Sept. 20, 1971 E. B. McDOWELL ET AL 3,605,610

TYPE MEMBER POSITION SENSING SYSTEM IN A HIGH SPEED PRINTER

Filed June 4, 1968 4 Sheets-Sheet 1

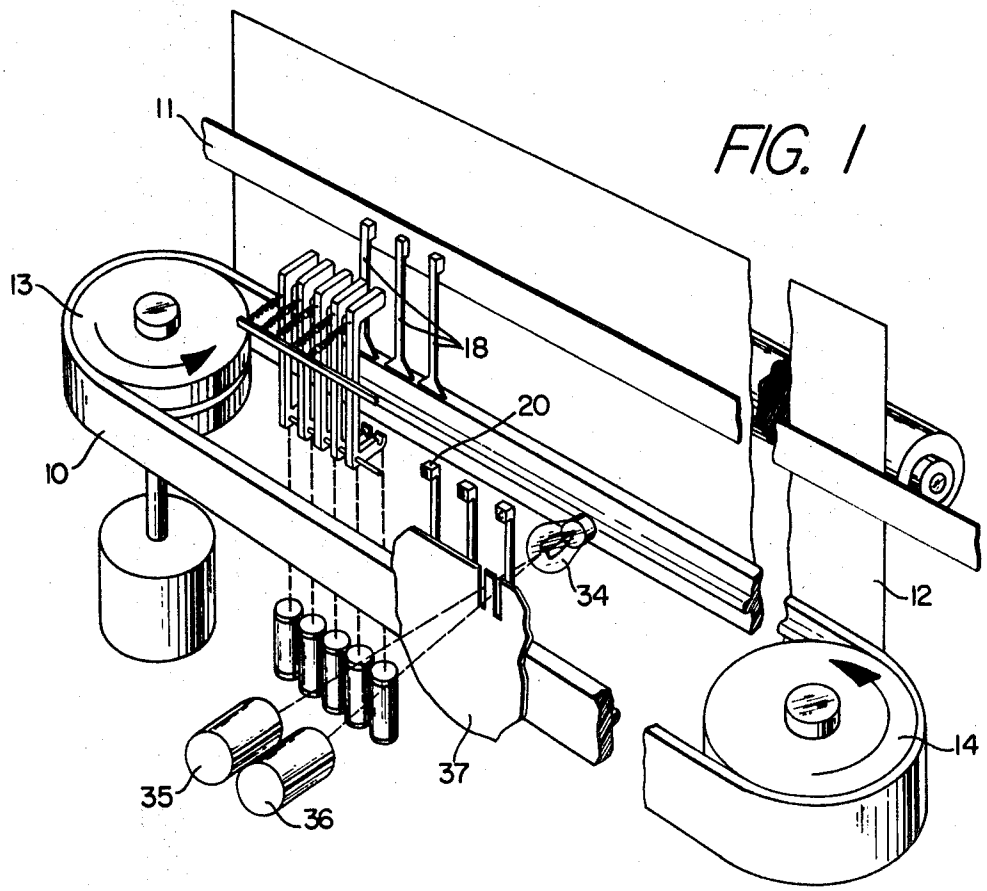

FIG. 1

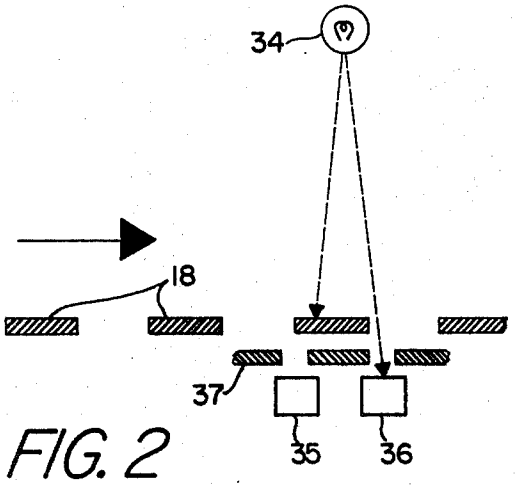

FIG. 2

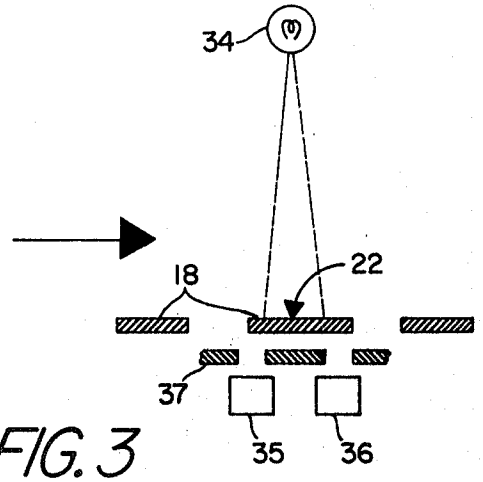

FIG. 3

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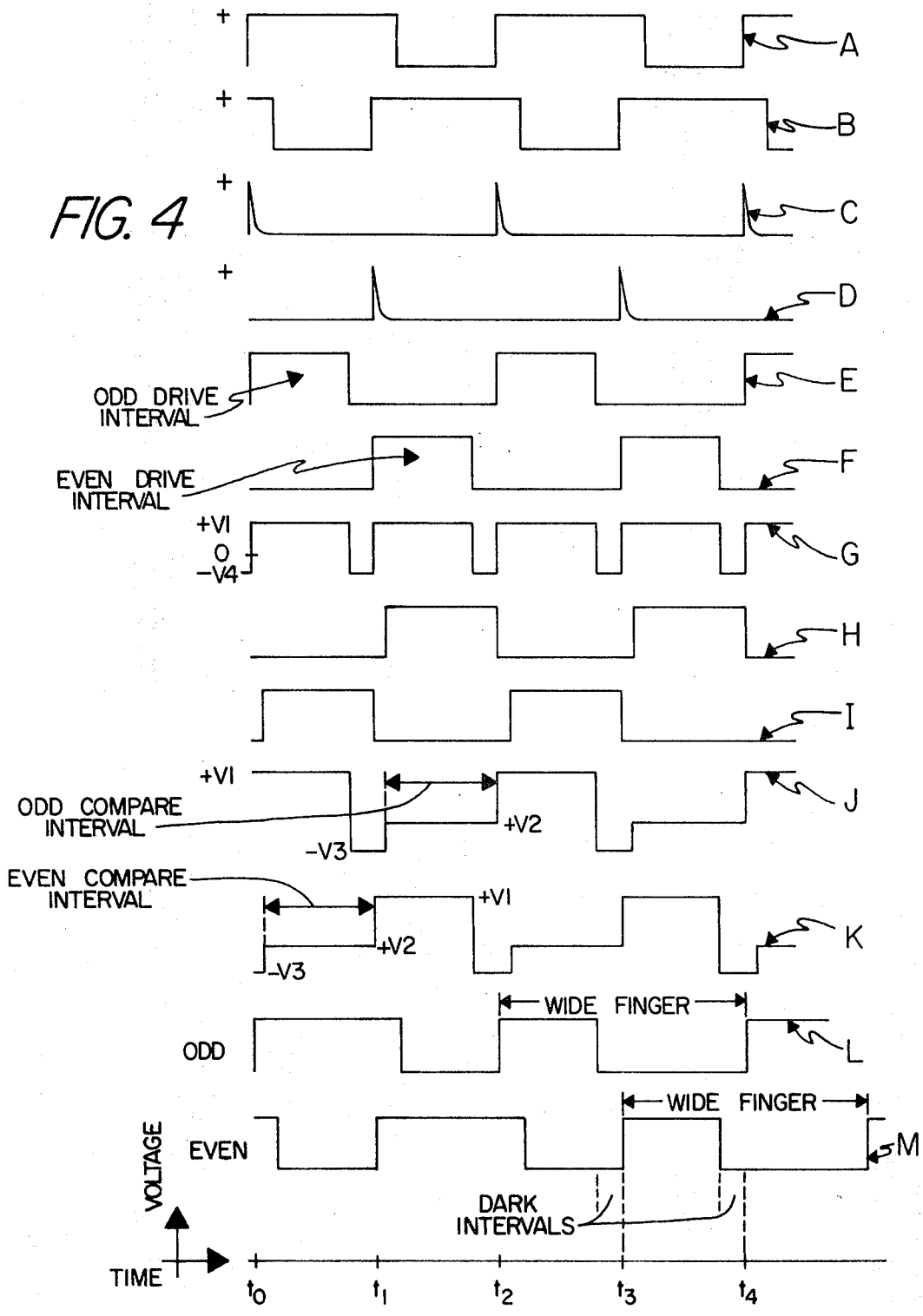
