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PRINTING SYSTEM WITH HELICAL ARRANGEMENT OF TYPE ON TYPE WHEEL

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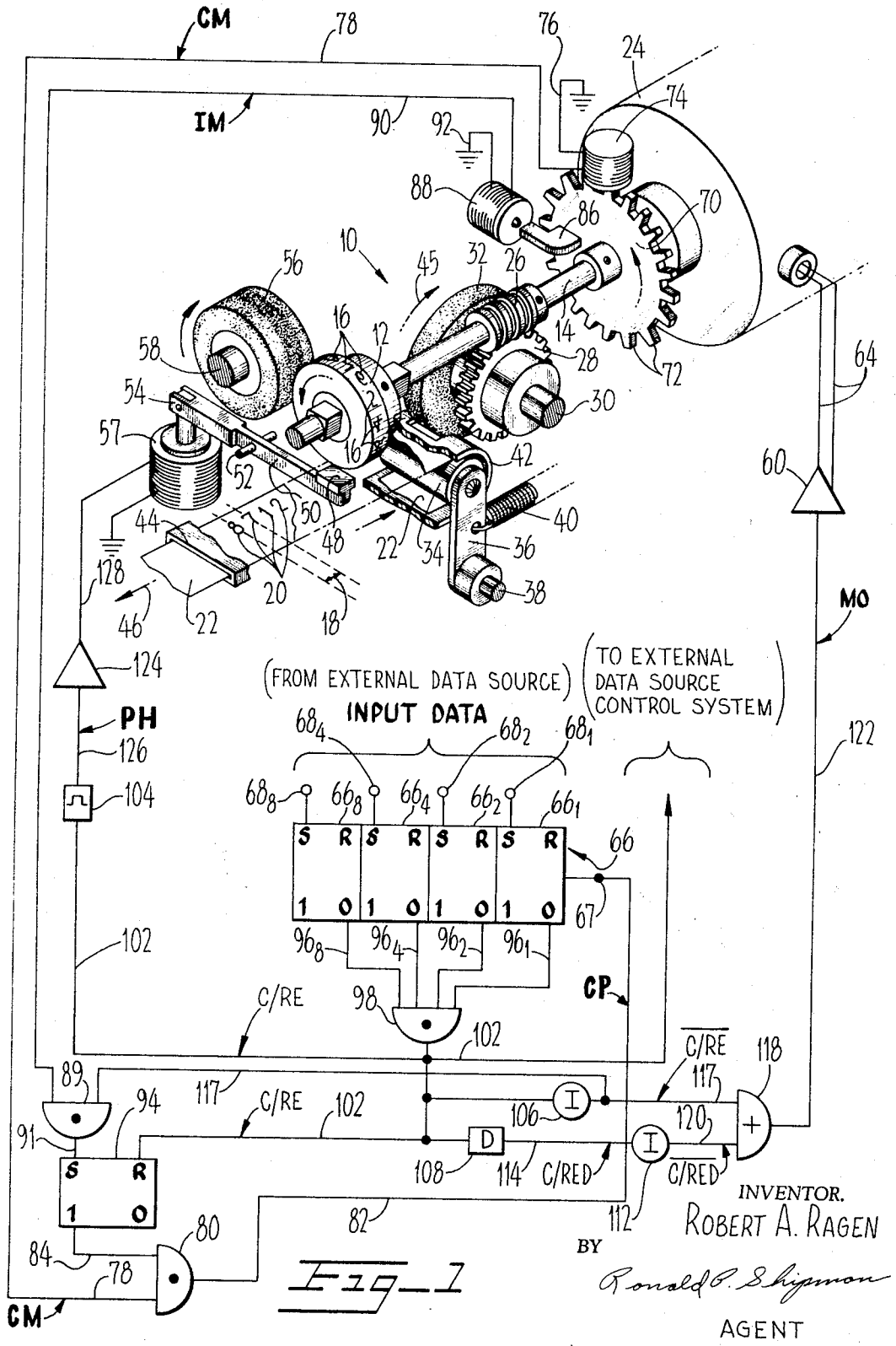


Fig. 1

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PRINTING SYSTEM WITH HELICAL ARRANGEMENT OF TYPE ON TYPE WHEEL

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ABSTRACT OF THE DISCLOSURE

An on-the-fly printer having a rotatable font wheel with printing types arranged in a helical pattern, and an arrangement for moving a strip of paper in a path of travel parallel with the axis of rotation of the font wheel in continuous synchronized movement with rotation of the font wheel. A control system receives and stores character indicative electrical signals from an outside source and responds to such signals for starting the synchronized rotation of the font wheel and movement of the paper strip. Rotation of the font wheel generates an indexing pulse and a train of counting pulses, each counting pulse being indicative of a particular printing type in printing position adjacent the paper strip and a print hammer. The counting pulses are applied to the contents of the character signal storage section, effects printing of one character, and ceases further movement of the font wheel and paper tape if new character indicative signals are not received from the outside source within a predetermined period of time.

