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Carbonneau

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[54] **BRAILLE COMMUNICATION TERMINAL**

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[52] **U.S. Cl.** ..... **197/6.1**; 101/18; 340/173 RC

[51] **Int. Cl.** **B41j 3/32**

[58] **Field of Search** ..... 197/1 R, 6, 6.1, 19; 178/92; 340/173 RC, 172.5; 101/3 R, 26, 28–32, 18; 61/93 C

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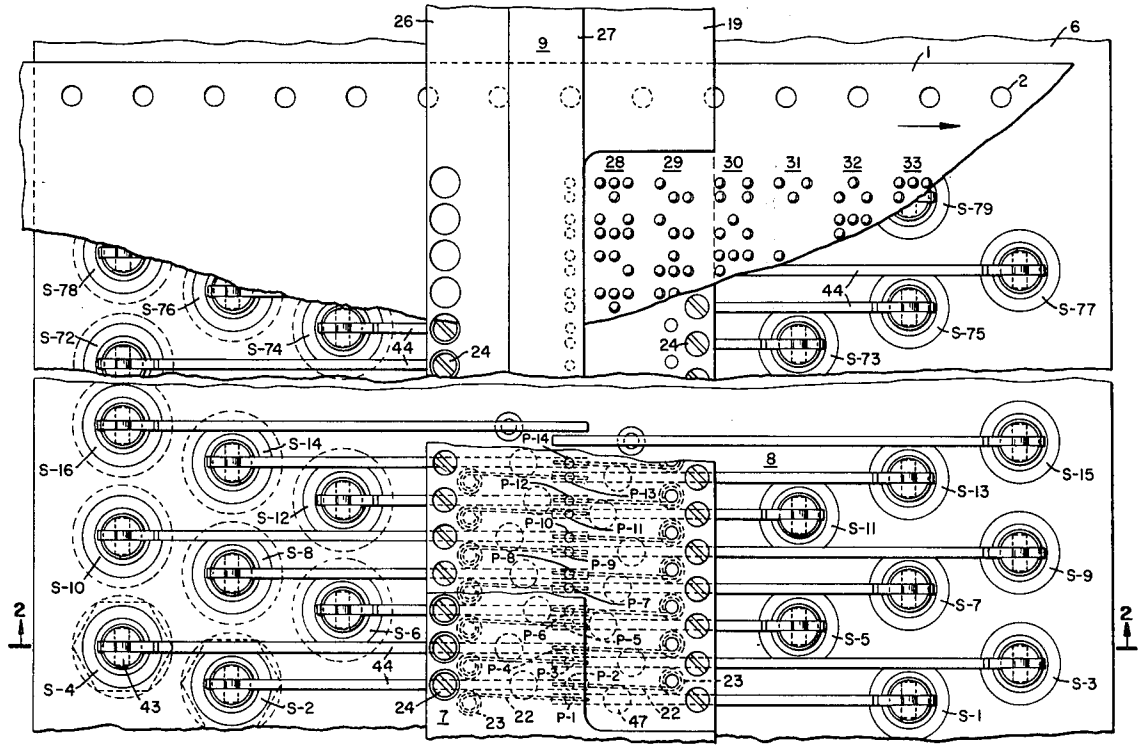
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Attorney, Agent, or Firm—Martin LuKacher

[57] **ABSTRACT**

A Braille Telecommunications Terminal is described herein which is adapted to emboss complete lines of braille characters at high speed in response to code characters received by the terminal from a communications line or from a keyboard in the terminal. A plurality of pairs of pins are disposed in a row and are actuable to move forward to an extended position against an embossable sheet to form pairs of code elements of the characters in a line of braille characters. The sheet is advanced and successive pairs of code elements are embossed upon each advance until the code elements which constitute the braille characters are embossed. In this manner an entire line of braille characters can be embossed at very high speeds. The pins and the advancing of the sheet are automatically controlled in response to code signals received by the terminal, or from the keyboard.

20 Claims, 10 Drawing Figures



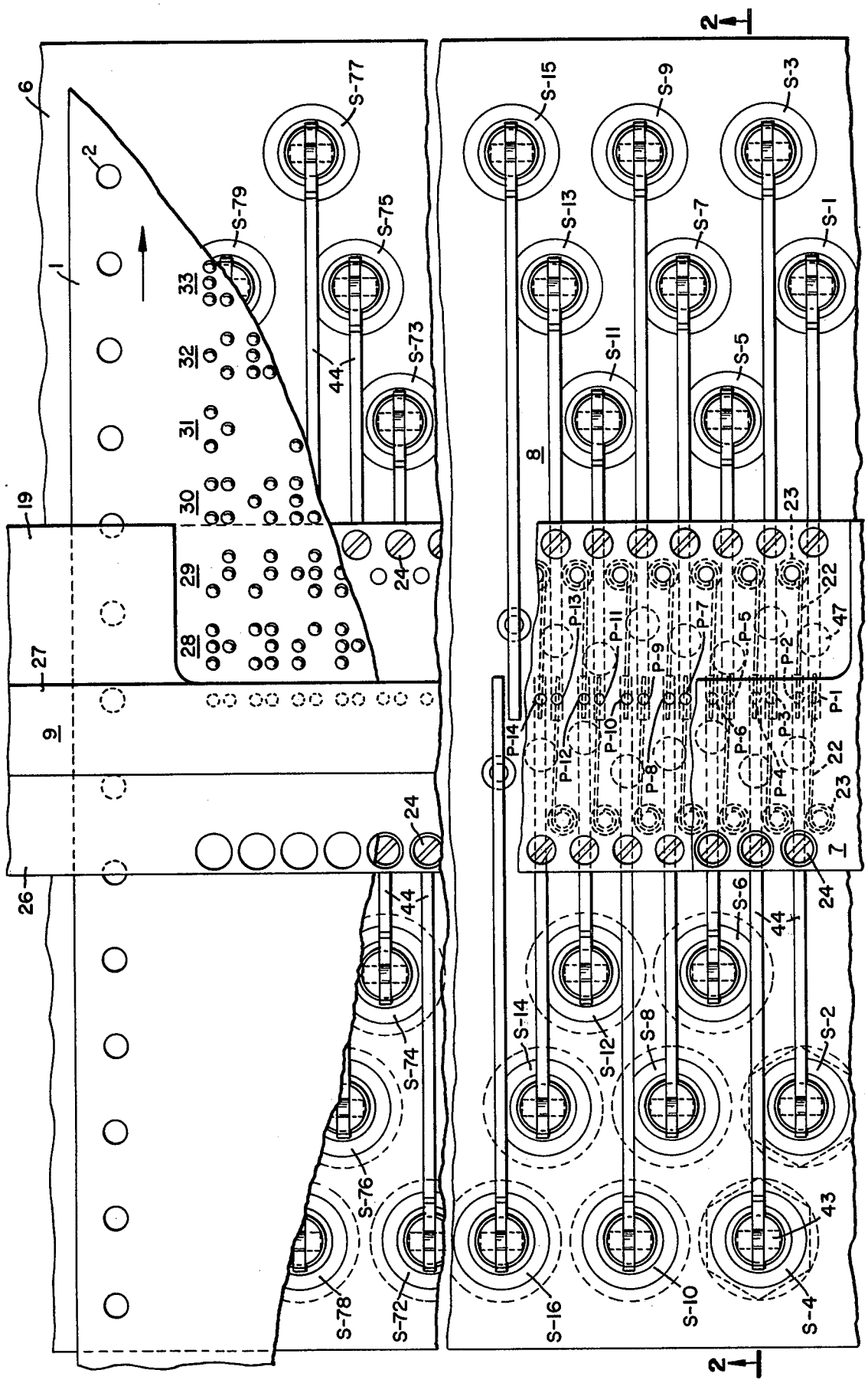
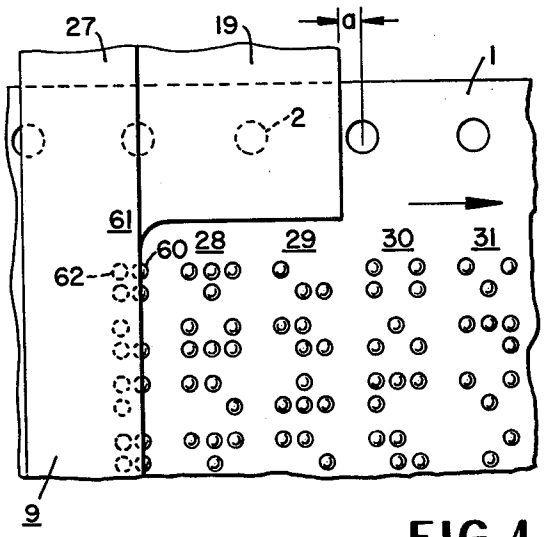
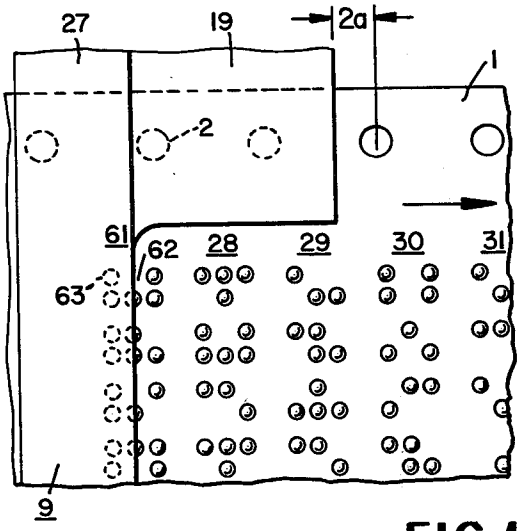

