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(54) ELECTROTHERMAL PRINTING UNIT

(71) We, ING. C. OLIVETTI & C., Societa per Azioni, a body corporate, organised and existing under the laws of Italy, of Via G. Jervis 77, 10015 Ivrea (Turin), Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electrothermal printing unit of an improved kind for impact-less typing of alphanumerical characters, in accordance with point matrices, on to a heat-sensitive recording medium. In this specification "row" refers to a row of points of a row and column matrix in contrast to "line" which refers to a line of characters, a row being parallel to a line.

For efficient utilisation of the speed of modern systems of electronic information handling it is essential to have available very high-speed peripheral printing units, and it is also desirable that the printing units should not be too numerous, since they are normally located near the user, in offices and other working places. The number of units required depends on the output of each unit.

The use of printing equipment with ballistic impact of a character-bearing member against an inked ribbon in contact with paper involves speed limitations intrinsic in the mechanical operation and noise levels which often reach the limits of toleration, but the introduction of impact-less printing equipment removes these drawbacks.

Impact-less printing devices are known which make use of the electrothermal typing method. For example, French Patent Application No. 2,168,132, filed on 7th May 1973, relates to an electrothermal line printer, i.e. designed to type simultaneously a complete line of characters by means of point matrices, on to a heat-sensitive recording medium.

It comprises a printing head which carries, aligned in parallel to the printing line, as many thermally-activable printing elements as there are characters in a line of print, multiplied by the number of points constituting a row of each matrix. For ex-

ample, if the matrix is of the kind having 7 rows $\times$ 5 columns and with a line of print having 16 characters, the number of elements required is $16 \times 5 = 80$ elements.

The head, during each elementary printing act, carries out the typing of a row of matrix points for all the characters in a line of print. Complete printing of a row of characters therefore requires as many elementary printing acts as there are points in a column of each matrix. During the elementary printing acts, the recording medium is fixed relative to the head, and carries out an inter-linear elementary movement equal to the distance between two rows of the matrix after each elementary printing act.

The selection and control circuits must therefore be designed to control a number of printing elements equal to a multiple of the number of characters in a line of print. The printing speed is obviously high and mechanical control is concerned solely with inter-linear movement of the recording medium. But the complexity and the number of the electronic control circuits for this kind of printing unit leads to serious electrical connection problems and above all to a very high construction cost which is not always justified by increased performance in terms of printing speed.

These drawbacks are removed by the unit according to the invention, which makes it possible to obtain a speed performance comparable with that of an electrothermal line printer of the kind described above, but using a much smaller number of thermoelements and an electronic control circuit which is consequently much smaller.

According to the present invention there is provided an electrothermal printing unit for impact-less printing of characters in accordance with a matrix of points arranged in rows, comprising means for supporting a heat-sensitive recording medium and for moving the medium incrementally perpendicular to the direction of a line of print for printing successive rows of points, a printing head carrying a plurality of thermo-activable printing elements aligned in the said direc-

tion, means for reciprocating the head in the said direction in synchronism with the movements of the recording medium, means for signalling the position of the head, means for storing codes designating a line of characters, and control means responsive to the signalling means and the storing means to selectively activate the printing elements at a succession of positions of the head in each of a succession of strokes thereof in an arrangement such that each element prints all the points of at least one character of the line of characters during the succession of strokes.

The invention will be described in more detail, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a perspective view of a printing unit embodying the invention;

Figure 2 is a plan view of a typing head for the printing unit;

Figure 3 shows a detail of Figure 2;

Figure 4 is a section on the line IV—IV of Figure 3;

Figure 5 is a block diagram of the electronic circuit for controlling the printing unit;

Figure 6 is a time diagram of some logical signals generated by the control unit of Figure 5;

Figure 7 is a time diagram of some logical signals generated by the control unit of Figure 5 with a time scale enlarged compared with Figure 5; and

Figure 8 shows a matrix format of points for typing characters with the printing unit.

