United States Patent

[11] **3,561,581**

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[54] **SIGNAL-CONTROLLED PRINTER**
5 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **197/49,** 197/168
[51] **Int. Cl.** **B41j 1/46**
[50] **Field of Search** 197/55, 49, 168

[56] **References Cited**

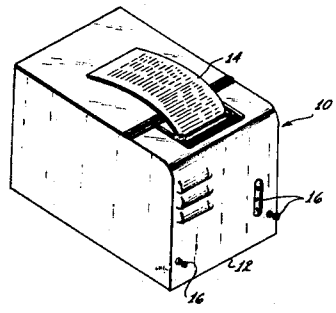
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ABSTRACT: An alphanumeric signal control character printer is disclosed for typing or printing symbolic data in accordance with binary code electrical signals. A somewhat cylindrical-type body or font carries the print symbols and is positioned by a pair of bidirectional stepping motors to align each character in printing relationship to a printing medium. One of the stepping motors translates the type font while the other revolves it. Thus, after a letter, numeral or other symbol disposed about the type font is selectively placed in printing position, a hammer closes the medium and the selected symbol. In this manner, characters are printed (one symbol at a time) and the type font along with the hammer is progressively stepped across the sheet of paper or other medium.

The system also incorporates structure defining a reference position for the font, from which the font is moved to print each character, then returned to the referenced position. By providing more than one reference position, the operating speed of the system is increased. The structure also incorporates a mechanical detent or indexing arrangement whereby the type font is stabilized only in printing position. A control system cooperates with the indexing system to maintain the font in the current reference position, by withholding the operation of the print font until passage of a period during which establishment of the reference position is verified. The system also incorporates an inking structure in the form of a continuous loop of ribbon that is mounted in changing relation to the path of the print font and which ribbon is continuously driven for effectively supplying ink. Still further, the system incorporates an automatic margin control structure whereby carriage return signals may be transmitted to terminate a line of type, or such signals will occur automatically upon reaching a predetermined position, with the occurrence of a space between words.