Background, field of invention

This invention concerns a high speed on-the-fly printing system, and more particularly concerns a system for controlling the movement of a strip of paper in synchronism with rotation of a font wheel, and for printing selected characters according to coded character signals.

Background, prior art

Strip printers, wherein successive characters are printed one-at-a-time longitudinally on a relatively long or endless strip of paper, are known in the art to which the present invention pertains. Certain types of prior art strip printers utilize a rotatable member such as a font wheel, or disk, on which a plurality or set of character or printing types are disposed circumferentially about the axis of rotation of the member such that each printing type is rotated in the same plane as all other printing types. In such prior art printers, the paper strip must be advanced intermittently in order to precisely position successive portions of the paper strip in proper printing orientation with respect to the path of travel of the printing types of the font member. Structure and control for intermittent advancement of paper requires consumption of a relatively large amount of time, and requires a relatively large number of parts which adds to the cost and maintenance of the apparatus, in addition to imposing a speed limit on the number of characters that may be printed in a unit of time.

Electronic data processors have the capability of transmitting character indicative electric signals or indicia to a printing apparatus at speeds substantially in excess of the printing rate capability of the printing apparatus. Therefore, there is a need for a reliable, efficient high speed printing apparatus in order to utilize data generated or initiated in electronic data processors, or the like, in as rapid a manner as possible.

Summary of invention

One embodiment of the present invention which overcomes the deficiencies of known prior art strip printers, as set forth above, is accomplished by providing a font wheel rotatable about a fixed axis and on which printing or character types are disposed in a helical or spiral pattern with respect to the wheel's axis of rotation, and moving paper strip, while the font wheel is rotating, in a path of travel through a printing position adjacent the font wheel in the same direction as the sweep of the helical or spiral pattern past such printing position. In this manner, for each revolution of the font wheel, each character type of the font wheel is successively positioned over the same portion of the paper strip upon which a character is to be printed. The paper tape is driven in its path of travel by means of constantly engaged inch rollers. At least one of the pinch rollers is operatively coupled with the font wheel so that any rotation of the font wheel results in corresponding proportional movement of the paper strip in its path of travel.

A control system is provided for automatically turning on motive power to the font wheel upon receipt of character data and for automatically turning off such motive power when the character is printed and no other character data is received within a predetermined period of time. Part of the control system includes a subsystem for generating a train of pulses as the font wheel rotates at full operational speed, and a subsystem for utilizing such pulses to detect when the properly desired character type is in printing position. Upon such detection a printing hammer is rapidly impressed against paper to urge the paper into printing contact with the chosen character type.

It is, therefore, an object of the present invention to provide an improved strip printer.

Another object of the present invention is to provide a rapid on-the-fly strip printer.

Still another object of the present invention is to provide a novel means for turning motive power on and off in a high speed printer.

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

Brief description of the drawing

The figure is a combined simplified perspective of the printer structure of the present invention and a simplified logic diagram showing the control system of the present invention.

Description of a preferred embodiment

In the figure there is shown a printing apparatus **10** having a font member or wheel **12** mounted on a longitudinal shaft **14** for rotational movement with the shaft and fixed against axial movement along the shaft. A plurality of printing or character types **16** are suitably formed integrally with, or fixed to, the outer perimeter or circumferential portion of the font wheel in a left-hand screw or helical pattern.

The number of character types **16** may be any desired number. For the purposes of this description it is assumed that there are fifteen character types on the font wheel as set forth in Table I below. It is to be noted that the set of fifteen character types includes the character "space."

"Space" is actually the absence of any raised character printing surface at a location where a raised surface printing type could be. It will be apparent to those skilled in the art to which the present invention pertains, that "space" is required when it is desired to separate printed characters by a predetermined distance, such as, for example, between the last letter of a printed word and the first letter of the next succeeding printed word. The character types are circumferentially (i.e., angularly) spaced from adjacent types by equal amounts. Thus the

outer perimeter of the font wheel is divided into fifteen segments or portions, each having contained thereon a saparate character type. Each character type is axially offset from adjacent character types according to a left-hand screw or helical pattern. The pitch of the helical pattern is a predetermined value substantially equal to the center-to-center spacing **18** of printed characters **20** on the strip of paper **22**.