In Figure 1 there is shown a preferred embodiment of an electrothermal printer according to the invention. This comprises an electrothermal printing head 2 (see also Figure 2) in which printing elements 33 are positioned on the face 3 in contact with a heat-sensitive sheet 4 along its typing line. The heat-sensitive recording sheet 4 in the zone facing the head is partly wrapped on a platen 7 keyed on the shaft 8. The head is fixed on a slider 10 running along a guide 11 extending across the width of the sheet 4 parallel to the typing line and fixed, at opposite ends, to the frame of the machine, indicated generally by 13. A transport system 15 imparts a reciprocatory oscillating movement along the guide 11.

A pawl system 17 controlled by a cam 18 gives the shaft 8 an intermittent stepwise rotary movement, so that the sheet 4 is incrementally advanced by the roller 7 in the direction indicated by the arrow 19.

A sensing device 22 is designed to signal the position of the slider 10 and to furnish electrical synchronising impulses to an electronic device 30 (Figure 5) for controlling the typing operations of the printer by selecting the timing the thermal excitation of the typing elements 33 of the head 2.

Another sensing device 27 sends a synchro-

nising impulse to the control device 30, for each complete rotation of the cam 18. In more detail, if we take as an example a printer designed to form lines of print composed of 16 alphanumeric characters according to the 7×5 point matrix (7 rows×5 columns), the printing head 2 (Figure 2) is composed of a rectangular plate 31 made of insulating material on which are deposited parallel to its smaller side and regularly spaced along a major side 32 of the same, sixteen pairs of conductors 35 and 36, having terminal portions 35a and 36a (Figures 3 and 4) near the side 12, opposite each other and of equal width.

On the portions 35a and 36a there are provided sixteen resistor deposits 33 which constitute the printing elements. The part 33a of the printing elements (for the resistor deposits) 33 comprised between the facing portions 35a and 36a of the conductors 35 and 36 is the only part that can be electrically, and hence thermally, activable, since the other parts of the elements 33 are short-circuited by the underlying conductors 35a and 36a. The part 33a is therefore rectangular in form with height A equal to the width of the ends 35a and 36a, this height corresponding to the height of the printed points intended to be obtained on the sheet 4 (e.g. A=200μ) and with a width B, equal to the distance between the facing ends 35a and 36a, much smaller than the width of the said printed points (e.g. B=50μ). In what follows we shall always refer to the thermally activable part 33a by the name "thermo-element" 33a. The distance between two adjacent thermo-elements 33a is equal to the typing step, i.e. the pitch between corresponding columns of points belonging to adjacent characters of a given line of print.

The conductors 36 are connected to a common return conductor 37. Both the conductors 35 and the conductor 37 have in addition terminal portions 35b and 37b regularly spaced on the side of the head opposite the side 32, and are designed to connect with spring contacts 38 supported by the slider 10. By means of wire connections not shown in Figure 1, the contacts 38 are connected with the control unit 30.

The techniques, the materials of construction of the head 2, and also the advantages obtained by this type of head in typing "at will" on the recording medium, have been described in Application No. 44448/74 (Serial No. 1,473,868) and therefore will not be described herein.

The head 2 is fixed, for example by an adhesive, to a support block 9 which is fixed by screws 39 to the slider 10. As already stated, the slider is mounted to run on the guide 11 and it can also rotate around it. A spring 40 stretched between an arm 42 of the

slider 10 and the frame 13 tends to turn the slider 10 counterclockwise (in Figure 1), thus making the part of the head 2 next the edge 32 and carrying the aligned resistor elements 33, rest on the typing line of the sheet 4.

The transport system 15 of the slider 10 is composed of a shaft 44 on which is keyed a pulley 45 which is driven by a pulley 46 keyed on a shaft 47 of a motor 48, through a belt 49 which couples the two pulleys. On the end 50 of the shaft 44 there is fixed, eccentrically with reference to the axis of the same, a peg 51 on which is pivoted one end of a bar 52 whose other end is pivoted on an arm 53 of the slider 10.