S-77
S-79
S-75
S-73
S-15
S-9
S-3
S-13
S-7
S-1
S-11
S-5
S-74
S-76
S-78
S-72
S-14
S-12
S-8
S-6
S-2
S-16
S-10
S-4
P-14
P-12
P-10
P-8
P-13
P-11
P-9
P-7
P-5
P-3
P-1
P-6
P-4
P-2
1
2
6
19
27
9
26
33
32
31
30
29
28
24
44
8
23
22
47
7
43

FIG. 1.



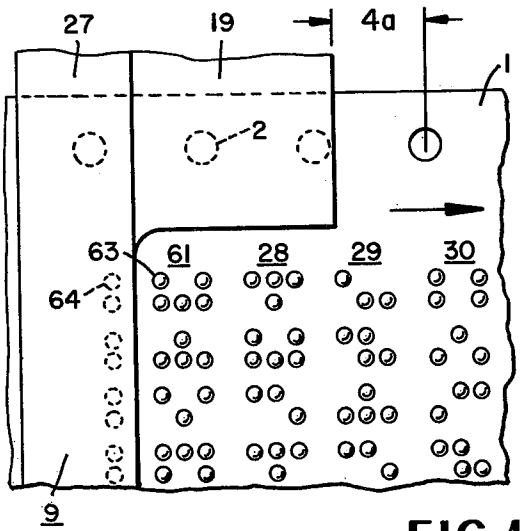
SECOND ROW OF IMPRESSIONS

FIG. 1A.



THIRD ROW OF IMPRESSIONS

FIG. 1B.



DOUBLE SPACED FOR FIRST ROW OF NEXT ROW OF IMPRESSIONS

FIG. 1C.

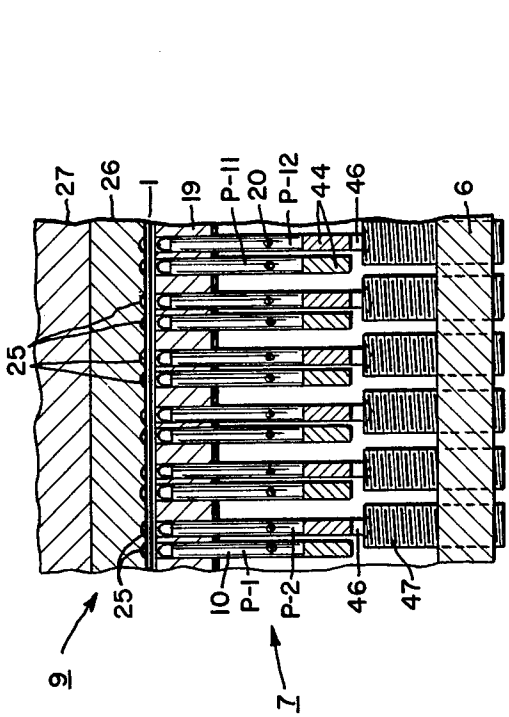

27
26
1
19
P-11
20
P-12
44
46
6
25
10
P-1
P-2
46
47
9
7

FIG. 3.

2
3
4
5
6
41
45
50
44
42
S-3
S-7
S-5
S-6
S-8
S-4
1
8
9
19
24
23
46
47
49
P-4
20
22
25
27
26
52
3

FIG. 2.

