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(54) Dot matrix serial printer.

(57) Dot matrix serial printer for the simultaneous serial printing of two subsequent rows with line pitch selectable between several values, provided with a printing head having two needle groups arranged along a line transversal to the printing lines and with selection means which, according to a line pitch defining signal, select needle sub-groups within two groups to perform the simultaneous printing of characters on two subsequent lines having a line pitch value defined by said signal.

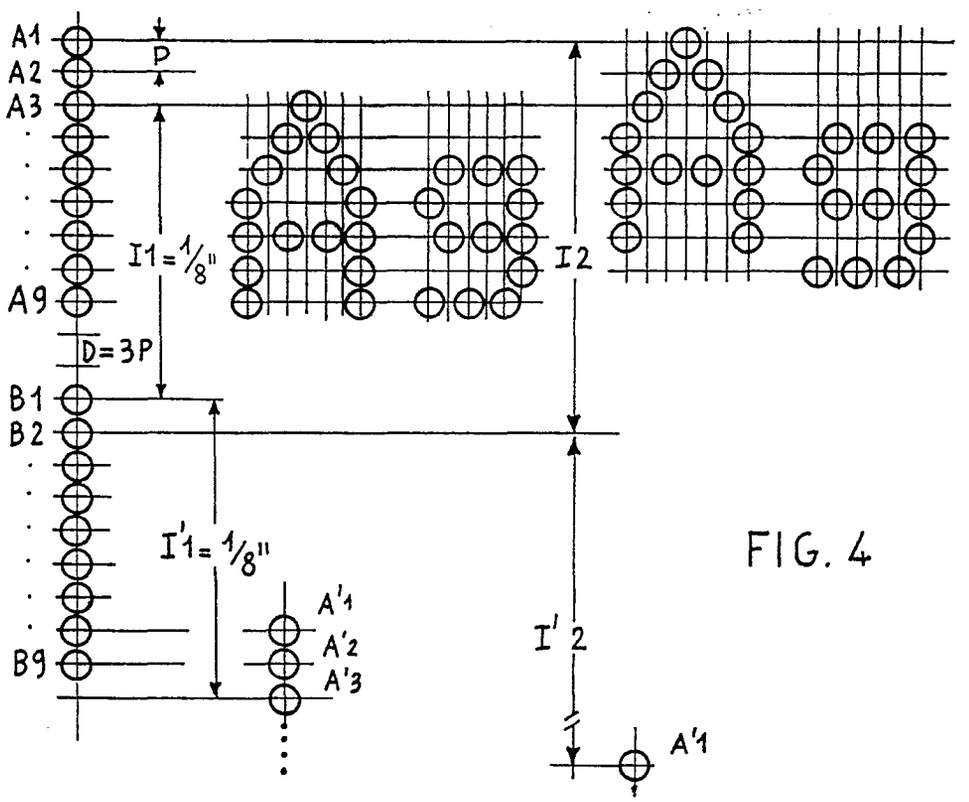

FIG. 4

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Dot matrix serial printer

The present invention relates to a dot matrix serial printer for the simultaneous printing of two rows, able to serially print, at high speed, two simultaneous rows with selectable line pitch.

It is known that in data processing systems dot matrix serial printers are largely used as console printers and, within certain limits, as system output printers.

Generally, when the data amount to be printed is considerable the so-called parallel printers are used of the drum, belt or bar type, which offer better performances but are intrinsically much more expensive than the serial printers.

Typically a parallel printer is able to print from 800 to 1600 rows per minute.

The matrix serial printers, intrinsically less expensive, offer more limited performances and have a typical speed ranging between 100 and 200 characters per second.

An univocal relation does not exists between printing speed expressed in characters per second and speed expressed in rows, as such relation varies according to the length of the row expressed in characters and to the modes of serial printing. These modes are affected by several functional expedients, such as the bidirectional print, the so-called "logic seeking" between direct or opposite printing direction, in order to reduce to the minimum the execution time and the horizontal resolution of the printing dot matrix within which the characters are contained.

The serial printers, in their simpler version, typically comprise a printing head provided with a needle line, generally 7 or 9, moving along a printing line in order to subsequently print vertical portions of each character of a printing line.

Such kind of printers, when using a printing matrix of the so-called "draft" type, can reach a printing speed of 200 rows per minute, the row length being of 80-100 characters, therefore very far from the performances obtained with the parallel printers.

Several approaches have been followed and several emboding solutions have been put on the market for increasing the serial printer performances.

The consideration is omitted of the evolution of the so-called serial-parallel printers which offer intermediate performances between serial printer and parallel printers, at a relatively high cost.

The approaches followed to increase speed tend towards three directions.

1. Development of improved and faster actuation elements.

In such direction printing heads have been developped provided with actuators able to operate at printing repeated operation frequencies of 2KHz.

These heads allow to extend the printer performances to 200-400 rows per minute, with acceptable cost increases and maintaining all the flexibility characteristics of the printing modes (bidirectional printing, logic seeking) related to the serial printing.

2. Development of serial printers provided with a plurality of printing heads (typically two) movable along the printing line, each one designed to the printing of a row portion (typically half row).

This approach, for instance disclosed by US patent n. 3,858,703 limits the advantages which can be obtained using the logic seeking.

Therefore, it does not allow, as expected, the doubling of the performances.

Besides it requires control mechanisms of the head movement along the printing line more powerful and expensive, and a much more stout frame.

3. Development of serial printers having a printing head arranged with several vertical and parallel lines (typically two) of needles at a close distance.

