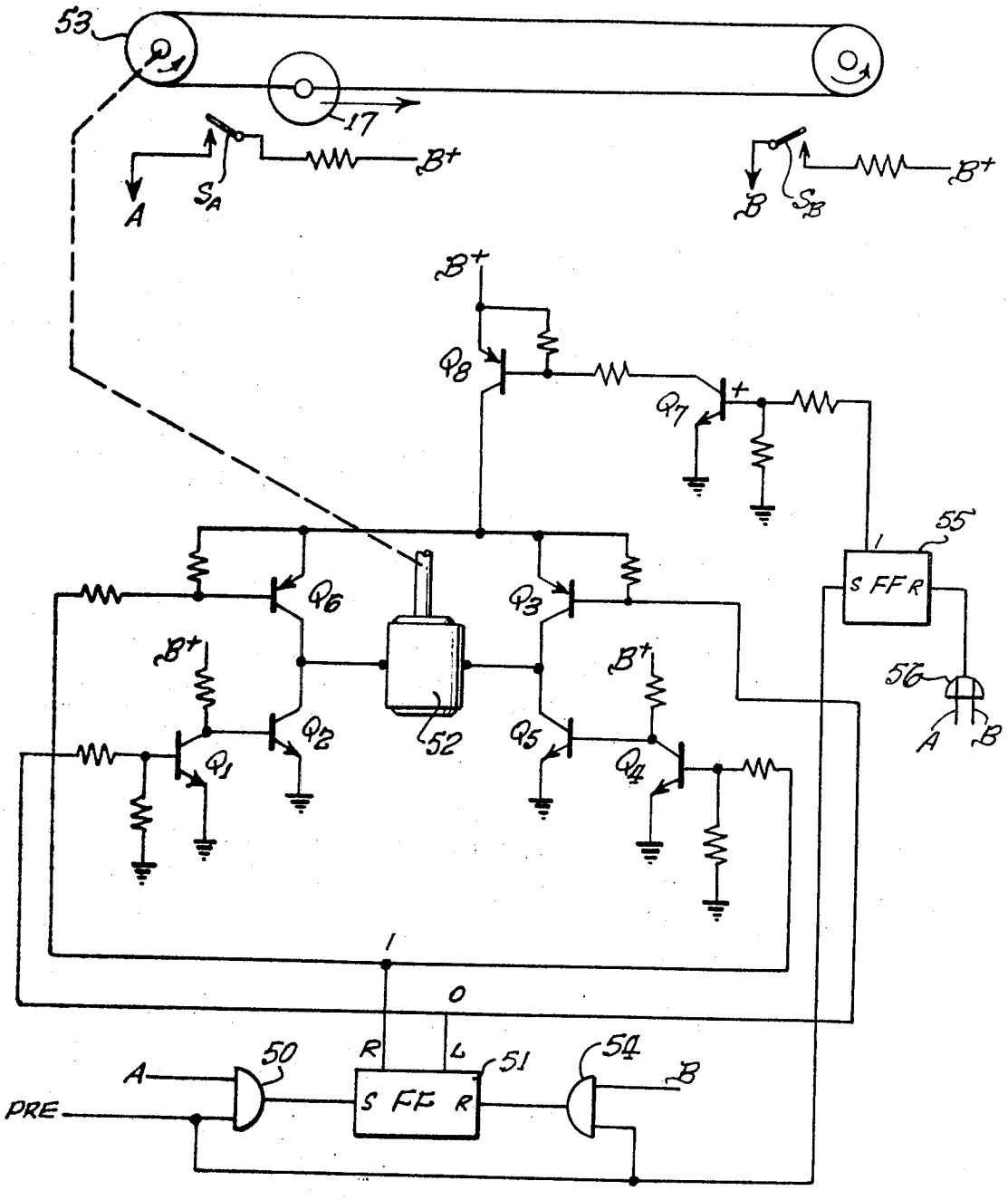

10_N
10_1
11
24
23
13_1
B^+
PRE
48
45
47
S R
SHIFT REGISTER
44
46
PRINT
DATA SOURCE
REGISTER
G
COMP.
43
OR GATES
40
41
42

FIG. 6.