FIG. 4



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TYPE MEMBER POSITION SENSING SYSTEM IN A HIGH SPEED PRINTER

Filed June 4, 1968 4 Sheets-Sheet 3

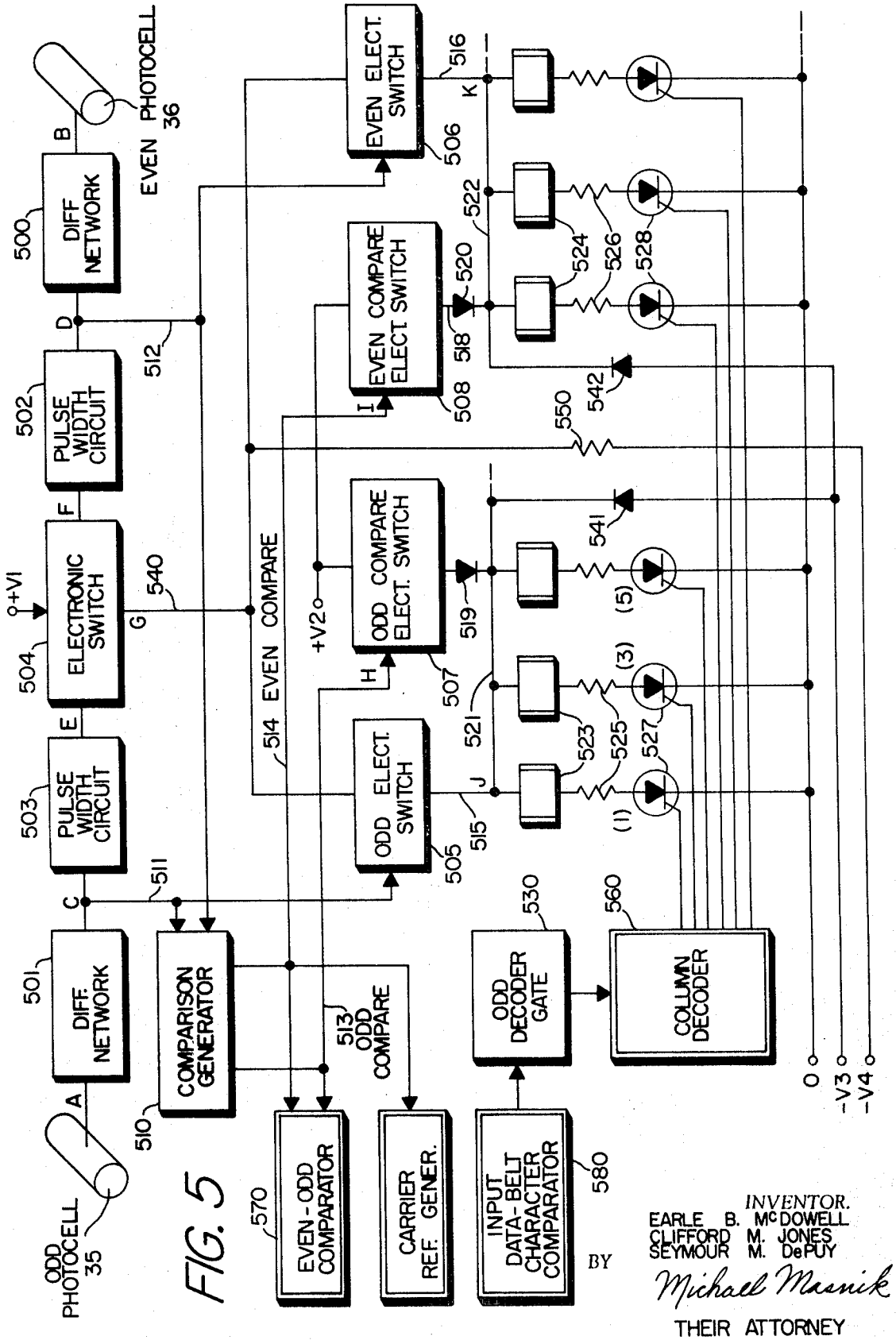

FIG. 5

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Filed June 4, 1968 4 Sheets-Sheet 4