The shaft 44, the peg 51 and the bar 52 constitute a system for transmission of motion of the crankshaft type, by which constant rotary motion imparted to the shaft 44 of the motor 48 is transformed into periodic reciprocating motion of the slider along the guide 11, the radial distance of the peg 51 from the axis of the shaft 44 and the length of the bar 52 being calculated so as to give an amplitude of oscillation of the slider 10, and hence of the head 2, little greater than the width of the characters that are to be obtained on a printing line (e.g. 3 mm).

As already stated, the advancing movement of the sheet 4 is effected by means of the pawl system 17, governed by the cam 18, keyed on a shaft 55 which is rotated by the motor 48 through a worm 56 and worm wheel 57. The pawl system 17 comprises a saw-toothed wheel 60 keyed on the shaft 8 and which cooperates with a peg 61 fixed to one end of a lever 62 whose other end is pivoted on an arm 63 of a lever 64 pivoted on the frame of the machine 13. To another arm 65 of the lever 64 there is fixed a peg 66, cooperating with the external profile of the cam 18 under the action of a spring 67 stretched between the arm 63 of the lever 64 and a fixed point of the frame 13. A spring 68 is stretched between the lever 62 and the arm 63 of the lever 64. The external profile of the cam 18, extending through 360°, comprises seven arcs of circumference 70, 71, 72, 73, 74, 75, 76, with their centres on the axis 55, of equal angular amplitudes, and with increasing radii, and a lobe 77 extending through an angular amplitude equal to the above. The arcs 70 to 76 are connected by ramps 70a to 75a which provide a constant radial increment between adjacent arcs.

The lobe 77 is composed of a ramp 78 determined by a radial increment equal to a multiple (e.g. 3-fold) of the radial increments between the preceding arcs, of a constant-radius track 79, and a decreasing-radius track 80 which joins the track 79 to the arc 70.

A positioner, composed of a lever 83 with one end having its fulcrum on the frame of

the machine 13 and having at the other end a pivot 84 on which is pivoted a roller 85, cooperates, under the action of a spring 86 stretched between the lever 83 and a fixed point on the frame 13, by means of the roller 85 with the teeth of the saw-toothed wheel 60 in order to prevent the latter from rotating clockwise.

The pawl system 17 has, in the working phase, the following method of functioning, assuming an initial position corresponding to that indicated in Figure 1, i.e. with the peg 66 at the beginning of the arc 70.

When rotation of the cam 18 counterclockwise brings the ramp 70a into collaboration with the peg 65, the lever 64 turns counterclockwise through a certain angle against the action of the spring 67.

The lever 62 is displaced upwards, being pulled by the spring 68 in such a way that the peg 61 rests in the gap between two teeth 60a, 60b thus making the wheel 60 and the platen 7 turn through a small angle and thereby producing an advance of the sheet by an elementary increment, equal to the distance between two adjacent rows of the matrix format. The same thing is repeated during engagement of the peg 66 with each of the other ramps 71a to 75a, while during engagement of the peg with the arcs 70 to 76 there is no variation in the position of the lever 64 and hence none also of the wheel 60.

Continuing the rotation of the cam 18, when the peg 66 engages with the ramp 78 which, as already stated, comprises a radial increment which is a multiple of those preceding, the lever 64 carries out a further rotation in the counterclockwise direction making the wheel 60 turn further counterclockwise by an angle equal to a multiple (3-fold in the example considered) of the preceding angular rotations, thus determining a corresponding advance of the sheet 4 which is thus positioned on a new typing line.

Thus when the peg 66, having passed over the constant-radius track 79, descends along the track 80 making the lever 64 turn clockwise, the peg 61 is constrained to climb the sloping side of the tooth 60b, against the action of the spring 68 until it goes over the crest and falls into the next tooth, corresponding to return of the peg 66 into the starting position.