53
Q1
17
A
SA
B+
B
SB
B+
Q8
Q7
55
S FF R
Q6
Q3
B+
B+
Q2
Q1
52
Q5
Q4
56
A
B
1
0
R
L
51
50
54
A
B
PRE
S FF R

PRINTER WITH PRINT WHEELS HAVING CODED PERFORATIONS FOR SELECTIVE POSITIONING

BACKGROUND OF THE INVENTION

This invention relates to improvements in printers, and more particularly to improvements in low cost printers.

In the field of high-speed printers, a technique which has been successfully exploited is the provision of a rotating drum on which the symbols to be printed are provided with one complete set of all symbols circumferentially disposed, one set for each column of information to be printed. Identical symbols are aligned in a row parallel to the drum axis in order that printing of the same symbol in every column in which it is to appear can be effectuated at one time. Consequently, to print any given symbol in selected columns, the proper position of the character drum is detected as it continues to rotate, and print hammers for the selected columns are energized, thus printing the symbol where needed in a line of printed information.

The symbol to be printed is detected at the print station by either counting symbols from an index position, or by detecting a unique code on a disc or cylinder attached to the shaft to rotate with the drum. High speed printing is achieved because a line of information is printed each time the drum completes one revolution without stopping. In practice, that is done by comparing separately the position of the drum with the symbol to be printed at each column. When the symbol to be printed at any given column comes up to the print station, a print hammer is energized to print that symbol in that column. Perforations in the disc or drum are often used to implement the code because of their permanency and the ease with which they can be detected optically.

Such high-speed printers are much too expensive for general use. A major cost factor is the need for a separate print hammer for every column. Due to the dynamics of printing with a hammer, the hammer must be properly designed and produced with precision. Otherwise, the hammer may smear the symbol being printed if it dewlls too long, or cause a ghost of the symbol to be printed if it bounces upon impact. For slow printers, it would be desirable to use separate print wheels individually set for the line of information to be printed. Once set, a moveable platen may be employed to print the entire line of information.

Many printing calculators have been provided with low cost printers in which the positioning of the print wheels has been effectuated as an integral part of the calculations. Others may have mechanial means for stepping each print wheel individually from an index position common to all after calculations are complete. What is needed is an inexpensive technique for positioning print wheels individually at a reasonably fast rate without dependence on any other operations, aside from providing the information to be printed in a digital code.

SUMMARY OF THE INVENTION

An object of this invention is to provide an improved low-cost printer for use in any system to print information provided electronically in digital code.

Still another object is to provide an inexpensive system for aligning individual print wheels for each line of information to be printed in response to digital codes representing symbols to be printed in the position of each print wheel.

These and other objects of the invention are achieved by providing a plurality of print wheels, each with symbols on the circumferential surface thereof and V notches on that surface between symbols used for holding the print wheel in an indexed position with a symbol in proper alignment with symbols of all other print wheels at a print station. Each print wheel is provided with two sets of perforations, each set comprising a plurality of grouped perforations, each group having one or more perforations in a fixed pattern of perforations. All groups of one set have at least N perforations for use only as light paths in sensing coded groups of the other set in one rotating print wheel while all other print wheels are latched in an indexed position. The perforations in N perforation positions of the groups in the second set in the same pattern as the N perforation positions of groups in the first set are provided in accordance with a predetermined code to uniquely identify the positions of symbols on the print wheel. In operation, all perforations of groups of the first set in one wheel are in line with all groups of the first set of all other wheels while latched, and perforations of one group of every wheel will be in line to form N light beam paths from a source, or sources, illuminating all N perforations of a group on a wheel at one end and N photocells each of which is positioned opposite one of N perforations of a group on a wheel at the other end.

To select a symbol on a given print wheel, that print wheel is unlatched and caused to rotate by a motor-driven shaft through a friction clutch, thus causing code groups on that wheel to be driven past the aligned perforations of the remaining print wheels at rest until the code of the desired symbol is detected by the photocells. The latching means for the print wheel being set is then caused to again latch. The position of the latching means relative to the sensing position stops the print wheel with the selected symbol in the print position. The V notch into which the latching means fits assures the selected symbol will come to rest in proper alignment at the print station. When all print wheels have been individually set, a print roller is driven across the selected symbols at the print station, thus applying pressure on paper against the selected symbols for printing the symbols on the paper.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 discloses the organization of a printer embodying the principles of the present invention.

