United States Patent [19]

Takenaka

[11] E **Re. 30,942**

[45] Reissued **May 25, 1982**

[54] **PRINTING APPARATUS EMPLOYING BIDIRECTIONAL STEPPING MOTORS TO POSITION TYPE MEMBER**

[75] Inventor: **George Takenaka**, Santa Ana, Calif.

[73] Assignee: **Tracor, Inc.**, Austin, Tex.

[21] Appl. No.: **32,125**

[22] Filed: **Apr. 23, 1979**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,374,873**
Issued: **Mar. 26, 1968**
Appl. No.: **345,342**
Filed: **Feb. 17, 1964**

[51] **Int. Cl.**[3] **B41J 1/50;** B41J 9/04

[52] **U.S. Cl.** **400/154.2;** 400/154.5

[58] **Field of Search** 400/154.2, 154.5, 163, 400/903; 178/28, 34; 101/93.19, 93.22; 340/317–319; 318/138, 685, 696

[56] **References Cited**

U.S. PATENT DOCUMENTS

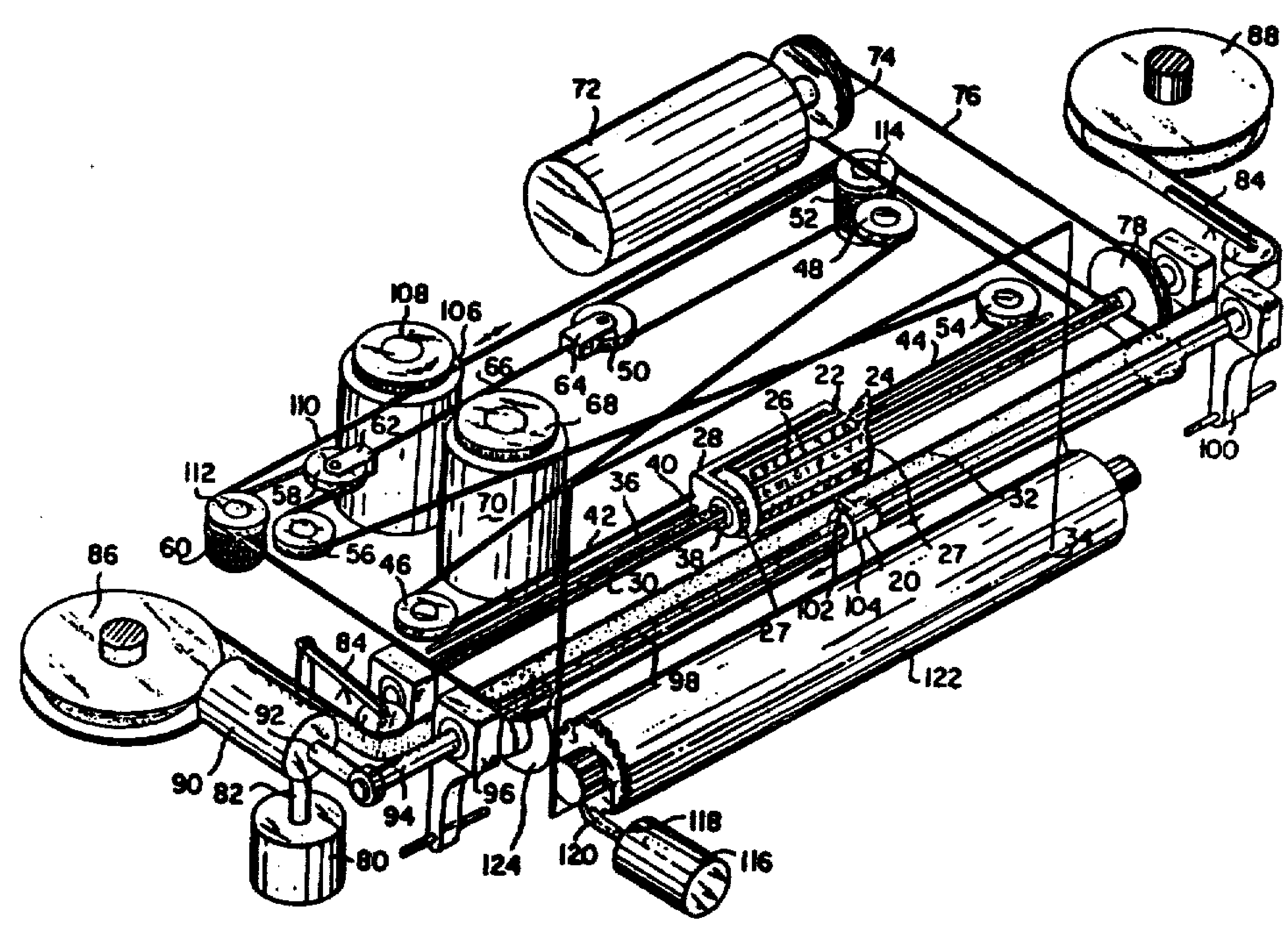
2,617,870	11/1952	Kern	340/373 X
2,727,944	12/1955	Howard	400/154.2 X
2,750,548	6/1956	Van Dalen	318/696
2,757,775	8/1956	Hickerson	400/154.2
2,769,029	10/1956	Howard	400/154.2 X
2,823,345	2/1958	Ragland et al.	318/602
2,847,505	8/1958	Kratt et al.	178/34
2,864,044	12/1958	Pardee	318/664
2,884,581	4/1959	Schunemann et al.	318/612
2,927,676	3/1960	Abbondanza	400/134.2
2,945,091	7/1960	Canepa	178/34
2,989,680	6/1961	Weiser et al.	318/601
3,024,399	3/1962	Valentino	318/283
3,042,174	7/1962	Howard	400/154.2 X
3,042,819	7/1962	Kennedy	318/696 X
3,063,540	11/1962	Howard	400/154.2
3,103,651	9/1963	Heinecke et al.	340/203
3,109,167	10/1963	MacIntyre et al.	340/319
3,117,268	1/1964	Madsen	318/283
3,127,587	3/1964	Rasmussen et al.	340/146.2
3,132,558	5/1964	Wymann	318/696 X
3,142,054	7/1964	Burri	340/318
3,206,665	9/1965	Burlingham	318/312
3,218,625	11/1965	Knotowicz	340/319
3,227,258	1/1966	Pannier et al.	400/131
3,239,738	3/1966	Welch	318/696
3,241,017	3/1966	Madsen et al.	318/138
3,256,969	6/1966	Bretti	400/154.2 X
3,267,456	8/1966	Morris et al.	340/317
3,282,389	11/1966	Rudisch et al.	400/130
3,294,211	12/1966	Mason	400/154.3
3,304,858	2/1967	Reach et al.	101/93.19
3,307,676	3/1967	Hickerson	400/155
3,327,191	6/1967	Goto	318/696
3,466,517	9/1969	Leenhouts	318/603

