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EUROPEAN PATENT APPLICATION

21 Application number: 80303686.2

51 Int. Cl.³: **B 41 J 3/02**
B 41 J 3/12

22 Date of filing: 17.10.80

30 Priority: 17.10.79 IT 6901579

43 Date of publication of application:
29.04.81 Bulletin 81/17

84 Designated Contracting States:
DE FR GB

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54 Dot matrix printing device.

57 The printing device comprises a printing head having a row of printing elements, e.g. 18 wires 31 actuated by corresponding electro-magnets for printing symbols and characters in conformity with dot matrices. The inclination of the row relative to the direction of movement of the printing is variable. With the row vertically aligned, the height l of the 18 wires is equal to that $(h + b + h)$ of the two lines of printing as a result of which it is possible to print two rows of characters simultaneously. By inclining the head and suitably selecting the speed of movement it is possible to print one line at a time with high definition dot matrices.

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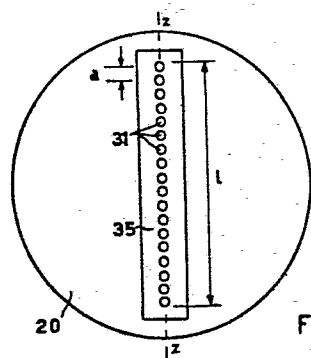
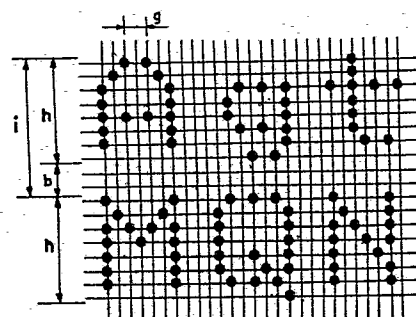


FIG. 4



DOT MATRIX PRINTING DEVICE

The present invention relates to a dot matrix printing device for accounting, data terminal, telewriting and similar office machines, comprising a row of dot printing elements, the row extending transverse to a direction of relative movement between the printing
5 elements and the medium on which they print. As is well known, by selectively operating the individual printing elements during such movement it is possible to print alphanumeric characters and other symbols within the resolution permitted by the dot matrix.

Although the invention will be described mainly in terms of wire
10 printers in which the printing elements are wires activated for impact printing of the dots by electromagnets it is not restricted to a particular type of printing element. For example, thermal dot matrix printers are known using resistive printing elements heated by current pulses.

15 A dot matrix printing device is known in which, to increase the printing speed, the printing ends of the wires are disposed side by side along two rows, parallel relative to each other and perpendicular to the direction of forward movement of the printing head carrying the wires, referred to as the printing direction.

20 The wires are selectively actuated to write at high speed the characters of a line according to a dot matrix which is very readable but with rather low definition. The drawback of such a device is that the speed of the movement of the head-carrying carriage is very high, as a result of which the mechanical parts
25 are subjected to considerable wear, and the control circuit is necessarily complex and therefore costly.

A dot matrix printing device is also known in which, to improve the printing quality, the printing ends of the wires are aligned on a single row which is slanted relative to the printing direction. In
30 this manner the characters are written with high dot definition since the dot spacing in the vertical direction is less than the

dot spacing along the row and the printed dots can even overlap in a vertical column of dots. This printing device, however, suffers from the drawback of being rather slow, and thus little suited to being used in those machines such as data terminals, where a high writing speed is required.

A first object of the present invention is that of providing a printing device able to write symbols and characters both at high speed, according to low definition dot matrices, and at low speed according to high definition dot matrices.

A second object of the present invention is that of providing a device which, though capable of writing at high speed, is very reliable and inexpensive.

The dot matrix printing device according to the invention is defined below in Claim 1 and advantageous developments of the invention are set forth in the dependent claims.

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

Fig. 1 is a plan view of a printing device embodying the invention;

Fig. 2 is a rear left perspective of an enlarged detail of the device of Fig. 1;

Fig. 3 is a diagram of the circuit for controlling the printing device;

Fig. 4 shows characters printed by the device in a first operating condition;

Fig. 5 shows a different form of characters which can be printed by the device in the first operating condition;

Figs 6 & 7 show characters printed in second and third operating conditions; and

Fig. 8 is an enlarged detail of a character printed in the third operating condition.

The printing device comprises a base 10 (Fig. 1) provided with four vertical sides 11, 12, 13 and 14 all parallel to each other.

65 Between the sides 12 and 13 a platen 16 is mounted to support a recording medium 17 which, for example, may consist in a sheet of paper, a continuous form, a cheque, a small book or a bank card.

A printing head 20 with wires, which will be described in detail hereinbelow, is mounted on a carriage 21 which is slidable along
70 a front guide 22, fixed to the sides 12 and 13 and parallel with the platen 16. An inked ribbon 23 is arranged in between the head 16 and the bar 16.

For movement in front of the platen 16, the carriage 21 is in engagement with a lead screw 25, rotatably mounted in the sides
75 12 and 13 and coupled directly to an electric motor 26, for example of stepping type, which controls its rotation.

A synchronisation disc 28 is keyed on the screw 25 and has a series of radial notches, angularly equidistant one from the other. A photo-transistor 29 is disposed facing the notches and co-operates
80 with a corresponding light source 30. In particular, the photo-transistor 29 generates a synchronisation pulse FP at each elementary displacement of P of the head 20 along the direction of movement of the carriage 21, which we shall also call the printing direction. In the example described here the displacement P is 0.0529 mm, and
85 has been selected according to criteria which will be described below.