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SHEET 1 OF 3

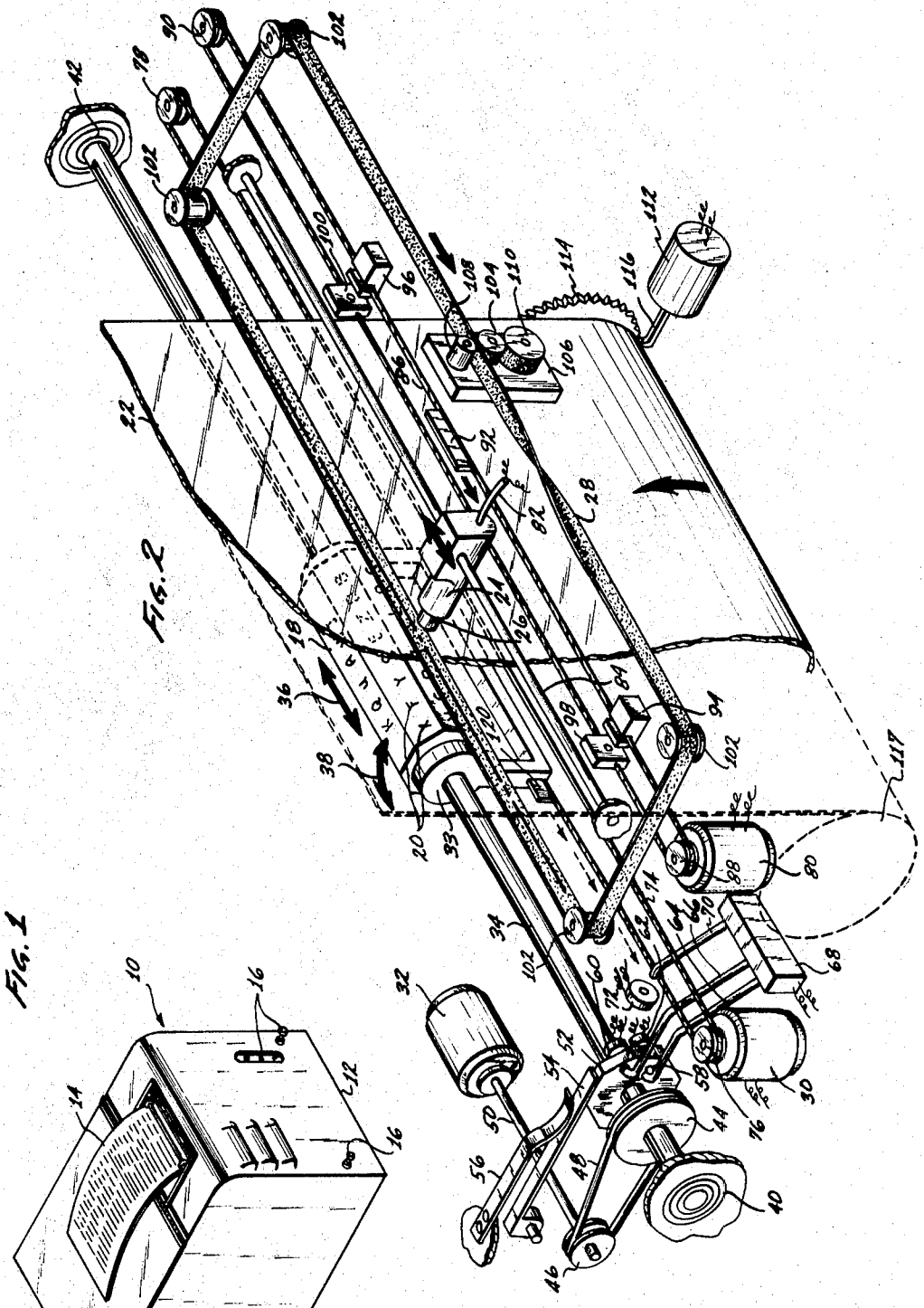


FIG. 2

FIG. 1

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FIG. 5

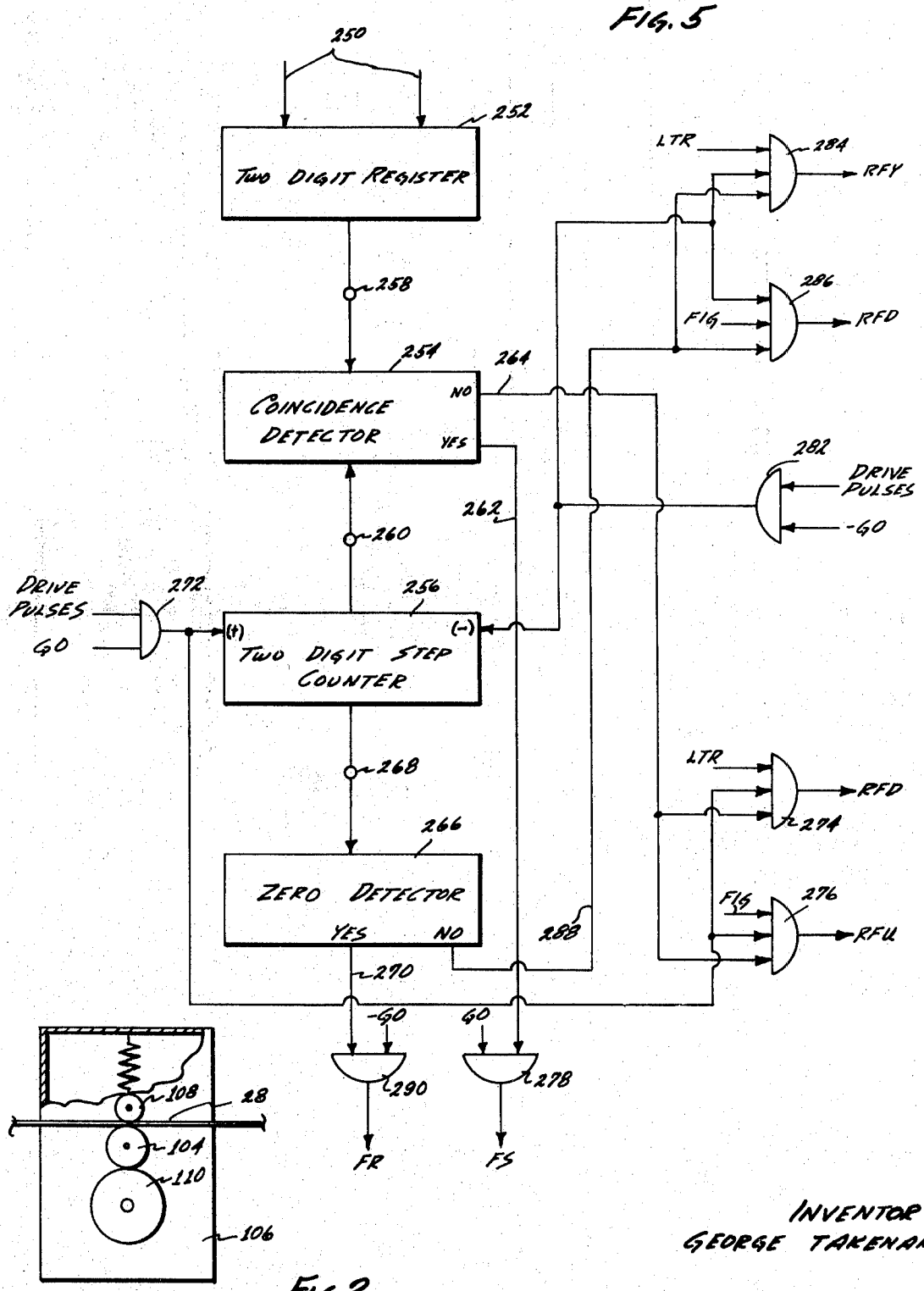


FIG. 3

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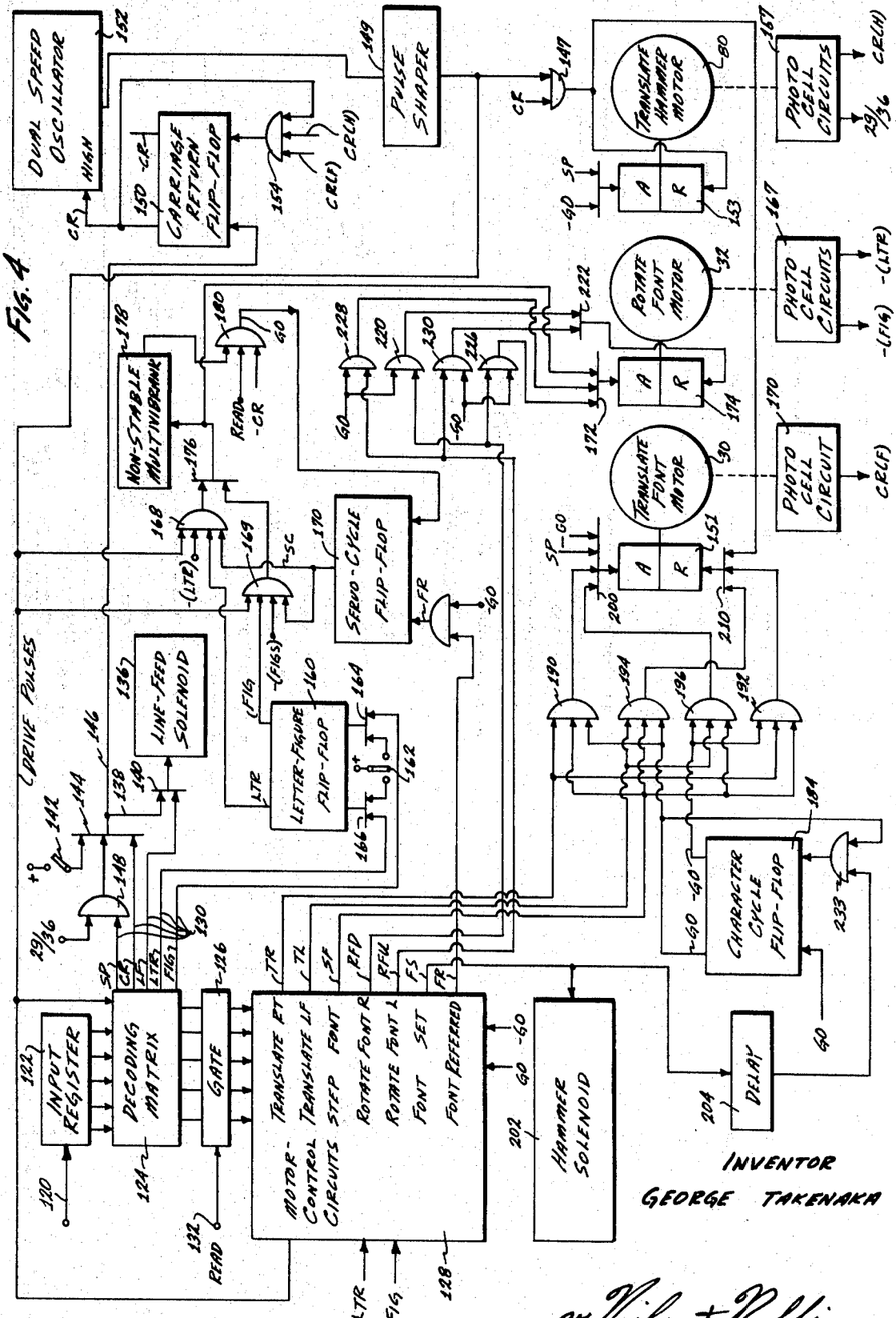