Primary Examiner—Paul T. Sewell

[57] **ABSTRACT**

A printer is disclosed that utilizes a single font of somewhat cylindrical configuration, bearing type for various symbols upon its peripheral surface. The font is movably mounted to accommodate rotation and axial displacement, to set a desired symbol in printing position. The type font is controlled in movement by shift registers operating in combination with a source of pulses bi-directional stepping motors and reset apparatus. The printer is responsive to various codes which are registered by components in the shift registers which are then cleared by pulses that step the stepping motors to position the type font by driving the stepping motors in a forward direction to accomplish the desired position in components. Thereafter, the type font is actuated to print the desired symbol. Structure is disclosed for returning the type font to a home position by reverse stepping the stepping motors.

8 Claims, 3 Drawing Figures



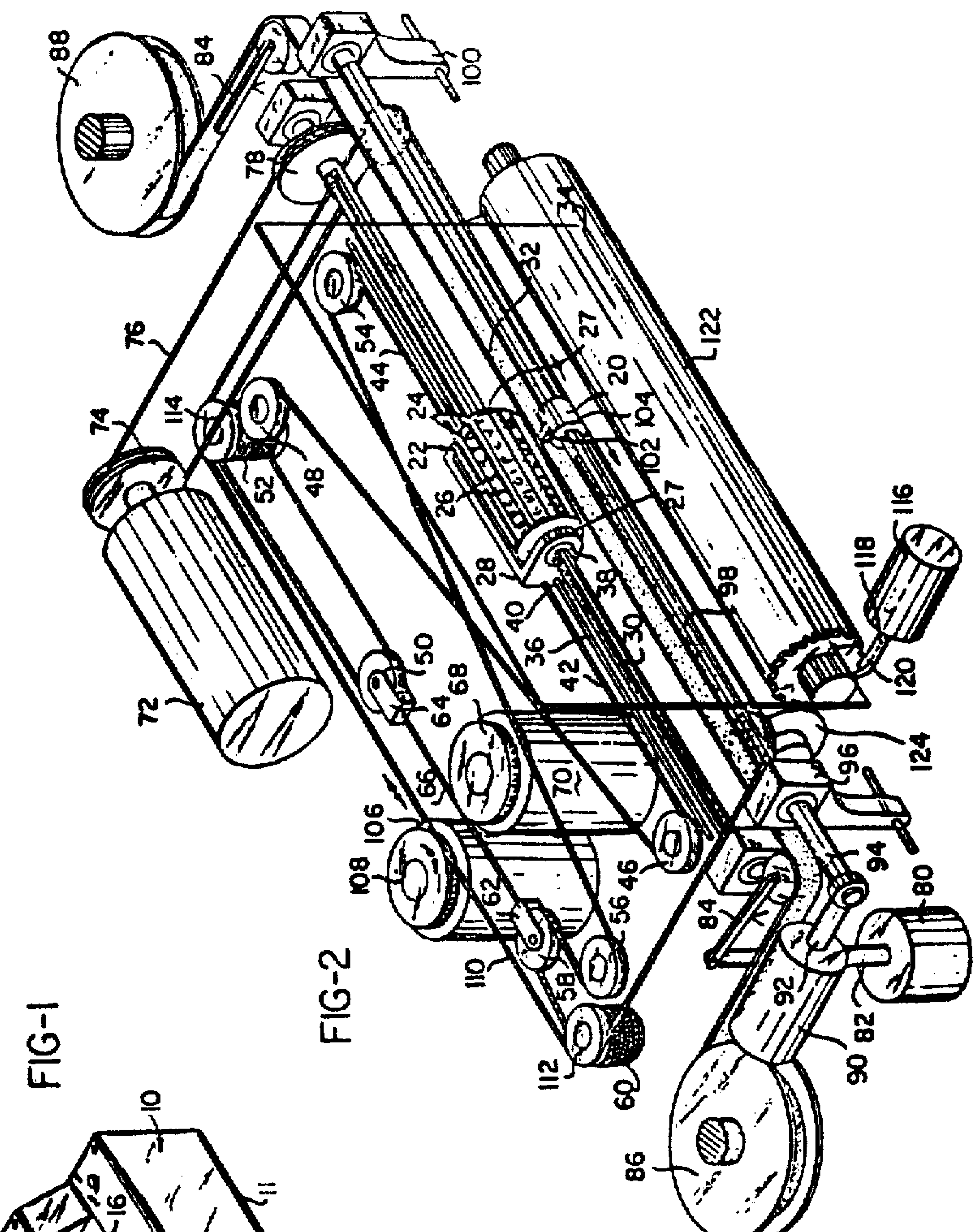


FIG-2

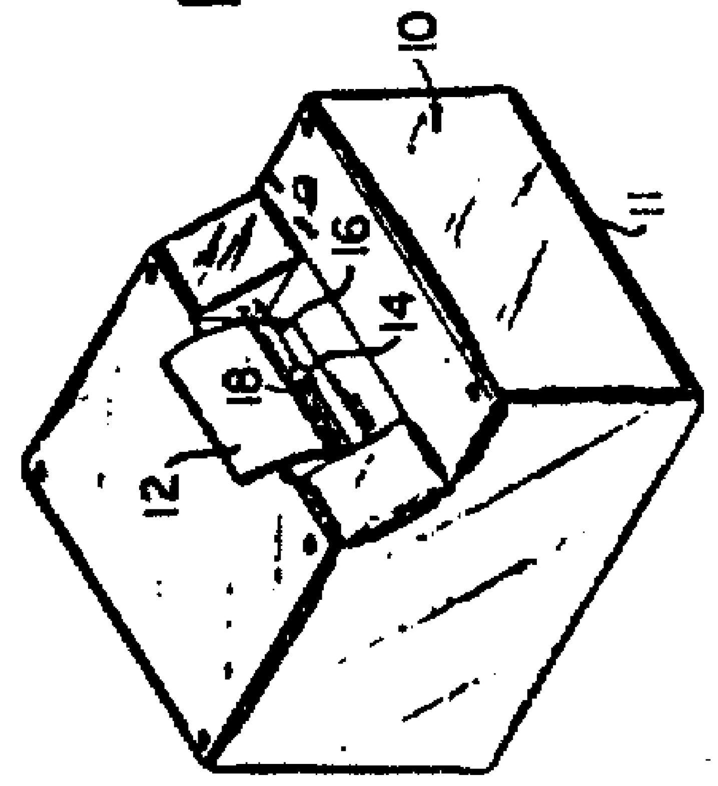
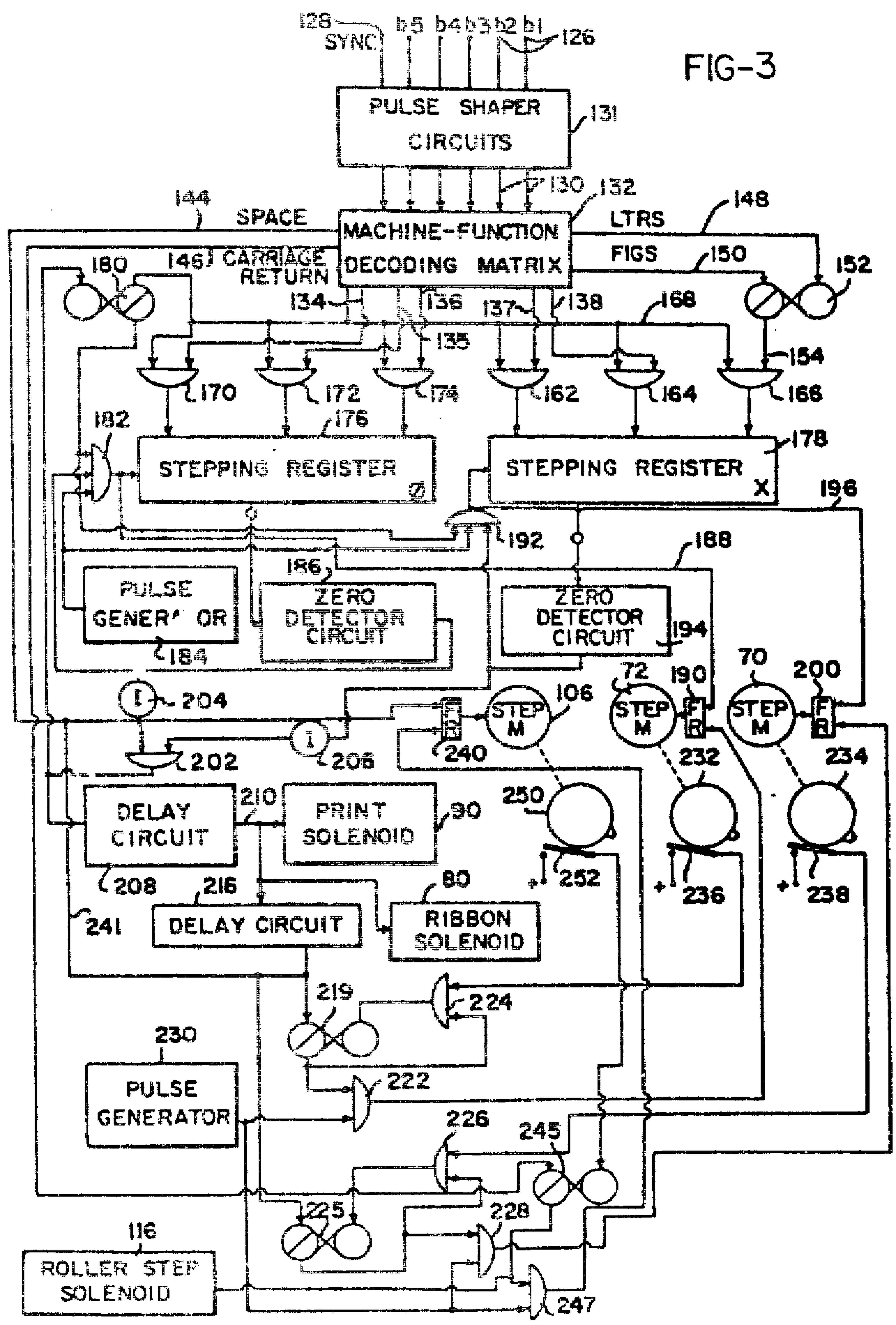


FIG-1

FIG-3


SYNC
b5 b4 b3 b2 b1
PULSE SHAPER CIRCUITS
SPACE
MACHINE-FUNCTION DECODING MATRIX
CARRIAGE RETURN
LTRS
FIGS
STEPPING REGISTER
STEPPING REGISTER
PULSE GENERATOR
ZERO DETECTOR CIRCUIT
ZERO DETECTOR CIRCUIT
STEP M
STEP M
STEP M
DELAY CIRCUIT
PRINT SOLENOID
DELAY CIRCUIT
RIBBON SOLENOID
PULSE GENERATOR
ROLLER STEP SOLENOID

PRINTING APPARATUS EMPLOYING BIDIRECTIONAL STEPPING MOTORS TO POSITION TYPE MEMBER

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

The present invention relates to a printing apparatus, which for example may be embodied in a telegraphic printer for sequentially printing symbols in accordance with applied electrical signals.