According to such approach the several vertical portions of each character are printed alternatively using one of the two needle lines. This approach, disclosed for instance by US Patent 4,079,824 is fully consistent with the modes of bidirectional printing such as "logic seeking" and effectively enables a doubling of the performances without requiring substantial increases in the power and stoutness of the control mechanisms of the printing head movement.

Further it enables to obtain, in alternative to high performances as concerns the speed, the additional performance of a good printing quality of the printed characters by the vertical shifting of a needle line as to the other one of a quantity equal to a fraction, typically a half, of the vertical pitch center to center between two contiguous needles.

Such solution is for instance disclosed by US patent 4,010,835.

This kind of serial printers, having printing head provided with two vertical parallel lines of needles, more generally printing elements, are nowadays largely diffused thanks to their performance flexibility. It may be thought that the matching of approach 1. with this last one enable the embodiment of serial printers able to print up to 800 lines per minute and therefore in the position to compete with parallel printers in their typical application field at reduced cost and with much more performance flexibility.

Actualy this is not possible because it would involve moving of the printing head along the printing line at a speed double as to the one used at present and acceleration/deceleration of the same four times higher.

Exceptional problems exist to embody actuation mechanisms for the printing head movement along the printing line having the desired features, and the considerable higher costs are not compensated by the increase in the printing speed.

Further a basic inconsistency exists in the matching of the two approaches, substantially due to the considerable speed of the printing head movement as to the support and the interposed inked ribbon, which cause an enormous decrease in the printing quality. In fact a "smearing" in horizontal sense occurs of the several printed dots and any minimum inaccuracy in the actuation time of the several printing elements/needles results in an important vertical misalignment.

A more serious inconvenient is due to the high translation speed which causes a possible jamming of the actuation elements in the inked ribbon stich or in the ribbon mass, if it is homogeneous, with the consequent breaking of the needles or of the inked ribbon or, at least, the fast wearing of the sames or of the needle guiding elements

(rubies). The resisting force too, opposing the printing head movement along the printing line becomes quite undeterminate and the head movement itself becomes practically uncontrollable.

Substantially the functionality of the whole printer is seriously jeopardized.

To overcome such limits a printing head has been recently put on the market provided with 18 needles arranged along a continuous vertical line which enable both the printing of macrocharacter rows with height equal to the needle line height, and the simultaneous printing of two character rows with maximum height equal to the half of the needle line height.

As a vertical pitch between the needles is 1/72" a printing head of such type is able to simultaneously print two rows having a fixed pitch of 1/8" at very high speed.

Such kind of heads, and the printers using them, present however the inconvenient of preventing the simultaneous printing of two rows having pitch of 1/6" which is the standard required on the market together with pitch 1/8".

In other words the users require that the same printer be able to print both with pitch 1/8" and with pitch 1/6" according to a simple selection between the two possibilities.

The above mentioned head present a further inconvenience; in fact, when the printing is performed according to a 9 dot line character generation matrix the two contiguous rows meet, that is the descending characters of the upper row touch with their lower portion the upper portion of the capital characters of the lower row.

So, the use is compelled of generation character matrixes with only 7 dot lines, or 8 dot lines at the most, without the possibility of a printing according to pitch 1/6".

Such limitations are overcome by the dot matrix serial printer for the simultaneous printing of two rows object of the present invention which enables serial printing at high speed and offers the possibility of a selective printing with pitch 1/8" or 1/6".

The problem of printing with pitch selected between two possible ones is solved, according to the invention, by providing the printer with a printing head having a vertical needle line, the needle being preferably separated in two groups by a suitable space, and with means for selecting, within each of the groups and according to the desired pitch a needle subgroup.

The simultaneous printing of the two lines, with the desired pitch is therefore perfomed by the use of a needle subgroup in each group. According to a further feature of the invention the pitch between two contiguous vertical needles and the vertical space between two needles lines are suitably chosen in order to reduce to the minimum the difference between the number of needle actually used for the character matrix generation and the total needle number.

Accordingly to a further aspect of the invention the needle number of the head is 18 needles, identical to the needle number generally used on the fast serial printers already present on the market, so that a doubling of the speed performances consistent with the possibility of selection between the pitches is obtained without substantial mechanical and electronic modifications of the printers already available on the market.

These and other features of the invention will result more clearly from the following description of a preferred embodiment and from the enclosed drawings where:

Figure 1 shows in schematic perspective view the elements constituting a matrix serial printer already known in the art;

Figure 2 shows in schematic perspective view a matrix printer head for the emboding of a printer according to the invention.

Figure 3 shows a printing matrix commonly embodied by the matrix printers.

Figure 4 shows a preferred arrangement of printing elements in the printer object of the invention and their selection for the simultaneous printing of two rows at different pitch.

Figure 5 shows in simplified diagram the printing element control circuits of a preferred embodiment of a printer according to the invention.

Figure 6 shows an alternative arrangement of printing elements.

Figure 1 shows in perspective view the elements constituting a dot matrix serial printer known in the art.

The printer comprises a frame constituted by a base 1 and two side plates 2, 3, two parallel guiding bars 4, 5 mounted between the side plates, a platen 6 mounted between the side plates and parallel to the guiding bars and a guiding and driving bar 7 for two paper feeding pin wheels 8, 9.

A printing carriage 10, supporting a printing head 11, is slidably mounted on guiding bars 4, 5.

The carriage movement along the guiding bars is controlled by a motor 12, generally a step motor, fixed to side plate 3, through transmission means generally constituted by a tractor pulley 13 splined on the motor shaft.

A drive belt or cable, to which carriage 10 is fixed, winds up on pulley 13.