FIG. 2 is a side elevation of a print wheel and latching plate representative of the arrangement for each of the print wheels in FIG. 1.

FIG. 3 is an isometric view of a complete arrangement for the latching plate and actuating means of FIG. 2.

FIG. 4 illustrates in perspective the arrangement of photodetecting means for detecting a coded group of perforations in one rotating print wheel through aligned sense perforations in stationary print wheels.

FIG. 5 illustrates in a block diagram the electronic system for specifying the symbols to be selected for printing in each of the print wheels of FIG. 1.

FIG. 6 is a circuit diagram for the control of a motor which drives a print roller in the arrangement of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 in more detail, there is shown an exemplary arrangement of apparatus for printing in accordance with the present invention. A plurality of print wheels 10_1 through 10_N are supported by a motor driven shaft 11 and engaged for rotation with the shaft through a slip clutch 12 (FIG. 2). Each print wheel is held in a stationary position by a separate latching means consisting of a plate 13 of non-magnetic material with a pointed arm 14 engaging a V notch, as is more clearly shown in FIG. 2. A spring 15 holds the plate 13 in the latching position.

Once all of the print wheels have been selectively positioned, the symbols at the print station are printed on paper supplied from a roll 16. The printing is done by driving a roller 17 between guides 18 and 19 extending across all the wheels at the print station. The paper is impressed on the raised symbols of the print wheels. Carbon or ink ribbon 20 is supplied between the paper and the print wheels if pressure-sensitive paper is not used.

Each print wheel has a number of raised portions, one for each symbol such as the numerals 1 through 9 and 0 to be selectively printed. Each print wheel also has two interspaced sets of perforations, one set consisting of groups of four sense holes disposed on evenly spaced sectors, and more particularly on spaced radial lines, one group of holes for each symbol position, such as a group 21. The other set consists of groups of code holes disposed on intermediate sectors spaced in the same pattern, namely radial lines. Thus, one code group for each symbol is interspaced between two groups of sense holes, such as a group of sense holes 22.

When at rest, the four holes of the sensing group 21 in one print wheel are aligned with the four holes of sensing groups in each of the other print wheels at rest in order for light from a source or sources 23 to pass through all of the aligned sensing holes to a group of four photocells 24. When a pancake coil 25 in the latching plate 13 is energized, the coil moves through a magnetic field provided by four fixed magnets 26_1–26_4 mounted on a slotted aluminum support 28_1. End keepers 28_2 and 28_3 of soft iron provide flux paths between the magnets at each end as shown in FIG. 1. Current in the coil causes the plate 13 to pivot about a point 29 away from the print wheel 10 to a position against a stop 30 affixed to an upright portion of the support 28_1. The shaft 11 then engages the print wheel 10 through the friction clutch 12 to rotate it. As the alternate groups of sense and code holes pass the sense stations between the light source of sources and photocells, the code groups of holes are detected.

When the code of the desired symbol is detected at the sense station, the coil 25 of the latching means is de-energized, thereby allowing the spring 15 to pivot the plate 13 back so that the arm 14 will re-engage a V notch and thereby index the selected symbol at the print station. For example, assuming the print station to be at the left as viewed in FIG. 2, and that the numeral 1 is to be selected, the code group of hole positions for the numeral 1, enclosed by a dotted line block 31, are detected at the sense station represented by a dotted line block 32 in FIG. 2. The inherent delay in de-energizing the latching means permits the code group of hole positions 31 for the numeral 1 to advance from the sense station 32 to the position shown in FIG. 2. When in that position, the arm 14 of the latching means engages a V notch to align the numeral 1 for proper printing at the print station assumed to be at the left.

It should be noted that the print station may be positioned any place with respect to the latching means, such as opposite the latching means as just assumed and illustrated in the arrangement of FIGS. 1 and 2, or at nearly a right angle which would place the print station at the top of FIG. 2. Positioning one relative to the other is completely arbitrary so long as the latching means engages a V notch with a selected symbol aligned for printing. It should also be noted that although the groups of sense holes and code holes are uniformly spaced, with a group of code holes halfway between two groups of sense holes, the group of code holes may be closer to one group of sense holes than the other, but the group of sense holes should be uniformly spaced in order that the symbols and indexing V notches between symbols be uniformly spaced. And finally, it should also be noted that although the sense holes are shown in radial alignment with the symbols on the periphery of the print wheel, that is not necessary because the sense station may be positioned any place in relation to the print station just so the print station is centered over a line of symbols while all wheels are at rest. What is important is that having selected positions for the groups of code holes relative to the symbols represented thereby, the sense station is positioned such that when a selected code group is detected, and the latching means is de-energized, the print wheel will be stopped with the symbol selected at the print station.