One complete rotation of the cam therefore corresponds to advancing the sheet 4 by six elementary increments, for typing the rows of the matrix format of the characters of a row of print followed by a row increment, i.e. for the spacing between one row of characters and the next.

The synchronism between rotation of the shaft 55 and the shaft 44, ensured by suitable dimensioning of the diameters of the

pulleys 45 and 46 and the ratio of the worm gear 56, 57, makes it possible to obtain advancement by one elementary increment of the sheet 4 for each single stroke of the slider 10. The time required for rotation of the cam through the angle of one of the arcs 70 to 76 or of the lobe 77, including the connecting ramps, therefore coincide with the half-period of oscillation of the slider.

The sensing device 22 comprises a disc 88 carrying two groups of five diametrically opposed notches 89 and 90, the five notches of each group being spaced on a circumferential arc having an amplitude less than the angle of rotation of the shaft 44 required to ensure the travel of the slider 10 between one reversing point and the next (180°).

The notches are observed by a photoelectric device 91 of known type, designed to generate, in coincidence with the observation of a notch, a synchronous electrical impulse 92 (Figures 6 and 7) to be sent through a wire 114 to the electronic control system 30. The photoelectric device 91 is positioned relative to the disc 88 as shown in Figure 1, in such a way that, when the slider is in one of the two reversing points, there passes in front of it the mid part of one of the two sectors 89a, 90a of the disc 88, free from notches.

Each of the impulses 92 constitutes permission to print for the same matrix point for all the characters to be typed on the row of print. Since the shaft 44 finishes a complete rotation for each stroke of the slider 10, it is clear that each of the two groups of notches 89, 90 constitutes permission to print in succession all five points of a row of matrices for all the characters of a line of print. A row of points is typed while the slider carries out a stroke from right to left, and the next while the same carries out its next stroke from left to right.

The spacing between the notches of each group has to be calculated from the laws of movement of the slider, avoiding permission to print for the points in which the displacement of the slider relative to its central position is close to the maximum value, and e.g. by spacing the notches of each group on an angle well below 180° , it is possible to obtain good typing results even for a constant spacing between the five notches, due to the fact that these limited permissions to print occur at points in which the displacement of the slider from its central position as a function of time does not depart very much from a linear law.

A notch 93 is cut in the cam 18. The sensing device 27 of known type, for example photoelectric, is designed for noting the passage of the notch 93 in front of it and to generate, at the same time a synchronous electric signal 95 (Figure 6) to be sent, through a wire 131, to the control unit 30.

The frequency of this signal is obviously equal to the frequency of rotation of the cam 18. Since each complete rotation of the cam corresponds to the typing of a row of print on the sheet 4 and advancement of the latter on to a new printing line, the notch is positioned on the cam in such a way that every signal generated by the sensor 27 constitutes permission to print a new row of print by the circuit 30.

We shall now describe the electronic system for controlling the printer, shown according to a block diagram in Figure 5. A register 100, known in itself, is designed to store the codes (e.g. of 6 bits) for the sixteen characters to be typed on a row of print, sent by the computer to which the printer is understood to be, for instance, connected on the channel 101. The present block diagram excludes the further connections between the computer and the electronic control system 30, designed to permit activation and deactivation of the printer by the computer and to synchronise the flow of data on to the channel 101, since they are known and do not constitute an object of the present invention.

The register 100 has a number of stages equal to the number of characters of a line of print, each stage being formed by as many bistable elements as there are bits in the codes of the characters (six in the example considered). The stages are interconnected to form six parallel shift registers so that information can be shifted from right to left in bit-parallel, character serial fashion.

The register has an exit channel 104 (of six bits in the example considered) connected to the outputs of its extreme left stage, which are, however, connected through a channel 102 and AND gates 105 to the inputs of the extreme right stage of the register.