The cable is stretched by a return pulley 15 fixed to side plate 2. Printing head 11 is provided with a printing nose 16 arranged next to platen 6.

The carriage movement along the guiding bars causes the shifting of the printing head and nose 16 along platen 6.

Some controlled printing elements, generally needles, get out from the printing nose and allow the printing of dots on a printing support interposed between platen and printing nose together with an inked ribbon. For sake of drawing simplicity and clearness the printing support and the inked ribbon are not shown.

Platen 6 defines an horizontal printing line along which the printing is performed.

The printing support, generally a continuous form with sprocket holes is fed perpendicularly to the printing line, that is in vertical direction, by pin wheels 8 and 9, splined on shaft 7 rotated by a motor 17 preferably of the step motor type.

In some cases the printing platen, instead of fixed type can be constituted by rotating roller which also act as feeding means for the printing support.

In the printers known in the art and shown by Fig. 1, the printing needle ends get out from nose 16 arranged in one or more vertical lines (with reference to the space directions already established for the platen and the paper feeding).

Each vertical line of needle tips is typically constituted by a group of 7 or 9 contiguous needles, and the several lines are arranged parallely each other, exactly parallely or with a vertical "offset" equal to a fraction of the pitch between two contiguous needles.

For the printing of elaborated characters, such as the oriental characters KANGI, macrocharacters, and for the simultaneous printing of two rows, heads provided with 18 equally spaced needles arranged along one vertical line has been proposed too.

The mechanical structure of a printer of the disclosed type can be used, without any modification, for the embodiment of a matrix serial printer able to contemporaneously print two rows at selectable pitch as offered by the present invention.

In fact the result is obtained by mounting on such printer a printing head as the one schematically shown in perspective view in fig. 2. The constructive details of printing head 18 are not shown in Fig 2 as the structure of such head is beyond the scope of the invention and already known in the art.

Different embodiments have been disclosed by several patents among which US Patent N. 4,260,270 is, for instance, mentioned.

The specific feature to be mentioned is only the particular arrangement of the printing elements or needles in correspondence of printing nose 19.

As shown in fig. 2 two needle guiding rubies 20, 21 are set on the end of printing nose 19, juxtaposed in order to form a plurality of needle guiding openings arranged along a vertical line and separated into two groups A and B by a suitable space C.

Through such openings the printing needles tips contained therein get out performing the selective printing of dots on the printing support. The group guided by opening A, for the following indicated as "group A" is intended to print a character row.

Needle "group B" is intended to print the subsequent character row.

It is clear that in this way the printing of two character rows can be executed simultaneously with only one carriage shifting along the printing line, so, the carriage translation speed remaining the same the printing speed is doubled as to the one of the printers which print one only row each time.

Such kind of printer, without the adding of any further provision has a limitation: the distance between two subsequent rows, that is the line pitch, is rigorously fixed and established by the distance between the two needle groups A and B, while the user generally requires the possibility of selecting between different line pitches or line pitch multiples.

To overcome such inconvenient it could be though to use needle end guiding elements for group A different from the ones of group B and movable the one as to the other as well as means for modifying the vertical relative distance of the two elements and therefore of the two needle groups.

Such expedient is for instance adopted by some printers to vary the relative position between two parallel needle lines by adding an offset which allows to select between the execution of a fast printing and a quality print with the same printer.

This concept is for instance disclosed by the already mentioned US Patent 4,010,835.

However the "offset" which can be actually obtained with reliable simple and unexpensive solutions is limited to a few tenths of mm. and to a fraction of the distance, center to center, of two contiguous needles.

To obtain an "offset" in the range of millimeters expensive and complicated solutions should be required, such as for instance the division of the printing head into two separated heads shiftable the one as to the other.

According to the invention this limitation is overcome by providing two needle groups each one having a number of needles greater than the one actually used for the printing of two parallel lines. This allows the establishing of two subgroups in each needle group which can be selectively actuated, and through such selection the choice between two or, more generally, several alternative line pitch is enabled. For sake of clearness reference is made to Fig. 3 which shows how alphanumeric characters are obtained by discrete dots printable in a matrix of N lines by M columns.

Generally matrix of 7 lines by M columns are used with M varying within wide limits, which are beyond the scope of the invention.

Capital characters are obtained with 7 line matrixes, such as letter A shown in the figure and the character quality can be improved by increasing the horizontal resolution of the matrix.

The grid nodes stand for the possible points where the printing can be performed, possibly with the limit that the printing can be executed on the same matrix line only for dots separated by a space longer than an established multiple of the matrix pitch.

With a 7 line matrix the "descending" characters, such as letters p, q, j, y cannot mantain their characteristics but must be changed to forms which can be contained into the matrix.

Fig. 3 shows letter p printed according to this concept.

A printing quality closer to the current one is obtained by the use of 9 line matrixes, extending the 7 line matrix downwards.

In this case the dots which can be printed in the lower lines allows to shape the descending characters as "real descending" ones.

Fig. 3 shows, for example, letter "q" printed according to such matrix. An intermediate matrix of 8 lines by M columns is also used which allows to obtain a good printing quality and when combined with the known concepts of printing through multiple passes or through two lines of staggered needles the printing quality becomes excellent.

In this case the printing is performed according to a composite matrix virtually constituted by 16 lines.

According to such considerations the printer object of the invention preferably consists of a printing head provided with 18 needles separated into two groups A, B of 9 needles the tips of which are vertically arranged the one over the other one.

Such arrangement of the needle tips, thereafter referred to as needle arrangement, is shown in Fig. 4.