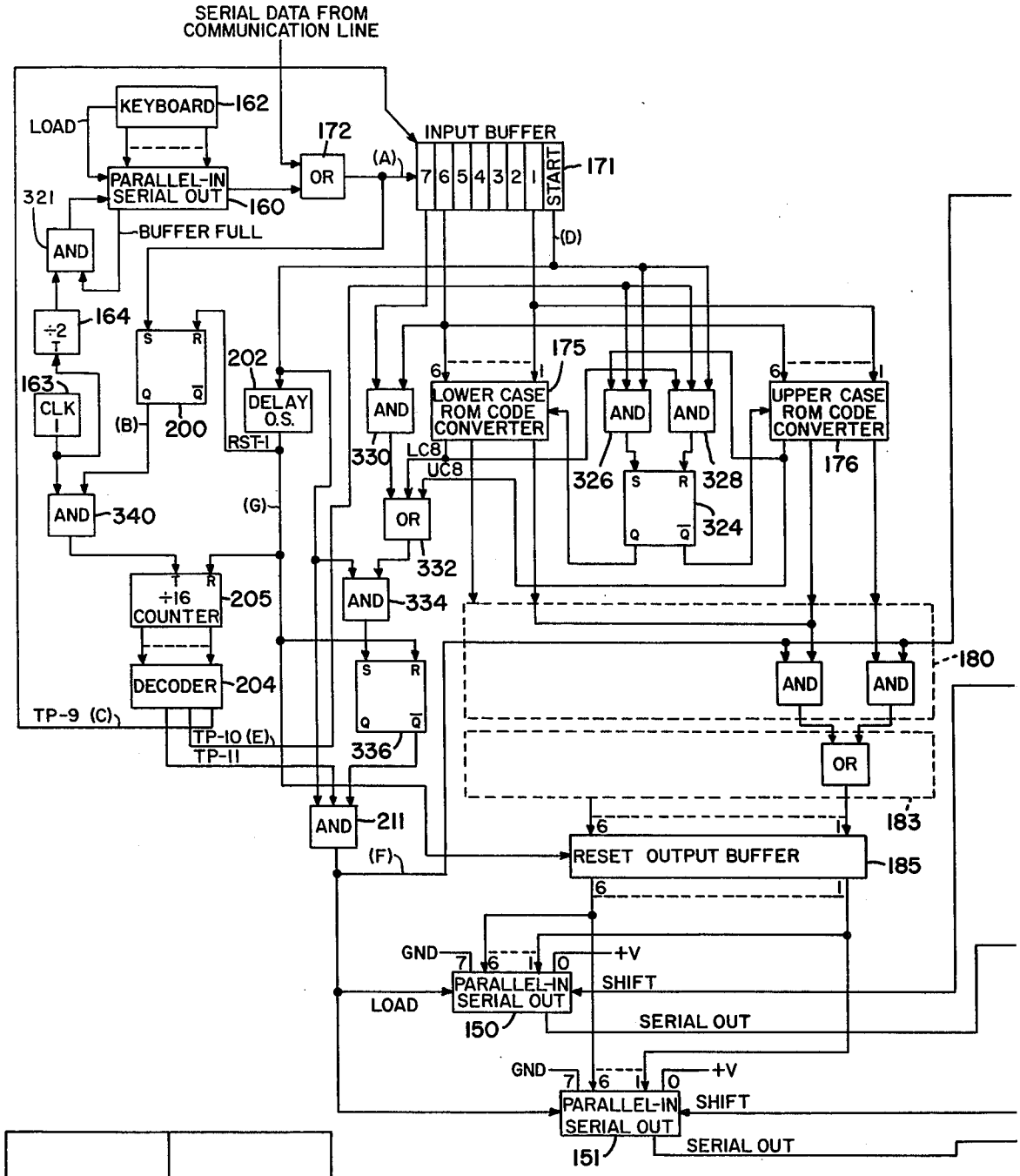


FIG.4A.

FIG.4A. FIG.4B.

FIG.5.

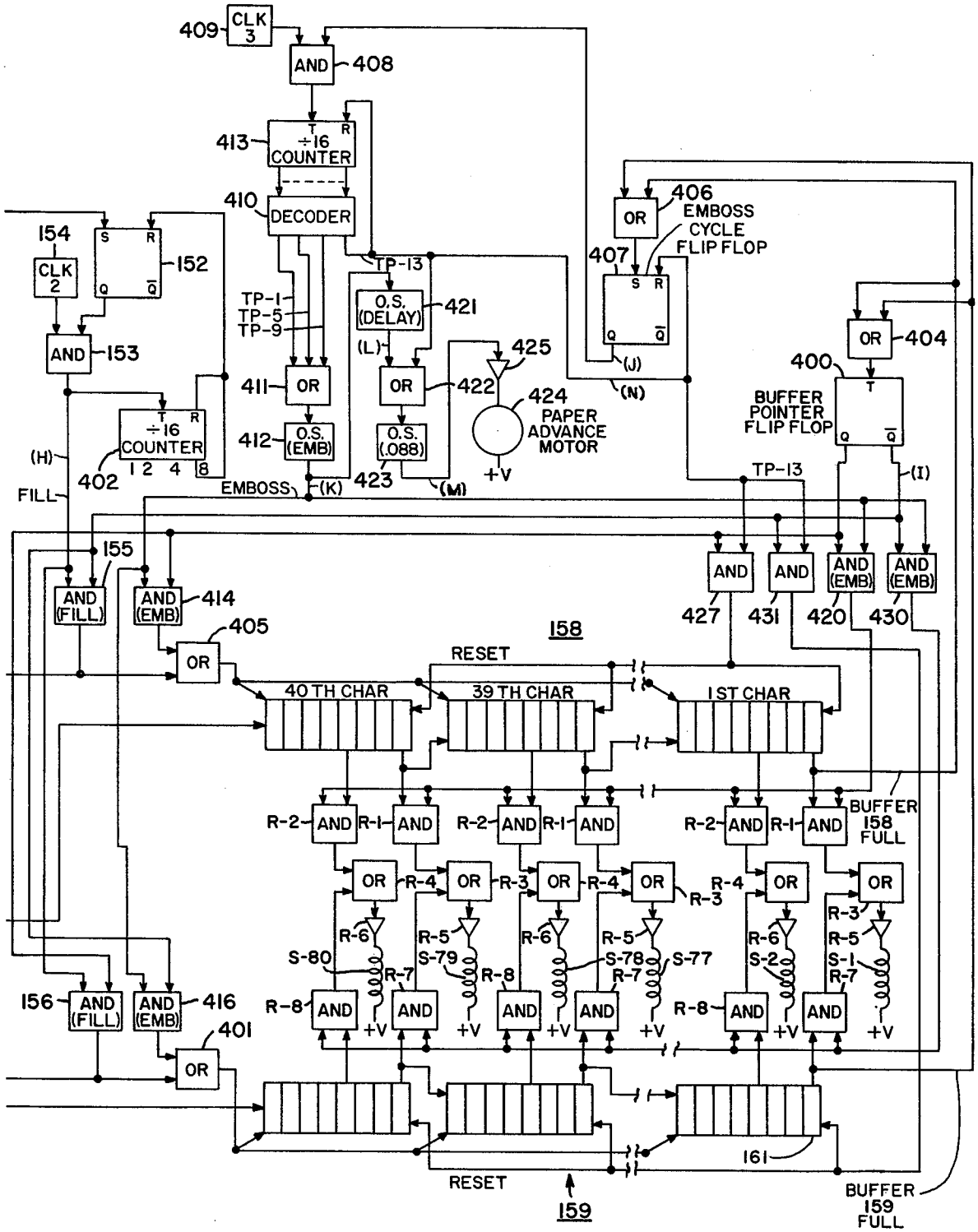

409
CLK 3
AND
408
413
÷16 COUNTER
410
DECODER
406
OR
EMBOSS CYCLE FLIP FLOP
407
404
400
BUFFER POINTER FLIP FLOP
154
CLK 2
152
153
TP-1
TP-5
TP-9
411
OR
412
O.S. (EMB)
TP-13
O.S. (DELAY)
421
(L)
OR
422
O.S. (.088)
423
425
424
PAPER ADVANCE MOTOR
+V
(J)
(N)
(H)
402
1 2 4 8
FILL
EMBOSS
(K)
(M)
TP-13
(I)
155
AND (FILL)
AND (EMB)
414
405
OR
158
RESET
40 TH CHAR
39 TH CHAR
1 ST CHAR
AND
427
431
AND (EMB)
420
430
BUFFER 158 FULL
R-2
R-1
OR
R-4
R-3
R-6
R-5
R-7
R-8
S-80
S-79
S-78
S-77
S-2
S-1
+V
156
416
401
161
RESET
159
BUFFER 159 FULL

FIG. 4B.