The printing head 20 (Fig. 2) comprises a frame 33, on the front part of which eighteen control electromagnets 32 are mounted, which are individually joined to an equal number of writing wires
90 31. The wires 31 have a diameter of 0.3 mm and are guided at their front end by a guide 36 which holds them aligned in a single row

Z-Z (Fig. 4). The distance between the axes of the wires 31 is 0.423 mm and the total length l of the row is 7.491 mm. This is equal to twice the height of h of a line of characters of standard type, plus the space b between two lines. These values have been
95 chosen so as to yield a line pitch of 4.23 mm, which is a standard spacing widely used in printers.

The head 20 (Fig. 2) is mounted on the carriage 21 in such a manner as to be variably oriented relative to the direction of writing.
100 For the purpose the front or guide 36 of the head 20 is rotatable in a support 37 of the carriage 21. A helical gear 39 is fixed to the head 20 and engages with a screw 40, rotatably mounted in the support 37. A disc 41, solid with the head 20, is provided with a series of radial notches 42 facing which, on the carriage
105 21, a photo-transistor 44 is arranged, co-operating with a corresponding light source 43 to generate a synchronisation pulse FT (Fig. 3) when the head 20 is oriented according to one of the predetermined angles.

On the end of the screw 40 (Fig. 2) is one member 46 with front
110 teeth of a dog coupling. When the carriage 21 is at rest at its extreme left position, the member 46 engages with a corresponding member 47 which also has front teeth and is mounted on a shaft 48 rotatable between the sides 11 and 12 of the base 10.

On the shaft 48, between the sides 11 and 12, a toothed gear 50,
115 is keyed. This gear engages with a toothed gear 51 mounted on the shaft 52 of an electric motor 54, of stepping type. The shaft 48 is axially slidable, and a helical spring 55 urges the gear 50 constantly towards the side 12.

The electro-magnets 32 are of known type, for example as described
120 in our Italian Patent No. 1011721 and have an actuation cycle T of about 1000 μ sec. The circuit used to control the excitation of the electromagnets 32 and the electric motors 26 and 52 is illustrated in Fig. 3 and comprises a central unit 60 into which the data of the alphanumeric characters and other symbols to be printed are fed

125 along a first channel 61 from an output device 62. Along a second
channel 64, from an operational console 65, the data relating to
the type of printing to be effected arrive at the central unit. The
central unit 60 is connected to two random access memories RAM 66
and 67, by means of two channels 69 and 70 respectively. The central
130 unit 60 is also connected, through a channel 71 to a circuit 72
which controls the motor 26 and, through a channel 73, to a circuit
74 which controls the motor 54. The control circuits 72 and 74 are
of known type, for example of the type described in our Italian
Patent No. 1,009,48.

135 The signal FT generated by the photo-transistor 44 is sent to the
central unit 60, after having been squared by a monostable circuit
75. The signal FP issuing from the photo-transistor 29 is fed to
a monostable squaring circuit 76 which generates a corresponding
square signal FQ, which is fed to a binary counter 77 which generates
140 a print enabling signal FS. The signal FQ is also despatched, as a
feedback signal, to the control circuit 72 of the motor 26. The
binary counter 77 is connected to the central unit 60 by means of
a channel 80 and can be set to overflow on a variable number, in
such a manner that the time interval between two successive pulses
145 of the signal FS may be suitably selected, as will be described
hereinbelow.

The central unit 60 is connected to a multiple switching circuit
81 through two channels 82 and 83. In its turn, the circuit 81 is
connected to a plurality of decoding ROM's 83a, 83b,83n, by
150 means of a corresponding plurality of channels 84a, 84b,
84n. Each ROM 83a, 83b,83n has 18 output lines 85a, 85b,
85n respectively, connected to 18 NAND gates 86 which generate
control signals EL 1 to EL 18 and each have an input connected to
the output of the binary counter 77. Each control signal EL 1 to
155 EL 18 issuing from the gates 86 is fed to a corresponding
monovibrator 87 which, in response, generates a pulse PZ which
remains at the logical level 1 for the time actually necessary for
controlling the electro-magnets 32 (approximately 500 μ sec); this
pulse PZ is then fed through a driver circuit 88n, to the

160 corresponding electro-magnet 32.

The operation of the printing device so far described is as follows:-

At rest, the carriage 21 (Fig. 1) and the head 20 are stopped at the left end 12, and the toothed members 46 and 47 are coupled together. In this position the motor 54 can rotate the head
165 20 relative to the support 37 of the carriage 21 through the gears 50 and 51, the coupling 46, 47, the screw 40 and the gear 39, disposing it in one of its possible positions, suitably inclining the row of writing ends of the wires 31 relative to the horizontal direction of movement of the carriage 21. In the particular
170 embodiment here described, three different inclinations of the head 20 relative to the horizontal direction have been assumed for the sake of example. In a first operating condition (Figs. 4 and 5) the head 20 is positioned in such a manner that the row Z-Z of the printing ends of the wires 31 is vertical.