Signal-controlled printers are widely employed in various applications to transcribe messages carried in the form of telegraphic code signals. In addition to the widespread use of such printers in stationary installations, there exists a considerable need for them in mobile installations. For example, automobile and aircraft installations are often desirable for a telegraphic printer to provide an accurate readily-perceivable message. However, in the past, considerable difficulty has been experienced in mobile installations of printers, both as a result of their size and their mechanical complexity. That is, prior printers have generally required a considerable space and have added considerable weight to the carrying vehicle. Furthermore, such prior printers have conventionally required complex mechanical positioning elements, to selectively drive printing fonts. Therefore, during mobile use, even slight acceleration forces may cause these prior printers as described, to malfunction resulting in an error in the transcribed message. As a result, these mechanisms have often been shock-mounted to reduce difficulties resulting from acceleration and shock forces; however, at best any improvement in reliability has been accompanied by increased weight and space requirements. Therefore, a need exists for an improved printer, which may be embodied in a unit of relatively small size, and lightweight, and which may be economically manufactured for use in mobile installations having reliable operation.

In general, the present invention comprises a type element or font which may take a generally-cylindrical configuration and which bears type for various symbols upon its peripheral surface, and is mounted so that it may be variously displaced to present different symbols in a printing position. The system further includes means for providing electrical pulses in sequences, indicative of the desired displacement for the type element or font to accomplish a predetermined symbol. Stepping motors, i.e. motors which accomplish a predetermined rotational displacement upon receiving an electrical pulse, are then provided to receive the sequence of pulses and are connected to position the type font accordingly. The system further includes apparatus for activating the type font to accomplish a printed symbol after the desired symbol has been properly positioned.

An object of the present invention is to provide an improved printer which may be embodied in a compact rugged form.

Another object of the present invention is to provide an improved telegraphic printer with simplified mechanical controls.

Still another object of the present invention is to provide an improved printing mechanism, which may

be economically constructed, in a form sufficiently rugged for practical mobile use.

A further object of the present invention is to provide an improved telegraphic printer which employs digital stepping motors to position a type font in accordance with electrical command signals.

Still a further object of the present invention is to provide a system wherein electrical code signals indicative of symbols are decoded into a sequence of pulses, numerically indicative of the symbol, and further including a digital stepping motor to receive said pulses and thereby position a type font to print a selected symbol.

These and other objects and advantages of the present invention will become apparent from a consideration of the following taken in conjunction with the appended drawings, wherein:

FIG. **1** is a perspective view of a telegraphic printer incorporating the principles of the present invention;

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

FIG. **3** is a diagrammatic representation of the electrical system employed in the printer of FIG. **1**.

Referring initially to FIG. **1**, there is shown a compact printer **10** in a relatively-small housing **11**, incorporating the principles of the present invention, to accomplish a printed message on paper **12**. The printer **10** receives electrical signals, as by radio or direct line for example, which signals are representative of various symbols carried on a type font (not shown in FIG. **1**).

The type font in the machine operates in cooperation with a hammer **14** which is carried on a shaft **16** in front of a printing ribbon **18**. The hammer **14** and the type font (not shown) are positioned in accordance with the received electrical signals, so that the hammer **14** lies over the section of the paper **12** upon which the next symbol is to be printed, while the commanded symbol lies immediately under the hammer, behind the paper. When the positioning operation is complete, the hammer **14** is driven against the ribbon **18** which engages the paper **12** that is backed by the type or print lines of the desired symbol which is thus printed. In general, an important feature of the present invention resides in the manner in which the type font, along with the other mechanical elements in the printer, are positioned, by the use of digital stepping motor apparatus.

Referring now to FIG. **2** for a more detailed consideration of the printer, a type hammer **20** is shown, which operates in conjunction with a type cylinder or foot **22**. The font **22** as shown in FIG. **2**, has eight rows **24** of type symbols **26** spaced about its periphery and each of the rows **24** contain eight symbol positions. Therefore, to provide a desired symbol under the hammer **20**, the font **22** may have to be displaced rotationally about its axis (to locate a proper row **24**), and along its axis (to locate a particular symbol **26**).

The font **22** may be variously constructed, as for example, of lightweight plastic material to which a metallic surface containing type symbols is applied. Such a structure preserves the weight of the font low with resultant low inertia. Of course, various other embodiments for the type cylinder or font **22** are practical in accordance with the knowledge of the prior art.

The type cylinder or font **22** is mounted between the arms **27** of a frame **28**, that is fixed against rotation and carried on a splined shaft **30** along with the font. To provide a desired character on the font **22** in printing position under the hammer **20**, the frame **28** is placed to the proper position along the shaft **30**, then the shaft **30** revolves the font **22** to select the desired letter. Thereafter, a print ribbon **32** raises to a position between the font **22** and the hammer **20**, after which the hammer **20** strikes the ribbon **32** against a printing medium or paper **34** (shown in phantom).

After the symbol is printed, the ribbon **32** drops back into position to reveal the print while the hammer **20** and the type font **22** advance to the next character location on the paper **34**.

The frame **28** slides on a guide shaft **36** which holds the frame against rotational displacement as the shaft **30** revolves. The frame **28** is generally of U-shaped configuration, with the shaft **30** extending through bearings **38** contained in arms **27**, and through the type font **22**, engaging the latter. One end **40** of an inelastic cable **42** is connected at one side of the frame **28** while an end of a similar cable **44** is connected at the other side. These cables are driven to travel the frame **28** along with the font **22** across the width of the paper **34**. The cable **42** passes over a rotatively-mounted stationary pulley **46**, reverses direction, and passes over a similar pulley **48** to again reverse direction and pass over a single movable rotatively-mounted pulley **50**, then is taken up on a rotatively-mounted stationary drum **52**. The cable **44** in a somewhat similar manner passes from the frame **28** over a stationary rotatively-mounted pulley **54**, then over a similar pulley **56**, and over a movable rotatively-mounted pulley **58** to be taken up on a rotatively-mounted drum **60**.