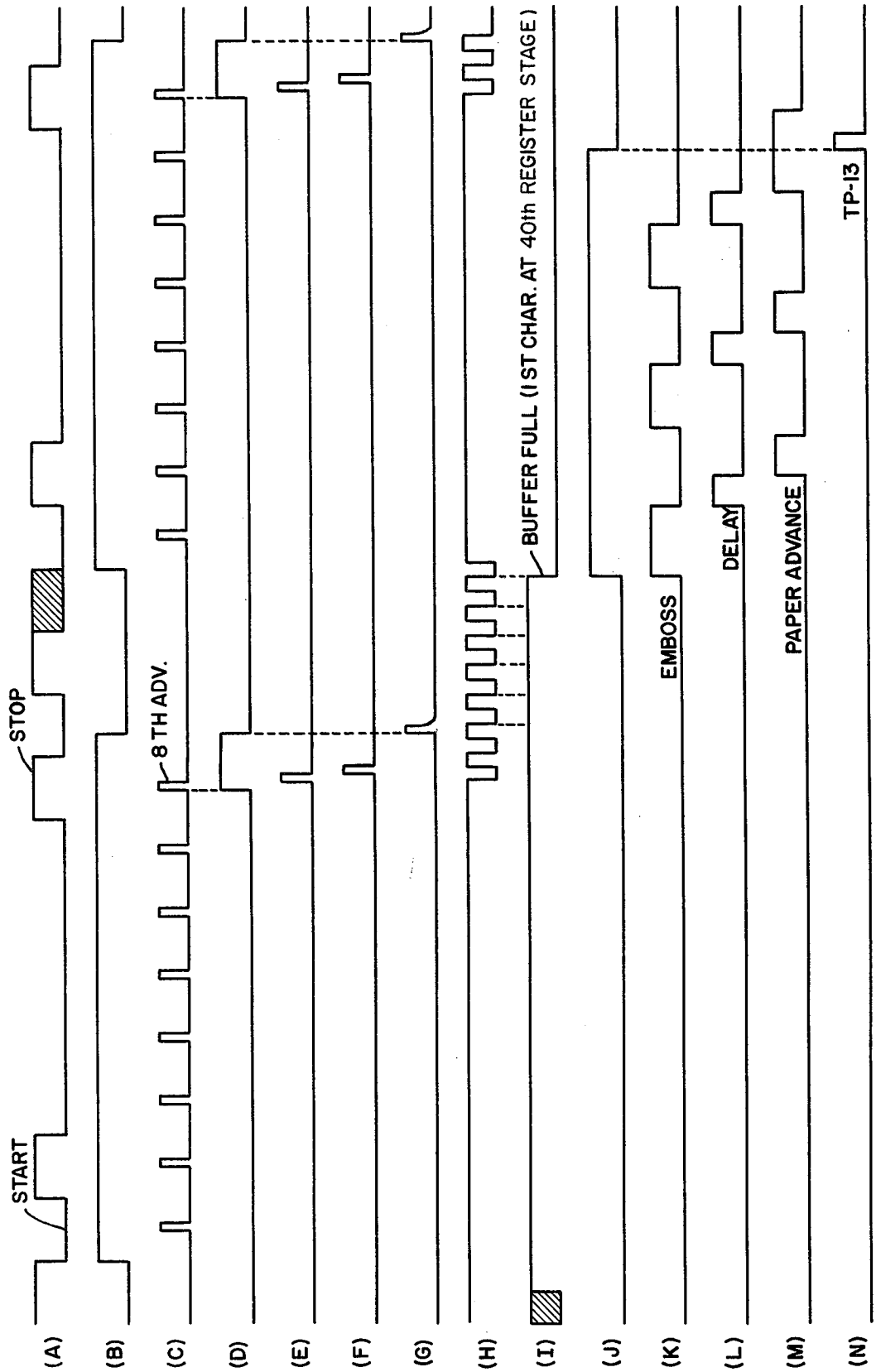

START
STOP
8TH ADV.
BUFFER FULL (1ST CHAR. AT 40th REGISTER STAGE)
EMBOSS
DELAY
PAPER ADVANCE
TP-13
(A)
(B)
(C)
(D)
(E)
(F)
(G)
(H)
(I)
(J)
(K)
(L)
(M)
(N)

FIG. 6.

BRAILLE COMMUNICATION TERMINAL

THE FIELD OF THE INVENTION

This invention relates to braille communications terminals and particularly to an improved system for embossing braille characters at very high speed.

BACKGROUND OF THE INVENTION

There have heretofore been provided braille typewriters which are of a complex mechanical design thus making them relatively slow, noisy and expensive. Such braille typewriters are operative to emboss one braille character at a time, much in the same manner as a conventional typewriter which types alpha-numeric characters. Thus conventional braille typewriters are limited in speed of operation in that they are bound by the inherent limitations of the speed of their moving parts. Moreover, conventional braille typewriters are adapted to be manually operated and can not be operated by message data received from a telecommunications line or link as is the case for alpha-numeric teletypewriters and teleprinters. Thus there has not been available for persons who are not sighted the same high speed and flexible communications facilities (e.g., teletypewriters and teleprinters) which are available for sighted person. It is particularly important that braille information be presented at extremely high speed compatible with the speeds at which blind person who are adept in reading braille can read braille characters. There have not been made available for the benefit of blind persons, prior to the present invention, extremely high speed braille character embossing apparatus and particularly an apparatus which is automatically operated to receive the same type of message data which is provided for teletypewriters and teleprinters for embossing braille characters at high speeds a line at a time.

OBJECTS AND SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide improved apparatus for braille communications.

It is another object of the present invention to provide improved braille embossing apparatus which is capable of embossing braille characters a line at a time using message data of the type which is available and used conventionally for digital telecommunications applications.

It is a still further object of the present invention to provide an improved braille typewriter which is also operative as a braille teletypewriter when coded signals are applied thereto via a transmission line or other communications channel or link.

It is a still further object of the present invention to provide an improved braille communications terminal which is relatively low in cost.

It is a still further object of the present invention to provide an improved braille communications terminal capable of printing braille characters at extremely high speeds, say **120** characters per second or 180lines per minute.

It is a still further object of the present invention to provide an improved high speed braille communications terminal which is relatively quiet.

It is a still further object of the present invention to provide an improved high speed braille communications terminal which operates automatically in response to received message data, translates such data into braille characters, and enbosses a sheet with braille characters corresponding to the received message data and advances the sheet in to permit the embossing of successive lines of the braille characters.