175 With the head 20 thus disposed, the printing device can write either simultaneously two lines of characters of standard height according to a matrix of 7 x 7 dots (Fig. 4), or a single line of characters of double height 1 according to a matrix of 18 x 12 dots (Fig. 5), thus effecting, for example, letter heads and titles.
180 In addition, again with the head 20 thus disposed, it is possible to write alpha-numerical characters, graphic symbols, non-Latin characters and ideograms, according to dot matrices with variable definition. The definition and sizes of characters in the vertical direction are determined by the number of wires 31 chosen, while
185 the corresponding values, in the horizontal direction, are determined by the pitch between two dots, with a consequent correction of the speed of movement of the carriage 21.

The speed of movement of the carriage 21 is indeed a determining factor to obtain a predetermined type of writing, account being
190 taken of the time T taken by each electro-magnet 32 to effect a complete printing cycle.

For a type of writing such as that illustrated in Fig. 4, the distance $\underline{g}$ between two successive dots in the horizontal direction of writing is equal to ten elementary pitches $\underline{p}$ and is 0.529 mm; this distance $\underline{g}$ is moved by the carriage 21 in a time T which is 1000 μ sec. Therefore, for this type of writing, the speed of travel of the carriage 21 is 529 mm/sec., the head 20 can write 200 characters per second, for each line, and thus have a productivity of 400 characters per second.

For this type of printing, in addition, the console 65 is set up in such a manner that the data transmitted by the input device 62 (Fig. 3) to the central unit 60 are first memorised on alternate lines of the two RAM memories 66 and 67, and then despatched in parallel, two lines at a time, to the circuit 81 through the channel 82. The central unit 60, through channel 83, conditions the circuit 81 so that the data from channel 82 go to the ROM 83a, through channel 84a, ruling out the other ROM's 83b.....83n. The central unit 60, in addition, through channel 80, sets the binary counter 77 in such a manner that every five pulses FQ a pulse FS is generated, enabling printing. (Although the horizontal dot spacing $\underline{g}$ is equal to $10\underline{p}$ the dots are printed at intervals of $5\underline{p}$ as adjacent dot rows may be staggered in a manner apparent from Fig. 4.) Finally, through channel 71, the central unit 60 controls the circuit 72 controlling the motor 26 in such a manner that the speed of travel of the carriage 21 be as predetermined.

The type of printing such as that illustrated in Fig. 5 the distance $\underline{f}$ between two successive dots in the horizontal direction of writing is equal to six elementary pitches $\underline{p}$, and is 0.3174 mm. As the carriage 21 has to travel through that space $\underline{f}$ in time T, which is 1000 μ sec, the speed of travel of the carriage 21 in front of the bar 16 is 317.4 mm per second. In this case, in addition, the console 65 is set in such a manner that the data transmitted from the input device 62 (Fig. 3) to the central unit are memorised line by line in one of the RAM memories (66 or 67) and are then despatched serially to the circuit 81, through the channel 82. The central unit 60, through channel 83, conditions the circuit 81 in

such a manner that the data from channel 82 go to the ROM 83b, through the channel 84b, ruling out the other ROM's 83a,....83n. The central unit 60, in addition, through channel 80, sets the
 230 binary counter 77 in such a manner that a pulse FS is generated every six pulses FQ, enabling printing. Finally, through channel 71, the central unit 60 conditions the circuit 72 controlling the motor 26 in such a manner that the speed of travel of the carriage 21 be as predetermined.

235 Let us now assume that we wish to slant the head 20 to write characters and symbols according to other dot matrices.

When the head 20 (Fig. 1) is in the rest position, with the engagement members 46 and 47 coupled together, the console 65 (Fig. 3) is set according to the type of character, ideogram or other symbol
 240 to be printed. The central unit 60, through the channel 73, controls the circuit 74 controlling the motor 54, in such a manner that the head 20 (Fig. 2) rotates, relative to the support 37 of the carriage 21 by an angle α (Fig. 6) predetermined relative to the vertical axis. When the rotation has taken place, the photo-transistor 44 generates
 245 a feedback pulse FT which is fed to the central unit 60 to stop the motor 54 and the head 20. For the writing of characters of the Kanji alphabet according to a matrix of 12 x 14 dots, as illustrated in Fig. 6, the angle α is $48^{\circ}37'$. This angle has been selected in such a manner that the projection $\underline{c}$ on to the horizontal axis
 250 of the distance between the centres of two wires 31 which are adjacent is an exact multiple of the elementary pitch $\underline{p}$. In particular when $\alpha = 48^{\circ}37'$ the distance $\underline{c}$ is equal to 6 $\underline{p}$ and is 0.3174 mm. This is in order to be able to obtain perfectly vertical strokes.

255 In this second working condition and for this type of printing, the distance $\underline{r}$ between two successive dots in the horizontal direction of writing is equal to 5 elementary pitches $\underline{p}$, and is 0.2645 mm. As the carriage 21 has to travel through this distance $\underline{r}$ during the time T which is 1000 μ sec, the speed of travel of the
 260 carriage 21 is 264.5 mm/sec. At this speed the head 20 can write

35 Kanji characters per second. In this case also the data transmitted to the central unit 60 are memorised line by line in one of the RAM memories (66 or 67) and are then despatched serially, through channel 82, to the circuit 81 which despatches
 265 them to another of the n ROM's 83, not shown in order to simplify the drawing. In this case also, the central unit 60, through channel 80, sets the binary counter 77 in such a manner that every five FQ pulses a FS pulse, enabling printing, is generated.