The channel 101 can be enabled and disabled by means of AND gates 106. The register 100 is controlled by command signals 107 (Figure 7) conveyed to it by a generator 108 of high frequency shift pulses and is permitted to oscillate in the presence of a signal 92 (Figure 7) conveyed to it on the wire 114 through an AND gate 115. Coinciding with each of the shift pulses, the content of each stage of the register 100 is shifted into the stage next to the left, and simultaneously there is made to enter into the extreme right stage the code present on the enabled channel 102.

A binary counter 113, known *per se*, of capacity 35, is designed to count the synchronising impulses 92 sent to it on the wire 114 through the AND gate 115 from the sensor 22. Every so often the counter 113 reaches its maximum capacity, i.e. its stages assume the combination corresponding to the number 35 and it is designed then to generate a signal of logical level "1" on a wire 120.

The outputs of the counter 113 through the channel 126 are connected at the entrance of a read only memory (ROM) 112 of known type. The output channel 104 of the register 100 is also connected at the input to the ROM 112. The ROM 112 contains information of type/not type for all points of the matrix format, for information of every printable alphabetical or numerical character. Each point of the matrix format is identified in the ROM by an ordinal number 1 to 35 according to the convention shown in Figure 8.

Corresponding therefore to a particular character code sent to the input of the ROM 112 through the channel 104 of the register 100, and a particular point code (ordinal number of a matrix point according to the binary code of the counter 113) sent as input to the ROM 112 on the channel 126 of the counter 113, the ROM provides on the output channel 138 composed of a single wire, a logical level "1" if it is necessary to type the matrix point selected for formation of the required character, "0" in the contrary case.

A bistable flip-flop 130 is designed to be placed in its "set" condition (with the output Q at the logical level "1") by means of the signals 95 (Figure 6) sent to its "set" input "S" by the sensor 27, through the wire 131. The output Q of the flip-flop 130, when it is at the logical level "1", activates the AND

gates 105. The output $\bar{Q}$ (which is at "1" when Q is at "0") activates, when it is at the logical level "1", the AND gates 106.

The output channel 138 of the ROM is connected as input to the element at one end of a shift register 140, known *per se*, and composed of as many bistable elements as there are characters in a row of print (sixteen in the example considered here). The register 140 is shifted by the impulses 107 sent to it by the generator 108 which is connected to it. At each impulse the register 140 is designed to transfer the binary information carried by each bistable element on to the next element and then make the binary information carried on the channel 138 enter the end bistable element.

The outputs 141 of the bistable elements of the register 140 are connected as inputs to AND gates 144 whose outputs are connected to the base electrodes of drive transistors 150 each of which has its collector connected to the conductor 35 of a thermoelement 33a and the emitter connected to a power supply circuit 152. The common conductor 37 of the plate 10 is also connected to the circuit 152. The feed circuit 152 is designed to apply between the conductor 37 and the emitters of the transistors 150 a suitable potential difference to make an electric current flow in the thermoelements 33a whose

corresponding transistors 150 are, as will be seen later, rendered conductive.

The generator 108 also feeds a binary counter 145 of known type having a capacity equal to the number of characters in a row of print (sixteen in the example considered here). The counter 145 is incremented by the generator 108 by one unit for each impulse 107. On reaching its maximum capacity the counter 145 is designed to return to zero and to generate on an output wire 146 a signal which terminates oscillation of the generator 108.

The output wire 146 is connected, through an AND gate 147 opened by the logical signal present on the wire 120, to the reset terminal R of the flip-flop 130 and to the zeroing terminal Z of the counter 113, so that the logical signal generated by the counter 145 on reaching its maximum capacity causes, when the counter 113 has reached its maximum computation, reset of the flip-flop 130 and zeroing of the counter 113.