Briefly described, a braille communications terminal involving the invention includes a row of embossing members for embossing the collinearly disposed elements of a line of braille code characters all at the same time. Each braille code character consists of three pairs of code elements disposed one below the other, or six code elements in all. In accordance with this invention a line of braille characters is embossed by successively embossing the pairs of code elements which constitute a line of braille characters all at the same time. The sheet which is adapted to receive the embossing is advanced so that the second pair of code elements of the line of characters is embossed. Then the sheet is advanced a third time until the third pair of code elements is embossed. In this way entire lines of braille code characters is adapted to be embossed at extremely high speed. The communications terminal includes a system of electronic circuits such as registers, memories, gates, flip-flops, and sources of timing signals, all of which are responsive to the code signals of the data characters to be embossed in the from of braille characters for successively operating the embossing apparatus so that successive lines of the braille characters are embossed, and the sheet on which the characters are embossed is automatically advanced.

The foregoing and other objects and advantages of the present invention will be more readily understood from the following detailed description of an illustrative embodiment of the invention shown in the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partially broken away top view of a braille communications terminal embodying the invention;

FIGS. **1***a*, **1***b*, and **1***c* are fragmentary plan views of the portion of the structure shown in FIG. **1** which illustrates the operation of the appratus in embossing rows containing successive pairs of successive lines of braille characters so as to emboss such successive lines at very high speed.

FIG. **2** is fragmentary sectional view of the apparatus shown in FIG. **1**, the section being taken along the line **2—2** in FIG. **1**;

FIG. **3** is a fragmentary sectional view showing the embossing pins of the apparatus in greater detail, the section being taken along the line **3—3** in FIG. **2**;

FIGS. **4A** and **4B** when joined together in the manner illustrated in FIG. **5**, show a detailed block diagram of the electronic circuitry included in the braille communications terminal which is provided in accordance with the invention;

FIG. **5** is a diagram illustrating the relationship between FIGS. **4A** and **4B**; and

FIG. **6** shows timing diagram which is explanatory of the operation of the electronic circuitry shown in FIGS. **4A** and **4B**

DETAILED DESCRIPTION

Referring more particularly to the drawings, there is shown a braille communications terminal or teletypewriter for embossing lines consisting of **40** braille characters per line on an embossable medium. As shown in

FIGS. 1 to 3 the embossable medium is a sheet 1 of paper of the type used in continuous computer forms. The paper has sprocket holes 2 along its longitudinal edges which are adapted to be engaged by the pins 3 of a tractor pin 4 mechanism (see FIG. 2) of the type used in computer printers. The tractor 4 has a sprocket wheel 5 which is adapted to be driven by a paper advance mechanism.

The apparatus has frame 6 on which its various parts are mounted. These parts are in general an embossing pin mechanism 7, an actuating mechanism 8, a die member 9.

The embossing mechanism 7 includes 40 pairs of embossing pins P-1 to P-80. Only the pair 10 P-1 and six others are shown in detail in the drawing to simplify the illustration. The pins of these pairs P-1 to P-14 are also shown in detail as is the case for the pin P-4 (see FIG. 2). Each pin is a cylindrical rod having an embossing tip 17 at the upper end thereof. The embossing pins are located in holes 18 in a support plate 19 which is mounted on the frame 6. Each pin has a hole 20, a spring wire 22 held on the plate 19 by a screw 23 extends through the hole 20 in the pin and biases the pin downwardly in a direction away from the sheet 1 against the actuating mechanism 8. Also mounted in the plate 20, as by being screwed therein, are adjustable stop members 24. The tips 17 are adapted to enter recessed dies 25 in a die member 26 which is disposed above the plate 19 and held in the position shown with the recessed dies in alignment with the tips of the pins by a bracket member 27.

It will be observed from FIG. 1 that the embossing pins are collinearly disposed in a row transversely across the sheet 1. When actuated, the pins are extended upwardly into their cooperating dies 25 which are disposed in a line with the pins in a row across the sheet 1. The tips 17 of the pins thus emboss the sheet with protuberances which form the code elements of a line of code elements in a braille character. The pair of pins 10 form the upper pair of code elements of the first braille character, next pair of pins form the elements of the second braille character, and so forth, for the 40 braille characters which are adapted to be embossed in a line across the sheet. The braille characters as in the case of the lines 28 to 33 partially shown in FIG. 1 consist of three pairs of code elements which may or may not be present depending upon the character represented by the braille code. The pins P-1 to P-40 are selectively actuated by the actuating mechanism 8 so as to emboss entire lines consisting of the pairs of the braille code elements which constitute these characters.

The actuating mechanism itself contains 40 solenoids S-1 to S-80 which are disposed in rows on opposite sides of the row of pins P-1 to P-80. The solenoids are offset at different distances from the rows of pins and on opposite sides of the row of pins in the interest of simplicity and compactness and for limiting the mechanical movements so as to reduce the noise produced from the operation of the apparatus thereby rendering it more silent. The solenoids are attached as by mounting bolts 41 to the frame 6. Each solenoid has an armature 42 which has a slot 43 in the upper end thereof. One end of a link or lever 44 is disposed in the slot 43 and is held there in position by a pin 45. The links or levers 44 are of three different lengths depending upon the distance between the solenoid and the row of pins P-1 to P-80. Each line is privotally mounted intermediate the ends thereof at a fulcrum 46 provided by a set screw 47. The fulcrums 46 are disposed at different positions depending upon the length of their respective levers. The top edge of the forward end 49 of each link 44 is disposed below the bottom of a different one of the pins P-1 to P-80. The armatures 42 of each of the solenoids are biased by coil springs 50 which are disposed about the armatures and bear upon the frame 6 and the bottom of their respective links 44.

The bias provided by the springs 50 maintains the links in unactuated position as shown in full line in FIG. 2 of the drawings. When a solenoid is actuated, for example the solenoid S-4, its armature is pulled in to the body of the solenoid so as to bring the line 44 which is disposed in the slot 43 of the solenoid armature 42 to the position shown in dash lines in FIG. 2. Such actuation causes the link 44 to pivot about its fulcrum 46 and drive or extend the pin P-4 upwardly so that the tip of the pin P-4 enters the recessed die 25 and embosses a protuberance representing the braille code character element in the sheet 1. By virtue of the location of the fulcrums 46 the travel of each of the links is the same no matter its length or the position of its actuating solenoid S-1 to S-80. The set screws 24 act as stops limiting the upward travel of the links 44 in response to the bias of the springs 50 about the solenoid armatures 42. It will be noted that the fulcrums 46 are projections which extend downward from the links into recesses 52 in the set screws 47.

The operation of the mechanisms to print lines of braille characters may be more apparent from FIGS. 1A to 1C. The lines of characters 28 to 31 have already been embossed or printed on the sheet 1. Consider that the pins P-1 to P-80 have been extended to emboss the first row 60 of the next line 61 of braille characters as shown in FIG. 1A. The sheet 1 is then advanced by the tractor mechanism 4 (see FIG. 2) a distance *a* which is measured for the sake of convenience from the right hand edge of the plate 19; *a* may be 0.088inch for example. Then the actuating mechanism 8 is operated to selectively emboss; the protuberances forming the second row 62 of code element of the line of characters 61.