The purpose of printing two subsequent lines with a line pitch selectable between 1/6" a,d 1/8", which constitute a market standard, is achieved by the needle arrangement with vertical pitch p = 1/72" that is about 0,3526 mm and needle diameter of preferably the same value or of a slightly lower value, for instance 0,32 0,34 mm.

Group A is constituted in the order by needles A1, A2 ... A9 arranged the one below the other one.

Group B is constituted in the order by needles B1, B2, ... B9 arranged the one below the other one.

The vertical distance D between the axis of needle A9 and the axis of needle B1 is chosen to be

$$D = 3p = 1/24" \simeq 1{,}058 \text{ mm}.$$

With this needle arrangement it is clear that the center distance l_1 between needle A3 and needle B1 is exactly equal to

$$l_1 = 9 \cdot p = 9/72" = 1/8"$$

that is it corresponds to a line pitch of 1/8".

The simultaneous printing of two subsequent rows can be therefore executed by needles from A3 to A9 for the first row and by needle from B1 to B7 for the second one.

The printing is performed according to a matrix of 7 lines by M columns with line pitch 1/8" and "offset" descending characters.

This needle arrangement and the considered line pitch do not allow the simultaneous printing of two rows according to an 8 or 9 line matrix, but this is not a substantial limitation as the resulting text would be of poor printing quality, with too closed printing rows and, in the extreme case with printing rows contacting each other.

With the already mentioned needle arrangement the center distance l_2 between needle A1 and needle B2 is clearly exactly equal to

$$l_2 = 12 \cdot p = 12/72" = 1/6"$$

that is it corresponds to a line pitch of 1/6".

The simultaneous printing of two subsequent rows can therefore be executed by using needle from A1 to A8 for the first row and needle from B2 to B9 for the second row.

The printing is performed according to a matrix of 8 lines by M columns with line pitch 1/6" and with a true, even if partially, descending character.

In alternative a printing can be executed according to a matrix of 7 lines by M column by indifferently using the pair of subgroup A1-A7, B2-B8 or B3-B9.

Fig. 4 shows for example characters "A" and "g" which can be obtained in the case of printing with line pitch 1/8" and 1/6".

The already mentioned needle arrangement allows to maintain the desired line pitch during the printing of pair of subsequent rows.

It is known, in fact, that the printing support can be fed by discrete increments through the activation of a paper feeding step motor. Expensive motors allowing feeding resolution of fraction of pitch p are not required. It suffices that the motor allow incremental feeding IN equal to 6p.

It is clear that by feeding the printing support of a quantity equal to 3IN, the relative vertical shifting is such that needle A3 is moved to position A'3 of fig. 4, that is at a distance from needle B1, center to center, equal to $l'1 = 1/8"$.

The printing support being fed of a quantity equal to 4IN, the vertical shifting is such that needle A1 is moved to position A'1 of fig. 4, that is at a distance from needle B2, center to center, equal to $l'2 = 1/6"$. Obviously the simultaneous printing of two rows with line pitch selectable between 1/6" a,d 1/8" is enabled by a printer provided with the disclosed head only for simple line pitches, not for multiple ones, but this does not represent a substantial limitation as to the market requirements.

In fact the high printing speed as the one obtainable with the simultaneous printing of two subsequent rows is required only in the case a great volume of data is to be printed.

In this case however, the information are generally compacted on the printing support so renouncing, for paper saving or for easier information retrieval, the refined pagination obtained with a multiple line pitch printing.

On the other hand the use of a head with two needle groups arranged as disclosed does not prevent the possibility of using the printer as having a single 9 needle group head, thus obtaining from such head all the typical performances of such a printer, the good quality of a row printed with multiple passes and the printing according to a 9xM matrix included.

Before considering possible variants of the mentioned embodying concept it is suitable to point out that such concept can be embodied in a printer known in the art and already available without modifications in the electromechanical structure and with little modifications in the electronic architecture, or even with the only modification of the printing head and of the so-called control firmware. Therefore clear advantages are obtained in the design and manufacturing costs if the printer object of the invention is considered as a model of a product family characterized by a substantial component homogeneity even if the offered performances satisfy different and specifical requirements. From the electronic point of view, the activation of the printer object of the invention requires circuits and logical devices which slightly differ from the ones of already known printers; for instance quality printers having heads with 18 needles arranged on two lines vertically staggered, or fast printers having heads with 18 needles arranged along two side by side lines.

It is known in fact that such printers are generally provided with an architecture comprising a microprocessor, a control memory, a working memory or buffer, and some interface registers devoted to latch, for suitable intervals, the energization commands for the several printing elements.

The control memory contains, further to suitable microprograms, some character generation tables that is tables which allow to couple to each alphanumeric character binary code a set of binary codes or "patterns" representative of the particular dot matrix corresponding to the character to be printed.

A printing "pattern" is coupled to each column of the printing matrix. As soon as they are received the character codes to be printed are loaded into a working memory zone. When such zone is loaded with the codes of the whole printing row, the codes are read out one at a time with a timing imposed by the printing speed and are used for reading out, from the character generation tables, which are the patterns to be used for the printing of the desired character.

The read out patterns are loaded into the interface registers with a suitable timing and they provide for the selective control of the several actuation element energization.

An example of such architecture is disclosed by several patents among which is for instance mentioned, for simplicity and clearness of description US Patent N. 4,079,824.

It is clear that such type of architecture intrinsecally contains all the physical elements to control a printer provided with 18 needles arranged along one vertical line instead of two parallel vertical lines, and that the sole differences are referred to the particular microprogram controlling the system operations.