FIG. 4 illustrates with sections of three print wheels 10_1, 10_{N-k}, 10_{N-1} and 10_N the manner in which a code group 0011 is detected in the rotating print wheel 10_{N-k} between stationary print wheels 10_1 and 10_N. A bit 0 in the code is represented by the absence of a hole in a hole position in line with holes of sense groups on the wheels 10_1 and 10_N. When the wheel 10_{N-k} is in the position shown, and all other wheels are at rest with groups of four sense holes aligned, the output of the photodetectors will be four digital signals representing the code 0011, where the most significant bit is from the upper most photodetector.

The manner in which the data to be printed may be entered will now be described with reference to FIG. 5. A data source 40 such as a keyboard or calculator enters the data into a register 41 in digital form, either serial by symbol and parallel by bit, or serial by symbol and serial by bit. For the example illustrated in FIG. 1, the symbols are specified by 4-bit codes. Assuming an eleven place printer, the register 41 will consist of 44 bit positions, a group of four bit positions for every symbol position. A 4-bit code will provide for printing the numerals 1–9 and 0, and four other symbols, such as a plus (+), a minus (−), a decimal point (.) and a blank (no print). It should be noted that every symbol position must be specified by a code having at least one hole, but not four because four holes are used for the sense groups. The following is the assignment of codes illustrated in FIG.2.

CODE	SYMBOL
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	0
1011	+
1100	−
1101	.
1110	(BLANK)

A 6-bit code would provide for the additions of letters of the alphabet plus many other symbols for punctuation, and still one more additional bit would provide for the addition of both upper and lower case letters of the alphabet. The principles illustrated for a 4-bit code would be the same for a 6 or 7-bit code.

A bank of AND gates **42** couples the output of the register **41** to a comparator **43** (one symbol group at a time starting on the right) when a **PRINT** command is issued by the data source **40.** The command sets a flip-flop **44** which in turn sets a flip-flop **45** and enables a group of four AND gates in the bank **42** to couple the 4-bit code of the first symbol to the comparator **43.**

Once the flip-flop **45** is set, the solenoid of the latching means 13_1 for the first print wheel 10_1 is energized, thereby releasing the first print wheel for rotation. When the code of the first symbol is detected, the comparator **43** transmits a signal through a power driver **46** to reset the flip-flop **44** and the flip-flop **45,** and to shift a commutating shift register **47.** The bit **1** of the flip-flop **44** then being reset is thus shifted into the register **47.** The leading edge of the bit **1** shifted into the register, i.e., the leading edge of the output of the first state of the register **47,** sets a flip-flop **48** to release the next print wheel. That output of the register **47** also enables the next group of AND gates in the bank **42** to couple the 4-bit code of the second symbol to the comparator **43.** When that code is detected in the second print wheel, the flip-flop **48** is reset and the bit-**1** in the shift register **47** is advanced. The procedure is repeated until the last print wheel is reset, at which time the bit-**1** in the register **47** is shifted out as a print execute signal, PRE.

The PRE signal is transmitted by an AND gate **50** (FIG. **6**) to set a flip-flop **51** if the print roller **17** is a rest over a switch S_A. That turns on transistors Q_1, Q_2 and Q_3 to apply current to a DC motor **52** of a polarity to drive a pulley **53** in a direction to move the roller to the right. Had the roller been at rest over a switch S_B, the flip-flop **51** would have been reset via a gate **54** to turn on transistors Q_4, Q_5 and Q_6 to drive the roller to the left. Power is applied to the motor **52** once a flip-flop **55** is set directly by the leading edge of the signal, PRE, to turn on transistors Q_7 and Q_8. When the roller **17** reaches the other side, a switch A or B, is closed to transmit a step voltage, the leading edge of which resets the flip-flop **55** via an OR gate **56.** That ends one complete cycle of setting the print wheels and printing. Means (not shown) will then advance the paper from the supply roll **16** and advance the printing ribbon **20.** The means may be, for example, a stepping motor which operates through gear trains to advance the paper and ribbon the proper amount.