If it is desired to write alphanumerical characters and symbols
 270 according to a matrix with higher dot definition, the head 20 is inclined to a greater extent relative to the vertical axis, changing its setting and bringing it to a third operating condition.

Setting the console 65 (Fig. 3) on the new type of characters to be printed, when the head 20 is at rest, the central unit 60,
 275 through the channel 73, controls the circuit 74 controlling the motor 54 in such a manner that the head 20 (Fig. 2) rotates relative to the support 37 of the carriage 21 until it forms a predetermined angle β (Fig. 7) relative to the vertical axis. When rotation has taken place, the photo-transistor 44 generates a feedback
 280 pulse FT which stops the motor 54 and therefore the head 20.

For high definition printing according to a matrix of 15 x 48 dots, as illustrated in Figures 7 and 8, the angle β is $61^{\circ} 7'$. This angle β also is selected in such a manner that the projection $\underline{d}$
 285 on to the horizontal axis of the distance between the centres of two adjacent wires 31 should be an exact multiple of the elementary pitch $\underline{p}$. In particular, when $\beta = 61^{\circ} 7'$, the distance $\underline{d}$ is equal to $7\underline{p}$ and is 0.3703mm.

In this third working condition, and for this type of printing, the distance $\underline{s}$ between two successive dots along the horizontal
 290 direction of writing is equal to four elementary pitches $\underline{p}$ and is 0.2116 mm. As this distance has to be travelled by the carriage 21 in time T, the speed of travel of the carriage 21 is 211.6 mm/sec. At this speed, the head 20 can print about 83

10.

295 characters per second. Also in this latter case the data transmitted to the central unit 60 are first memorised one line at a time on one of the RAM memories (66 or 67) and then despatched serially to the ROM 83n, through the circuit 81. The central unit 60 sets the binary counter 77 in such a manner that at each FQ pulse a pulse FS enabling printing is generated.

300 The elementary pitch $p = 0.0529$ mm corresponds to $1/480''$ and has been selected on the basis that the characters are normally printed with constant spacings of 10, 12 or 15 characters per inch, or with different spacing pitches which are multiples of $1/60''$ (0.423 mm). In accordance with this selection the spacing of a character with
305 $1/10''$ spacing is divided into 48 parts, and the spaces of the characters of $1/12''$ and $1/15''$ and proportional ones are subdivided respectively into 40 parts, 32 parts and exact multiples of 8 parts.

It will be clear from the present description that the slanting of the row of printing ends of the wires 31 relative to the
310 direction of writing is selectively variable from a first position in which the wires 31 can write simultaneously a plurality of lines of printing to a plurality of other indications in which the wires 31 can write on a single line symbols and characters with dot matrices with variable definition.

315 It is clear that in addition to those described so far, other types of printing, with other dot matrices, may be printed by the device according to the invention.

Among many possible modifications it may be mentioned that there may be more, if need be many more, or less wires than 18, and the
320 lines of characters written simultaneously (Fig. 4) may be more than two. As already mentioned printing elements other than wires can be used. For example, thermal printing elements are known and also ink jet printing elements which project dots of ink on to the recording medium.

C L A I M S

1. A dot matrix printing device with a row of selectively operable printing elements (31), the row extending transverse to a direction of relative movement between the printing elements and the medium on which they print, characterised in that the inclination of the row of elements relative to the said direction is variable between a plurality of settings enabling printing in dot matrices of differing definitions, and by control means (Fig. 4) operable in one of the settings to cause a plurality of lines of printing to be printed simultaneously utilizing different segments (h) of the row of elements.
2. A printing device according to Claim 1, characterised in that the printing elements (31) are aligned on a single line (Z-Z), and in that in the said one setting this line is perpendicular to the said direction.
3. A printing device according to Claims 1 or 2, characterised in that the control means respond to the variation of the inclination of the row of printing elements to use alternatively the data in series-parallel fashion for simultaneous printing along two lines, and in serial fashion for printing one line after the other.
4. A printing device according to Claims 1, 2 or 3, characterised in that the control means comprise a central unit (60) connected to an input device (62) and to two line memories (66, 67) the data to be printed supplied by input device being memorised in alternate lines in the two memories and taken from the central unit in parallel manner when the row of printing elements is in the first setting, and being memorised one line at a time in one of the memories and taken in serial manner by the central unit when the row of printing elements is in another of the plurality of settings.

12.

5. A printing device according to any of the preceding claims in which a first electric motor effects the movement of the printing elements in front of the printing medium along the said direction characterised in that a control circuit (74) for the motor alters the speed of travel of the printing elements (31) depending upon the inclination of the row and the type of matrices of dots to be printed.
6. A printing device according to Claim 5, characterised in that a second electric motor (26) varies the inclination of the row of printing elements from the first setting to the plurality of other settings.