Such microprogram will load into a particular working memory zone the codes of the characters to be printed referred to two subsequent rows instead to one only row.

It will then read out, in immediate succession, the codes of the two characters of the two rows which are placed in the same column and read out form the character generation tables which are the patterns to be used for the printing of the first and of the second character respectively.

It will at last load such patterns into the interface registers coupled to the several needle groups.

It is now essential to point out that the same letter of an alphanumeric set, for instance letter "A" configured according to a matrix of 7 columns by M lines, must be printed using, for the first row, different needles depending on whether the selected line pitch is 1/8" or 1/6". The same concept is valid for the second row.

In other words, a univocal correspondence cannot be established between the printing "pattern" representative of letter "A" and the printing needles.

This difficulty can be overcome by providing a plurality of character generation tables in order that a suitable character generation table can be selected according to each selectable line pitch and, if required, also according to the row, if two rows are to be contemporaneausly printed. An univocal relation is therefore established between the several printing "patterns" which can be selected (and are representative of the same character) and the printing needles.

It would however require a great waste of control memory positions. Such inconvenient is overcome according to another feature of the invention, by using one only character generation table and providing a suitable translation or "shift" of the printing patterns read out from control memory, the translation being function of the selected line pitch and, if necessary of the printed row.

This aspect of the invention is schematically shown in Fig. 5.

In Fig. 5, a microprocessor, for instance microprocessor 8085 of firm INTEL, is connected, through a channel AD 0-7, to a control memory 32, a portion of which stores a character generation table.

A portion of the table describing the pattern binary code of character "A" is shown in the figure.

Two "buffer" registers 33, 34, intended to control the actuation of needle groups A1, ... A9, B1, ...B9 respectively, are connected to channel AD 0-7.

If, during the printing process character "A" is to be printed in the row by needles A1, ... A9, the "patterns" from 35 to 41 are subsequently loaded, at suitable instants, into register 33.

If character "A" is to be printed in the row printable by needles B1, ... B9, the patterns from 35 to 41 are subsequently loaded into register 34.

The information is transferred into registers 33 to 34 in a one to one relation, that is the information contained into position or cell 0 of the pattern is loaded into cell 0 of register 33, 34 respectively; the information contained into position or cell 1 of the pattern is loaded into cell 1 of register 33, 34 respectively and so on.

The outputs of register 33, 34 are connected to the input of a multiplexor circuit 42, 43 respectively provided with nine elements having two input paths.

As the outputs of the several elements control each one a corresponding needle, the several elements are referenced with the same reference A1,..., A9, B1, ..., B9 of the controlled needle.

In Fig. 5 it is shown that element A1 of multiplexor 42 controls, through lead 44, AND gate 45 and resistor 46 the base of a transistor 47 which enables to energize coil 48 controlling needle A1.

AND gate 45 is enabled by an enabling command EN sent by a not shown timing unit.

Elements A2, ..., A9 and B1, ..., B9 of the multiplexor circuits control, through similar circuits, needles A2, ..., A9, B2, ..., B9 respectively.

The outputs of elements A2, ... A9 and B1, ... B9 constitute a multiple leads control channel of the several printing elements.

The outputs of cells from 0 to 6 of register 33 are respectively connected to a first input of elements A1, ... A7 respectively of multiplexor 42 and to the second input of elements A3, ... A9 respectively. Multiplexor 42 is controlled by the signal at logical level 0, 1 present at a control input 49.

When the logical level of such input is 0 the first input of the several elements is enabled.

When the logical level of such input is 1, the second input of the several elements is enabled.

Input 49 can be selectively connected to a source of logical signal 0 or 1 through a key 50, which establishes with its position if the printing is to be made according to a line pitch 1/6" or 1/8".

It is therefore clear that, according to the position of such key the several "patterns" can be selectively designated to control needles from A1 to A7 or from A3 to A9.

Likewise the outputs of cells from 0 to 6 of register 34 are connected to a first input respectively of elements B2, ...B8 of circuit 43, and to the second input of elements B1, ... B7.

Control input 51 too of multiplexor 43 is connected to commutator 50 and it is therefore clear that according to the position of such commutator, that is according to the selected line pitch, the several "patterns" are selectively designated to control the suitable needles subset in group B1, ... B9.

Fig. 5 diagram therefore shows that with a single character generation table, the simultaneous printing of two rows with selected line pitch can be suitably controlled.

The disclosed control circuit differs form the ones know in the art owing to the presence of multiplexors 42, 43 and of commutator 50. It is to be noted that multiplexors 42, 43 and commutator 50 are only exemplifying means, although preferred, for the correct and selective assignment of a same pattern to several needle subsets depending on the selected line pitch.

It is in fact clear that the same operation can be performed by registers 33, 34 themselves which, in this case, must be constituted by shifting registers with possibility of parallel loading.

The shift can be controlled by microprocessor 31 according to the selected line pitch and to the line to be printed.

Likewise the shifting operations can be performed by arranging multiplexors 42, 43 upstream registers 33, 34 or, without additional physical means, by using the processing performances of microprocessor 31 which is able to arrange for the required patterns translation, with a suitable microprogram, before loading registers 33, 34.

As above mentioned, the printer object of the present invention does not prevent the exploitation of all the functionalities offered by the technology in the use of dot matrix printers with printing heads having a single column of 7 or 9 needles.

Actually it offers higher performances together with great constructive simplifications.