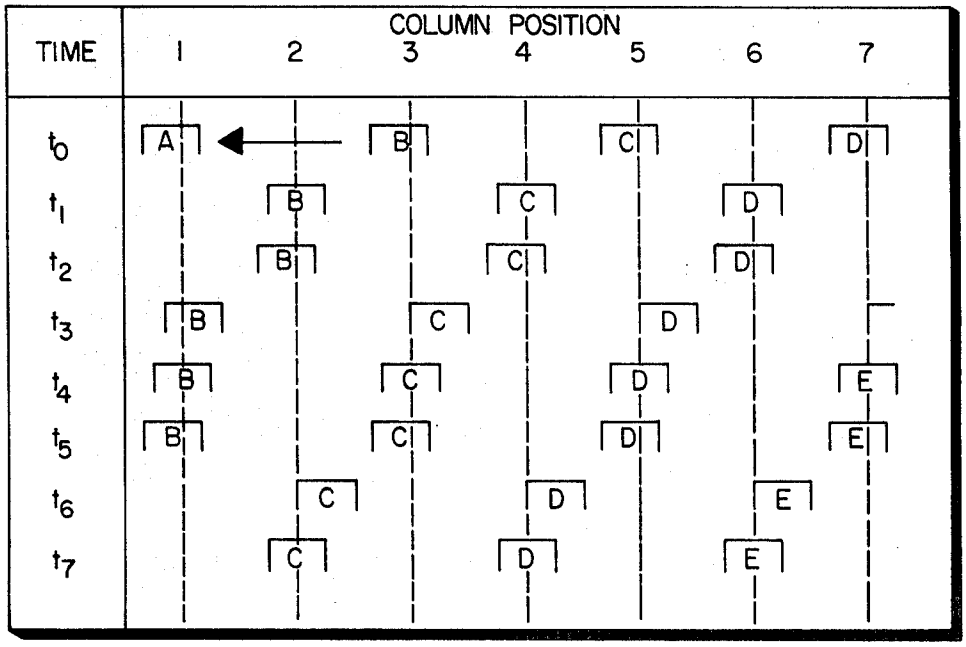

FIG. 6

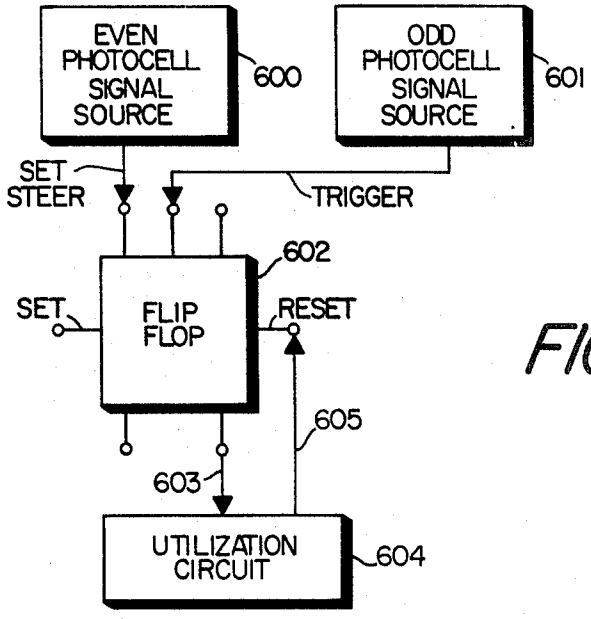

FIG. 7

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United States Patent Office 3,605,610
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3,605,610

TYPE MEMBER POSITION SENSING SYSTEM IN A HIGH SPEED PRINTER

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Filed June 4, 1968, Ser. No. 734,500
Int. Cl. B41j 5/30
U.S. Cl. 101—93 15 Claims

ABSTRACT OF THE DISCLOSURE

A position sensing system that detects the location of each element of a plurality of elements as they traverse a predetermined path. The system is disclosed in conjunction with a printing arrangement wherein the elements are the character bearing fingers on a continuous moving belt.

BACKGROUND OF THE INVENTION

The rapid expansion of the data transmission field has brought with it the need for high-speed printing devices that can accept input data at a high rate. United States patent application Ser. No. 734,501, filed June 4, 1968, by Earle B. McDowell and Clifford M. Jones, and assigned to the General Electric Company, discloses an improved partial line-at-a-time type printer which provides a rapid printout of data. The apparatus of the cited copending patent application utilizes a continuously moving character belt that carries the typefaces for each character to be printed. The number of typefaces carried on the belt depends upon the number of characters or symbols the apparatus is to be capable of printing. A plurality of hammers are arranged in a row across the face of a record medium such as paper, the position of each hammer establishing a column in which a character may be printed. An inking ribbon is positioned in front of the record medium and the path of the character belt is located behind the inking ribbon and in front of the hammers.

If the format of a page provides for a line length of eighty characters, this means that the printer must be capable of printing any desired character in any one of eighty columnar positions. Means must be provided for discretely indicating to the control circuitry where each character appears relative to the record medium. When this is known, circuitry may be provided for energizing the hammers at an appropriate position to imprint the appropriate characters in any desired position. The line-at-a-time aspect of the apparatus is achieved by rotating the type carrying belt at a speed which permits presentation of each character at each of the column positions within the time required for receipt of an entire line of data information.

With this type of printing system, it is necessary to know the position of each character at any instant of time. Since the relative position of each typeface on the belt is fixed, it is possible to simply establish the position of a particular or reference character or type bearing finger on the belt and extrapolate from this information. When this particular character is detected at a predetermined point or reference column location on the complete path of the belt, a "font signal" is generated and the font signal is used to initiate circuit operations that ultimately result in the proper operation of the various type hammers.

Since the movement of the character belt is subject to slight variations in speed, it is also desirable to generate a signal that reflects the velocity of belt movement. More precisely, a pulse is generated each time any character passes a particular point on the path of the belt. The repetition rate of these pulses corresponds to the velocity of the belt and their relative timing discretely represents the relative position of the character.

SUMMARY OF THE INVENTION

The present invention relates to a control system for use with a partial line-at-a-time type printers; more particularly, it relates to a control system for generating signals discretely representative of the relative position of the characters on a character belt and the columns on a record medium.

The illustrative embodiment of the invention described hereinafter, operates in conjunction with a character belt wherein the typeface for each character is located at one end of a flexible finger. The fingers project at right angles from equi-spaced positions on the body of the belt and in general are of identical form. The belt is normally mounted on drive devices which rotate about parallel axes at each edge of the record medium. Thus, the fingers move along a linear path across a line on the record medium.

An object of the invention is to provide improved means for detecting the position of individual elements traversing a predetermined path.

Another object of the invention to provide an improved means for detecting the position of individual characters on a continuously moving character carrying device.