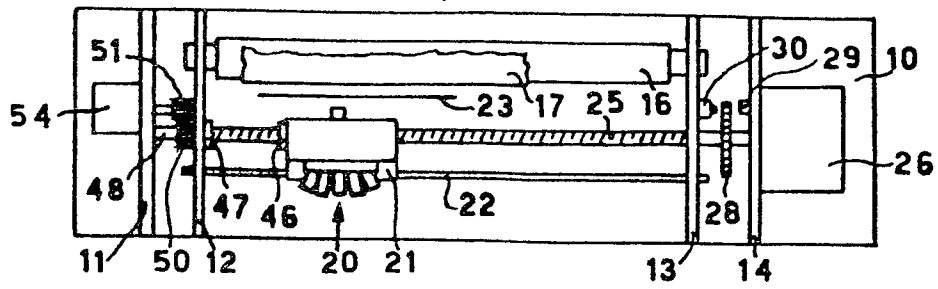


FIG. 1

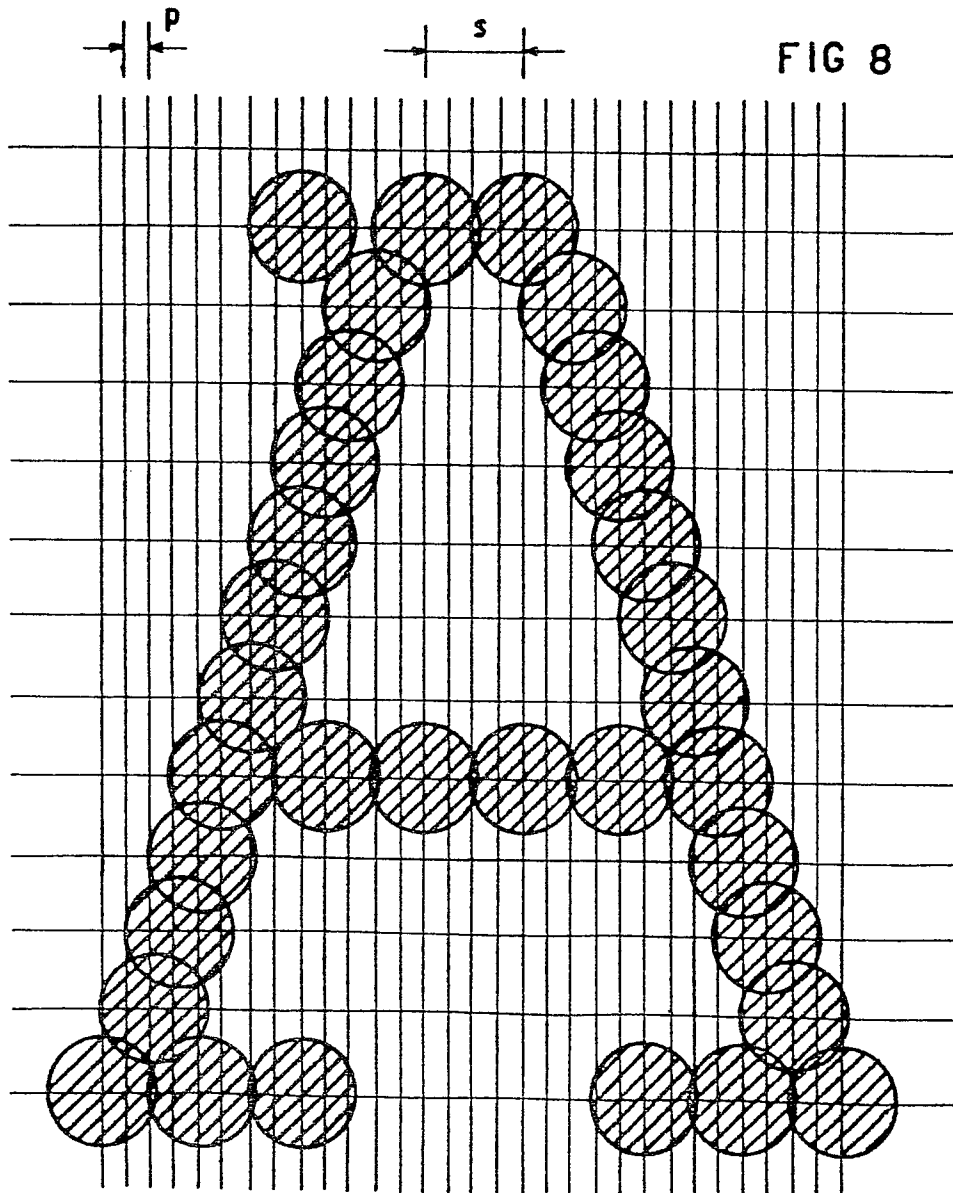