For instance in several printers with two parallel needle lines known in the art, the possibility to print at an high speed in "draft" mode and at lower speed with quality printing according to a matrix with 14, 16, 18 lines by M columns, is obtained by the expensive and unreliable con-

structive complication of a needle guiding ruby consituted by a fixed section, defining the stable position of a first needle line, and by a movable section, defining two position of the second needle line.

In the first position the two lines are arranged exactly side by side, that is two side needles print exactly on the same matrix line to obtain a high speed printing.

In the second position the two lines are arranged side by side with a vertical "offset" equal to 1/2p, that is the second line needles print on matrix lines intermediate to the ones where the first line needles print.

Such a concept can be applied to the printer object of the invention with a modification, that s the whole guiding ruby of the two needle lines can be mounted, with known mechanical arrangements, in order to be movable and to define two positions, for both the needle groups, with a vertical "offset" equal to 1/2p.

As the printing speed is achieved with the simultaneous printing of two rows, a good simultaneous printing quality always at relatively high speed, and with the simultaneous printing of two rows can be obtained performing a two pass printing; the first pass with the needle guiding ruby in a first position, the second one with the needle guiding ruby in the second position.

Alternatively, without the need of rubies movable between two positions with the related control means, it is possible to take advantage of the printing support shifting between one pass and the subsequent one for a quantity equal to 1/2p.

In the previous description the embodying concept has been emphasized of a fast printer for the simultaneous printing of two rows which substantially differs in its constituting elements from the known printers only for the particular embodiment of the printing head and for the easily modifiable control elements constituted by microprograms, that is the firmware.

It is clear that, forfaiting this concept of consistency or productive modularity with other printers, several modifications can be brought to the invention embodiment.

For instance the adding of one needle, designated with A0 above A1 in group A, or, that is the same, the adding of one needle, designated with B10, below B9, in group B, enables the printing according to a printing matrix of 9 lines by M columns at least, when the selected line pitch is 1/6".

The matching of such variant with the relative shifting between printing support and needle guiding ruby equal to 1/2p enable the execution, with two printing passes, of characters printed according to quality printing matrixes of 18 lines by M columns.

In the case the relative shifting between printing support and vertical position of the needles is 1,5p as disclosed by european application n. 84103585 it is still possible to print according to a quality printing matrix of 16 lines by M columns, with the further possibility of true underlining, overlining of the text.

This is obviously limited only to the case of selected line pitch 1/6". The same performances can be obviously obtained also in the case of line pitch A/8" by the addition of a needle A10, below needle A9 and of a needle B0 above needle B1 so obtaining a printing head provided with a line of 21 needles arranged with a distance center to center of 1/72" as shown in Fig. 6.

It is also to be noted that in Fig. 4 two needle groups A and B are shown as constituted each of 9 needles, but the separation into two groups can be made with different criterions.

It is clear for instance that group A can be constituted of 10 needles from A1 to A10, while group B can be constituted by 8 needles (from B2 to B9) or viceversa.

In this case the printing with line pitch 1/8" is performed by using needles from A4 to A10 in group A and from B2 to B8 in group B. Likewise it is clear that if for the printing with line pitch 1/6" a matrix of 7 lines by M columns suffices the minimum required needle number is cut to 17 omitting, in alternative, needle A1 or needle B9.

At last, though reference has always been made to a line of vertically aligned needles, the needle line can be slanted and the two needle groups can be arranged along different vertical or slanted lines provided the vertical distance, center to center, between the several printing elements and the two groups has the mentioned characteristics.

Claims

1. Dot matrix serial printer for the printing of two simultaneous rows, of the type comprising a printing head movable transversally to a printing support for the printing of subsequent character rows in the moving direction of said head, the subsequent rows being obtained by the shifting of said printing support in direction perpendicular as to said moving direction, said head being provided with a plurality of printing elements aligned according to a direction transversal to said moving direction and structured in two separate groups, the first group providing for the printing of a character row and the second set providing for the simultaneous printing of a subsequent character row,

characterized by that one of said set at least is constituted by a plurality of different and selectable subgroups having in common some of said printing elements

and by that it comprises

selection means controlled by a signal defining one among several different line pitch, to select a subgroup in said plurality and perform with said subgroup the printing of a character row with line pitch defined by said signal as to a character row simultaneously printed by elements of the other group.

2. Dot matrix serial printer as per claim 1, characterized by that said printing elements are arranged in the two groups with an established pitch in the direction perpendicular to said moving direction and the two groups are spaced a width equal to an integral multiple of said pitch measured between the center of the two group elements nearer each other.

3. Printer as per claim 2 characterized by that said pitch being 1/72" said space width is equal to 1/24".

4. Printer as per claim 1 characterized by that said printing elements are 21 and arranged with pitch 1/72" in the direction perpendicular to said moving direction.

5. Printer as per claim 1 characterized by that said selection means comprises a character generator providing for each printable character, a set of binary printing "patterns", independently from the printing line and the printing line pitch, said patterns being sequentially read out from an output channel of said generator, and shift means connected to said output channel and to a channel controlling said printing elements for shifting said patterns on said

control channel depending on both the line to be printed and the line pitch.