Another object of the invention is to provide an improved arrangement for monitoring passage of an element of known dimensions past a predetermined point along its path.

Still another object of the invention is to provide an improved system for generating discrete signals upon approach and departure of an element relative to a predetermined position.

Yet another object of the invention is to provide an improved system for generating signals upon passage of a plurality of elements past a predetermined point and for generating an additional discrete signal when the characteristics of one of said elements differs from those of the other elements.

In accordance with the invention, there is provided an improved position sensing system operative to establish the precise location of individual elements in a plurality of elements traversing a predetermined path, comprising first and second sensing means positioned proximate to the path which are separated by a discrete distance, and means for modifying the output of the sensing means upon approach and departure of each element.

A complete understanding of the invention and a fuller appreciation of its obejcts and features will be available from the following detailed description which is made in conjunction with the drawings of a particular illustrative embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustrative sketch showing one type of partial line-at-a-time printing apparatus adapted for utilization of the present invention;

FIG. 2 is a view of a photoelectric pickup structure embodying the principles of the invention;

FIG. 3 is a view similar to FIG. 2, showing another embodiment of the invention;

FIG. 4 comprises a plurality of waveforms illustrating the voltage conditions at various points in the circuitry of a further embodiment of the invention;

FIG. 5 is a block diagram of circuitry employed for developing a print control circuit in accordance with the invention;

FIG. 6 is a chart showing the positions of various fingers with respect to the control functions that are initiated by the circuitry of FIG. 5 at those positions;

FIG. 7 illustrates in block diagram form an embodiment of the invention for generating a font signal.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sketch shown in FIG. 1 illustrates the principal components of a partial line-at-a-time printing apparatus of the type shown in the aforementioned U.S. patent application Ser. No. 734,501. This sketch shows a character belt or carrier **10** adapted to be driven at a substantially constant speed around pulleys or drive wheels **13, 14** in a counterclockwise direction as viewed from above. The direction of movement of character belt **10** relative to a record medium **12** is such that it traverses a line or proposed line on the record medium. The belt contains a plurality of type members or flexible fingers **18** each of which includes a type-formed character, numeral, legend, etc., **20** at the upper end thereof. The character belt **10** may contain one or more sets or fonts of type-formed characters.

The record medium **12**, which may for example be paper, is driven in the vertical direction. Adjacent to the record medium and aligned across one row thereof is a typing or inking ribbon **11**. A plurality of individual hammers **28** (only four being shown) are spaced apart from the inking ribbon **11** and are similarly aligned across one row of the record medium **12**. The horizontal position of each hammer corresponds to a column on the recording medium that may register one of the available characters. Character belt **10** is driven with the type-formed characters maintained in alignment between the hammers **28** and the inking ribbon **11**. Thus, each of the characters **20** passes by the face of each of the hammers **28**, so that responsive to appropriate correspondence of a desired character adjacent a selected column, the appropriate hammer can be actuated by energization of a respective solenoid **29**. When energized, each solenoid **29** causes its plunger arm **21** (shown in dotted line) to depress and rotate its associated hammer **28** about a pivot axis **23**, thereby driving the upper impact head of the hammer against a passing flexible type finger **18**. The type fingers responds to hammer actuation by deflecting toward the ribbon, driving the ribbon into the record medium to cause the character to be printed on the record medium at the selected column location.

FIG. 1 also shows a light source **34** and a pair of photosensors **35** and **36**. Interposed between the light source and the photosensors are the fingers **18** on the character belt and an apertured shield **37**. As explained hereinafter, light source **34** and the pickup photosensors **35, 36** with respectively associated apertures **30** and **31**, are used to provide a "count" signal and a "font" signal. The character belt has at least one font of characters arranged in a predetermined sequence. The "font" and "count" signals are effective to indicate registration of the characters adjacent to a reference location. This indication is derived as follows. Generator **33** responds to the output of photocells **35** and **36** to produce a character count and a font signal. The font signal represents the passage of a special finger which will be described hereafter indicating the passage of a particular reference character past a predetermined print column position. Following the font signal, each finger passing slot **30** interrupts the light beam from **34** and causes photocell **35** to produce an odd signal count at the output of photocell **35**, and then in subsequently passing the aperture **31** interrupts the light beam again to produce an even column count signal at the output of photocell **36**. The font signal, as will be described shortly, is produced in response to the output of both photocells. The character count and font signals available from **33** are applied to the print command signal source **39**. Source **39** responds to the application of input data character signals from a source **40**, such as a tape reader, keyboard or incoming transmission line message, and the output from **33** to produce hammer actuation control signals over cable **23**. Source **39** responds to its logic circuitry and the various inputs supplied thereto to energize respective one or more of said solenoids **29** to cause hammer operation and printout of the proper characters at the desired column positions. Further details of the operation of the print command signal source and character conut and font signal generators will be described hereafter.

As explained relative to the control circuitry in the aforecited application, a circulating shift register memory unit in **39** receives and serially circulates input data character signals. The printer is effective to generate "sum" signals which denote the sum of the signal representing the particular finger located at the reference point and the desired column at which each character is to be printed. The sum signal is then applied to a comparator where it is compared with each of the circulating data character signals in the memory unit and a print command signal is generated in response to a coincidence comparison. This print command signal applied over cable **23** controls energization of the appropriate solenoid **29** and operation of the associated hammer **28**. This is shown in FIG. 1 by the cable **23** interconnecting the print command signal source **39** to respective ones of solenoids **29**.

In the system disclosed in the aforecited United States patent application, it was found desirable to double space the character fingers **18**. In other words, rather than having a character finger positioned in accordance with each column on the recording medium, the fingers are spaced to be positioned at every other column. Of course, it is necessary to have hammers for printing at each column position. Accordingly, means must be provided for accommodating the difference between the hammer and finger spacing.

In view of the fact that the character fingers are double spaced, it will be recognized that the sum signals are distinct for one half of the column positions. That is, the sum signal is the same for columns **2** and **3**, for columns **4** and **5**, and every column thereafter. It is thus necessary to provide means for obtaining the additional information required to separate the odd columns (which may be considered at a first instant of time to contain the fingers), from the even columns (which at said first instant of time do not contain the fingers). When this is known, it is possible to energize the comparator outputs to only the odd column hammers during the time that the characters are approaching the odd columns and to energize the outputs to only the even column hammers during the time that the characters are approaching the even columns. The present invention provides for detecting and indicating the character position and effects the necessary unraveling of the odd and even conditions to properly control the hammers **28**.