As shown in FIG. 1B, in order to emboss the third row 63 of code elements, the sheet 1 is advanced another distance *a* or a total distance 2*a* with the embossing of the row 63 the entire line 61 of braille characters is embossed. Then, as shown in FIG. 1C, the sheet 1 is advanced or fed a double distance (viz., double space) so as to place the sheet in position for embossing the first row 64 of the next line of braille characters. Inasmuch as the plate 19 is cut away over the die section 27 the line of braille characters can be edited, conveniently, by scanning the finger of a person who can read braille across the line. The blind person can thus read the lines of braille characters for editing or other purposes as quickly as they are printed. The mechanism as illustrated in FIGS. 1 to 3, has a relatively small number of mechanical parts which execute relatively small movements. These movements can be accomplished quickly and with a minimum of noise. The rapid operation of the mechanism in printing lines of braille characters provides for a very high speed printing or embossing of such characters, say at 180 lines per minute.

The electronic circuitry for operating the mechanism illustrated in FIGS. 1 to 3 to emboss the successive lines of braille characters on the sheet 1 is illustrated in FIGS. 4A and 4B. The timing of the circuit operations

is illustrated by the waveforms shown in FIG. 6, to which reference should be made as the description of the circuitry proceeds.

The terminal may be provided with its own keyboard 162 or it may receive serial data in the form of "baudot"or "selectric"or "ascil" coded signals from a communication line or other link. The apparatus operates in accordance with any such digital data messages to provide the lines of braille characters on the sheet 1.

Consider the case when the keyboard 162 is used. The keyboard may be any conventional keyboard which inputs a 7-bit binary code for each character into a register 160. The keyboard automatically provides a load command to the register 160 whenever a key is depressed. The register 160 itself maybe a parallet-in/serial-out register, such as an integrated circuit (IC) that is available from the General Instruments Company as their part AY51010. When data is contained in the register 160, a buffer full level enables an AND gate 321 which allows clock pulses from a clock oscillator CLK-1, which is also designated by reference numeral 163, to the shift input of the register 160 for reading our the register. The clock pulses are divided by 2 in a triggerable flip-flop 164 which operates as a divide-by-2 counter. The IC 160 is internally provided with a divide-by-eight counter which affords the requisite timing. Thus, each character in the keyboard code is read out through an OR gate 172. The register 160 provides a serial code for each character consisting of a start bit, and six data bits. The stop bits are always levels indicated as being positive voltage representing binary 1's and the start of bit level is always indicated by a binary 0, (see Waveform (A), Fig. 6). The serial data from the communications line is also made up of multi-bit characters, the first bit of each character being a binary 0 level. In the case of "ascii" there are special control characters which are represented by the value of the 6th and 7th bits of the code. In "selectric" and "baudot" codes (baudot being the usual teletypewriter code) there are upper case and lower case characters. These characters are not embossable and provisions are made in the electronic circuitry for inhibiting the embossing of such characters, as will be described more fully hereinafter. The six bits of each character, after the start bit, represent and distinguish the particular character. It is these bits which are translated or converted into braille code characters and used by the system to control the embossing mechanism.

The start bit, whether from the register 160 or from the characters which are received from the communication line, are operative to set a latch 200. The latch 200 when set enables an AND gate 340 to pass the CLK-1 pulses to a divide-by-16 counter 205. The output of this counter (viz., the five stages which make up the counter) are decoded in an AND gate decoder 204 to provide timing pulses TP-9, TP-10, and TP-11 for each received character.

TP-9 corresponds to the ninth received clock pulse; TP-10 to the tenth; and TP-11 to the eleventh received clock pulse. TP-9 is applied as a shift pulse to an input buffer 171. The rate of the CLK-1 pulse is sufficiently higher than the data rate so that a TP-9 pulse will occur during the interval of each bit of the coded characters form the line or from the register 160.

By the time the eighth advance, as provided by TP-9 shift pulses to the input buffer 171 occurs, the start bit will be in the first or start stage of the buffer 171 (see Waveform (C), FIG. 6). The start bit is applied to a delay one-shot 202 which produces a reset pulse RST-1 (see Waveform (G), FIG. 6) which resets the latch 200 and the counter 205 thus ending a character timing cycle. Upon occurrence of the start bit and during the time of that bit, the input buffer 171 will be loaded and full of the data bits of a character.

The six stages of the buffer which contain the six data bits of the character are applied to code converters 175 and 176 for upper and lower case character respectively. These code converters may be conventional Read Only Memories (ROM's) which are programmed to convert the binary codes in the buffer into braille codes having six bits. The lower case ROM 175 also decodes an upper case character by providing an output level on the LC-8 output of the ROM 175. The upper case converter 176 decodes a lower case character by providing a UC-8 output. Special characters are decoded by an AND gate 330 which is interconnected to the sixth and seventh stages of the input buffer 171. During the time of TP-10 and during the start bit time, an AND gate 326 will be enabled when UC-8 is decoded by the upper case ROM 176. During the same time period and LC-8 level from the lower case ROM 175 will enable another AND gate 328. Therefore for subsequent lower case characters a latch 324 will be set by the output of the AND gate 326 so as to enable the lower case ROM 175 to provide braille output codes and for subsequent upper case characters the AND gate 328 will reset the latch 324 thus enabling the upper case ROM 176 to provide the braille code characters. An OR gate 332 passes either the special character LC-8 or UC-8 levels, and when TP-10 occurs, an AND gate 334 will be enabled so as to set a latch 336. The latch 336 when set inhibits an AND gate 211 which otherwise passes TP-11 during the start bit period. TP-11 (see Waveform (F), FIG. 6) enables a group of AND gates 180, only two of which (for the first bit of the braille code character) are shown to simplify the illustration. These AND gates 180 pass the braille characters through OR gates 183 to an output buffer 185. Thus when the AND gate 211 is inhibited, as when upper case/ lower case or other special characters are decoded, there is no readout from the ROM's 175 or 176 and embossing will not occur.

The reset pulse from the delay one-shot 202 also resets the latch 336 and the output buffer 185 at the end of each character reception cycle.

The braille code characters from the output buffer 185 are loaded into a pair of parallel-input/serial-output registers 150 and 151 upon occurrence of the load pulse (TP-11) (see Waveform (F), FIG. (6)). The registers 150, 151 have their first stage connected to a positive source of voltage and their last, or seventh stage, connected to ground so as to be preset to have a binary "1" level start bit in their first stage and binary "0" level stop bit level in their last stage.

The same load pulse (see Waveform (F), FIG. 6) sets a latch 152. An AND gate 153 is enabled when the latch 152 is set and allows CLK-2 pulses from a clock oscillator 154 to be applied to the input of fill AND gates 155 and 156. The output of the fill AND gate 155 applies shift pulses to the register 150 for shifting or reading out data out of the register 150 into the input of the fortieth character or last register of a first group of buffer registers 158. The AND gate 156 applies shift pulses to the other register 151 for shifting the characters stored in

that register into the last or fortieth character register of a second group **159** of output buffer registers. Only one of the AND gates **155** or **156** is enabled depending upon the state of a buffer pointer flip-flop **400.**

THe output buffer registers **158** and **159** consist of forty serially connected eight-stage shift registers, each corresponding to a successive character of the forty characters in a line of characters that can be printed by the embossing apparatus illustrated in FIGS. **1** to **3.** One of the group of registers is filled with forty successive characters which are received form the line or from the keyboard **160,** converted into braille code characters and stored in one of the parallel-in/serial-out registers **150** and **151.** The other group of registers has the data stored therein read out for the purpose of operating the actuating mechanism and printing a line of braille characters.