The shaft **14** is connected to a rotative power means, or source, such as electric motor **24** by direct drive as shown, or intermediate couplings such as, for example, gears or pulleys and belts as desired.

A worm gear **26** having right-handed threads is fixed on the shaft **14** for rotation therewith and held against axial movement therealong. A ring gear **28** is fixedly mounted on a shaft **30** suitably mounted in a base frame (not shown), and disposed beneath the shaft **14**; the shaft **30** extends substantially normal to the shaft **14**. The teeth of the ring gear are in mesh with the threads of the worm gear.

A friction wheel **32**, for driving the paper strip **22**, as described in more detail below, is mounted coaxially with the ring gear **28** and fixed so as to rotate with the ring gear. The worm gear, ring gear and circumference of the friction wheel are chosen and interrelated with each other in such a manner that one revolution of the worm gear (and thus one revolution of the font wheel **12**) will cause the outer radial or peripheral surface of the friction wheel to move through an arc having a length equal to the pitch of the helical pattern of the character types on the font wheel **12**; i.e., equal to the center-to-center spacing **18** of printed characters **20**. Such movement of the friction wheel is utilized to synchronize movement of the paper strip **22** with the font wheel.

A pinch roller **34** mounted for rotation about an axis parallel with the axis of shaft **30** is disposed on the upper end of a pivot lever **36** which is pivotally mounted on a shaft **38** secured to the base frame (not shown). A biasing means, such as tension spring **40**, connected between the lever and base frame (not shown), biases the pinch roller **34** against the friction wheel **32** with a small predetermined force.

A curved paper strip guide channel **42** is fixedly mounted on the base frame and curves about the rear portion of the pinch roller **34**.

Paper **22**, in strip form, is fed in a path of travel from a supply spool (not shown) into the lower forward end of the guide channel **42**, up through the nip between the friction wheel **32** and pinch roller **34**, forwardly through the upper end of the curved guide channel, beneath the lowermost point of the font wheel, which is the printing position, and then through a paper tear-off lip or channel **44**.

The force of the biasing spring **40** will cause the pinch roller **34** to urge a small portion of the paper strip into firm frictional contact with the outer circumferential portion of the friction wheel **32**. In this manner, rotation of the friction wheel in the direction shown by arrow **45**, will drive the paper strip **22** in a path of travel past the printing position, or lowermost point of the font wheel **12**, in the direction of arrow **46**.

The degree of friction established between the wheel **32** and strip of paper **22** should be large enough that the paper strip is moved with substantially no slip with respect to the wheel **32**. Thus, in this manner, when the outer perimeter of the font wheel **32** is rotated through an arc equal to the center-to-center printed character spacing **18**, an equal length of paper strip is passed beneath the printing position or lowermost point of the font wheel. It will be clear from the above that due to the left-hand screw, or helical arrangement of the character types **16**, each revolution of the font wheel will cause each character type of the font wheel to pass or be positioned over the same point, or area, on the strip of paper as such point, or area, advances by the spacing or distance **18** beneath the font wheel. Thus, for each revolution of the font wheel, each character type will be in position to be urged into printing contact with the same portion of paper, even though the paper tape is moving with respect to the font wheel.

A print hammer **48** is disposed beneath the lowermost point of the font wheel **12** and beneath the strip of paper **22**. The hammer **48** is disposed on one end of an arm **50** pivoted on a shaft **52** which is secured to the base frame (not shown). The other end **54** of the arm **50** is connected to the armature of a solenoid **57**. Energization of the solenoid will cause the arm to pivot and effect rapid upward movement of the hammer **48** so as to drive the immediately adjacent paper strip portion into printing engagement with that particular character type located immediately above the hammer and paper.

It is to be noted that a rotatable inking roller **56** mounted on a shaft **58** rotates with the font wheel by frictional engagement. Other forms of supplying ink to the types may be utilized, or an inked ribbon passing between the font wheel **12** and paper strip **22** may be utilized, if desired.

The control system of the present invention for turning the motor **24** on and off and for energizing the print hammer at the proper times will now be described.

A data input buffer or counter/register means **66** is shown as having four stages, 66_1, 66_2, 66_4 and 66_8. Each stage is illustrated as a flip-flop (the construction of which is well known in the art to which the present invention pertains and thus is not further described here) having a set or S input, a reset or R input, a "1" output and a "0" output. Individual ones of four input leads 68_1, 68_2, 68_4, 68_8, are connected with an associated set or S input of an individual counter/register stage. The input leads **68** are suitably connected to a source of character indicative signals or data such as, for example, a paper tape reader, a magnetic tape reader, an electronic data processor, etc.