DUAL SPEED OSCILLATOR
HIGH
CARRIAGE RETURN FLIP-FLOP
PULSE SHAPER
TRANSLATE HAMMER MOTOR
PHOTO CELL CIRCUITS
ROTATE FONT MOTOR
TRANSLATE FONT MOTOR
PHOTO CELL CIRCUIT
NON-STABLE MULTIVIBRATOR
SERVO-CYCLE FLIP-FLOP
LINE-FEED SOLENOID
LETTER-FIGURE FLIP-FLOP
CHARACTER CYCLE FLIP-FLOP
DELAY
INPUT REGISTER
DECODING MATRIX
GATE
MOTOR-CONTROL CIRCUITS
TRANSLATE ET
TRANSLATE LF
STEP FONT
ROTATE FONT R
ROTATE FONT L
FONT SET
FONT REFERRED
HAMMER SOLENOID
DRIVE PULSES
READ
LTR
FIG
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FIG. 4

SIGNAL-CONTROLLED PRINTER

BACKGROUND OF THE INVENTION

This is related to U.S. Pat. No. 3,374,873, entitled PRINTING APPARATUS EMPLOYING BIDIRECTIONAL STEPPING MOTORS TO POSITION TYPE MEMBER, with which it was copending.

Signal control printers are widely employed in various applications to transcribe messages that are received in the form of electrical signals. In addition to the widespread use of such printers in stationary installations, a considerable need also exists for them in mobile installations. For example, small printers in various vehicles considerably improve the accuracy of communication and also provide a permanent record of messages. Such installations have been proposed, for example, in police work as well as many other fields.

Although prior printer have been effectively employed in mobile units, the need remains for such a system with improved reliability. For example, one of the problems of prior structures of the type utilizing a single, movable type element, has been maintaining the type element in the proper position immediately before a printing operation is to be performed. That is, the unit may be quiescent for a time, during which the motion of the vehicle, or some other shock displaces the type font from a reference position. If such displacement occurs, when the unit is commanded to print, an erroneous symbol is produced.

Another difficulty with prior structures has been somewhat limited operating speeds. Therefore, a need exists for improving the speed of the operation as well as improving the reliability. Other desirable features in relation to systems of the prior art, include automatic margin control, effective inking, and so on.

In general, the present system is directed toward the accomplishment of the printer having greater reliability, improved operating speed, automatic margin control, and effective inking structure, which unit employs a single type body defining the characters to be printed, which type body is positioned by bidirectional stepping motors in accordance with electrical code signals.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which constitute a part of this specification, an exemplary embodiment demonstrating various objective and features hereof, is set forth. Specifically:

FIG. 1. is a perspective view of a printer constructed in accordance with the present invention;

FIG. 2. is a perspective and diagrammatic view of the mechanical system employed in the structure of FIG. 1;

FIG. 3 is a vertical plan view of a portion of the system of FIG. 2;

FIG. 4 is a diagrammatic representation of the electrical system employed in the printer of FIG. 1; and

FIG. 5 is a diagrammatic representation of a portion of the system of FIG. 4 shown in somewhat greater detail.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

As required, a detailed illustrative embodiment of the invention is disclosed herein. However, it is to be understood that the embodiment merely exemplifies the invention which may be embodied in many forms that are radically different from the illustrative embodiment. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims defining the scope of the invention. Referring initially to FIG. 1, there is shown a printer **10** contained in a relatively small housing **12** and incorporating the principles of the present invention, to accomplish a printed message on paper **14**. The paper **14** moves out of the housing **12** line-by-line, the individual characters in each line being printer one at a time. These characters (along with control operations) are commanded by electrical signals which may be supplied either by a direct electrical line, radio communication or otherwise. The housing **12** supports certain controls **16** including an "On-Off" switch, a shift control (letters or numbers), carriage return, and so on.

Considering the structure of the system in greater detail, reference will now be made to FIG. 2 which shows the type cylinder or font **18**, carrying the type **20** for individual symbols which are to be printed on paper **22** or other medium. Essentially, the printing operation is accomplished by positioning the type font **18** so that a desired one of the symbols lies under the paper **22** at the location of a hammer drive unit **24**. On energization, the unit **24** drives a hammer **26**, forcing an ink-bearing ribbon **28** into momentary contact with the paper **22** in a pattern defined by the symbol type **20** which lies in printing position. As a result, the desired symbol is printed on the paper **22**. In this regard, to position the desired symbol type **20** under the hammer **24**, it may be necessary to revolve and/or translate the font **18** as a preparatory operation. Such translatory operations or movement are accomplished by a stepping motor **30** while the rotational motions are accomplished by a stepping motor **32**.

The type font **18** operates from a specified "home" or reference position and after each printing operation, it is returned to that reference position. In accordance herewith, either of two reference positions may be specified (depending upon the class of symbols to be typed) thereby substantially increasing the operating speed of the system.

The type font **18** is carried in a yoke or cradle **33** which is in turn received on an elongate splined shaft **34**. Thus, the font **18** (being somewhat cylindrical) axially receives the shaft **34** to be moved thereon as indicated by an arrow **36**. Rotational displacement of the font **18** is accomplished by revolving the shaft **34** (keyed to the font **18**) however, which is freely rotatable in the cradle **33**. Thus, as the splined shaft **34** is revolved, the font **18** is similarly revolved as indicated by an arrow **38**.

Considering the rotation of the font **18** in greater detail, the shaft **34** one-eight terminated in bearing sockets **40** and **42** which are integrally affixed into the housing **12** (FIG. 1). Rotational drive for the shaft **34** (FIG. 2) from the motor **32**, is supplied through a pulley **44** which is keyed to the shaft **34** and which is coupled to a pulley **46** by a drive belt **48**. The pulley **46** is carried on a shaft **50** which comprises the shaft of the stepping motor **32**. Thus, the stepping motor **32** is coupled to the font **18** through a drive whereby each step of the motor **32** moves the font **18** through one-eighth revolution, e.g. 45°.

The shaft also carries an octagonal index disc **52** that positively keyed thereto. The disc **52** peripherally defines eight sides to receive a pivotally mounted lever arm **54** which is backed by a leaf spring **56**. As a result, the disc **52** (and the font **18** coupled through the shaft **34**) is limited to eight stable positions, each of which presents one row of the type **20** in aligned printing position.

The disc **52** defines an aperture **58** for operation with a pair of photoelectric devices **60** or **62**, which are operated in cooperation with light pipes **64** and **66** respectively. In this regard, a light source **68** provides illumination to optical light pipes **64** and **66** and **70**, (as well known in the prior art) for delivery to photoelectric devices **62**, **60** and **72** respectively

The photoelectric devices **60** and **62** serve to detect the rotational "home" or reference positions of the font **18** while the photoelectric device **70** detects the completion of a carriage return operation by the font **18** returning to the left, as will be described in detail below.