Consider that the pointer flip-flop **400** is set so that its - output is high. The fill AND gate **156** will then be enabled so as to apply shift pulses to read out the register **151.** The shift pulses are also applied via an OR gate **401** to shift data in the forty registers which make up the output buffer group **159.** The registers of the group **159** will be filled one at a time during each received character cycle. It will be appreciated that the CLK-2 oscillator **154** is a high speed clock having a rate, say **100** times greater than the CLK-1 oscillator **163.** For each character that is received, converted into braille characters, and stored in the registers **150** and **151,** eight CLK-2 pulses are produced because a divide by **16** counter **402** counts the CLK-2 pulses. The eighth pulses when counted resets both the counter **402** and the latch **152;** thus only eight shift pulses will be produced upon the reception of each character. The forty registers in the output buffer group **159** will then be filled successively one at a time. When the register group **159** is filled, the start bit of the first character will be located in the first or start bit stage **161** of the first register in the group **159.** A buffer **159** full pulse then appears which is applied via an OR gate **404** to trigger the pointer flip-flop **400** which then provides a Q level which enables the fill AND gate **155** to shift characters from the register **150** into the buffer group **158.** The shift pulses for the register group **158** are applied via an OR gate **405.**

Consider the case where the buffer group **158** has just filled with forty characters and a buffer **158** full level is obtained from the first or start stage of the first character register of the group **158.** The buffer **158** full signal is applied via an OR gate **406** to set an emboss cycle flip-flop **407.** When set, the flip-flop **407** enables an AND gate **408** to pass CLK-3 pulses from a clock oscillator **409.** The repetition rate of the CLK-3 pulses may be approximately equal to or slightly less than the CLK-1 pulse rate. When the flip-flop **407** is set it initiates an embossing cycle. The timing of embossing operations during the cycle is controlled by a divide by **16** counter **413.** The five stages of that counter are connected to an AND gate decoder **410** which provides outputs on the first, fifth, ninth and thirteenth of the CLK-3 clock pulses which are counted by the counter **413.** The decoder **410** thus provides four timing pulses, TP-1, TP-5, TP-9, and TP-13. The first three pulses, TP-1, -5, and -9 are applied via an OR gate **411** to trigger a one-shot **412** which provides three embossing pulses of sufficient time duration during the embossing cycle (viz., the period during which the emboss cycle flip-flop **407** is set) (see Waveform (J), FIG. **6**). The one-shot **412** may be adjusted so as to adjust the embossing pulse duration (see Waveform (K)) to accommodate for the travel of the solenoid armatures **42,** link **44** and pins P-1 to P-80 (see FIGS. **1** to **3**). An approximately thirty millisecond embossing pulse from the flip-flop **412** has been found suitable for an embossing rate of **120** lines of braille characters per minute.

The embossing pulse passes through an AND gate **414** which is enabled when the pointer flip-flop is set. This AND gate **414** is referred to as the embossing AND gate. It will be noted that another embossing AND gate **416** is provided for passing embossing pulses when the pointer flip-flop **400** is reset (Q hight). Each embossing pulse passes through the OR gate **405** for shifting or advancing the bits in each of the forty character registers of the buffer group **158.** There are three embossing pulses per cycle (viz., corresponding to TP-1, -5 and -9). During each pulse period a pair of braille code elements will be embossed. As explained above, the braille code is made up of six elements in three pairs. Aside from the start and stop bits there are six bits stored in each of the forty character registers of the buffer group **158.** The first and fourth bits in the register, the second and fifth bits in the register and the third and sixth bits in the register, respectively, correspond to each of the three pairs of braille code elements per character. By reading out the first and fourth stages of each of the character registers in the forty registers which make up the buffer group **158,** signals representing each pair of braille code elements can be provided.

A pair of AND gates R-1, R-2, forty pairs in all, are respectively interconnected to the first and fourth stages of each of the forty character records to the buffer group **158.** These gates are enabled by the embossing pulses which are applied thereto via a second embossing AND gate **420.** The leading edge of the embossing pulse which is applied to the shift inputs of the character registers of th buffer group **158** advances the data in the forty registers. The rest of the embossing pulse enables the AND gates R-1 and R-2. Thus on the first embossing pulse (tp-1) the first and fourth bits of each braille character will be advanced into the first and fourth stages of the character registers of the buffer group **158,** and the AND gates R-1, R-2 will be enabled. Output pulses are then applied forty pairs of output OR gates R-3, R-4. Of course, pulses will not be passed through the AND gates R-1, R-2 if the bits in the register are binary 0 bits. THe outputs of the OR gates are applied via driver amplifiers R-5, R-6 to the operating windings of the solenoids S-1 to S-80. Alternatively, the output amplifier pairs R-5, R-6 may be inverters, which when the output of the OR gates R-3, R-4 are high, provide a low level at their outputs so as to permit current to pass through the operating windings of the selenoids S-1 to S-80 from sources of operating voltage indicated at +V.

In this manner a row consisting of forty pairs of braille code elements is simultaneously printed on the sheet 1 (FIGS. 1 to 3). The sheet is advanced one space (distance *a*, FIGS. 1A to 1C) upon the trailing edge of each embossing pulse. The trailing edge of each pulse triggers a one-shot **421** which provides an output pulse (see Waveform (L), FIG. **6**) immediately after each embossing pulse. The one-shot **421** output pulse passes through an OR gate **422** and triggers another one-shot

423 which provides a paper advance motor drive pulse (Waveform (M)), which may for example be 20 milliseconds in duration to allow a paper movement of 0.088 inch. this pulse is applied to a paper advance motor **424** via a drive amplifier **425.** The paper advance motor is mechanically coupled to the sprocket of the pin tractor **4** (FIG. 2) and advances the sheet **1** by the distance *a* (.**088**). The sheet is then in position to receive the second row of braille character elements.

The second embossing pulse TP-**5** then advances bits two and five of the braille characters into the first and fourth stages of the character registers of the buffer group **158.** Embossing and paper feed then occurs as was the case for the first pair of braille character elements in the first row. The sheet is then advanced into position to receive the third row of braille element pairs. The third embossing pulse TP-**9** then advances the third and sixth braille character code elements into the first and fourth stages of the register. Embossing then occurs as was the case for the first and second row of braille character element pairs.

The next timing pulse from the decoder is the TP-**13** pulse (see Waveform (N)). That pulse resets the counter **413** ending the embossing cycle. It also is applied via the OR gate **422** to trigger the one-shot **423** and produces a second paper advance (thus after printing the third row of characters there are two paper advances, one due to the TP-**9** and the other due to the TP-**13** pulses from the decoder **410.** The sheet is now in position to receive the next line of braille characters (see FIG. 1C). The next or successive line of charcters are read out of the buffer group **159** which has been filling with characters while the characters stored in the buffer group **158** were being read out and used to operate the embossing mechanism. The TP-**13** pulse also passes through an AND gate **427** which is enabled by the Q output of the pointer flip-flop **400.** IT will be recalled that the Q output of the pointer flip-flop **400** is high during an embossing cycle when the buffer group **158** is read out. The TP-**13** pulse then resets the registers in the buffer group **158.** The buffer group **159** has an embossing AND gate **430** and a reset AND gate **431** which operates when the buffer group **159** is read out during its embossing cycle.