The data word or character indicia periodically furnished to the counter/register **66** is in the form of predetermined voltages and/or current levels on the lines **68**. A voltage and/or current level of one value is representative of a binary "1" while a voltage and/or current level of another value is representative of a binary "0." Thus, with the four input lines **68** and four stages **66**, shown in the figure, binary signals or indicia representative of fifteen alphanumeric characters may be supplied to the counter/register. It is to be noted that the four-stage colunter/register is capable of registering sixteen different data words of four binary digits. However, one of those data words is the binary word "0000," while each of the other fifteen binary words includes at least one binary "1." The binary word "0000" in this invention is equivalent of "no data word." The "no data word" or binary zero condition of the counter/register **66** is utilized advantageously in the present invention. Each respective one of the other fifteen conditions, or four-bit binary words, of the counter/register are representative of a respective alphanumeric character and hence a particular character type **16** of the font wheel **12**, as shown in the following table.

TABLE

Character type position number (measured clockwise with respect to index tab)	Character type	Binary word (4-bit Binary code)	Number of character pulses (CP) to return the counter/register to zero contents (0000)
1	$	1111	1
2	—	1110	2
3	+	1101	3
4	=	1100	4
5	9	1011	5
6	8	1010	6
7	7	1001	7
8	6	1000	8
9	5	0111	9
10	4	0110	10
11	3	0101	11
12	2	0100	12
13	1	0011	13
14	0	0010	14
15	"Space"	0001	15

For example, as shown in the preceding table, the character type "space" may be associated with the binary word "0001," while the previous character type "9" is associated with the binary word "0010," and the next previous character type "8" is associated with the binary word "0011," etc.

In the standby, or waiting condition of the present invention, the content of the counter/register **66** is the binary data word "0000"; i.e., each stage 66_1, 66_2, 66_4 and 66_8 of the counter/register **66** in its reset condition. Each of the "0" output leads 96_1, 96_2, 96_4 and 96_8 from the respective stages of the counter/register **66** are coupled to an associated input of a four-input AND gate **98**. Each "0" lead **96** concurrently furnishes a true or "1" level signal to the AND gate **98** which, in turn, transmits a "1" level counter/register EMPTY (C/RE) signal over its output lead **102** to other parts of the system now to be described.

The "1" level C/RE signal is furnished to an external data source control system (not shown) such as, for example, an electronic data processor, or the like, to indicate that the counter/register **66** is now ready, or in condition to receive a new data word.

Further, the "1" level C/RE signal is furnished to and maintained on the input leads of a one-shot multivibrator **104**, and the R or reset of a flip-flop **94**. The effect of the "1" level C/RE signal to the one-shot multivibrator **104** will be described below in connection with the initiation of energization of the print hammer solenoid **57**.

Upon each occurrence of the "1" level C/RE signal to the R input of the flip-flop **94**, the flip-flop is placed in its reset state, thereby placing a "0" level signal on its output lead **84** for disabling AND gate **80**. It may be assumed that the flip-flop **94** is at this time in its reset state.

Also the "1" level C/RE signal is furnished to the inputs of a first inverter **106** and a signal delay element, or means, **108**. The output signal, or Inverted Counter/Register Empty Signal ($\overline{C/RE}$), of inverter **106** is a binary "0" signal so long as its input signal (C/RE) is at a binary "1" level, and its output signal in a binary "1" signal when its input signal is a binary "0" signal.

The output signal C/RED from the delay element **108** is the same as its input signal, except that any change in level of the input signal appears at the output only after a certain predetermined period of time. The output signal C/RED of the delay element is transmitted to a second inverter **112** via lead **114**. The output signal $\overline{C/RED}$ of inverter **112** is a binary "0" when its input signal is a binary "1," and its output signal is a binary "1" when its input is a binary "0."

The output signal $\overline{C/RE}$ from inverter **106** is furnished via lead **117** to one input of a two-input OR gate **118**, and to one input of a two-input AND gate **89**. The output signal $\overline{C/RED}$ of inverter **112** is furnished, via lead **120**, to the other input of OR gate **118**.

So long as both the $\overline{C/RE}$ and $\overline{C/RED}$ signals to the OR gate **118** are "0" level, the OR gate transmits a "0" level MO signal (motor on false), via lead **122** to a motor control means shown, for example, in the figure as an amplifier **60**. When the signal to the amplifier **60** is false or "0" level the output of the amplifier is such that the motor **24** is not energized. However, when the MO signal on lead **122** from OR gate **118** is a true, or "1" level (MOTOR ON), as will be described below, the amplifier **60** furnishes energizing power to the motor **24** via leads **64**. The shaft or rotor of the motor is thus accelerated, thereby accelerating the shaft **14**.