Although particular embodiments of the invention have been described and illustrated herein it is recognized that modifications and equivalents may readily occur to those skilled in the art. Consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

What is claimed is:

1. A printer employing a plurality of print wheels on a shaft, each carrying two sets of perforations, first set for coded groups of perforations, each group in a predetermined pattern of perforation positions, each coded group identifying by its position on the wheel a symbol on the print wheel, each group having N perforation positions and the code being in the form of a unique combination of perforations and no perforations in said positions, and a second set of perforations in groups, each group being arranged in said predetermined pattern and having a hole in every position, each group in said second set being available for sensing the coded groups on a turning print wheel while all other print wheels are at rest, each with a symbol in proper aligned position for printing at a printing stations, means for rotating one print wheel at a time while the rest of the print wheels are stationary with a group of sensing perforations in each stationary wheel in line with a group of sensing perforations in all other stationary wheels for permitting light to pass through all sensing perforations of aligned groups of said second set to N photocells, one photocell for each perforation position at one end of said shaft, said light being interrupted only by said coded groups of perforations of said first set of perforations in said turning print wheel as they rotate past said sensing groups in line with said photocells, each of said coded groups being disposed to have its perforation positions to be in line with perforation positions of said aligned sensing groups in stationary wheels as said turning wheel brings each coded group into a position to block light to said photocells.

2. A printer as defined in claim **1** including a comparator connected to receive signals from said photocells for comparison with a coded group of N signals specifying a symbol to be positioned at said printing station, and means responsive to said comparator for stopping said turning wheel when signals produced in said photocells in response to the interruption of light by a unique coded group of perforations coincide with said signals to said comparator specifying the symbol to be printed, whereby a symbol identified by the position of said unique coded group of perforations is positioned at said print station.

3. A printer as defined in claim **2** wherein said means for turning one print wheel at a time is comprised of means for turning said shaft, a slip clutch coupling each print wheel to said shaft, separate means for holding each print wheel in a stationary position, a separate actuating means for each holding means responsive to a control signal for causing said holding means to release a print wheel for rotation, and means for removing said control signal from an actuating means when said comparator detects coincidence.

4. In a printer having a plurality of axially aligned print wheels, each to be individually set with a selected symbol on the circumferential surface thereof in an indexed position at a print station in line with symbols

similarly set on all other print wheels, an improved apparatus for setting said print wheels comprised of:

a first set of perforations in said wheel arranged in uniformly spaced groups, each group consisting of a plurality of perforations in a particular pattern such that perforations of all groups coincide with perforations of groups in adjacent print wheels when at rest with symbols in said indexed position,

a second set of perforations in said wheels arranged in groups of one to N perforations in a pattern of perforation positions coinciding with N perforations of a group in said first set in an adjacent print wheel when one is rotated relative to the other to bring the two groups opposite each other, said groups of said second set being interspaced with said groups of said first set, and each group of said second set having a unique combination of perforations according to a predetermined code, every unique combination specifying a symbol on said surface by its spatial relationship therewith, said relationship being the same for every code group and symbol combination,

means for transmitting light through one group of said first set of each stationary print wheel in alignment,

a set of N photocells for detecting light through N perforations of said aligned groups of said stationary wheels, said photocells being arranged in a pattern corresponding to said pattern of perforation positions of said coded groups in said second set,

means for providing a group of N coded digital signals for specifying a symbol on a particular print wheel to be positioned at said print station,

means for comparing said group of N coded digital signals with output signals from said photocells, and

means for turning the print wheel to be positioned with said specified symbol in said print station until said comparing means detects a coincidence between output signals of said photocells and said group of N coded digital signals specifying said symbol.

