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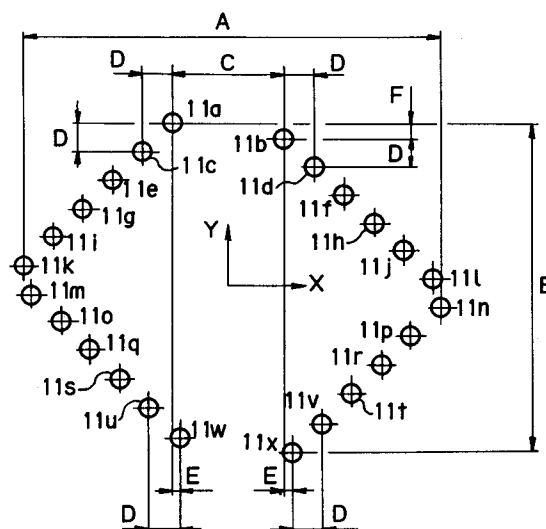
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W-8000 München 5(DE)(54) **Wire dot print head.**

(57) A wire dot print head has end guides (11) for guiding plural print wires (10) so that the print wires are placed in a desired arrangement at a free end of the print head (FIG. 2). By these end guides (11a-11x), the plural print wires are so guided that any plural ones of the print wires are prevented from alignment on the same line in a direction (Y) perpendicular to an advancing direction (X) of the print head. The timings of actuation of the individual print wires can therefore be varied, thereby making it possible to reduce the noise which occurs when the print wires strike a platen (15). It is also possible to reduce magnetic interference between print elements so that the drive current for each print element can be decreased to reduce the generation of heat.

Fig. 3

BACKGROUND OF THE INVENTION

Printers include those which form characters by arranging plural dots in the form of a matrix. Printers of this type are called dot printers. Of these, wire dot printers which imprint dots by using wires are well known. This invention relates to a wire dot print head which is to be mounted on the above-mentioned wire dot printer and makes use of wires as print elements. In particular, this invention is concerned with the arrangement of wires at a free end of such a wire dot print head.

As to the arrangement of wires, the simplest is the vertical single-row arrangement disclosed in U.S. Patent 4,119,383. Besides, there are zigzag and oblique arrangements disclosed in Japanese Patent Application Laid-Open (Kokai) No. SHO 54-127723. In addition, there is also the rhombic arrangement disclosed in Japanese Patent Application Laid-Open (Kokai) No. SHO 60-109857.

The vertical single-row arrangement, the simplest among these arrangements, is used for wire dot print heads having a relatively small number of print wires, for example, 7-9 print wires (i.e., pins). On the other hand, the zigzag arrangement is often adopted for wire dot print heads having a relative large number of pins such as 18-24 pins, whereas the rhombic or oblique arrangement is used for noise reduction and electric power saving in many instances.

The arrangement of wires affects the power consumption and heat generation of the print head and the printing noise and throughput when the print head is used in a printer. This will be described with reference to FIGS. 1(a) and 1(b). FIG. 1(a) shows, by way of example, nine print wires arranged in a row, while FIG. 1(b) illustrates one example of print fonts for 9-pin heads. Assume that the illustrated font is printed by a print head having print wires arranged at intervals of P per pitch in a vertical row. When the print head has come to the second column of the font, the seven print wires arranged on the upper side are simultaneously driven to print the body stroke or stem of the font, said body stroke being indicated by solid dots. As the print head moves in the printing direction, namely, in the rightward direction in FIG. 1(b), desired print wires are driven in accordance with print information so that printing is performed. When many print wires are driven at the same time upon printing as described above, the sum of striking forces applied at once from the print wires to a platen and hence the noise become greater as the number of driven wires increases. Further, when the number of wires driven at the same time becomes greater, magnetic interference occurs between the individual print elements so that the drive current becomes greater than that needed when

such magnetic interference does not take place. As a result, more heat is produced and the throughput is reduced. Similar phenomena are also observed in the zigzag pattern.

On the other hand, the rhombic and oblique arrangements have been put in practical use in an attempt to reduce the number of wires simultaneously actuated upon printing a body stroke with a view toward achieving reduced printing noise, improved throughput, etc. In these arrangements, problems as described above are relatively minor. However, even in these rhombic and oblique arrangements, a substantially large number of print wires are still actuated simultaneously, thereby failing to fully attain the above-mentioned object.

SUMMARY OF THE INVENTION

According to the present invention, plural print wires are arranged so that any plural ones of the print wires are prevented from alignment on the same line in a direction perpendicular to an advancing direction of a print head. Upon printing a body stroke, the timings of actuation of the corresponding printing wires can therefore be varied. It is generally at the time of printing a body stroke that there is a high chance of simultaneous actuation of many print wires. By arranging the individual print wires so that they are not aligned on the same line, it is possible to reduce the possibility of simultaneous actuation of plural print wires.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1(a) and 1(b) illustrates a printing operation;
FIG. 2 is a cross-sectional view of a wire dot print head;
FIG. 3 shows an end guide arrangement according to a first embodiment of the present invention;
FIG. 4 illustrates an end guide arrangement according to a second embodiment of the present invention;
FIG. 5 diagrammatically depicts the percentage of print wires actuated simultaneously;
FIG. 6 is a histogram showing the frequency of occurrence of simultaneous actuation of print wires;
FIG. 7 illustrates end guides in a zigzag arrangement; and
FIG. 8 depicts end guides in a rhombic arrangement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 2 shows the construction of the wire dot

print head in cross-section. For the convenience of description, other elements are also shown together with the wire dot print head. As is apparent from FIG. 2, unless a coil 8 is energized, the magnetic flux of a permanent magnet 4 flows in the order of core → armature 1 → upper yoke 6 → lower yoke 5 and then returns to the permanent magnet 4. Owing to the magnetic flux of the permanent magnet 4 which flows through a closed loop, the armature 1 with a spring 2 fixed on one end thereof and a print wire 10 secured on an opposite end is attracted on the core 3. While the armature 1 is attracted on the core 3, the spring 2 has undergone resilient deformation so that the spring 2 retains resiliently restoring (spring-back) force for turning the armature 1.