The pulleys **58** and **50** are mounted respectively in blocks **62** and **64** which are connected by a cable **66** that passes around a drive capstan **68** of a stepping motor **70**. The stepping motor **70** may, for example, take the form of various models manufactured by Pace Controls Corporation of Needham Heights, Mass., which motors provide a predetermined angular displacement of a rotative shaft upon receipt of a digital pulse. Of course, various other forms of stepping motors have also proved satisfactory in the system.

The stepping motor **70** acts through the cable **66**, the pulleys **50** and **58**, and the cables **42** and **44**, to place the type font **22** in any of eight positions, each of which provides one symbol location under the hammer **20**. A stepping motor **72** similar to the motor **70** drives a capstan **74** carrying an endless cable **76** which passes over a drive wheel **78** mounted on the splined shaft **30**. Thus, the stepping motor **72** revolves the shaft **30** through the cable **76**, to in turn revolve the font **22** and position any of eight rows **24** of symbols **26** under the hammer **20**.

After the motors **70** and **72** have operated to position the desired symbol space under the hammer **20**, the symbol is printed and the font is returned to home position. Somewhat simultaneously the hammer **20** and the font **22** are moved to the next area on the paper.

The printing operation is accomplished in several steps, the first being energization of a solenoid coil **80** acting through an armature **82** and a pivotally-mounted lift linkage **84**, to raise the ribbon **32** to a position between the hammer **20** and the type font **22**. The ribbon **32** is carried on spools **86** and **88** as well known in the prior art and may include an automatic mechanism, also as well known in the prior art to variously advance the ribbon from one spool to the other providing even wear over the ribbon **32**.

With the ribbon **32** in a raised position, a printing or typing solenoid coil **90** is energized acting through an armature **92** and a shaft extension **94** to drive the hammer **20** against the ribbon **32**. The extension **92** is journaled through a pivotally-mounted support block **96**, to pass through the splined shaft **98** carrying the hammer **20**, then into a pivotally-mounted support block **100**. The hammer **20** includes a head **102** which provides the actual striking surface, and which is integrally formed with an annulus **104** in which the splined shaft **98** is matingly received.

After a printing operation has been completed, the solenoid coils **80** and **90** are deenergized permitting the hammer **20** and the ribbon **32** to fall back into their quiescent positions. Somewhat simultaneously, the hammer **20** and the type font **22** are advanced one step to the right so that the hammer **20** dwells over the next area to receive a symbol. The hammer and type font are moved stepwise to the right by a stepping motor **106** which may be similar to the stepping motors previously described, and which carries a capstan **108** that drives a looped cable **110**, the ends of which are affixed to the hammer **20**. In passing to the hammer **20** from the capstan **108**, the cable **110** passes about corner pulleys **112** and **114** which are axially mounted on drums **60** and **52** respectively. The drums **60** and **52** receive the end of the cables **42** and **44** respectively which are affixed thereto. Therefore, on rotation of the pulleys **112** and **114**, to accommodate the movement of the cable **110** to drive the hammer **20**, the drums **52** and **60** are also revolved shifting the position of the pulleys **50** and **58** to advance the position of the font **22**. That is, at the conclusion of each printing operation to establish a symbol or space on the paper **34**, the stepping motor **106** is pulsed to revolve the capstan **108** in a clockwise direction thereby pulling the hammer **20** one step to the right through the cable **110**, and moving the type font **22** one step to the right through the pulleys **58** and **50** and the cables **42** and **44**. After the stepping motion, the printer is ready for another symbol to be printed.

At the completion of a line of type on the paper **34**, the hammer **20** and the type font **22** are returned to the left preparatory to printing another sequence of symbols. This operation is accomplished by the stepping motor **106** moving in a reverse direction under control of electrical impulses as described below. In addition to returning the hammer **20** and the type font **22** to the left position, the paper **34** must be raised one line. The paper **34** is raised by a solenoid coil **116**, the armature **118** of which engages a ratchet **120** affixed to a drive roller **122** which mates with a backup roller **124**. Thus as the solenoid coil **116** is energized, the ratchet **120** is stepped revolving the roller **122** in a clockwise direction raising the paper **34** to the next line to receive another roll of print. Of course, various other well-known techniques may also be employed in this regard.

The stepping motors considered in FIG. **2** along with the solenoid coils are controlled by electrical signals which are derived from applied code pulses. The manner in which these signals are derived will now be considered with reference to FIG. **3**.

At the top of FIG. **3** are a set of terminals **126** labelled b_1 through b_5 and separately provided to receive the five parallel bits of a Baudot telegraphic code. That is, parallel pulse-no pulse (binary) code signals are separately applied to the terminals **126** to manifest various commands and symbols. A synchronizing signal, or clock pulse, for the parallel code is applied to a terminal **128** to manifest the time interval during which a set of code signals are manifest.

Of course, a wide variety of code signals may be employed in accordance with the present invention, for example, both parallel and serial signals may be employed and virtually any form of representation or format may be utilized so long as a separate code is provided for each symbol or command to be identified.

The pulses received at the terminals **126** are applied to pulse shaper circuits **131** which may take the form of six separate trigger circuits or other networks to form discrete noise-free pulses in the parallel lines **130**, coinciding to the input terminals. Thus, six lines **130** emerging from the pulse shaper circuits **131** carry signals b_1 through b_6 and "sync" which are applied to a machine-function decoding matrix **132**.

Structurally, the decoding matrix **132** may comprise a plurality of diodes or other logic network elements to provide a translation of the input code signals to a form of coding applicable to the present system. Of course, various translating or decoding matrix techniques are well known in the prior switching art to accomplish this function, as for example is taught in the book "Arithmetic Operations in Digital Computers," by R. K. Richards, published 1955 by D. Van Nostrand Co.

Thus, the matrix **132** provides five outputs on conductors **134** through **142** through **138** which are coded to designate the various symbols desired to be printed. Furthermore the decoding matrix **132** also recognizes a particular input code to indicate: a "space"; a "carriage return"; and a designation for "the following code groups are letters" or "figures."