The translation or axial movements of the font **18** are accomplished by the stepping motor **30** driving a cable or tape **74**. The tape **74** is mounted between a pulley **76** (carried on the shaft of the motor **30**) and a pulley **78** (fixed to the housing or other rigid support). The tape **74** passes through the cradle **33** and is affixed thereto so as to be aligned parallel to the shaft **34**. As a result, each incremental step by the stepping motor **30** displaces the font **18** axially by one incremental space.

In a motion pattern which is somewhat related to the axial movement of the font **18**, the hammer-drive unit **24** is driven by a stepping motor **80**. The unit **24** incorporates a solenoid that is electrically driven through a cable **82**, which serves to propel the hammer **26** against the type **20** of the font **18** with the ribbon **28** and the paper **22** therebetween, thus printing a symbol. The hammer unit **24** is carried on an elongate shaft **84** which is rigidly supported at its end. The hammer unit **24** is also coupled to a cable or tape **86** which is carried on a pulley **88** (driven by the motor **80**) and a fixed pulley **90**. The tape **86**, in addition to being affixed to the hammer unit **24**, also carries a flag **92** which functions in cooperation with a pair of photoelectric devices **94** and **96** (positioned at the left and right margins) and a pair of light sources **98** and **100** which may comprise light pipes or actual independent light sources. The path of the tape **86** is through guide groove formed in the devices **94** and **96** behind the light sources **98** and **100**. The system for supplying ink to the paper **22** includes the ribbon **28** which is of an endless type known in the mathematical art as a "Moebius Strip" having the structure of a single or one-sided surface. The ribbon **28** is made by giving the ribbon a half twist before joining the free ends to make the endless loop. The ribbon is carried on idler rollers **102** which guide it in a path between the parallel paths of the hammer structure **24** and the print font **18**.

The ribbon **28** is held engaged between a drive roller **104** (affixed to a drive unit **106**) and a spring-loaded idler roller **108** (FIG. **3**). Drive roller **104** serves as a transfer roller, contacting an absorbent-pad roller **110** similarly affixed to drive unit **106**) that supplies ink to drive roller **104** and thence to ribbon **28**. As the ribbon **28** moves continuously during operation of the printer, the hammer **26** strikes the ribbon in the top outside portion of the ribbon width during one complete pass, but due to the Moebius Strip configuration of the ribbon **28**, the hammer **26** strikes the bottom inside portion during the next complete pass. As a result, ribbon wear is distributed, enabling the ribbon **28** to: be employed for a prolonged period of use and to be mounted to receive ink in quadrature relation to the printing plane.

As indicated, the illustrative system operates by printing symbols defined by the type **20** on the font **18** onto the paper **22**. At the completion of each line of type, a line-advance solenoid **112** is energized to raise the paper preparatory to the next line. The solenoid **112** is coupled to a ratchet wheel **114** through an armature **116**, the ratchet wheel **114** being connnected to a roll **117** from which the paper **22** is dispensed.

Considering the operation of the system of FIG. **2** during the initial sequence on energization the type font **18** is immediately moved to one of the two reference positions. In the system as disclosed, the reference positions are selected, depending upon whether the system is to be in a "letters" or a "figures" state of operation. The "figures" state of operation may be considered a shift state somewhat analogous to the shifted state of operation in a conventional typewriter. Specifically, if the unit is to type an alphabetic letter next, it is set in the "letter" state and remains in that state so long as letters are to be typed However, when a number, symbol or other figure is to be printed, the system is shifted to the "figures" state.

With the system in one of its residual states, electrical code signals are applied to a decoding an control system (not shown in FIG. **2**) to develop drive pulses to actuate the stepping motors **30** and **32** so as to translate and revolve the font **18** to place the desired symbol type **20** under the hammer **26**. Next, the hammer is drive forward to forcefully engage the ribbon **28** to the paper **22** along with the desired symbol that is that printed. Of course, this operation occurs in an instant of time. The stepping motors **30** and **32** are then actuated to return the font **18** to its residual position. Finally, both the hammer unit **24** and the font **18** are advanced one position to the right to accommodate the next symbol which will be printed on the paper **22**.

At any time, between individual printing operations, the reference state of the system may be altered between the "letters" state and the "figures" state, as will be described hereafter. This transition does or does not occur, depending upon the current state, and whether the next following character is to be a letter or a figure. The transition can be accomplished manually by one of the controls **16** (FIG. **1**) or by a receipt of a command code signal. In this regard, it is to be noted that while the symbols on one side (FIG. **2**) of the font **18** are letters those generally disposed on the other side (not shown) are figures as will be set forth in detail below.

The instant reference state of the system is maintained by the disc **52** in cooperation with a control circuit and the associated photoelectric devices **60** and **62**. That is, the photoelectric device **62** senses the "letters" state, while the photoelectric device **60** senses the "figures" state. These devices function in cooperation with a servosystem that operates during an interval immediately prior to a printing operation or cycle to establish the font **18** in the proper position. Thus, immediately before a typing operation, the font is correctly positioned by a servoloop system (described below) to avoid errors that would otherwise result from displacement of the font **18**, resulting from shock or vibration. Thus, recapitulating, the correct font position is established prior to printing each character, then the font is displaced to set the type **20** for the desired character under the hammer **26**, the hammer unit **24** is energized and the character is printed. Subsequently, the font **18** is returned to its reference position, then both the font and the hammer unit **24** are advanced one step or space to the right.

The cycle is repeated with printed characters and/or blank spaces until a line is completed.

On the completion of a line of type, the "carriage return" operation is initiated either: by supplying an appropriate electrical code signal, automatically when the line is full, or manually, by actuating one of the controls **16**. The carriage-return operation involves a control program for returning the font **18** and the hammer drive unit **24** to the extreme left operating position. This program is performed by the electrical system, as described below, functioning in cooperation with the photoelectric devices **72** and **94** which sense the completion of the return operation.

The carriage-return operation is initiated automatically, if not commanded by a code signal or manually actuated. Automatic return occurs at the first occurrence of a space (between words) after the 29th character position, or unconditionally at the 36th character position. Structurally, the flag **92** reaches the photoelectric device **96** at the 29th position and remains in a light obstructing position from the 29 th position to the 36th position. Thus, the flag **92** functions in cooperation with the photoelectric device **96** and the light source **100** to provide a signal **29/36**, indicative of those character positions. In a related manner, the photoelectric device **72** provides a signal CR(F) indicating the carriage return operation of the font **18** is complete, (flag **120** returned) and the photoelectric device **94** provides a related signal CR(H) the hammer unit **24**.