FIG 8

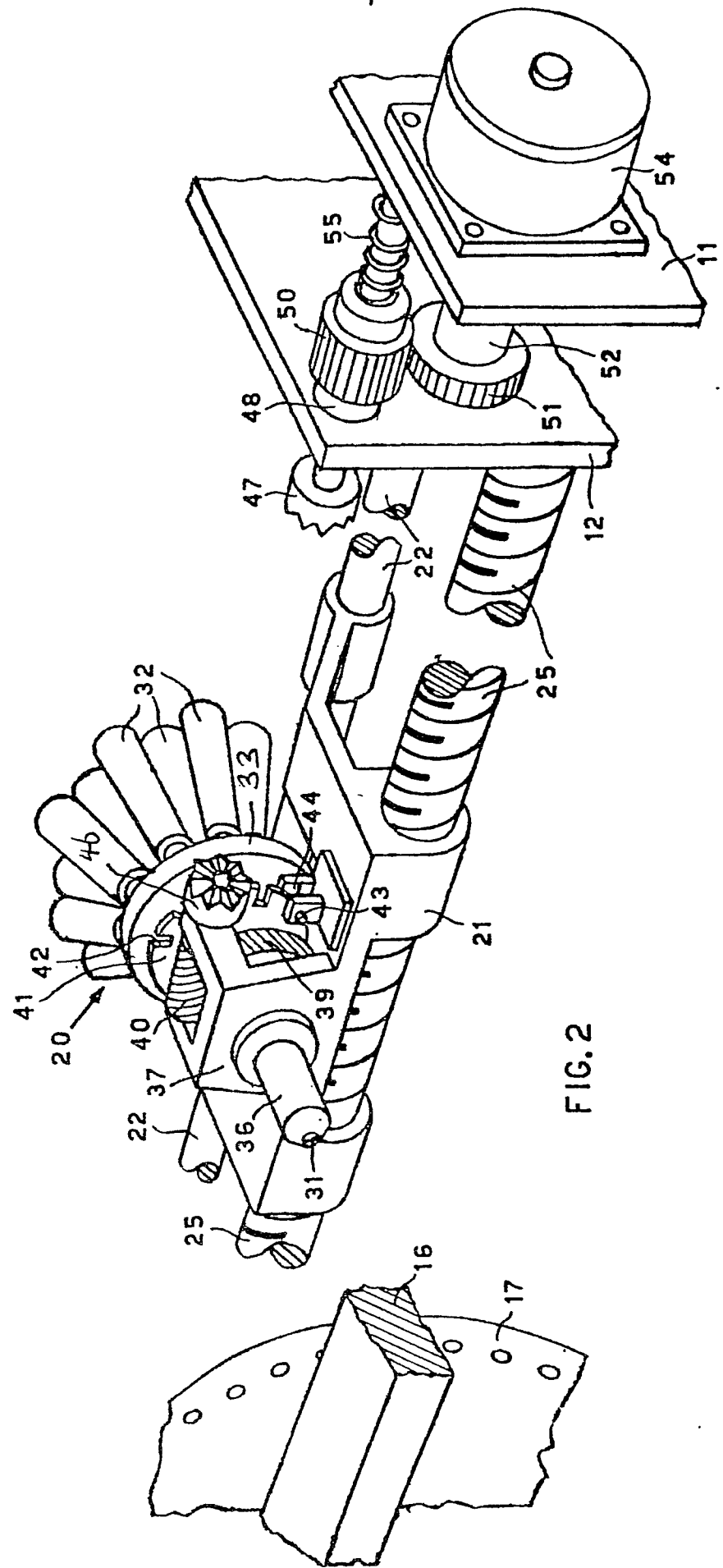
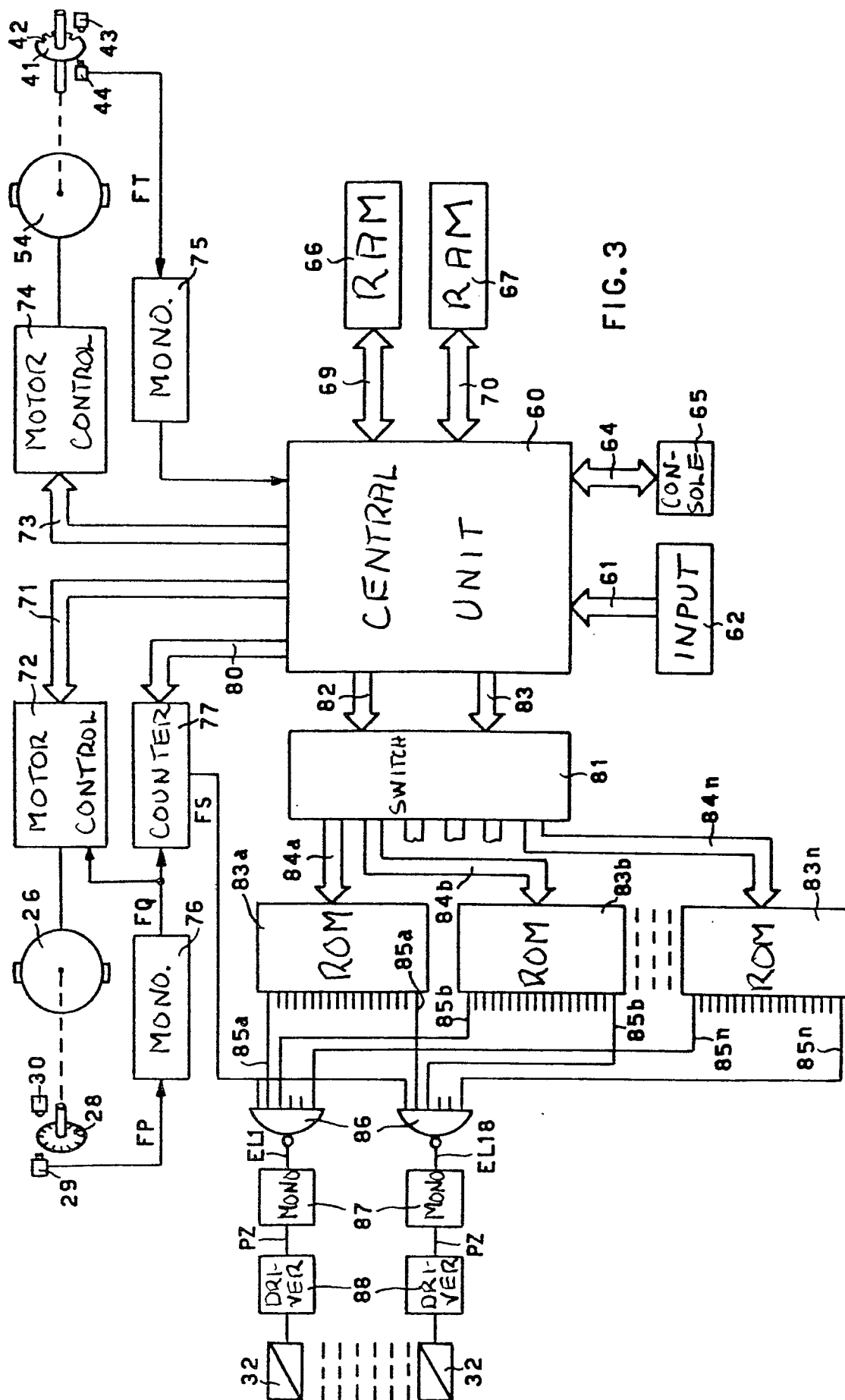