Upon receipt of character data, or a binary word, in the counter/register **66**, one or more of the stages 66_{1-8} are placed in their set state. Those stages that are placed in their set state will transmit and maintain a "0" level signal from their associated "0" output lead to the AND gate **98**. A "0" level C/RE signal will thus be transmitted via lead **102** to the external Data Source Control System; this "0" level signal will indicate to the Data Source Control System that character data is in the counter/register and no further character data signals are to be sent to the counter/register **66**.

In addition, the "0" level C/RE signal is inverted by first inverter **106**, thereby furnishing a "1" level Counter/Register Empty Not ($\overline{C/RE}$) signal to OR gate **118**, plus one input of AND gate **89**. The OR gate **118** thus immediately transmits a "1" level Motor On (MO) signal to amplifier **60**, even though the other input to the OR gate remains at a "0" level until a predetermined period of time as determined by the delay element **108**. The motor **24** is thus energized upon the receipt and presence of data in the counter/register **66**.

The "0" level C/RE signal on lead **102** to the reset (R) input of flip-flop **94**, and the input of one-shot multivibrator **104** has no effect on those components at this time.

The "0" level C/RE signal to the delay element **108** appears at its output after a short period of time; thus the second inverter **112** is caused to transmit and maintain a "1" level $\overline{C/RED}$ signal on the second input of OR gate **118**. Since the signal on lead **118** to the first input of OR gate **118** is already at a "1" level there is no change in the output of that OR gate. The character data or binary word in the counter/register remains contained or stored therein until changed as now to be described.

As the motor begins to rotate in the counter-clockwise direction, shaft **14** also rotates in such direction. A toothed character mark forming wheel or disk **70** is attached to the shaft **14** for rotation therewith. There are as many circumferentially spaced teeth **72** as there are character printing types (fifteen, as shown in Table I). A transducer **74** is disposed adjacent the circular path of travel of the teeth. The transducer may be of a type wherein the flux density passing through the coil of the transducer is periodically changed as teeth and then spaces between teeth of the wheel **70** pass by the core of the transducer. The change in flux density induces a periodic signal or surge of current in the coil windings and a periodic change in voltage across the transducer's output leads **76** and **78**. Thus the voltage and/or current level of the signal on lead **78** will periodically vary between a maximum and a minimum. The lead **76** is shown as connected to ground. The other lead **78** is coupled to one input of two-input AND gate **80**. The AND gate **80** is any well-known type of electronic circuit responsive to the concurrent presence of signals on each of its inputs having the same voltage and/or current level (commonly termed a true or "1" level signal) by transmitting an output signal (commonly termed a true or a "1" level signal) on an output lead **82**. Likewise, the presence of a signal of another voltage and/or current level (commonly termed a false or "0" level signal) on any one or both of the inputs to the AND gate **80** will cause the gate to transmit an output signal on lead **82** of another voltage and/or current level (commonly termed a false or "0" level signal). The voltages and/or current levels may be of any desired value compatible with the circuits used to make the AND gate **80**.

However, it is to be noted that the magnitude of the voltage and/or current that will appear on the transducer lead **78** is dependent upon the rate of change of the flux density through the coil of the transducer. If the flux density passing through the coil of the transducer is changed at a relatively slow rate, the magnitude of the voltage and/or current on lead **78** will be relatively low. On the other hand, if the flux density passing through the coil of the transducer **74** is changed at a relatively high rate, the magnitude of the voltage and/or current on lead **78** will be relatively high. The rate of change of the flux density through the coil of the transducer is dependent upon the speed at which the teeth **72** are moved past the transducer **74**. The speed at which the teeth are moved past the transducer is dependent upon the angular speed of the disk **70** and the radius of the disk. It can thus be

readily understood that the maximum value of the signals generated on lead **78** will not be reached until the motor **24** reaches its full operating speed. Thus it can be readily understood that a series or train of "1" level character mark (CM) signals will be transmitted via lead **78** to the lower input of AND gate **80** only after the toothed disk **70** rotates at near full operating speed.

The pulses (CP) transmitted from AND gate **80** are to be utilized by the counter/register **66** in order to determine when the font wheel **12** has rotated from a reference position such that a desired character type **16** is in proper printing position just above the print hammer **48**.

As measured from a reference point each tooth **72** of the toothed wheel is associated with a particular character type, as shown in the table. Accordingly, each particular character mark (CM) transmitted from the transducer **74**, in response to particular tooth **72** passing by the transducer, is associated with a particular character **16** on the font wheel **12**.