Upon recognizing a "space" command, the matrix provides a pulse output on a conductor **144**. The occurrence of a "carriage return" command provides a high output from the decoding matrix **132** on a conductor **146**; and depending upon whether a command indicates "letters" or "figures" are to follow, a high output appears in either of the conductors **148** or **150**, respectively.

The conductors **148** and **150** are applied to the input terminals of a bistable multivibrator or flip-flop **152** which is represented by a somewhat-conventional symbol employed here throughout for that circuit. Essentially, the output of the flip-flop **152** provides another digit or binary signal b_0 along with those contained in the conductors **134** through **138** to result in a six-bit binary code word. Of course, the output from the flip-flop **152** to conductor **154** changes only after a command signal is given to the decoding matrix **132**, instructing that "the following code signal or code signals shall be interpreted as letters" for example.

The six-bit code word emerging from the matrix **132** in the conductors **134** through **138** and from the flip-flop **152** in conductor **154** may follow the format set forth in the following Table 1. Note that the conductor **154** carries the most significant binary digit, conductors **137** and **138** next, and conductors **134**, **135** and **136** carrying the least-significant digits.

TABLE 1

Code Register 178:176	Designation	X Displacement	φ Displacement
000000	Blank	0	0
000001	T	0	1
000010	(GR)	0	2
000011	O	0	3
000100	(SP)	0	4
000101	H	0	5
000110	N	0	6
000111	M	0	7

TABLE 1-continued

Code Register 178:176	Designation	X Displacement	φ Displacement
001000	(LF)	1	0
001001	L	1	1
001010	R	1	2
001011	G	1	3
001100	I	1	4
001101	P	1	5
001110	C	1	6
001111	V	1	7
010000	E	2	0
010001	Z	2	1
010010	D	2	2
010011	B	2	3
010100	S	2	4
010101	Y	2	5
010110	F	2	6
010111	X	2	7
011000	A	3	0
011001	W	3	1
011010	J	3	2
011011	(FIGS)	3	3
011100	U	3	4
011101	Q	3	5
011110	K	3	6
011111	(LTRS)	3	7
100000	(BL)	4	0
100001	5	4	1
100010	(CR)	4	2
100011	9	4	3
100100	(SP)	4	4
100101	(STOP)	4	5
100110	,	4	6
100111	.	4	7
101000	(LF)	5	0
101001	)	5	1
101010	4	5	2
101011	&	5	3
101100	8	5	4
101101	φ	5	5
101110	:	5	6
101111	;	5	7
110000	3	6	0
110001	"	6	1
110010	$	6	2
110011	?	6	3
110100	(Bell)	6	4
110101	6	6	5
110110	!	6	6
110111	/	6	7
111000	-	7	D
111001	2	7	1
111010	'	7	2
111011	(FIGS)	7	3
111100	7	7	4
111101	1	7	5
111110	(	7	6
111111	(LTRS)	7	7

Thus, according to the above table, three digits of the code word are applied from the conductors **137**, **138** and **154** to "and" gates **162**, **164**, and **166**, respectively each of which also receives a signal from a conductor **168** manifesting the synchronizing pulse. The "and" gates may take the form of any of a variety of coincidence circuits which pass the high state of a two-state signal upon simultaneously receiving all input signals in a high state. These gates are represented in FIG. **3** by a symbol somewhat conventional in the art which is employed here throughout to manifest a coincidence or "and" gate.

A similar set of "and" gates **170**, **172** and **174** receive inputs from the conductors **134**, **135**, and **136** respectively carrying the less-significant digits of the code words set forth above, and are also qualified by the synchronizing signals appearing in the conductor **168**. The digital signals passing through the gates **170**, **172** and **174** are registered in a stepping register **176** while the similar signals passing through the gate circuits **162**, **164** and **166** are registered in a similar register **178**. Thus, the stepping register **176** contains the three least-significant digits of the codes set forth in the above chart while the register **178** contains the three most-significant digits. Thus, the three digits in each of the registers serve to control in one case the rotational displacement from a home position of the type font **22** as shown in FIG. **1**, and second the displacement of the font **22** parallel its axis. Specifically, the contents of the stepping register **176** serve to control the rotational or angular displacement of the font while the contents of the stepping register **178** serve to control the linear displacement of the font along its axis, both in accordance with the table set forth above.

The stepping registers **176** and **178** may comprise a variety of binary digital stepping registers which include three binary stages and are thus capable of accomplishing three binary digits to represent values up to "eight." For example, the registers **176** and **178** may be constructed in accordance with well known prior art principles using magnetic core elements or various other two-state devices interconnected in a step-register configuration.

The operation of a system as disclosed may now be best further considered by assuming the existence of certain numerical values in the registers **176** and **178**, and proceeding with the introduction of other elements concurrently with the description of their function as the explanation proceeds. Therefore, assume initially that the flip-flop **152** provides a low level of a two-state signal through the conductor **154** to the gate **166**, and therefore the stepping register **178** registers a "zero" as the most significant digit, along with a "one" as the next most significant digit, followed by a "zero." Further assume that the register **176** contains the binary digits "100" from the most significant to least significant. As indicated in the table above, this composite code "010", "100," designates the symbol S and requires a rotational displacement of four positions along with a transverse displacement of two positions. Therefore, in accordance with the table, the stepping register **176** contains a binary equivalent "four" while the stepping register **178** registers "two."

With the registers **176** and **178** in the configuration described, assume a flip-flop **180** (upper right in FIG. **3**) is in a set state as a result of receiving the synchronizing signal from the conductor **168**. Therefore, the high output from the flip-flop **168** qualifies an "and" gate **182** permitting pulses of regular interval from a pulse generator **184** to pass through the "and" gate **182** to the stepping register **176**. The gate circuit **182**, in addition to receiving pulses from the generator **184** and qualification by the flip-flop **180**, receives a signal from a zero detector circuit **186** which functions to detect the clear state of the stepping register **176**.