The buffer group **159** also has associated with the first and fourth stages of each of its character registers, a pair of AND gates R-**7,** R-**8** which serves the same purpose as the AND gate pairs R-**1,** R-**2** for providing embossing signals via and OR gates R-**3,** R-**4** to the solenoid S-**1** to S-**80** operating windings. After each embossing cycle the TP-**13** pulse resets the emboss cycle flip-flop **407** to terminate the cycle.

In the event that it is desired to emboss partial lines rather than full lines and alternate path for CLK-**2** pulses to the AND gates **155** and **156** may be provided via another AND gate (not shown). When less than forty characters per line are desired a flip-flop (not shown) may be set, say by a button such as the character return key on th keyboard **162.** The buffer full signal from the first character register stages may be applied to reset the flip-flop. When set, the flip-flop enables the AND gate in the alternate pair to apply CLK-**2** pulses for advancing such characters as have been received so as to fill a register group **158** or **159.** The characters which are stored in the character register which are not filled will then be binary 0's and will not cause any embossing operations.

From the foregoing description it will be apparent that there has been provided an improved braille communications terminal or typewriter which is capable of printing or embossing braille characters a line at a time and thus provides extremely high speed brailling operations. Variations and modifications in the herein described embodiment of the invention will undoubtedly suggest themselves to those skilled in the art. Accordingly the foregoing description should be taken merely as illustrative and not in any limiting sense.

Whatt is claimed is:

1. Braille communications apparatus which comprises:

a. means including a collinear row of embossing elements grouped in a plurality of pairs for embossing the collinearly disposed code elements in a line of braille code characters on a sheet, and

b. means coupled to each of said embossing elements and responsive to code signals representing said characters for successively operating said embossing means to emboss on each of said successive operations successive entire lines of said braille code elements until an entire line of braille code characters is formed.

2. The invention as set forth in claim **1** wherein said embossing means includes means for advancing said sheet to present lines on said sheet which have a first displacement from each other between the lines of collineraly disposed code elements in each line of braille characters, which lines of elements are embossed on each advance until the line of code characters is formed, and second displacement greater than said first displacement between successive lines of braille characters.

3. The invention as set forth in claim **1** wherein said embossing means comprises a row of pins each corresponding to a different braille character code element, and means for reciprocating said pins into and out of embossing relationship with said sheet.

4. The invention as set forth in claim **3** wherein different pairs of said pins are laterally offset from each other in said row for embossing successive pairs of code elements of different braille code characters in each said line of braille code characters.

5. The invention as set forth in claim **4** including a member havng a plurality of pairs of recessed dies corresponding to said pins and disposed in a row, said member being disposed opposite to said pins and spaced therefrom to permit said sheet to pass therebetween, and with said dies aligned with their corresponding pins.

6. The invention as set forth in claim **5** further comprising a plurality of electromechanical actuators each for a different one of said pins.

7. The invention as set forth in claim **6** wherein pairs of said plurality of actuators are provided for each of said pairs of pins, each of said actuators in each of said pairs being disposed on an opposite side of said row of pins.

8. The invention as set forth in claim **6** wherein each of said actuators includes a solenoid, and a link pivotally mounted intermediate the ends thereof and extending between said solenoid on the one of said pins actuated by said solenoid.

9. The invention as set forth in claim **8** including spring means for biasing each of said pins away from said sheet, said bias being overcome by said solenoid

when actuated to advance said pin into embossing relationship with the sheet.

10. The invention as set forth in claim **9** wherein said solenoids are disposed in rows parallel to said row of pins and on opposite sides of said row of pins, and wherein said links extend perpendicularly to said row of pins.

11. The invention as set forth in claim **10** wherein said rows of solenoids are offset at different distances form said row of pins, said links being of different length corresponding to the distance between their respective solenoids and the pins actuated thereby, and a plurality of members each defining a fulcrum on which said links are separately pivotally mounted, said fulcrum members being disposed in rows parallel to said row of pins and offset from said pin rows by different distances in accordance with the lengths of the links pivoted thereon whereby said links have substantially equal travel paths when actuated by their respective solenoids.

12. The invention as set forth in claim **2** wherein said advancing means comprises a pin tractor mechanism adapted to engage holes disposed along the edge of said sheet, and an electromagnetic actuator for providing stepwise movement of said pin tractor mechanism for electively feedng said sheet a distance corresponding to the separation of one plurality of braille character code element lines.

13. The invention as set forth in claim **1** wherein said operating means comprises means for receiving code signals representing successive characters,

means having storage for a plurality of said characters which are adapted to constitute a line of braille characters, and

means for reading out said storage means a plurality of times, each time to read out simultaneously all of the signals corresponding to the collinearly disposed elements in said line of braille characters.

14. The invention as set forth in claim **13** wherein said storage means comprises a plurality of registers each for a successive one of said braille characters, each of said registers having a plurality of stages which provide storage for code signals correponding to different ones of the code elements of said braille characters, and means for successively reading out of said registers the different pairs of said code signals, each of said pairs corresponding to a collinearly disposed pair of code elements of a braille character whereby the collinearly disposed code elements in each line of element constituting a line of braille elements are presented for operating said embossing means.

15. The invention as set forth in claim **14** wherein said embossing means comprises a separate pair of pins for embossing each of said pairs of code elements, said pins being disposed in a row extending across the sheet, and electromagnetic means for actuating said pins into embossing relationship with said sheet, said operating means further comprising means responsive to each of said different pairs of code signals read out of said registers for operating said actuating means for each of said separate pairs of pins.

16. The invention as set forth in claim **15** including means for feeding said sheet upon each read-out of said pairs of code signals and the embossing of line of said braille code character elements in response thereto.

17. The invention as set foth in claim **16** including means for operating said feeding means for feeding said sheet a distance greater than the distance said sheet is fed after read-out of a line of said braille code character elements when a plurality of said pairs of said code signals constituting an entire braille character are read out of said registers.

18. The invention as set forth in claim **14** wherein said register read-out means comprises means for simultaneously reading the code signals stored in two of the stages of said registers, and means for shifting said code signals through said register stages a plurality of times, each such shifting providing a successive pair of said code signals for read-out, and means responsive to said shifting means for operating said embossing means in response to each of said successive pairs of code signals.

19. The invention as set forth in claim **18** further comprising means included in said receiving means for converting said code signals representing each of said characters into braille character code signals, and means for entering said braille character code signals serially into said registers.

20. The invention as set forth in claim **19** wherin said registers comprise a plurality of groups of registers each having storage for a plurality of said braille character code signals equal in number to the number of said braille characters adapted to be embossed in each of said lines of braille characters, and means operative when the one of said registers in one of said plurality of groups which has storage for the braille character to be embossed at the beginning of the line is full for operating said reading out means for reading out said full register in said one register group while enabling another of said plurality of register groups to receive additional braille character code signals whereby successive lines of said braille characters corresponding to braille character code signals stored in differnt ones of said register groups are embossed on said sheet.

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