The output wire 146 is also connected as input to a monostable multivibrator 149 of known type, whose output Q is connected as input to each AND gate 144. The monostable multivibrator 149 is designed to generate in its output Q corresponding to every signal emitted by the counter 145 on the wire 146, an impulse 155 of logical level "1" having a suitable duration T (Figure 6). The AND gates are thereby opened to transmit to the base terminals of the drive transistors 150 these impulses, only if the corresponding inputs 141 are at the logical level "1". The selected transistors 150 are ordered into conduction by the impulse 155 for the above-stated time T, and there is a circulation of current in the corresponding thermoelements 33a, leading to heating of the latter to a temperature high enough to produce a visible point imprint on the heat-sensitive recording medium 4.

In describing the method of functioning, the following working conditions are assumed:

(1) Slider in the extreme left position with reference to Figure 1.

(2) Printer enabled by the computer to which it is connected, and codes for the characters to be typed on the next row of print already stored in the register 100.

(3) Counters 113, 145 zeroed.

(4) Flip-flop 130 in its reset condition (Q=0).

When the notch 93 passes in front of the sensor 27 there is generated an impulse 95 (Figure 6) on the wire 131 which forces the flip-flop 130 into its "set" position, thus opening the AND gates 105 and 115. The slider begins its course to the right and when the first notch of the disc 88 passes in front of the sensor 27 an impulse 92 is sent on the

wire 114 which, through the gate 115, increases by one unit the counter 113.

The same impulse permits oscillation of the generator 108 which sends pulses 107. Each pulse 107 leads to an increase of one unit in the counter 145, and displacement by one stage to the left of the character codes stored in the register 100 and hence sequential presentation in the farthest left stage (and in the input to the ROM through the channel 104) of the character codes of all of the printing positions of a row, and their successive re-entry, through channel 102, into the extreme right stage.

Based on the character code at input and the code of the point position sent to the ROM respectively from the register 100 and the counter 113 (point 1°) the ROM furnishes at the output on the channel 138 a logical level "1" if, according to the matrix format, in the position of the selected point it is necessary to type a point for formation of the character in question, "0" in the contrary case.

The register 140 is also commanded by the pulses 107 during each of which it stores in the input end stage the logical level entering and moves the information already stored one step on.

When the counter 145 has reached its maximum count the register 100 has the same initial configuration, the codes having returned to the starting position after having passed through all the stages. The register 140 carries in its bistable elements the information "type" or "not type" for each of the thermoelements 33a, and the corresponding AND gates 144 are allowed to open only if the logical level of the corresponding output 141 of the register 140 is "1".

As stated, the counter 145, having reached its maximum capacity, generates an impulse which stops the oscillator 108, zeroes the counter itself, and orders into conduction the permitted transistors, through the monostable 149 for a definite time T, but in any case less than the time intervening between the passage of one notch and the next in front of sensor 22, thus inducing the passage of current in the permitted thermoelements 33a and typing, in each printing position of the typing line of sheet 4, a point whose breadth in the direction of motion depends on the excitation time T and the velocity of the slider 10.

It is to be noted that the whole loading of the register 140 takes place at "electronic" velocity and therefore in a time which is extremely short relative to the mechanical movement of the slider. Even considering for the slider very high mechanical velocities, the above-stated time is only a minimal portion of the time intervening between the passage of one notch and the next of the disc 88 in front of the sensor 22. The

same procedure is repeated for the passage of the next four notches in front of the sensor 22, and each time there is an increment of one unit in the counter 113 and the typing of one point of the first row of the matrix format for all characters one row of print.

After the passage of the first group of five notches, the slider is at the end of its run to the right and gets ready to reverse its motion, and the roller 7 and hence the sheet 4 are advanced by an elementary step by the cam 18 and the pawl system 17. The functioning then proceeds as in the typing of the first row, and so also for the typing of all seven rows.

At the end of typing the seventh row and hence of the points 35, the counter 145 having reached its maximum capacity generates, as already seen, a reset signal through flip-flop 130, which bringing its output Q to zero, closes the AND gate 115 and inhibits computation by the counter 113, which is zeroed, and the starting of the oscillator 108.