As shown in FIGS. 1 and 2, the pickup or detection elements comprise a light source **34** and two photocells **35, 36**, respectively located so that the fingers **18** intercept the light received by the cells. An aperture plate **37**, or similar means, is employed to insure that there is a small aperture in front of each cell. The signals generated by each cell as the light impinges thereupon, are utilized to derive all of the other signals discussed hereinafter in order to effect and initiate the various control functions. The two apertures **30** and **31** are spaced so that the suc-

cessive signals generated by the passage of a finger **18** occur at a time interval corresponding to the passage of one column width. Each finger generates two signals as it passes by the apertures. With reference to the position of the fingers relative to the record medium **12** and hammers **28**, it will be appreciated that the first signal occurs as the fingers approach the odd columns and the second signal occurs as the fingers approach the even columns. The apertures are precisely spaced to effect an accurate spacing of the odd-even signals with no variation for changes in belt speed.

A graphic illustration of the signals that are generated as the fingers **18** pass the photocell assembly, may be had by consideration of waveforms A and B in FIG. 4. Each character finger **18** is designed with a width less than the distance between photocells **35** and **36**. In a typical embodiment, the column width was 0.1 inch, the finger width was 0.09 inch and the space between the fingers was 0.11 inch. This relationship between the width of the fingers and the distance between the cells results in the energization, i.e., exposure to light, of each cell for a longer period than its disablement. The abscissa of each of the waveforms A and B represents time and the ordinate thereof represents voltage. Accordingly, the light "on" interval is represented by those portions of the waveform shown as having a positive voltage. In FIG. 2 the fingers **18** are considered to move from left to right. At time t_0, the trailing edge of a finger may be assumed to uncover the aperture **30** in front of photocell **35**. It will be further assumed that at this time, the fingers are approaching the odd columns and accordingly cell **35** will be hereinafter referred to as the "odd" photocell. At time t_1, the trailing edge of the same finger will uncover the aperture **31** in front of photocell **36**. In view of the previous assumptions, the fingers are approaching the even columns at this time, and accordingly, cell **36** will be hereinafter referred to as the "even" photocell. As successive fingers **18** pass the photocells, their respective trailing edges will expose the photocells in the same manner, effecting positive voltage swings at the output of odd photocell **35** at times t_2, t_4, etc., and at the output of even photocell **36** at times t_3, etc.

Obviously, although a single light source **34** has been illustrated in the drawnig, individual light sources for each photocell may be employed. Still further, it will be appreciated that the photocell sensor assembly may be positioned in line with finger movements in order to adjust the point at which the signals are generated relative to column location.

The manner in which the signals generated by photocells **35** and **36** are used to control the hammer energization circuitry, will be seen by reference to the block diagram in FIG. 5. For brevity, FIG. 5 and the following discussion provides details concerning only the elements that are germane to this invention. Circuits and units employed in the system disclosed in copending application Ser. No. 734,501, are shown by double-line blocks in FIG. 5. A thorough understanding of the functioning of such circuits is available from said application. The capital letters appearing in FIG. 5 indicate that the voltage appearing at that location corresponds to the like designated waveform shown in FIG. 4.

Each output signal from the Photocell Sensors **35** and **36** has its positive going excursions differentiated in order to develop a sharply defined pulse commencing at the positive-going portion thereof. This is accomplished by means of a Differentiation Network **501** for the signal from odd photocell **35**, and a Differentiation Network **500** for the signal from even photocell **36**. Waveforms C and D in FIG. 4 are illustrative of the signal outputs from the Differentiation Networks **501** and **500**, respectively. After differentiation, driving signals are developed by applying the differentiated pulses to Pulse Width Circuits **503** and **502**, respectively. Waveforms E and F in FIG. 4 illustrate the drive pulse outputs of Pulse Width Circuits **503** and **502**. The successive odd drive pulses in waveform E and the successive even drive pulses in waveform F, are each spaced by a time equivalent to the time for movement of the fingers through two column positions. All of the odd drive pulses are offset in phase from the even drive pulses by a time interval equivalent to the time for movement of a finger from one aperture to the next. This is one column width.

The fixed duration of the drive pulses illustrated in waveforms E and F is used to establish the time interval during which voltage is applied to the hammer solenoids in order to permit actuation of the appropriate hammer for printing a selected character. It is desired to generate a voltage during either the even or odd timed interval. This is accomplished by applying the signals from Pulse Width Circuit **503** and Pulse Width Circuit **502** to an Electronic Switch **504**. Switch **504** is operative during presence of a drive pulse to connect a regulated voltage, identified as **+V1**, via lead **540** to an Odd Electronic Switch **505** and an Even Electronic Switch **506**. In the absence of either an odd or even drive signal, Electronic Switch **504** does not operate and the voltage on lead **540** is maintained at a lower level as a result of an interconnection to a voltage designated **—V4**, by means of a resistor **550**. The Odd Electronic Switch **505** and its even counterpart **506** are used to apply voltage to respective hammer buses **521** and **522**, to which all of the solenoid coils of the respective hammers are connected. A suitable component for effecting the desired switching function is a silicon controlled rectifier Odd Electronic Switch **505** is operative to apply the voltage **+V1** to odd hammer bus **521** via lead **515**. Similarly, Even Electronic Switch **506** applies the voltage **+V1** to even hammer bus **522** via lead **516**. The Even and Odd Electronic Switches **506** and **505** are rendered conductive by the output of Differentiation Network **500** and **501**, respectively. Thus, it will be seen that each switch applies an operating voltage to its associated bus in accordance with the signal developed by the respective photosensors. The Electronic Switches **505** and **506** are in effect turned on by the differentiated signals illustrated by waveforms C and D in FIG. 4 and they are turned off (removing power from the hammer solenoids) upon termination of the drive pulses shown by waveforms E and F in FIG. 4.

The odd and the even hammer solenoinds are controlled by circuits that are similar. The even hammer solenoid circuit may be considered as typical. Even hammer solenoids **524** are each connected from even hammer bus **522** via a resistor **526** and a switching element **528** to a common bus **529**, which may be grounded. Switching elements **528** are shown as silicon controlled retcifiers having their control electrodes connected to a Column Decoder **560**. The Column Decoder is fully disclosed and discussed in the aforecited patent application Ser. No. 734,501. It determines which hammers are to be actuated in order to print appropriate characters in desired columns on the record medium. The determination is indicated by the development of a triggering pulse on the lead connected to the control electrode of the appropriate controlled rectifier. By way of refinement, the response time of the various hammer solenoids is increased by providing resistors **526**. In addition, to provide for decay current in a solenoid, unidirectional conducting devices **541** and **542** are provided between a voltage source **—V3** and the odd and even hammer buses, respectively. The relative magnitudes of the various voltage levels referred to, will be apparent from FIG. 4.