However, some reference or index point must be established for correct counting of CM pulses to determine the particular character type that is in printing position just above the print hammer **48** as the font wheel rotates.

A means for establishing a reference point is provided by attaching an indexing tooth, or tab, **86** at one side of the toothed disk **70** and angularly located so as to be between two character representing teeth **72** of the wheel, and providing a second transducer **88** mounted adjacent the circular path of travel of the index tab. The construction and operation of the second transducer **88** is like that described above for transducer **74**. One lead **90** of the second transducer **88** is connected to the second input of previously mentioned AND gate **89**. The other lead **92** of the transducer **88** is connected to ground potential. It can thus be understood that for each revolution of the toothed disk **70** a "1" level index mark (IM), or pulse, will be generated on lead **90** after the toothed disk is rotating at full operating speed.

It will be recalled that a "1" level $\overline{C/RE}$ signal is placed on the first input of AND gate **89** at the time the motor is turned on. Thus, AND gate **89** will transmit a "1" level pulse on its output lead **91** to the set or S input of flip-flop **94** upon the first passage of the index tab **86** past its associated transducer **88** after the motor is up to full operating speed and cause flip-flop **94** to be placed in its set state. When flip-flop **94** is placed in its set state, a "1" level signal will be transmitted from its "1" output via lead **84** to the second input of previously mentioned AND gate **80**.

It can thus be understood that AND gate **80** will not be enabled to transmit pulses on its output lead **82** until after the toothed disk **70** has reached near full operating speed and has caused generation of an index mark (IM).

Thus it can be understood that with the system of the present invention there is no need to have the toothed disk **70** and font wheel **12** start rotation from any particular "home" position in order to accurately associate the character marks (CM) with certain character types of the font wheel. In other words, the font wheel and disk may be stopped in any angular position, and then started up again from any angular position.

Now, upon receipt of "1" level character marks (CM) via lead **78**, the AND gate **80** will transmit a train of "1" level character pulses (CP) to the counting input terminal **67** of counter/register **66**.

Each successive "1" level CP pulse increases the binary word in the counter/register by one. Since all binary words (except "0000") contain at least one binary "1," at least one of the stages in the counter/register will be in its set state as the count, or word contained therein, is increased, until such time as the count or word contained therein is changed to "0000" as now to be described.

The counter/register **66** is so constructed and arranged that the next succeeding CP pulse, after the count or word "1111," will cause the count or word to be "0000." Thus it can be readily understood from the above discussion, that the contents of the counter/register will be counted up to its maximum count and then returned to its reset or "no data" condition, i.e., the content of the counter/register is counted "up" to zero.

Assume, for example, that the binary word "1111" was originally entered into the counter/register **66**. Reference to the table shows that this binary word is representative of the symbol or character "$" to be printed. Further, it will be understood that the first tooth **72** of the wheel **70** to pass by the first transducer **74** after the index tab **86** passes the second transducer **88**, is associated with the "$" character type **16** on the font wheel **12**. Further, the font wheel **12** is arranged angularly on the shaft **14** with respect to the disk so that the "$" character type is substantially at the lowermost point on the font wheel just above the print hammer **48** at the time the tooth **72** associated with the symbol "$" causes generation of a "1" level CP pulse. Such "1" level character pulse will cause the contents of the counter/register **66** to be counted up from "1111" to "0000." Thus it will be understood that the character type "$" is substantially in printing position at the time the content of the counter/register is changed to "0000."

From the above example it will be understood that after generation of an index pulse (which generation occurs some indefinite time after receipt in the counter/register of a particular data word) the font wheel will be rotated through as many character positions as necessary to cause the character type represented by the initially entered data word to be in printing position, and when such character type is in printing position the content of the counter/register is made "0000."

The change in the contents of the counter/register **66** to "0000" is utilized to initiate driving of the print hammer upward so as to effect printing contact between the paper **22** and the particular character type now in proper printing position.

When the contents of the counter/register is changed to "0000" all of its "0" output leads 96_1, 96_2, 96_4 and 96_8, transmit "1" level signals to the AND gate **98**. The output of the AND gate is thus changed from "0" level to "1" level and thus the signal on lead **102** to the one-shot multivibrator **104**, and the reset (R) input of flip-flop **94** is changed from "0" level to "1" level. The flip-flop **94** is immediately reset, thereby transmitting, via lead **84**, a "0" level signal to AND gate **80**. Since AND gate **80** is now disabled, no further "1" level CP pulses will be sent to the counter/register **66**. The content of the counter/register **66** thus remains "0000" until a new data word is entered from the Data Control System.