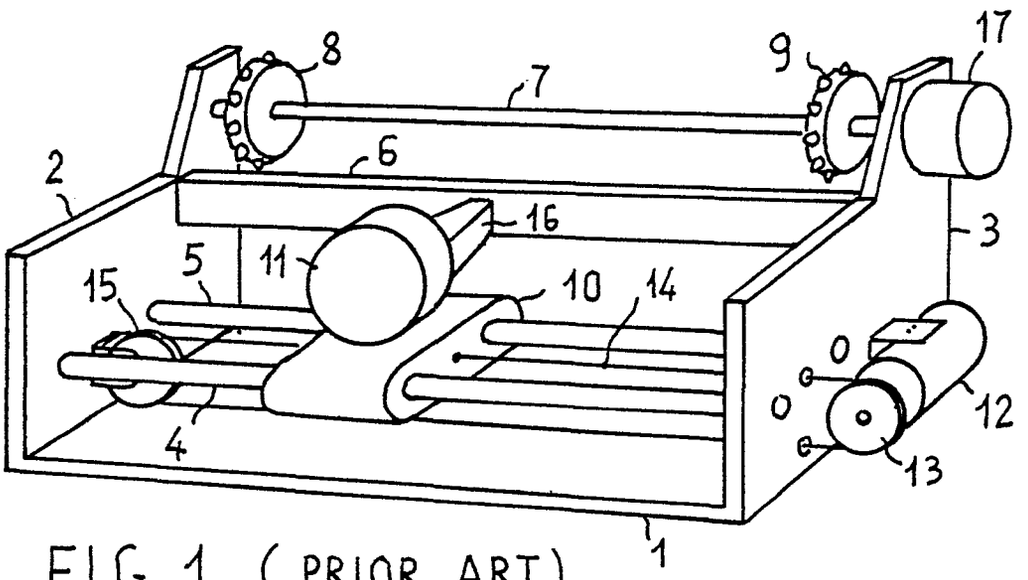

FIG. 1 (PRIOR ART)