The zero detector circuit **186** may take a variety of forms, one of which is simply a well known "or" gate connected to receive a "one" output from each of the stages of the stepping register to provide a high output if any of the stages contain a "one."

The stepping register **176** receives clearing pulses through the gate **182** which remains qualified as long as the register **176** contains a value above "zero." The pulses applied to the stepping register **176** are also applied through a conductor **188** to a control circuit **190** functioning in conjunction with a stepping motor **72** as described in FIG. **2**. As a result, the identical number of pulses required to clear the stepping register **176**, is applied to the stepping motor **72** advancing that motor by a number of angular increments coinciding to the number of pulses received. The control circuit **190** may take various forms, well known in the prior art, as manufactured with the stepping motor **72** described above. In function, the control circuit has two distinct inputs; in input F to result in forward motion by the stepping motor and an input R that results in reverse motion by the step motor.

Control of the stepping motor **68** to move the type font along its axis (as described in FIG. **2**) is accomplished in a somewhat similar fashion during the reset operation of the stepping register **178**. The stepping register **178** receives pulses from the pulse generator **184** through an "and" gate **192** which is qualified by the flip-flop **180**, and a zero-detector circuit **194** similar to circuit **186**, as previously described. The zero-detector circuit **194** provides an output as long as the stepping register **178** contains any binary "ones"; however, when the register is clear, the zero detector circuit **194** provides the low value of a two-state signal, thereby disqualifying the gate **192**. The pulses passed by the "and" gate **192** from the pulse generator **184** to clear the stepping register are also applied through a conductor **196** to the input F of the control circuit **200** functioning in conjunction with the step motor **68**.

Reconsidering the assumed value "010" in the stepping register **178** and the value "100" in the stepping register **176**, and further assuming the set state of the multivibrator **180** to provide a high output signal therefrom, the sequence of events which follow will now be described. The operation of the two stepping registers to set the associated stepping motors occurs simultaneously; however, consider first the operation of the stepping register **176** to rotationally displace the type font by energizing the stepping motor **72**. Because the stepping register **176** contains a binary value "100" (number other than zero) a high signal passes from the zero detector circuit **186**, which along with the high output from the flip-flop **180** qualifies the "and" gate **182** so that pulses from the pulse generator **184** pass to the stepping register **176** and to the input F of the control circuit **190** to advance the stepping motor **72**.

The binary value "100" is the equivalent of decimal "four," therefore, four pulses are required to clear the stepping register **176**. The same pulses employed to clear the stepping register are applied through the conductor **188** to advance the stepping motor **72** by four positions in accordance with the table set forth above to accomplish the desired rotational displacement of the type font to locate the symbol S.

In a somewhat similar fashion the zero detector circuit **194** and the multivibrator **180** qualify the "and" gate **192** to permit the passage of pulses frm the generator **184** to the stepping register **178**. The stepping register **178** contains a binary digital value "100," equivalent decimal two; therefore, two pulses are required to be applied to the stepping register before it is reset. Of course, upon being reset, the stepping register **178** is detected to contain "zero" by the circuit **194** thereby immediately disqualifies the gate **192**. The two pulses to reset the stepping register **178** are also applied through the input F of the control circuit **200** to advance the stepping motor **70** two positions and accomplish the desired linear displacement of the type font **22** to provide the symbol S in a position to print.

At this stage of operation, the desired symbol S is in a position to be printed and the zero detector circuits **186** and **194** both provide low outputs indicating both the registers **176** and **178** have been cleared. This condition is sensed by an "and" gate **202** which is connected to receive one input through an inverter circuit **204** from the zero detector circuit **186** and another input through an inverter circuit **206** from the zero detector circuit **194**. Thus, the "and" gate **202** receiving inverted forms of the signals provides a high output of a two-state signal when both the stepping registers **176** and **178** are cleared. The high output from the gate circuit **202** resets the multivibrator **180** and pulses a delay circuit **208**, which after a predetermined delay interval provides a pulse in a conductor **210**. The conductor **210** is connected to the print solenoid **90**, the ribbon solenoid **80**, and a delay circuit **216**. The pulse from the delay circuit **208** applied to the print solenoid **90** and the ribbon solenoid **80** activates the hammer as previously described and the ribbon, to accomplish the selected symbol as a printed letter on the paper.

The pulse from the delay circuit **208** applied through the delay circuit **216** serves to set a flip-flop **219** providing a high output to "and" gates **222** and **224**. The pulse employed to set the flip-flop **219** also serves to set a flip-flop **225** which provides a high output to "and" gates **226** and **228**. This portion of the system serves to reset the stepping motors **68** and **72** to return the type font to "home" position, i.e. the zero or dwell position.

The gate circuits **222** and **228** upon qualification by the flip-flops **219** and **225** respectively pass pulses from a pulse generator **230** to the control circuits **190** and **200** respectively. These pulses are applied to the input R of the control circuits driving the stepping motors **72** and **70** in the reverse direction. These stepping motors are mechanically coupled (as indicated in FIG. **3**) to home-position disks **232** and **234** respectively which upon reaching the "home" position close switches **236** and **238** respectively. Operation is similar; however, upon the closure of the switch **236** for example, a positive signal is applied through the gate circuit **224** to reset the flip-flop **119** stopping further pulses from being applied to the stepping motor **72** by disqualifying the gate **222**. In a similar fashion, the disk **234** upon reaching the "home" position closes the switch **238** to apply a positive signal through the gate **226** to reset the flip-flop **225** thereby inhibiting the gate **228**. Thus, the stepping motors **68** and **72** are returned to the home position preparatory to another operation of positioning a desired symbol in a printing position.

Along with resetting the type font to the "home" position, it is necessary to advance the hammer and the font to the next position to be printed upon. This operation is accomplished by a pulse from the delay circuits **216** which is applied through a conductor **241** to the input F of a control circuit **240** which functions in conjunction with the stepping motor **106**. The single applied pulse advances the stepping motor **106** one position preparatory to printing the next symbol. Of course, the next position may be established as a space rather than a symbol, which occurrence is manifest by a pulse in the conductor **144** from the decoding matrix **132**. The pulse appearing in the conductor **144** is applied to the control circuit **240** at the F input just as previously described to step the hammer **20** and the type font one more position to the right, leaving a blank space.