The change in signal level, on lead **102**, from "0" level to "1" level triggers one-shot multivibrator **104**. The one-shot **104** transmits a single "1" level print hammer actuate signal or pulse (PH) to an amplifier **124** via a lead **126**. The time duration of the output pulse (PH) from one-shot **104** is any predetermined value necessary to accomplish very rapid movement of the print hammer **48** into and rebound out of printing engagement with the paper **22** and properly positioned character type of the font wheel **12**. The amplifier **124** responds to the short duration PH pulse by transmitting a solenoid driving signal of sufficiently large current value to the coil of the print hammer actuating solenoid **57** via lead **128**. The short duration high current pulse thus furnished to the solenoid **57** effects very rapid pivoting of the arm **50** in the counter-clockwise direction and causes the print hammer **48** to very rapidly move upwardly to force the paper strip **22** into firm printing engagement with the properly positioned character type. The print hammer **48** will rapidly rebound after making printing engagement with the paper and character type and thus return to its normal position, as shown in the figure.

The "1" level C/RE signal is also transmitted, via lead **102**, to the data source control system and is indicative

of the fact that the counter/register **66** is now ready to receive another input data word.

In addition, the "1" level C/RE signal furnished to the input of the first inverter **106** causes that inverter to transmit from its output a "0" level signal on lead **117** to OR gate **118**, and to AND gate **89**. The AND gate **89** is thus disabled and, hence, no further index mark (IM) signals can be transmitted to the S input of the flip-flop **94**. In addition, the "1" level C/RE signal on lead **102** is transmitted to the input of delay element **108**. However, a "1" level signal still remains for a short period of time on lead **114** to the input of second inverter **112**; this short period of time is determined by the delay element **108**. Thus, a "1" level signal remains on lead **120** to OR gate **118** for a short period of time after the other input, via lead **117**, to OR gate **118** is changed to a "0" level. Thus it can be understood that a "1" level motor on (MO) signal is furnished on lead **122** for a short period of time after the print hammer solenoid is energized. Keeping the motor energized for a short period of time after the print hammer is energized is an optional feature, the purpose of which is to make sure that the chosen character type actually reaches the proper printing position beneath the print hammer at the time the print hammer makes or causes actual contact of the paper **22** with the chosen character type. It should be clear from the foregoing that, if desired, delay element **108**, lead **114**, inverter **112**, plus OR gate **118** may be eliminated, and lead **117** directly connected with lead **122**, and that the required assurance that the print hammer make proper printing contact with the paper and character type be accomplished by appropriate offsetting of the print hammer with respect to the print wheel provided, of course, that the deceleration of the motor and font wheel is a substantially constant factor to take into consideration. Thus, when both input signals to OR gate **118** are "0" level, that OR gate transmits a "0" level signal to amplifier **60** which responds and removes further energizing power from the motor **24**. The motor then decelerates and halts at any arbitrary angular position. The system is now in condition ready for another cycle of operation.

It is to be noted, however, that if the delay element **108**, inverter **112**, plus OR gate **118**, are incorporated as shown, a particular advantage is gained as will now be described. The time constant of the delay element **108** may be so chosen that upon receipt by the data source control system of the "1" level signal on lead **102**, such data source control system is able to transmit new data to the counter/register **66** prior to the time that the signal on lead **120** reverts back to its "0" level. In such an event, it will be noted that when a next succeeding data word is received into the counter/register **66**, a "1" level signal will be furnished to the OR gate **118** via lead **117** from inverter **106**. Thus, by the time the signal on lead **120** to OR gate **118** turns "0" level there will already be another "1" level signal to that OR gate from lead **117**. Thus there will be no change in "1" level output from OR gate **118** and the motor continues to rotate and does not cease rotation.

Additionally, in such event it will be noted that flip-flop **94** will not be placed in its set state until the next occurrence of an index mark. However, the next occurrence of the index mark will occur quite rapidly since the motor is continuing to run at full operating speed. Thus, no time or power is wasted in turning the motor off and then on again.

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

What is claimed is:

1. In an apparatus for printing successive characters on a web material, the combination comprising:

a rotatably mounted font wheel having a substantially circular peripheral portion and a plurality of character printing types disposed on said peripheral portion;

drive means for rotating said font wheel about a central axis normal to the plane defined by said circular peripheral portion, said circular peripheral portion being moved in a circular path of travel;

said drive means including means engageable with said web material for moving a portion of said web material in a predetermined unidirectional path of travel adjacent a part of said circular path of travel and substantially parallel with said axis, said drive means including a single power source for simultaneously rotating said font wheel and driving said web material, said font wheel being mounted on a shaft driven by said single power source and said web material being advanced by means positively driven by said shaft driven by said single source, the speed of rotation of said font wheel and the speed of movement of said web being fixed in an unchanging predetermined ratio by said positively driven means to thereby synchronize movement of said web material with rotation of said font wheel.