At the end of typing the seventh row of the matrix format, the slider will be in the extreme right position and will carry out the next run towards the left without any typing operation. During this return run, the peg 66 engages with the lobe 77 of the cam 18 and makes the paper carry out the spacing necessary for positioning it on a new printing line, and the computer sends on channel 101 the character codes for typing on a new printing line, or, for example, the order to stop the printer.

At the end of each run the passage of the notch 93 in front of the sensor 27 will produce the setting of the flip-flop 130 and the beginning of the operation of typing for a new row of print.

It is to be understood that various modifications are possible within the scope of the claims. For example, a variant may be that of halving the number of thermoelements 33a present in the head, doubling the spacing between them and the amplitude of oscillation of the slider, and in such case with suitable modifications to the control circuit 30, it is possible to obtain during each stroke of the slider, from a single element, one of the rows of the matrix format of two adjacent characters of the row of print.

WHAT WE CLAIM IS:—

1. An electrothermal printing unit for impact-less printing of characters in accordance with a matrix of points arranged in rows, comprising means for supporting a heat-sensitive recording medium and for moving the medium incrementally perpendicular to the direction of a line of print for printing successive rows of points, a printing head carrying a plurality of thermo-activable printing elements aligned in the said direction, means for reciprocating the head in the



wire 114 which, through the gate 115, increases by one unit the counter 113.

The same impulse permits oscillation of the generator 108 which sends pulses 107. Each pulse 107 leads to an increase of one unit in the counter 145, and displacement by one stage to the left of the character codes stored in the register 100 and hence sequential presentation in the farthest left stage (and in the input to the ROM through the channel 104) of the character codes of all of the printing positions of a row, and their successive re-entry, through channel 102, into the extreme right stage.

Based on the character code at input and the code of the point position sent to the ROM respectively from the register 100 and the counter 113 (point 1st) the ROM furnishes at the output on the channel 138 a logical level "1" if, according to the matrix format, in the position of the selected point it is necessary to type a point for formation of the character in question, "0" in the contrary case.

The register 140 is also commanded by the pulses 107 during each of which it stores in the input end stage the logical level entering and moves the information already stored one step on.

When the counter 145 has reached its maximum count the register 100 has the same initial configuration, the codes having returned to the starting position after having passed through all the stages. The register 140 carries in its bistable elements the information "type" or "not type" for each of the thermoelements 33a, and the corresponding AND gates 144 are allowed to open only if the logical level of the corresponding output 141 of the register 140 is "1".

As stated, the counter 145, having reached its maximum capacity, generates an impulse which stops the oscillator 108, zeroes the counter itself, and orders into conduction the permitted transistors, through the monostable 149 for a definite time T, but in any case less than the time intervening between the passage of one notch and the next in front of sensor 22, thus inducing the passage of current in the permitted thermoelements 33a and typing, in each printing position of the typing line of sheet 4, a point whose breadth in the direction of motion depends on the excitation time T and the velocity of the slider 10.

It is to be noted that the whole loading of the register 140 takes place at "electronic" velocity and therefore in a time which is extremely short relative to the mechanical movement of the slider. Even considering for the slider very high mechanical velocities, the above-stated time is only a minimal portion of the time intervening between the passage of one notch and the next of the disc 88 in front of the sensor 22. The

same procedure is repeated for the passage of the next four notches in front of the sensor 22, and each time there is an increment of one unit in the counter 113 and the typing of one point of the first row of the matrix format for all characters one row of print.

After the passage of the first group of five notches, the slider is at the end of its run to the right and gets ready to reverse its motion, and the roller 7 and hence the sheet 4 are advanced by an elementary step by the cam 18 and the pawl system 17. The functioning then proceeds as in the typing of the first row, and so also for the typing of all seven rows.