In addition to initiating control over the hammer solenoids, the differentiated signals shown as waveforms C and D in FIG. 4, are applied to a Comparison Generator **510**. Comparison Generator **510** develops two signals after a slight time delay. These signals are designated "ODD COMPARE" and "EVEN COMPARE." They are illustrated by waveforms H and I in FIG. 4. They are used in order to control two circuits which are more

fully described in the aforecited copending patent application.

First, the output signals from Comparison Generator **510** are compared in an Odd-Even Comparator **570** with a column signal representing the column currently being processed. If the column signal indicates that an odd column is involved and the ODD COMPARE signal is present, the Input Data-Belt Character Comparator **580** shown in the copending application is enabled. If neither of the above conditions exists, the Comparator **580** is disabled. As explained in said application, since the Comparator **580** controls the Column Decoder **560**, trigger signals will be applied to the silicon controlled rectifier gates only when the Comparator **580** is both enabled and indicates a comparison between stored data and character positioning.

The EVEN COMPARE AND ODD COMPARE signals from Comparison Generator **510** are also used to control further Electronic Switches **508**, **507** which are connected to the even and odd buses, respectively. These switches may be in the form of transistors and when the voltage on lead **540** is lower than +V1, they are not operable. Electronic switches **507** and **508** are used to sustain conduction of the hammer control silicon controlled rectifiers **527**, **528**, but not trigger them. For example, during the interval when the ODD COMPARE signal is present, Comparator **580** is enabled to odd column numbers. Whenever coincidence in the Comparator **580** occurs, the resulting decoded column signal is applied via Column Decoder **560** to the control electrode of the appropriate odd SCR's **527**, causing them to conduct. Similarly, during EVEN COMPARE intervals, decoded signals are applied to the control electrodes of the appropriate even SCR's **528**. The controlled rectifiers perform the function of short time memory devices, storing column information in the individual hammer circuits during the compare interval.

The waveforms J and K in FIG. 4 show the composite effect of the various voltages applied to odd bus **521** and even bus **522**, respectively. During the compare interval, when +V2 is applied to the buses via Electronic Switches **507**, **508**, various control electrodes will receive signals from Column Decoder **560**, and a small holding current flows in the hammer coils **523**, **524** whose controlled rectifiers have received signals. At termination of the compare interval, the voltage +V1 is applied and a large current flows in these coils. A short interval later, the hammers strike the fingers which have moved into column position. During the interval when neither +V1 nor +V2 is applied, energy is removed from the coils and the voltage of the hammer buses **521**, **522** decreases to −V3 (a voltage more positive than −V4). Rectifiers **519** and **520** function to isolate voltage supply of +V2 during the interval when the voltage supply of +V1 is being applied to the buses.

For a more complete understanding of the operating sequence hereinbefore described, reference is made to FIG. 6. In this figure, a chart is presented illustrating the position of the various character fingers at different periods in time.

At time t_0, the fingers of the character belt are assumed to be in the approximate positions shown with respect to columns **1** through **6** on the record medium. At this initial instant of time, the ODD COMPARE signal begins and the Input Data-Belt Character Comparator **580** is enabled to odd column numbers. Thus, if comparison is found during this interval, Column Decoder **560** permits its output to apply triggering signals to the control electrode of the appropriate controlled rectifier **527** associated with the odd column in which printing is to take place. This may occur several times during the ODD COMPARE period, and accordingly several odd controlled rectifiers **527** may be triggered into conduction. Excitation voltage has been applied to the coils **524** of the even hammers, but this will not be considered for the moment. As indicated in FIG. 6, character "B" is moving to the next odd column **1**, letter "C" is moving to column **3**, letter "D" is moving to column **5**, etc. If "B" is to be printed in column **1** and "D" is to be printed in column **5**, controlled rectifiers (**1**) and (**5**) would receive signals and holding current would flow due to voltage +V2 which was applied at time t_0.

During the interval from t_0 to t_1, decoding occurs and the characters move to the approximate positions illustrated. At time t_1, odd comparison terminates and the voltage +V1 is immediately applied to the odd hammer bus **521**. Current flows in those coils **523** with controlled rectifiers **527** that have been made conductive. Accordingly, the respective hammers begin movement.

At time t_2, the Column Decoder **560** adjusts its output to apply appropriate control signals to the even controlled rectifiers **528** in the same manner described relative to the odd hammer circuits. At time t_3, voltage is removed from odd bus **521**. The hammers are in flight at this point and inertia keeps them moving even though power is removed. At this instant the hammers are close to the fingers but in a preferred embodiment they have not yet made contact.

At time t_4, even comparison terminates and the voltage +V1 is applied to the even hammer bus **522**. An instant later, when the characters are aligned with each column, the odd hammers make contact with the fingers which have advanced from the initial positions shown at time t_0 and the typeface drives the ribbon onto the record medium.

The distance of the characters from the odd column locations at time t_1 when voltage +V1 is applied, is equal to the product of the finger velocity and the response time of the hammer. The photocell assembly is properly positioned so that voltage +V1 is applied when the fingers are at the correct distance from the column position to effect proper hammer actuation and printing. At time t_5, odd comparison begins again and the aforedescribed sequence of operations is repeated.

In addition to utilizing the photocell assembly for generating signals each time a finger passes, it is possible to use this same assembly to generate a font signal representative of a particular position of a character belt and/or the beginning of a font of characters. As described above, the width of the fingers **18** is normally narrower than the space between them. Thus, the interval when each photocell is dark is shorter than the interval when it receives light. Furthermore, because the photocell apertures are spaced approximately 0.1 inch apart, which is greater than the finger width, there is never a condition when both cells are dark at the same time.

In accordance with a further feature of the invention, one of the fingers **18** is increased in width at its leading edge in order to produce a dark interval of the photocells that is longer than the light interval. The increase in width may be for example from 0.09 inch to 0.13 inch. This condition is illustrated in finger **22** in FIG. 3. Waveforms L and M in FIG. 4 illustrate the signals which occur as the single wide finger passes the photocells. It will be noted that there are two intervals when both photocells are dark, i.e., at zero voltage, at the same time. The first dark interval occurs when the leading edge of the wide finger **22** covers the odd photocell **35**. At this time the trailing edge of the preceding finger also covers the even photocell **36**. The second dark interval occurs a short time later when the wide finger **22** has advanced to the illustrated position where it covers both photocells. The odd-even signals can be applied to suitable logic circuitry to generate a discrete signal for either one of the dark intervals. To make this a "font" signal, it is simply necessary to widen the appropriate finger.