The system hereof as mechanically presented in FIG. **2** incorporates several improved features as: servocontrol of the font **18** to avoid errors resulting from shock or vibration; automatic margin or carriage-return control; effective ribbon movement and inking; and so on. Although these features are somewhat apparent from a consideration of the above in cooperation with the structure of FIG. **2**, to accomplish a detailed understanding of the system and its operation, reference must also be had to a detailed diagram of the electrical aspect as set fort in FIG. **4**.

The code signals employed in cooperation with apparatus of the present invention may take a wide variety of different specific forms; however, as disclosed herein, binary code signals represented by digital pulses as well known in the prior art are employed in a format as set forth below in chart form to manifest characters and machine operations.

Binary word input code	Figures designation (case)	Letters designation (case)	Font rotation steps	Font direction and translation steps ("L" prefix-Left "R" prefix-Right)
00000			0	L0
00001	5	T	0	L1
00010	CR	CR	0	L2
00011	9	0	0	L3
00100	SP	SP	0	R1
00101	#	H	0	R2
00110	,	N	0	R3
00111	.	M	0	R4
01000	LF	LF	1	L0
01001	)	L	1	L1
01010	4	R	1	L2
01011	&	G	1	L3
01100	8	I	1	R1
01101	ϕ	P	1	R2
01110	:	C	1	R3
01111	;	V	1	R4
10000	3	E	2	L0
10001	"	Z	2	L1
10010	$	D	2	L2
10011	?	B	2	L3
10100		S	2	R1
10101	6	Y	2	R2
10110	!	F	2	R3
10111	/	X	2	R4
11000	—	A	3	L0
11001	2	W	3	L1
11010	'	J	3	L2
11011	FIG	FIG	3	L3
11100	7	U	3	R1
11101	1	Q	3	R2
11110	(	K	3	R3
11111	LTR	LTR	3	R4

Analysis of the above tabulation will reveal that the first two digits (least significant) of the input code determine the extent of the rotation by the font, while the last two digits (most significant) determine the number of translation steps. The center digit in the five-bit code designates the direction of translations, specifically, a "zero" digit indicates translation to the left while a "one" digit indicates translation shall be to the right.

The format of the print-symbols on the font **18** may also vary widely; however, in one arrangement which has been found effective and efficient, the print has been defined on the eight radial surfaces of the font in the following format:

Letters Portion (printed from letters state).	—	K	Q	U	A	W	J	
	X	F	Y	S	E	Z	D	B
	V	C	P	I	—	L	R	G
	M	N	H	—	*1	T	—	O

Figures Portion (printed from figures state).	.	,		#	—	*f	5	—	9
	;	:		ϕ	8	—	)	4	&
	/	!		6	—	3	'	$	?
	—	(		1	7	—	2	'	—

The asterisks in the above chart designate the two home or reference positions for the font **18**, from which stepping invariably occurs. Specifically, if the next character is to be a letter, the reference position for the font is with the upper asterisk *1 under the hammer **24** (FIG. **2**). However, if the next following character is to be a figure, the reference position will be such that the lower asterisk *f dwells under the hammer.

The electrical system, as shown in FIG. **4** therefore functions to displace the font to a position for typing either a letter or a figure, from one of the two reference positions.

The electrical input indicative of a character or a control operation is through a line **120** (FIG. **4**) to an input register **122**. The input line may take the form of a cable with a plurality of conductors (one for each binary bit) or may comprise a single conductor wherein the individual character digits are provided in serial form.

In the explanation below, several signals are designated. A summary of the signals is provided below in their order of introduction, for convenient reference.

Signals	Indication
29/36	The font is in the 29th to the 36th character position.
CR(F)	The font is in the first character position.
CR(H)	The hammer drive unit is in the first character position.
CR	Carriage return command signal.
SP	Space command signal.
LF	Advance to next line command signal.
FIG	Figures state command signal.
LTR	Letters state command signal.
Binary word	The input code works (5 bit) which command the different characters and machine operations.
READ	Commands start of a print operation (external).
TR	Translate font right on SF.
TL	Translate font left on SF.
SF	Step translate font.
RFD	Step rotate font down.
RFU	Step rotate font up.
FS	Font is set to print.
FR	Font is returned to reference position.
GO	Start print cycle by displacing font-period.
-GO	Return font to reference-period.
SC	Servo font period.
-(FIG)	Indicates font is not in figures position.
-(LTR)	Indicates font is not in letters position.

The input register **122** is connected through a decoding matrix **124** to accomplish selective output pulses indicative of control operations, as shown in the above chart. Specifically, output signals SP (space) CR (carriage return) LF (line feed) LTRS (letters state) and FIGS. (figures state) are provided, from the matrix which may comprise diode logic as well known in the prior art. Additionally, the matrix supplies the character-commanding code signals through a gang gate **126** to the stepping motor control circuits **128**. The decoding matrix supplies print-commanding code words through the gate **126** to the motor control circuit **128** on the occurence of a qualifying signal READ applied at the terminal **132**. The signal READ is supplied as part of the input to the machine, occuring when a character code word is settled in the input register **122**.

The gate **126** may comprise a gang of well-known AND gates and their qualification places the code words into a register that are contained within the circuits **128**. These circuits will be explained in greater detail below; however, their function is to supply various control pulses and signals in accordance with the font displacement that is to be accomplished. For example, if the code word commands a translation to the right, an output signal TR becomes high while if a translation to the left is commanded, an output TL is commanded. Other outputs include an output SF (step translate font); RFR (step rotate font right); RFL (step rotate font left); FS (font set) and FR (font returned). Motor control circuits **128** establish the displacement of the font **18** by pulsing the stepping motors, after which the signal FS emerges to command the actual printing operation. Subsequently, the outputs from the motor control circuits **128** return the font to its reference position and manifest that fact with a signal FR. During the period between such cycles, the system serves the font in the reference position, assuring such a position immediately prior to initiating a print cycle. The sequence of operation is readily defined logically as follows:

Logic	Operation
READ . font 0=GO	Set font.
GO . FS . delay= -GO	Return font.
-GO . FR=SC	Servo font.

The interval during which the font is under servocontrol is expanded to accommodate intervals of machine control operations, e.g. carriage return and so on.

Analyzing the various control operations, an output signal LF in one of the conductors **130** from the decoding matrix **124** commands a line-feed advance in the paper, and therefore simply supplies a binary signal to the line-feed solenoid **136** serving to advance the paper one discrete line. The line-feed solenoid is also energized automatically on the occurrence of

a "carriage-return" operation which results in a high signal CR in a conductor 138 that is connected to the line-feed solenoid 136 through a well-known "or" logic gage 140.