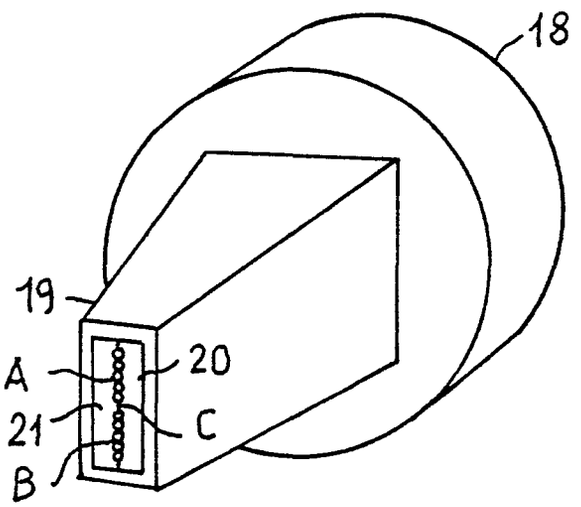

FIG. 2

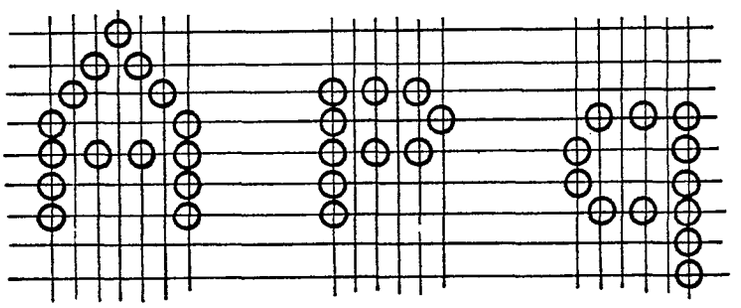

FIG. 3

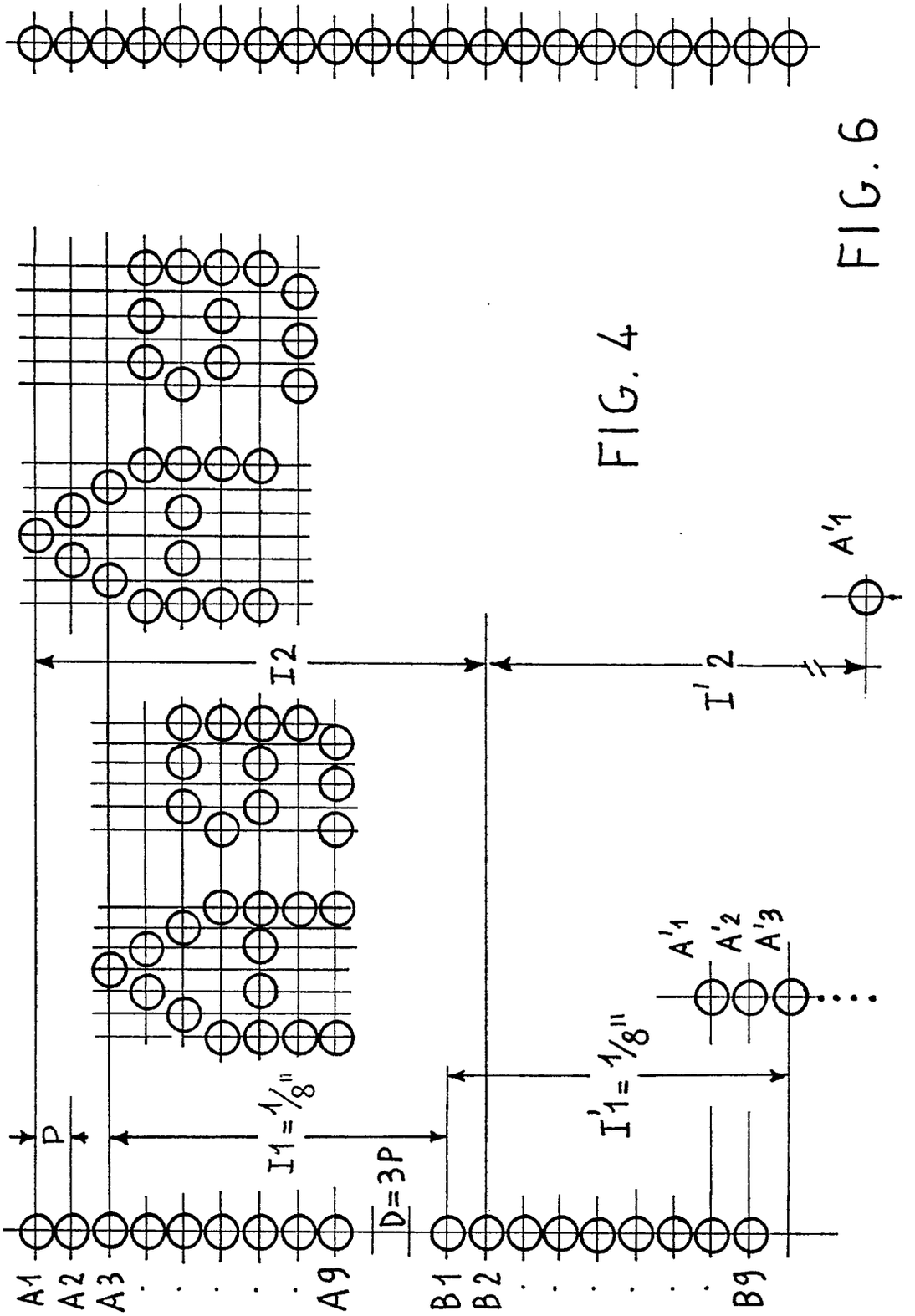

FIG. 4

FIG. 6

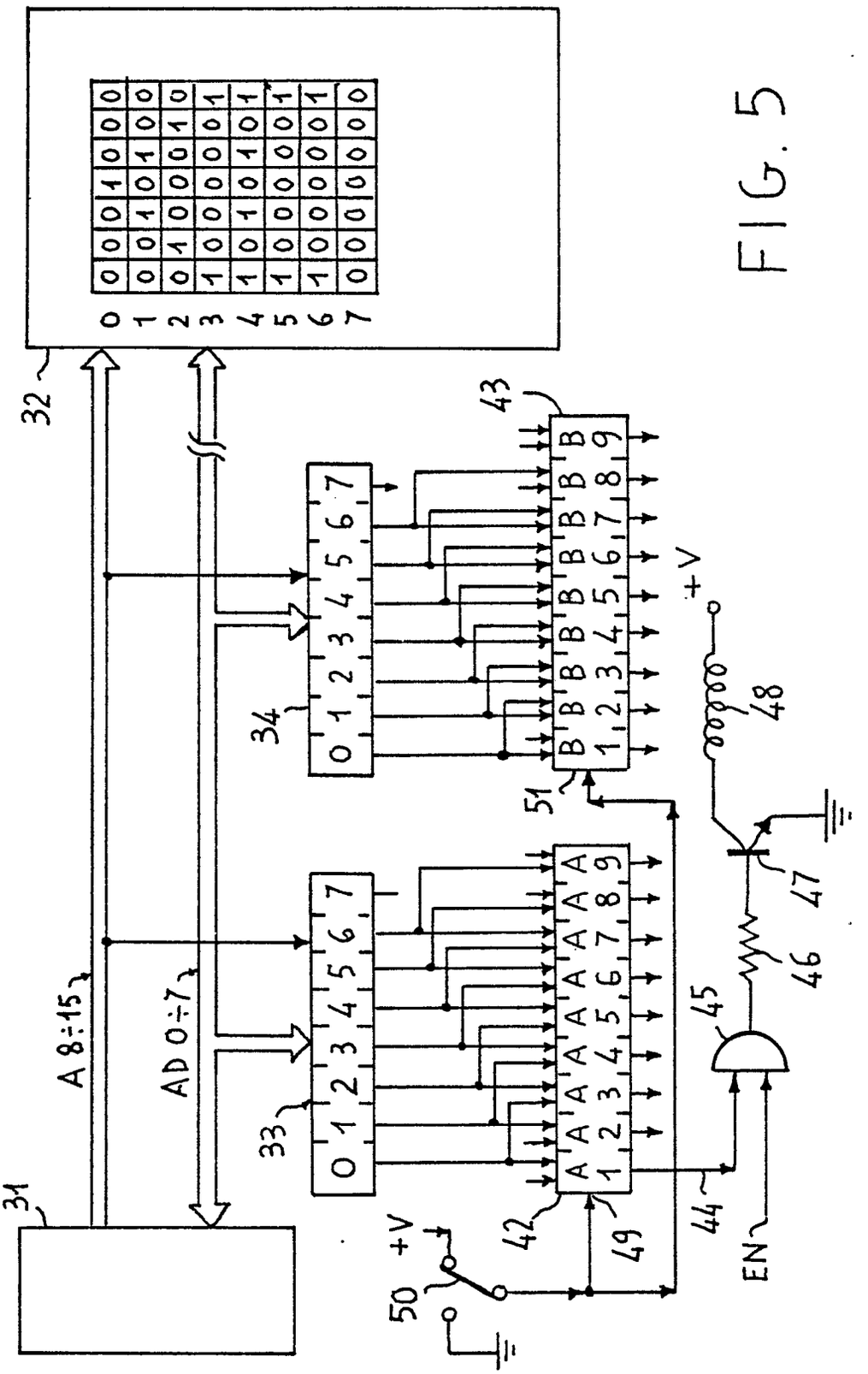

FIG. 5