2. In an apparatus according to claim **1** wherein said types are arranged on said font wheel according to a predetermined pattern wherein successive ones of said types are offset from said succeeding ones of said types according to the direction of movement of said web material.

3. In an apparatus according to claim **1** wherein said character printing types are arranged on said font wheel according to a helical pattern having a predetermined pitch and sense.

4. In an apparatus according to claim **1** wherein there is further included print hammer means disposed alongside said web material opposite from said part of said circular path of travel, and means for effecting printing contact between said print hammer, said font wheel, and said material while said material and said font wheel are both moving.

5. In an apparatus for printing selective ones of a plurality of characters in response to character representative data, individual ones of said characters being represented by individual character datum, the combination comprising:

a rotatably mounted font wheel having a substantially circular peripheral portion and a plurality of character printing types disposed on said peripheral portion;

power means for rotating said font wheel about a central axis normal to the plane defined by said circular peripheral portion, said circular peripheral portion being moved in a circular path of travel;

drive means engageable with said web material for moving said web material in a predetermined path of travel adjacent a part of said circular path of travel, said drive means including means for synchronizing movement of said web material with rotation of said font wheel wherein said web material moves in its path of travel while said font wheel rotates;

print hammer means disposed alongside said web material opposite from said part of said circular path of travel;

means for effecting printing contact between said print hammer, said font wheel, and said material while said material and said font wheel are both moving;

first means for receiving a character representative datum;

second means responsive to the presence of a character

representative datum in said first means for energizing said power means;

third means responsive to the rotation of said font wheel for generating a set of signals, individual ones of said signals being indicative of the presence of an associated one of said printing types at said part of said circular path of travel;

said first means being responsive to each of said successive ones of said signals for changing the datum contained therein according to a predetermined order wherein the datum contained in said first means is changed to a unique datum indicative of the presence at said part of said circular path of travel of the printing type represented by the datum received by said first means; and

fourth means responsive to the occurrence of said unique datum in said first means for energizing said print hammer means.

6. In an apparatus according to claim **5** wherein said second means is responsive to said unique datum for de-energizing said power means.

7. In an apparatus according to claim **6** wherein there is further included;

fifth means for delaying the response of said second means to said unique datum for a predetermined period of time, and said second means being responsive to the presence of a second character representative datum in said first means during said predetermined period of time for maintaining energization of said power means subsequent to said predetermined period of time.

8. An apparatus for printing selective ones of a plurality of characters on a web material in response to character representative data, individual ones of said characters being represented by an individual character datum, said apparatus comprising:

a rotatably mounted font wheel including a plurality of printing types spaced about the axis of rotation of the font wheel;

selectively energizable means for rotating said font wheel;

means for guiding said material in a path of travel, a portion of which passes adjacent said font wheel;

selectively energizable means for urging the web of material, at said path portion, into printing engagement with selective ones of said printing types as said font wheel rotates;

first means for receiving a character representative datum;

second means responsive to the presence of a character representative datum in said first means for energizing said font wheel rotating means;

third means responsive to the rotation of said font wheel for generating a set of signals, individual ones of said signals being indicative of the presence of an associated one of said printing types at said path portion;

said first means being responsive to each of successive ones of said signals for changing the datum therein according to a predetermined order wherein the datum contained in said first means is changed to a unique datum indicative of the presence of the printing type at said path portion represented by the datum rceived by said first means; and

fourth means responsive to the occurrence of said unique datum in said first means for energizing said web urging means.

9. In an apparatus according to claim **8** wherein said second means is responsive to said unique datum for de-energizing said font wheel rotating means.

10. In the apparatus according to claim **8** wherein said first means is comprised of a set of interconnected bistable means, each of which are switchable between a first condition and a second condition; said bistable means being responsive to said signals for changing states according to a predetermined order, said unique datum being the condition wherein all of said bistable means are in the same predetermined one of said conditions.

11. In the apparatus according to claim **10** wherein said second means includes first gate means responsive to the concurrent conditions of each of said bistable means wherein an energizing signal is transmitted to said font wheel rotating means when at least one of said bistable means is in a condition different from the condition of said one of said conditions and wherein a de-energizing signal is transmitted to said font wheel rotating means when all of said bistable means are in said one of said conditions.

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