The "carriage-return" operation may occur from any of three command sources. Specifically, on closure of a switch 142, a positive signal is applied to an OR gate 144 to produce a high signal CR in a conductor 146 which commands the "-carriage-return" operation. This signal cR may also occur automatically when the signal SP (indicating a space) is high coincidentally with the signal 29/36 (indicating the font has advanced at least to the 29th position). Upon occurence of these two events simultaneously, an AND gate 148 is qualified, thereby supplying the positive signal CR to the conductor 146 through the gate 144. Additionally, the carriage-return operation may be commanded by the appearance of the signal CR from the matrix 124.

When the conductor 146 receives the high signal CR, a flip-flop 150 set, conditioning an oscillator 152 for operation at a higher frequency with a residual form of the signal CR. In general, the oscillator 152 may comprise any of a variety of variable-frequency oscillators which is normally operated at a lower frequency; however, which upon application of the signal CR from the flip-flop 150 move steadily to a higher speed operation so as to more rapidly step the carriage elements (font and hammer) back to a returned position. The oscillator may include a capacitor that is charged by the signal CR to increase the frequency, as well known in the art.

The signal CR also is applied to an AND gate 147 along with output pulses from the oscillator 152, supplied through a conventional pulse shaper 149. Therefor, during the carriage-return operation, pulses (of increased frequency) are supplied through the reset side of the stepping motor circuits 151 and 153. Thus, the stepping motors 30 and 80 return the font 18 and the hammer unit 24 back to the left side of the printer. The arrivals of these elements at fully returned positions are sensed by the photoelectric devices 70 and 94 (described above with respect to FIG. 2) and indicated as circuits 155 and 157 in FIG. 4 providing the signals CR(F) and CR(H) along with the signal in a high state. The signals CR(F) and CR(H) along with the signal CR (from the flip-flop 150) qualify an AND gate 154 upper right) thereby resetting the flip-flop 150, and terminating the signal CR in its high state, to indicate the completion of a carriage-return operation.

Another machine control operation is the "space," commanded by the signal SP, in which a blank character space is accomplished. This operation involves a single step by each of the motors 30 and 80 to advance the font 18 and the hammer unit respectively. To accomplish such steps, the signal SP is supplied to the advance-side of the step circuits 151 and 153 through OR gates, as indicated. Similar operations occur after a character is printed, as a result of the application of the leading edge of the signal —GO to the same circuits, as shown. Thus, the type is advanced.

The remaining machine operation signals LTR and FIG establish the shift state of the system by determining the state of a flip-flop 160. The state of the flip-flop 160 may also be altered manually by actuating a toggle switch 162. More specfically, the flip-flop 160 is set upon the occurence of the signal LTR which is supplied through an OR gate 166. The flip-flop 160 may also be set (letters state) by moving the switch 162 to the left so as to supply a signal directly from a source of positive potential through the gate 166. Somewhat similarly, the flip-flop 160 may be reset (FIGS. state) by the signal FIG. supplied through an OR gate 164. The switch 162 may also be employed to reset the flip-flop 160 as indicated above, through the gate 164. Thus, the flip-flop 160 provides either the signal LTR or the signal FIG. in a residual high state until it is altered. In this manner, the signals LTR and FIG are complementary.

In addition to controlling the direction of font rotation (to accomplish a letter or a FIG. the residual signals LTR and FIG are employed in servoing the type font 18 to the selected reference position immediately prior to the initiation of a printing cycle. In this regard, as indicated above, photoelectric devices 60 and 62 (FIG. 2) sense the position of the type font 18 to be in either the letters or the figures reference position as manifest by the signals -(FIG) and -(LTR). When the photocell circuits 167 sense the font to be out of the letters position, a signal -(LTR) is high. Similarly when the font is not in the figures position, the signal -(FIG.) is high. The operation of position servoing the font is accomplished through a pair of AND gates 168 and 169. Specifically, the gate 168 receives the signal LTR from the flip-flop 160 along with the signal -(LTR), drive pulses from the oscillator 152 and a signal SC from a flip-flop 170 which is high during the interval of the servocycle. Therefore during the servocycle, the AND gate 168 remains qualified until the signal -(LTR) becomes low, indicating the font is properly positioned when the system is in the letters state. Until such an event occurs, drive pulses are supplied from the AND gate 168, through OR gates 176 and 172 to the advance-side of the circuit 174 controlling the font-rotating motor 32. As a result, the motor steps the font until the desired letters reference position is established

In a somewhat similar mode of operation the AND gate 169 is controlled by the signal FIG from the flip-flop 160 along with the signal -(FIG) from the photoelectric circuits 167 and the signal SC from the servocycle flip-flop 170. The AND gate 169 remains qualified, passing step pulses, until the figures reference position is attained by the font. The path of these pulses is from the AND gate 169, through the OR gates 176 and 172 to the advance side of the circuit 174 for the stepping motor 32.

It is to be noted that the actual printing cycle may not be initiated until this servooperation is complete i.e. the font is in the proper reference position. To accomplish this operating characteristic, a monostable multivibrator 178 is connected to receive stepping pulses from both the gates 169 and 168. As a result, the monostable multivibrator 178 remains set in a state to provide a low signal to a gate 180 for an interval bridging the period of the drive pulses and therefore disqualifies the gate 180 until the stepping pulses cease to be applied to the font-rotating motor 32. Thus, the gate 180 is inhibited until correction is accomplished. Thereupon, the monostable multivibrator 178 resets (after a brief delay, to provide a qualifying signal to the AND gate 180, thereby enabling the generation of the signal GO providing the system is not in process of a carriage-return operation, and if a starting signal READ occurs. Thereupon, the gate 180 is fully qualified and resets the flip-flop 170 to drive the signal SC low and halt the servooperation initiating a character-printing cycle.

The signal GO from the gate 180 is applied to a character cycle flip-flop 184 (lower left) which establishes a residual form of that signal to time the interval of a printing cycle. When the flip-flop 184 is set, the motor-control circuits 128 (which also receive the signal GO) proceed to set the type font in position to print the desired symbol. The motor 30 (controlling the translation of the font) may be stepped either through the advance-input A of the circuit 151 or through the reset input of that circuit. The advancing motion of the motor translates the font to the right while resetting motion translates to the left. The signal TR from the circuits 128 indicating the motion should be to advance (right) is applied to qualify a pair of AND gates 190 and 192. Conversely, the signal TL indicating reset or leftward movement qualifies a pair of AND gates 194 and 196. These gates are then oppositely connected to the circuit 151. Thus, depending upon whether the gates 190 and 192 are qualified or the gates 194 and 196 are qualified, the font motor either steps to the right or the left first, then returns in the opposite direction.