FIG. 2



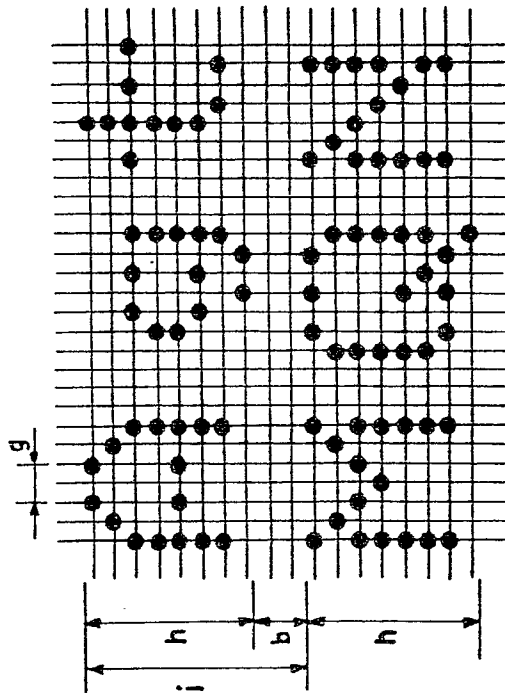


FIG. 4

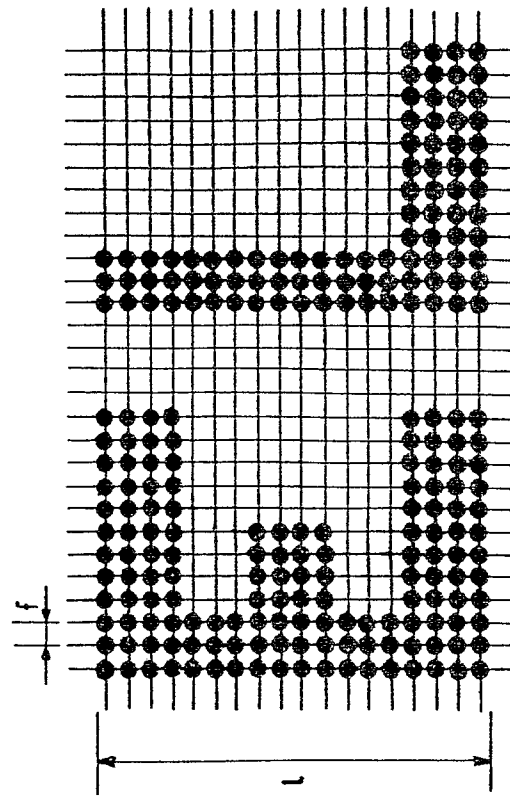
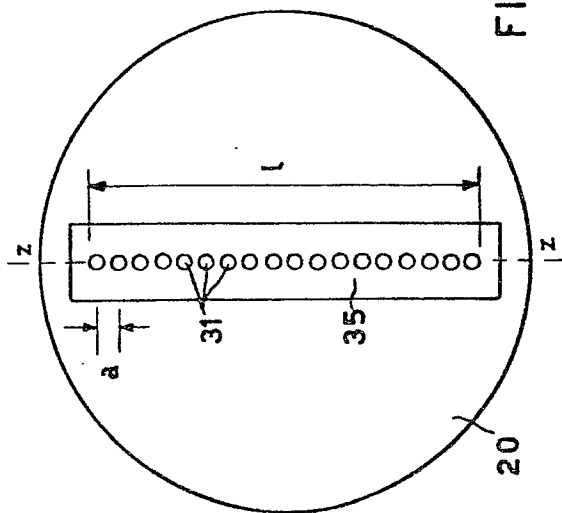
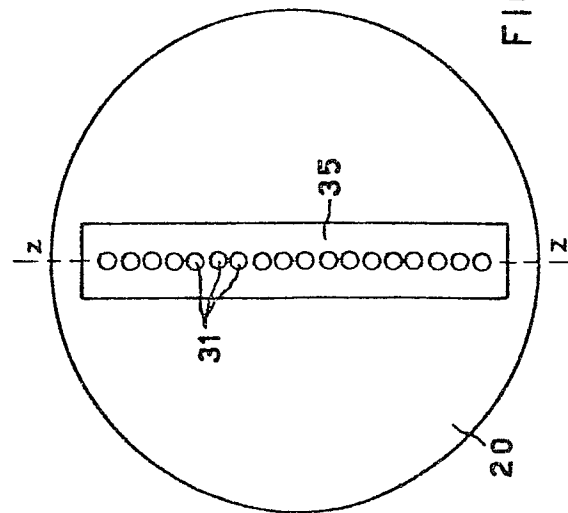
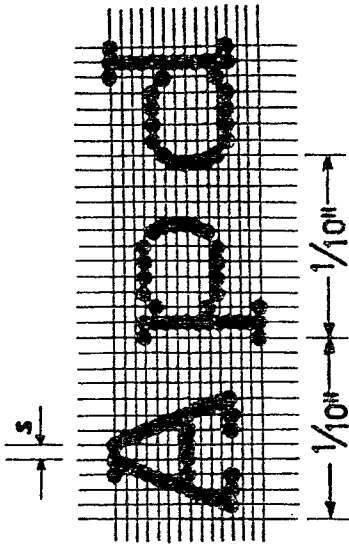
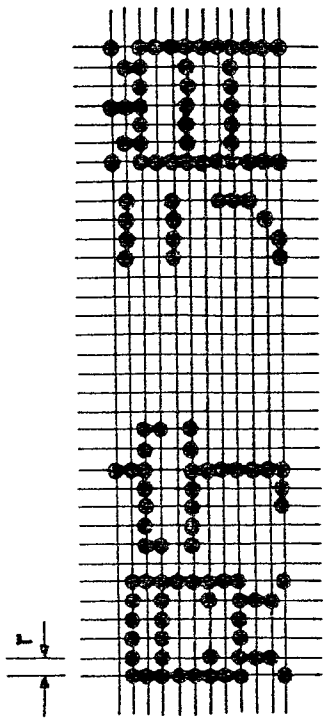
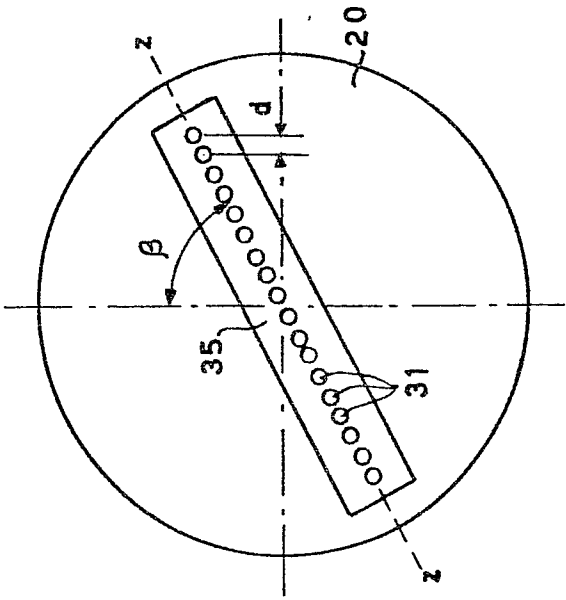
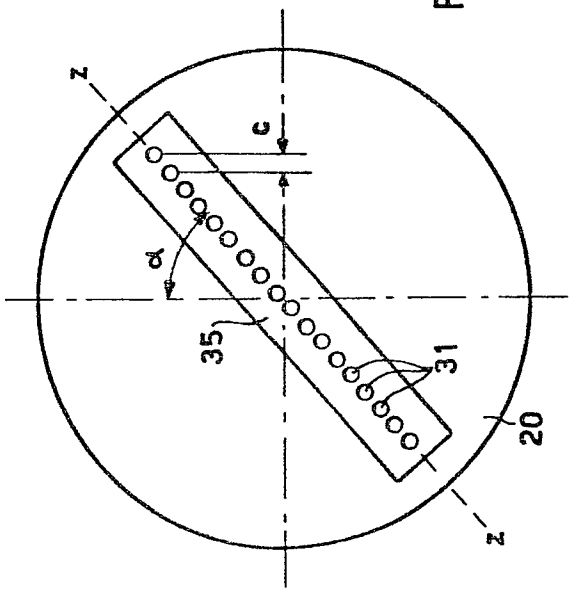


FIG. 5





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>US - A - 3 976 180</u> (G.A. JORIGNY) * Whole document *	1,2	B 41 J 3/02 3/12
	--- IBM TECHNICAL DISCLOSURE BULLETIN vol. 21, no. 1, June 1978, ARMONK (US) J.R. PIVNICHNY: "Matrix scan printing method" pages 103-104 * Whole document *	1	
	--- IBM TECHNICAL DISCLOSURE BULLETIN, vol. 16, no. 5, October 1973 ARMONK (US) F. TSUI: "Arrangement for data merging and line splitting in printers" pages 1594-1595 * Whole document *	1,4	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) G 06 K B 41 J
	--- <u>US - A - 4 059 182</u> (L.A.O. GUSTAFSSON) * Column 2, line 26 to column 5, line 15; figures 1-3 *	1,2	
	--- <u>US - A - 4 153 950</u> (E.J. NOSOWICZ) * Column 2, line 6 to column 3, line 5; figures 1-3 *	1,3	CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
	A <u>US - A - 3 945 019</u> (M. UENO) * Column 1, line 37 to column 2, line 2; figures 1, 9-11 *	./. .	&: member of the same patent family, corresponding document
 The present search report has been drawn up for all claims			
Place of search The Hague	Date of completion of the search 22-01-1981	Examiner VAN DEN MEERSCHAUT	



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	US - A - 3 931 761 (A. CARRUS) * Column 5, lines 8-59; figures 9-10 * -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)