With specific reference to the system described in the aforecited patent application, a font signal may be generated by the inclusion of a flip-flop as shown in FIG. 7. The signal from even photocell **36** is used as a steering

signal to the flip-flop, and the flip-flop is triggered only when the output of the odd photocell **35** reflects a change from dark to light. This arrangement assures that the flip-flop will function to produce a discrete font signal from the second dark interval.

Referring to FIG. 7 when both photocell signal sources **600** and **601** are illuminated or one is darkened and the other is illuminated, the flip-flop **602** is in the reset state, and no control signal is sent over lead **603** to the utilization device **604**. In a particular embodiment **600** and **601** comprised photocells **36** and **35** respectively, and **604** comprised a finger counter. Ordinarily each of the fingers **18** has at least one of its edges, the trailing edge in a particular embodiment, precisely located with respect to the same edges of the other fingers and having a width which precludes simultaneously darkening both photocells **35** and **36**. In view of the latter flip-flop **602** is precluded from operating device **604**. However, if one of the fingers, say **22** shown in FIG. 3 is broadened to permit simultaneous darkening of both photocells the even photocell cell circuit sends a set signal to flip-flop **602**. Then when the odd photocell goes from darkened to illuminated, a signal is sent to **604**. In a particular embodiment **604** comprised a finger counter, and the flip-flop output signal reset the counter to a reference count, indicating the beginning of a finger count. For further details of the embodiment reference can be made to FIG. 6 of the aforementioned application wherein the finger counter is reset to a count of 32. Thus only when one of the sensors, say the odd sensor, goes from darkened to illuminated in the presence of a darkened other sensor, i.e., even sensor, is a utilization signal produced and delivered to a utilization device. After the device **604** has been reset to its predetermined count state, a reset signal is delivered from **604** over **605** to **602**.

It should be noted that in the particular embodiment described, the precisely located trailing edge of the fingers was employed to initiate the hammer drive signals, both odd and even hammer drives, and a compare signal occurring between hammer drive signals and just prior to the initiation of a drive signal. An extension of the other or leading edge of one of the fingers provides the change in font signal. These results occur since the normal finger width is less than the spacing between aperture centers where the aperture center spacing is equal to the column center spacing. The wide finger, however, has a width which is greater than the spacing between aperture centers which permits both photocells to be darkened concurrently and thereby to provide a distinguishing and therefore useful signal.

It should be noted that in other applications, the particular edges employed may be interchanged and their functions may differ without departing from the spirit of the invention.

It will be appreciated that increasing the width of a finger at its leading edge does not interfere with normal operation because all other signals are initiated at the trailing edge of each finger as it uncovers the apertures and permits light to reach the photocells. Of course, it is only necessary to increase the width of the fingers at the portion that intercepts the light beam.

Although a particular embodiment of the invention has been shown and described, it will be appreciated that the applicant intends to include all those modifications which come within the spirit and teachings of the invention. By way of example only, it should be understood that although optical means have been described for detecting passage of elements, other means may be employed. Thus, magnetic principles may be adopted by using magnetc fingers and magnetic sensors having their points of sensing action positioned along the print line and spaced apart the requisite number of print column positions. A magnetic flux system employing non-magnetic fingers could also be used. An oscillator might generate a high frequency magnetic field in the path of the fingers. Suitably located pickup coils in the flux field would then have a change in induced voltage as the fingers passed through the field. Of course, the invention is also adapted for use with printing systems and apparatus differing from that of the oft-cited application Ser. No. 734,501.

While the optical elements have been shown on the side of the belt remote from the hammer location, it should be recognized that other locations may be more suitable. For example, the elements could be located on the hammer side of the belt and even entered along the line of type.

All arrangements falling within the fair meaning and scope of the following claims are intended to be included within this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A printer comprising a plurality of type members mounted upon a flexible type carrier means, said type carrier being movable along a print line having a plurality of spaced print positions, a plurality of selectively operable hammer means positioned along said print line for striking said type members at said print positions to cause printing along said print line at even and odd print column positions, each of said hammer means spanning a respective print column position, said type members having their centers uniformly spaced apart a distance equal to twice the distance between the centers of adjacent hammer means, first and second sensors positioned along said print line and spaced apart a distance equal to the distance between the centers of an odd number of print column positions, means to advance said type carrier means along said print line, means for supplying coded data to be printed, means responsive to one of said sensors for providing a first signal in response to the type bearing fingers coinciding with a given alignment with the odd print column positions, means responsive to the other of said sensors for providing a second signal in response to the type bearing fingers coinciding with a given alignment with the even print column positions, means responsive to both of said sensors to provide a third signal indicating the instantaneous position of the type carried by said carrier in relation to the columns of said print line, means responsive to said first, second and third signals for providing a coded signal denoting each of said plurality of said type members aligned for printing at desired print column positions, means for comparing said supplied coded data to be printed at particular print column positions and said provided coded signal for the type members aligned at desired print column positions, and means responsive to a given compare signal to actuate the proper hammer means to print the supplied characters at the selected print positions.

2. An arrangement according to claim **1** wherein said means for supplying a coded signal denoting each of said plurality of type members aligned for printing comprises a circulating column counter.

3. A position sensing system for printing symbols in response to input data along a print line having a plurality of alternately spaced odd and even print column positions comprising a plurality of type fingers, means for moving each of said type fingers in series to successively traverse all of the print column positions associated with said predetermined print line, said fingers having their centers uniformly spaced apart a distance equal to an integral multiple of twice the distance between the centers of adjacent print column positions, first and second sensors positioned along said print line and spaced apart a distance which is a function of the distance between the centers of adjacent print column positions, one of said sensors providing a first signal in response to the type fingers coinciding with a given alignment with one of said odd or even print column positions, the other of said sensors providing a second signal in response to the type fingers coinciding with a given alignment with the other of said odd or even print column positions, and print control means responsive to said first and second signals to enable operation of

desired type bearing fingers to effect printing in accordance with input data at one and the other of said odd or even print column positions respectively.

4. A system according to claim 3 wherein each of said sensors comprises a photosensitive means and associated apertured plate, a light source is disposed in a position to illuminate said photosensitive means through its associated apertured plate, and the path of said type fingers lying between said light source and said photosensitive means.

5. A system according to claim 3 wherein said fingers have a width in the direction of finger movement which is less than the width of a column position.