5. A printer comprising:

a plurality of print wheels, each carrying two sets of perforations arranged in radially aligned groups, each group having one or more perforations, all groups of a first set having a minimum number, N, of perforations in a fixed pattern for use as light paths through all axially aligned print wheels while at rest in an indexed position during the sensing of coded groups of a second set interspaced between groups of said first set in one of said print wheels while being selectively caused to rotate, each code group of said second set uniquely identifying a symbol, each symbol being positioned with the same spatial relationship to the code group of perforations which uniquely identifies it,

a shaft and means for rotating said shaft, each of said print wheels being axially mounted on said shaft and coupled to said shaft by a friction clutch,

a plurality of latching means, a separate one for each print wheel for holding said print wheels at rest in said indexed position with a selected one of said symbols on one print wheel in line with all other symbols selected on other wheels for printing at a print station,

means for directing light through N light paths provided by a group of perforations of said first set in one print wheel at rest aligned with groups of perforations of said first set in all other print wheels at rest,

a number of photocells, one for each of said N light paths positioned to receive light in said paths,

means for providing a group of N coded digital signals for specifying a symbol on a particular print wheel to be positioned at said print station,

means for individually unlatching said latching means for said particular print wheel,

means for comparing said coded signals specifying a symbol to be selected with coded signals produced by said photocells in response to perforations of said coded groups in said particular print wheel interrupting said light paths, and

means responsive to said comparator for causing said latching means to again hold said particular wheel stationary, whereby said latching means stops said rotating wheel in a position with said specified symbol on the circumferential surface thereof in said print position at said print station.

6. In a printer comprised of a plurality of print wheels on a common shaft, each print wheel being divided into a plurality of sectors and having a plurality of symbols, one symbol on every other sector, an improved mechanism for positioning said wheels individually to print desired symbols through the use of groups of coded perforations in said print wheels, each of said print wheels having coded perforations in predetermined positions, one group of coded perforations for each symbol in a sector of said wheel, each intermediate sector between every pair of adjacent coded sectors having a perforation in the position of every permissible perforation of each of said code groups, means for transmitting a light beam through each permissible perforation of each of said code groups in an intermediate sector of each print wheel while stationary with intermediate sectors aligned, means for rotating one print wheel at a time, means for individually positioning said print wheels as they are rotated, one at a time, by sensing said light transmitted through code perforations in a turning wheel and through aligned perforations in intermediate sectors of all other wheels which are stationary, and bringing said turning wheel to rest with its intermediate sectors aligned with intermediate sectors of all other wheels.

7. A low cost printer comprising a plurality of print wheels arranged side by side on a common shaft, each with symbols on the circumferential surface thereof and V notches on that surface between symbols, said norches being provided for the purpose of holding said print wheels in an indexed position with a symbol of each in proper alignment with symbols of all other print wheels at a print station, each print wheel being provided with two sets of perforations each set comprising a plurality of grouped perforations, each group having one or more perforations in a fixed pattern of perforations, all groups of one set having at least N perforations for use only as light paths in sensing coded groups of the other set in one rotating print wheel while all other print wheels are held stationary in an indexed position, the perforations in N perforation positions of the groups in the second set being in the same pattern as the N perforation positions of groups in the first set, and perforations in groups of said second set being pro-

vided in said positions in accordance with a predetermined code to uniquely identify symbols by relative position on the print wheel, whereby all perforations in said positions of groups of the first set in one wheel are in line with corresponding positions of all groups of the first set of all other wheels while stationary in said indexed position in order that one group of every wheel will be in line to form N light beam paths from a source, or sources, illuminating N photocells at one end of said print wheels arranged side by side, means for rotating one print wheel at a time, thereby sensing coded groups of perforations in the rotating print wheel as the coded groups of perforation positions on the rotating print wheel pass through a position of alignment with said N light beam paths, means for designating a symbol code for said rotating print wheel, and means for stopping said rotating print wheel when the designated symbol code is detected by said photocells.

8. Apparatus as defined in claim **7** wherein said common shaft is being rotated continuously by a motor and said print wheels are held stationary by individual latching means, each of said print wheels being coupled to said shaft by a separate friction clutch, thus causing code groups on one rotating wheel to be driven past the aligned perforations of the remaining print wheels held stationary until the designated code of a symbol is detected by said photocells.

9. Apparatus as defined in claim **8** wherein the position of the latching means relative to the photocells is such as to stop the rotating print wheel with the selected symbol in a print position.

10. Apparatus as defined in claim **9** wherein V notches are provided between symbols on said wheels and said latching means comprises a pointed arm which fits into a V notch thereby assuring the selected symbol will come to rest in proper alignment at the print station.

* * * * *