Assuming the initial movement of the font motor 30 is to the right, the gate 190 is first qualified by the signal TR and the signal GO so that the stepping pulses SF are passed through an OR gate 200 to the circuit 151 for advancing the font motor 30. At the conclusion of a stepping motion, the motor control circuits 128 provide a pulse FS, indicating the font is set. That pulse actuates the hammer solenoid 202, then passes through

a delay circuit **204** to incur a slight delay then reset the flip-flop **184** to initiate the operation of returning the font to its reference position. With the flip-flop **184** reset, the signal —GO qualifies the gates **192** and **196** to which the reset signal is applied so that the pulses SF may now be applied through either an OR gate **200** or **210** to return the font to the original central reference position.

In the event that the initial movement commands a translation to the left, the situation is reversed in that the initial stepping takes place through the AND gate **194** during the interval of the signal —GO and the return stepping occurs through the AND gate **196** advancing the font to the right, returning it to its starting position. Of course, as indicated above, the advancing or retarding (right or leftward movement) of the font is accomplished in accordance with the code set forth above in chart form.

The operation of the system to rotate the font is quite similar to that described above; however, the direction of rotation is determined by the letter-figure flip-flop **160**. That is, when the flip-flop **160** is set to provide the signal LTR high, the font is revolved downwardly (at the front) which coincides to advances by the font-rotating motor **32**. Specifically, the font must be either advanced or reset respectively, depending upon whether the character to be printed is a letter or figure. If the character is a letter, the output RFD (rotate font down) includes a pulse for each step of downward rotation. On the contrary, if the character is a figure, the output RFD includes pulses to rotate the font upward. The pulses RFD are applied through the AND gate **220** (qualified by the signal GO) and an OR gate **222** to the reset-side of the circuit **174** of the motor **32**. In such an event, the font is rotated into the letters section. To rotate the font into the figures section, pulses RFU are passed through an AND gate **228** (qualified by the signal GO) and the OR gate **172** to the advance-side of the circuit **174**. After establishing the desired rotation and accomplishing a printing operation, the signal GO goes low, the signal —GO becomes high and the font is returned to the reference position by a set of either the pulses RFU or RFD, opposed to the first set and supplied through one of the AND gates **226** or **230**, qualified by the signal —GO to return the font to its starting position.

In view of the above description of the system and its operation to perform certain functions, a detailed understanding may now be best accomplished by referring to FIGS. **2** and **4** for an explanation of the operations involved in printing characters as well as the operations involved in returning the carriage and so on. Therefore, assume initially that a binary code word lllll arrives as a series of pulses on the input conductor **120** to be registered in the input register **122**. The decoding matrix **124** responds to such an input, providing a high signal LTR at the appropriate output **130** from the matrix, which signal is supplied to the flip-flop **160** through the OR gate **166**, thereby setting that flip-flop to provide the residual signal LTR, so the next character produced will be a letter.

When the flip-flop **160** is set, the signal LTR is applied to the gate **168** and unless the photocell system **167** provides the signal -(LTR) in a high state, drive pulses from the oscillator **152** are supplied through the AND gate **168** and OR gate **176** and **172** to advance the font-rotating motor **32** until it is placed in the proper reference position, e.g. wherein the hammer dwells over the upper asterisk as indicated in the above chart. Thus, if for any reason the font is shocked or otherwise moved to be displaced from the reference position, the signal -(LTR) goes high and restoration occurs.

Assume next, that the code word **10011** appears as representative pulses passing through the conductor **120** to the input register **122**. The decoding matrix simply indentifies the code word as representing a character. After a short interval, the signal READ is applied at the terminal **132** qualifying the gates **126** to supply the code word **10011** to the motor control circuits **128**. The first two digits "**10**" of the code word indicate that the font shall be rotated (into the letters portion) two steps. The center digit "**O**" indicates the translation should be to the left and the last two digits "**11**" indicate the translation should be three steps to the left. From the above chart it may be seen that such displacement of the font will place the letter "**B**" immediately under the hammer **26**.

The desired displacement is accomplished by the motor control circuits **128** supplying the signal TL high, indicating that translation shall be to the left. Furthermore, the output includes three pulses SF (step font) which are passed through the AND gate **190** and the OR gate **200** to step the font-translating motor **30** three positions to the right. It is to be noted that the gate **190** is qualified during this interval by the flip-flop **184** providing the signal GO high.

Simultaneously with the above operation, the two pulses RFD, from the motor control circuits **128** accomplish two rotational steps of the font by passing through the AND gate **220** and the OR gate **22** to the circuit **174**. Thus, the font is placed in the desired position.

As the next operation, the motor control circuits **128** provide a font-set signal FS which is supplied directly to the hammer solenoid **202** (FIG. **4**) to actuate the hammer unit **24** (FIG. **2**) driving the hammer **26** to print the letter B on the paper.

The font-set pulse FS is also applied through a delay circuit **204** (FIG. **4**) and a qualified AND gate **233** to the reset flip-flop **184** and provides the signal —GO high. As a result, the reset AND gates **192, 196** are qualified so as to enable the font translating motor **30** to be returned to its original position. This operation occurs as a result of pulses SF supplied appropriately with signal TR from the motor control circuits **128** to return the motor to its appropriate central position. The font is also rotated (back to reference position) by return pulses RFU supplied through the gate **230** appropriately qualified by the signal font **18** —GO. As a result, the letter B is printed and the system is returned to its reference state.

When the font returns to its quiescent state as a result of the return pulses, the motor control circuits provide a signal FR manifesting that the font has been returned, which signal is supplied to set the servocycle flip-flop **170**. That flip-flop then functions to provide a time interval during which the font is servoed to the reference position. Another cycle of operations starts upon the occurrence of the signal READ which resets the flip-flop **170** and sets the character cycle flip-flop **184**.

It is thus apparent that three distinct operating intervals are provided, specifically, (1) an interval during which the font is set to accomplish the desired character; (2) an interval during which the font is returned back to its reference position; and (3) an interval during which the font is servoed to the reference position pending the arrival of another command character. The system operates repeatedly to space or print until either a carriage-return signal CR is decoded or, alternatively, a carriage-return operation occurs automatically when a space signal SP appears and the carriage is displaced to at least the 29the position. In such a situation, the gate **148** (upper left) is qualified resulting in the set state of the flip-flop **150** to produce the signal CR high applying a potential to the dual speed oscillator **152** and thereby causing the oscillator to gradually increase to a higher speed of operation. The increased speed of operation of the oscillator **152** serves to rapidly return the carriage elements (font and hammer). As explained above, the a carriage-return operation is halted when the signals CR(F) and CR(H) from the photocell circuits **170** and **157** go high, indicating the font **18** an and the hammer unit **24** have returned to the extreme left. Thereupon, the gate **154** is qualified and the flip-flop **150** is accordingly reset.