6. A system according to claim 5 wherein at least the same one edge of each finger is precisely located relative to all other fingers and said first and second sensors detect passage of said edge to generate a first or second signal respectively.

7. A system according to claim 6 wherein a selected finger has a wider configuration at the other edge and said first and second sensors simultaneously detect passage of both edges of said selected finger to generate a third signal defining the column location of said series of type fingers.

8. An arrangement according to claim 3 wherein said sensors comprise means for transmitting light to said sensors through the spaces between said fingers and said sensors successively sense light interruption by each finger traversing said print line.

9. An arrangement according to claim 3 further comprising means for producing a front signal establishing the instantaneous position of the type carried by said fingers in relation to the columns of said print line comprising the width of said one of said fingers being dimensioned to be greater than one column width, said sensors responsive to the passage of said one finger past said sensors simultaneously to provide a third signal, and means responsive to said first and second signals and said font signal for enabling selected ones of said type fingers to effect printing in accordance with input data at one and the other of said odd or even print column positions respectively.

10. A printer comprising a plurality of type members representing a plurality of fonts mounted upon a flexible type carrier means, said type carrier being movable along a print line having a plurality of alternately spaced even and odd print column positions, a plurality of selectively operable hammer means positioned along said print line for striking said type members at said print column positions to cause printing along said print line at said even and odd print column positions, each of said hammer means spanning a respective print column position, said type members having their centers uniformly spaced apart a distance equal to twice the distance between the centers of adjacent hammer means, first and second sensors having their points of sensing action positioned along said print line and spaced apart a distance equal to the distance between the centers of adjacent print column positions, means to advance said type carrier means to move each of said type members to traverse all of the print columns associated with said print line, means for supplying coded data to be printed, means responsive to said first sensor for providing an odd column position signal in response to the type members coinciding with a given alignment with said odd print column positions, means responsive to said second sensor for providing an even column position signal in response to the type bearing fingers coinciding with a given alignment with said even print column positions, means responsive to both of said sensors to provide a third signal indicating the instantaneous position of the fonts of type carried by said carrier in relation to the columns of said print line.

11. An arrangement according to claim 10 comprising means responsive to said even and odd column position signals to selectively operate said hammer means to only cause printing at said odd or even print column positions respectively, and means responsive to said third signal to establish the font of type to be printed.

12. A position sensing system operative to establish the precise location of individual type bearing fingers mounted upon a carrier such that movement of the carrier along a print line causes each of the fingers to successively traverse all of the print column positions associated with said line, said fingers having a width in the direction of carrier movement less than column width, said fingers being uniformly spaced apart a distance equal to twice the distance between the centers of adjacent print column positions, first and second sensors having their points of sensing action positioned along said print line and spaced apart a distance equal to the distance between the centers of an odd number of print column positions, said first sensor responsive to fingers coinciding with a given alignment with odd numbered ones of said print column positions to provide a first signal, said second sensor responsive to the fingers coinciding with a given alignment with even numbered ones of said print column positions to provide a second signal, and means responsive to said first and second signals to enable said fingers to alternately print along said print line at odd and even numbered ones of said print column positions respectively.

13. A position sensing system operative to establish the precise location of individual type bearing fingers mounted upon a carrier such that movement of the carrier along a print line causes each of the fingers to successively traverse all of the print column positions associated with said line, said fingers having a width in the direction of carrier movement less than a column width, said fingers being uniformly spaced apart a distance equal to twice the distance between the centers of adjacent print column positions, first and second sensors having their points of sensing action positioned along said print line and spaced apart a distance equal to the distance between the centers of adjacent print column positions, said first sensor responsive to fingers coinciding with a given alignment with odd numbered ones of said print column positions to provide a first signal, said second sensor responsive to the fingers coinciding with a given alignment with even numbered ones of said print column positions to provide a second signal, at least one of said fingers having its width extended in one direction of carrier movement to cause said first and second sensors to respond simultaneously with a given alignment of said one finger with both sensors to provide a third signal, and means responsive to said first, second and third signals to enable said fingers to alternately print along said print line at odd and even numbered print column positions.

14. A position sensing system operative to establish the precise location of individual type bearing fingers mounted upon a carrier such that movement of the carrier along a print line causes each of the fingers to successively traverse all of the print column positions associated with said line, said fingers having a width in the direction of carrier movement less than column width, said fingers being uniformly spaced apart a distance equal to twice the distance between the centers of adjacent print column positions, first and second sensors having their points of sensing action positioned along said print line and spaced apart a distance equal to the distance between the centers of adjacent print column positions, said first sensor responsive to the trailing edge of moving fingers coinciding with a given alignment with the odd numbered ones of said print column positions to provide a first signal, said second sensor responsive to the trailing edge of moving fingers coinciding with a given alignment with the even numbered ones of said print column positions to provide a second signal, at least one of said fingers having its width extended in the direction of carrier movement to cause said first and second sensors to respond simultaneously with a given alignment of said one fingers with both sensors to provide a third signal, and means responsive

to said first, second and third signals to enable said fingers to print along said print line.

15. A position sensing system operative to establish the precise location of individual type bearing fingers mounted upon a carrier such that movement of the carrier along a print line causes each of the fingers to successively traverse all of the print column positions associated with said line, said fingers having a width in the direction of carrier movement less than column width, said fingers being uniformly spaced apart a distance equal to twice the distance between the centers of adjacent print column positions, first and second sensors having their points of sensing action positioned along said print line and spaced apart a distance equal to the distance between the centers of adjacent print column positions, said first sensor responsive to each finger successively coinciding with a given alignment with an odd numbered one of said print column positions to provide a train of odd column position signals, said second sensor responsive to each finger successively coinciding with a given alignment with an even numbered one of said print column positions to provide a train of even column position signals, and said first and second sensors responsive to a further finger coinciding simultaneously with a given alignment with an even numbered and an odd numbered one of said print column positions to provide a start of font signal.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,605,610 Dated September 20, 1971

Inventor(s) Earle B. McDowell, Clifford M. Jones and Seymour M. DePuy

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 53, cancel "fingers" and insert -- finger --. Column 4 line 19, cancel "conut" and insert -- count --. Column 5, line 43, cancel "drawnig" and insert -- drawing --. Column 6, line 29, after "rectifier" insert a period. Column 7, line 17, cancel "AND" and insert -- and --. Column 9, line 69, cancel "magnetc" and insert -- magnetic --. Column 11, line 30, cancel "front" and insert -- font --. Column 12, line 69, cancel "fingers" and insert -- finger --.

Signed and sealed this 20th day of June 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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