At the end of typing the seventh row and hence of the points 35, the counter 145 having reached its maximum capacity generates, as already seen, a reset signal through flip-flop 130, which bringing its output Q to zero, closes the AND gate 115 and inhibits computation by the counter 113, which is zeroed, and the starting of the oscillator 108.

At the end of typing the seventh row of the matrix format, the slider will be in the extreme right position and will carry out the next run towards the left without any typing operation. During this return run, the peg 66 engages with the lobe 77 of the cam 18 and makes the paper carry out the spacing necessary for positioning it on a new printing line, and the computer sends on channel 101 the character codes for typing on a new printing line, or, for example, the order to stop the printer.

At the end of each run the passage of the notch 93 in front of the sensor 27 will produce the setting of the flip-flop 130 and the beginning of the operation of typing for a new row of print.

It is to be understood that various modifications are possible within the scope of the claims. For example, a variant may be that of halving the number of thermoelements 33a present in the head, doubling the spacing between them and the amplitude of oscillation of the slider, and in such case with suitable modifications to the control circuit 30, it is possible to obtain during each stroke of the slider, from a single element, one of the rows of the matrix format of two adjacent characters of the row of print.

WHAT WE CLAIM IS:—

1. An electrothermal printing unit for impact-less printing of characters in accordance with a matrix of points arranged in rows, comprising means for supporting a heat-sensitive recording medium and for moving the medium incrementally perpendicular to the direction of a line of print for printing successive rows of points, a printing head carrying a plurality of thermo-activable printing elements aligned in the said direction, means for reciprocating the head in the



5 said direction in synchronisation with the
movements of the recording medium, means
for signalling the position of the head, means
for storing codes designating a line of char-
acters, and control means responsive to the
signalling means and the storing means to
selectively activate the printing elements at
a succession of positions of the head in each
of a succession of strokes thereof in an ar-
rangement such that each element prints all
the points of at least one character of the
line of characters during the succession of
strokes.

10 2. A printing unit according to claim 1,
wherein the number of printing elements is
equal to the number of characters in a line,
the control means effecting a number of se-
lective activations of the printing elements
during printing a line of characters equal to
the number of points in the matrix.

15 3. A printing unit according to claim 2,
wherein the signalling means comprise a
plurality of markers positioned on a sup-
port movable in synchronism with the head
and a sensor device designed to sense the
markers during the movement of the head
and to generate corresponding electrical
impulses for enabling the control means for
selective and simultaneous printing a same
matrix point for all characters of a line of
characters.

20 4. A printing unit according to claim 1,
2 or 3, wherein the control means selec-
tively activate the printing elements during
strokes of the head in both directions, the
said succession of strokes being a number
of consecutive strokes equal to the number
of rows of the matrix.

25 5. A printing unit according to any of
the preceding claims, wherein each of said

elements has a thermo-activable printing
surface substantially rectangular in shape,
with the greater dimension perpendicular
to the said direction and substantially equal
to the height of the points of the matrix, the
control means activating the elements for a
sufficient time to form, with the movement
of the head, substantially square matrix
points.

30 6. A printing unit according to any of
the preceding claims, in which the support-
ing means is a platen rotated by means of a
programming cam having a profile with a
series of first steps with constant rise and a
second step with rise greater than the first
steps, a cam-following element cooperating
with the profile to turn the platen incre-
mentally to advance the recording medium
through increments corresponding to the dis-
tance between two adjacent rows of the
matrix, when it cooperates with the first steps,
and to effect a rotation of the platen and an
advancement of the recording medium corre-
sponding to an interline space between two
rows of characters, when it cooperates with
the second step.

35 7. A printing unit according to claim 5,
wherein the reciprocating means comprise a
constant speed motor and a crankshaft actu-
ated by the motor, the head being mechanic-
ally connected to the crankshaft, the motor
also actuating the programming cam.

40 8. An electrothermal printing unit sub-
stantially as hereinbefore described with
reference to and as illustrated in the ac-
companying drawings.

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