The system thus may be seen to accomplish carriage-return operations either on command or automatically. Furthermore, the system is relatively fast and accurate in operation. The tolerance of the system to shock and vibration is substantially increased and maintenance requirements are reduced, as by use of the improved ink ribbon arrangement.

These features and advantages can be variously accomplished by the utilization of different forms of detailed structure. In this regard, the various circuits shown in the system of FIG. 4, with the exception of the motor-control circuits 128, are well known in various forms and widely utilized in the prior art. As for the motor-control circuits 128, detailed structure is shown in shown in FIG. 5 and will now be considered.

As indicated above, the five-bit binary code word is dissected within the motor control circuits 128 into three distinct parts. The first two bits determined the font rotation steps, the next bit determines the direction of font translation and the remaining two bits determine the number of font translation steps. In this regard, the direction-determining bit performs the same function with regard to the translation operation as is performed by the letter-figure signals LTR and FIG with regard to the font rotation. That is, if the system is in a letter state, and the signal LTR is high, the font moves downwardly. The converse is true when the signal FIG is high. Therefore, the analysis of one structure for font control as incorporated in the motor control circuits 128 is fully explanatory of both structures. In this regard, it is emphasized that the motor control circuits 128 as well as the basic format of positioning the font is subject to wide variation and the disclosure herein is set forth merely as a basis for supporting the claims definitive of this invention.

Referring to FIG. 5, input conductors 250 individually carry the two binary bits from the gate 126 (FIG. 4) which indicate the number of rotational steps for the font. These signals are received and registered in a two-digit register 252 (FIG. 5) which is self-clearing as well known in the prior art. The register 252 is connected to a coincidence detector 254 along with the output from a step counter 256 as well known in the prior art. More specifically, cables 258 and 260 couple the register 252 and the counter 256 respectively to the coincidence detector 254. Various forms of coincidence detectors are well known in the prior art which may be employed as the detector 254. Functionally, the detector 254 provides a high output on a conductor 262 when the contents of the register 252 matches the contents of the counter 256. Otherwise, the detector provides a high output to a conductor 264.

The counter 256 is also connected to a zero detector 266, which connection is provided by a a cable 268. The zero detector 266 provides an output to a conductor 270 when the counter 256 is reset to zero. Otherwise, the output to the conductor 270 is low.

In view of the above preliminary structural explanation of the subsystem depicted in FIG. 5 a complete understanding thereof may best be accomplished by considering a cycle of operation, explaining the steps of such operation concurrently with the introduction of other component parts of the subsystem. Therefore, assume that two digits are received in the register 252 through the conductors 250 at a time when the counter 256 is clear. Now, upon the occurrence of the signal GO, drive pulses are supplied through an AND gate 272 to advance the counter 256 toward the counter registered in the register 252. Each pulse so applied is also passed to a pair of AND gates 274 and 276. These gates are qualified by the signal in the conductor 264 (indicating no coincidence) and additionally one of the gates is qualified, depending upon whether the state of the system provides the signal LTR or the signal FIG high. For example, if the signal LTR is high, each advancing count of the counter 256 is accompanied by the passage of a pulse from the gate 274 which pulse has been previously identified as a pulse RFD (rotate font down). Thus, pulses are provided until the counter 256 contains a value equal that registered in the register 252. Thereupon, the signal in the conductor 264 drops low disqualifying the AND gates 274 and 276, inhibiting the passage of further drive pulses to rotate the font.

At the same time the signal in the conductor 264 goes low, the signal in the conductor 262 goes high and qualifies an AND gate 278 which is also qualified by the signal GO and therefore provides a signal FS (font set). As a result, the signal GO is driven low while the signal —GO becomes high. It is to be noted this shift is coordinated with the motor control circuits accomplishing font translation as well.

When the signal —GO goes high, an AND gate 282 becomes qualified and reset pulses are supplied through that gate to the counter 256. These reset pulses are also supplied to a pair of AND gates 284 and 286, the outputs of which are also pulses RFU and RFD; however, which are reversed to accomplish the return stepping of the font. These gates 284 and 286 remain qualified until the zero detector 266 detects the counter 256 to have been cleared, whereupon a signal in the conductor 288 goes low and the gates 285 and 286 are inhibited. The occurrence of a zero in the counter 256 is also manifest by the zero detector providing high signal in the conductor 270 which qualifies an AND gate 290 along with the signal —GO, to produce the signal FR (font returned) in a high state.

As indicated above, the structure depicted in FIG. 5 may be employed in a similar form to control the font translation wherein the directional bit is analogous to the signals LTR and FIG. Of course, this distinction again emphasizes the various possibilities for implementing the system hereof. Therefore, the system as disclosed herein is to be deemed merely an exemplary embodiment and the scope hereof shall not be restricted accordingly but rather shall be interpreted in accordance with the claims set forth below.

I claim:

1. A printer for selectively imprinting symbols on a medium, in accordance with electrical code signals, comprising:
- a type body defining a plurality of said symbols thereon;
- means for registering a selected reference position for said type body;
- stepping motor means coupled to said type body for e incrementally moving said type body;
- first control means coupled to said stepping motor means, operative during a first time interval for driving said stepping motor means to dispose a symbol on said type body identified by said electrical code signals, in a printing position with reference to said medium;
- type means operative during a second interval for engaging said medium with said symbol on said type body in position, whereby to imprint said symbol on said medium; and
- second control means operative during other time intervals, to actuate said type body to said selected reference position indicated by said means for registering, said second control means including means for sensing the position of said type body to provide a reference position signal, and means operative under control of said reference position signal and said means for registering a selected reference position, to actuate said type body to said reference position.

2. A printer according to claim 1 wherein said stepping motor means includes at least one bidirectional stepping motor for translating said type body, and at least one stepping motor for revolving said type body.

3. A printer for selectively imprinting symbols on a medium, in accordance with electrical code signals, comprising:
- a type body defining a plurality of said symbols thereon;
- means for registering a selected reference position for said type body;
- stepping motor means for incrementally moving said type body;
- control means for driving said stepping motor means to dispose a symbol on said type body identified by said electrical code signals, in a printing position with reference to said medium;
- type means operative when said type body is disposed in a printing position, for engaging said medium with said symbol on said type body in a printing position, whereby to print said symbol on said medium;
- means for indexing said stepping motor means whereby to afford stable positions of a said type body at locations where symbols are positioned in printing relationship with reference to said medium;

means for sensing the position of said type body; and

means under control of said means for sensing to actuate said type body to said selected reference position during intervals when said control means and said type means are inoperative.

4. A printer according to claim 3 further including inking structure means, including a closed loop of ribbon the form of a Moebius strip, and means for supplying ink to said ribbon, said inking structure means for supplying ink to said medium being under control of said type body.

5. A printer according to claim 4 wherein said means for supplying ink to said ribbon incorporates a plurality of rollers in rolling relationship with said ribbon.