In this manner, the system functions to accomplish a complete line of type, after which it is necessary to return the printing elements to the starting position of a new line of type and advance the paper horizontally one line. The carriage return pulse sensed and formed from the decoding matrix **132** upon receiving such a command, is applied through a conductor **146** to a flip-flop **245** resulting in a high signal from the flip-flop which energizes the roller step solenoid **116** to advance the paper as previously described. The flip-flop **245** also qualifies an "and" gate **247** permitting pulses from the generator **230** to pass to the reset input R of the control circuit **240** thereby reverse stepping the stepping motor **106** until the associated disk **250** manifests the home position by closing a switch **252** which results in the application of a positive signal to reset the flip-flop **245**. Upon resetting the flip-flop **245**, the gate **247** is disqualified; however, the printing elements have now been returned to the starting position for another line.

It may therefore be seen, that the system of the present invention may be embodied in a compact unit wherein reliable stepping motors accomplish a simplified mechanical structure for reliable operation in mobile installations. Another important feature of the present invention resides in the use of stepping registers in conjunction with the stepping motors to control the stepping motors.

Although various features and concepts of the present invention have been set forth in the foregoing illustrative embodiment, the present invention is not to be limited in accordance therewith but is to be constructed in accordance with the claims set forth below.

What is claimed is:

[**1**. A printer for executing various symbols on command, comprising:

a type element with plural symbols carried thereon;
mounting means for said type element, whereby said element may be variously displaced to present said symbols thereon in a printing position;
means for providing a series of electrical pulses indicative of a desired displacement of said type element to accomplish a predetermined symbol;
at least one bidirectional stepping motor having a home position and connected to receive said pulses for displacing said type element in accordance with said electrical pulses;
means for activating said type element to print; and
means for returning said stepping motor for said home position after said type element is activated, by applying pulses to said stepping motor.]

2. A printer for a plurality of characters, comprising:

a type body having lines defining said characters about the surface thereof;
means for supporting said type body whereby said type body may be variously displaced in plural directions from a quiescent position whereby to present said characters in a printing position;
means for providing plural sets of electrical pulses, each of said sets being indicative of a displacement in one direction to accomplish a desired position for a predetermined character;
a plurality of bidirectional stepping motors, each connected to receive one of said sets of electrical pulses and being mechanically coupled to said type body whereby to displace said type body in one direction;
means for activating said type body to print; and
means for providing return pulses to said stepping motors after said type body is activated to print.

3. A printer for printing any of a plurality of characters in sequence on a printing medium, comprising:

a type body having lines defining said characters about the surface thereof;

support means for supporting said printing medium contiguous said type body;

mounting means for said type body whereby said body may be variously displaced to move each of said characters along at least two paths to position a select character in printing relationship to said medium;

means for providing at least two sets of electrical pulses, each indicative of a predetermined displacement of a select character along one of said paths to position said select character for printing;

at least two bidirectional stepping motors, each connected to receive one of said sets of electrical pulses, said stepping motors being connected to said type body whereby to displace each of said characters along one of said paths in accordance with said sets of electrical pulses; and

means to activate said type body relative said printing medium, whereby to print.

4. A printer for printing any of a plurality of characters in sequence on a printing medium, in accordance with electrical code signals indicative of characters comprising:

a type body having lines defining said characters about the surface thereof;

support means for supporting said printing medium contiguous said type body;

mounting means for said type body whereby said body may be variously displaced to move each of said characters along at least two directional paths to position a select character in printing relationship to said medium;

plural shift registers for receiving components of said electrical code signals indicative of characters;

means for pulsing said shift registers to provide sets of pulses, each indicative of a displacement in one direction to accomplish a desired position for a predetermined character;

a plurality of bidirectional stepping motors, each connected to receive one of said sets of electrical pulses and being mechanically coupled to said type body whereby to each displace said type body in one of said directions; and

means to activate said type body relative said printing medium, whereby to print.

5. A printer according to claim 4, wherein said type body is generally cylindrical and said mounting means enables displacement along and about the central axis of said generally-cylindrical type body,

6. A printer according to claim 5 wherein said means to activate said type body comprises a hammer means to drive said printing medium against said type body to impress a character on said medium.

7. A printer for printing any of a plurality of characters in sequence on a printing medium, in accordance with electrical code signals indicative of characters, comprising:

a type body having lines defining said characters about the surface thereof;

means for supporting said printing medium continguous said type body;

mounting means for said type body whereby said body may be variously displaced to move each of said characters in two directions along at least two paths to position a select character in printing relationship to said medium;

plural shift registers for receiving components of said electrical code signals indicative of characters;

means for pulsing said shift registers to provide sets of pulses, each indicative of a displacement in one direction to accomplish a desired position for a predetermined character;

a plurality of bidirectional stepping motors, each connected to receive one of said sets of electrical pulses and being mechanically coupled to said type body whereby to displace said type body in one direction;

means to activate said type body relative said printing medium, whereby to print;

shift means to shift said type body relative said printing medium upon each printing operation whereby to provide a fresh section of said medium for said type body; and

means to supply return pulses to said stepping motors to displace said type body in the other directions to a reset position.

8. A printer according to claim 7 wherein said stepping motors include means to signal a home position thereof and wherein said system includes means for providing return step pulses to said stepping motors after each printing operation, terminated by said means to signal a home position.

9. A printer according to claim 7 wherein said shift registers are connected to register component parts of said electrical code signals and wherein said system further includes means to provide pulses to form said sets of pulses, and to clear said code signals for said shift registers whereby to define said sets of pulses.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : Re 30,942

DATED : May 25, 1982

INVENTOR(S) : Takenaka, George

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

Col. 12, line 50, change "for" to -- from --.

Signed and Sealed this

Tenth **Day of** *August 1982*

[SEAL]

Attest:

GERALD J. MOSSINGHOFF

Attesting Officer *Commissioner of Patents and Trademarks*