When the coil 8 is energized while the armature 1 is adsorbed as described above, a magnetic flux is then produced in a direction opposite to the magnetic flux of the permanent magnet 4 by a current flowing through the coil 8 so that the magnetic flux of the permanent magnet 4 is canceled out. The armature 1 which has been attracted on the core 3 by the magnetic flux of the permanent magnet 4 is therefore released and, by the resiliently restoring force of the spring 2, turns clockwise about one of corners of the core 3. As a result, the print wire 10 fixed on the opposite end of the armature 1 is driven to project beyond the face of the wire dot print head. In the illustrated construction, the print wire 10 projects beyond the face of the head while being guided by an intermediate guide 12 and an end guide 11, whereby the print wire 10 strikes an ink ribbon 13, a print paper 14 and a platen 15.

When the energization of the coil 8 is subsequently stopped, the magnetic flux which has canceled out the magnetic flux of the permanent magnet 4 is eliminated. By the magnetic flux of the permanent magnet 4, the armature 1 is attracted again toward the core 3 and returns to its initial position.

Many print elements of such a construction as shown in FIG. 2 are generally disposed inside a wire dot print head. The print wire 10 in each print element is supported at a predetermined position by the intermediate guide 12 and the end guide 11. By driving the individual print elements in accordance with print information, plural dots are printed on the print paper 13 so that characters, patterns or the like are formed.

The end guides 11 determine the arrangement of the print wires 10, so that the arrangement of the end guides 11 substantially govern the timings of actuation of the individual print elements in the wire dot print head.

Referring now to FIG. 3, the guides 11 arranged in rhombic format as a whole in accordance

with the first embodiment of the present invention will be described. In this embodiment, the end guides 11 are arranged so that, in a vertical direction Y perpendicular to an advancing direction X of the print head, print wires to be actuated at the same instant upon printing a body stroke of a font are not aligned on the same line.

Described specifically, as is shown in FIG. 3, the arrangement of the lower half end guides 11m-11x is offset by a $P/2$ pitch - P being a standard pitch and either $1/180$ inch or $1/160$ inch - in the advancing direction X of the print head relative to the upper half end guides 11a-11l. Further, the individual end guides 11 are arranged to give the following dimensions - A: 26-29 pitches, B: 23 pitch, C: $(n + 0.5)$ pitches, n being an integer of 5-8, D: 2 pitches, E: 0.5 pitch, F: 1 pitch.

To actuate the wire dot print head of this embodiment in which the respective print wires are arranged as described above, the individual print wires may be driven basically in a similar manner to conventional wire dot print heads. Namely, the print wires selected based on print information are driven at predetermined timings determined in accordance with the moving speed of the print head. Although individual print wires have heretofore been driven pitch by pitch, the print wires are driven $1/2$ pitch by $1/2$ pitch in this embodiment. Such drive control can be easily performed by choosing the timing at which print information is read from a memory.

Referring next to FIG. 4, the arrangement of end guides 11 according to the second embodiment of the present invention will be described. To prevent arrangement of print wires, which are operated at the same timing upon printing a body stroke of a font, in alignment on the same line along a vertical direction Y of a font, the arrangement of the lower half end guides 11m-11x is offset by a $P/2$ pitch relative to the upper half end guides 11a-11l. This is similar to the first embodiment. In addition to this feature of the first embodiment, the second embodiment has another feature that a range G, in which the end guides 11 are arranged, is broadened to about 1.5 times the width of a character to be printed, namely, to 46-49 pitches. Corresponding to the thus-broadened width G, the individual dimensions are set as follows - H: 23 pitches, I: $(n + 0.5)$ pitches, J: 4 pitches, K: 0.5 pitch, L: 2 pitches, M: 1 pitch.

Advantageous effects of the present invention will next be described with reference to FIGS. 5 and 6.

In FIG. 5, the number of print wires to be actuated at the same time when a desired string of characters is printed is plotted along the axis of abscissas, while the percentage of cumulative dots based on the total dot number is plotted along the

axis of ordinates. Squares ($\square$) correspond to data when a print head in the zigzag arrangement shown in FIG. 7 is used, plus symbols (+) to data when a print head in the conventional rhombic arrangement shown in FIG. 8 is used, rhombi ($\diamond$) to data when a print head in the arrangement according to the first embodiment depicted in FIG. 3 is used, and triangles (Δ) to data when a print head in the arrangement according to the second embodiment illustrated in FIG. 4 is used. In all the arrangement, 24 print wires are used. The string of characters to be printed are a combination of alphabetic letters, numbers and symbols. In FIGS. 7 and 8, P represents the standard pitch (1/180 inch or 1/160 inch) and n stands for an integer of 5-8 as described above.

In FIG. 6, the number of print wires to be actuated at the same time when a desired string of characters is printed is plotted along the axis of abscissas, while frequency is plotted along the axis of ordinates. Left-descending coarse hatching (▤) corresponds to data when the print head in the zigzag arrangement shown in FIG. 7 is used, right-descending coarse hatching (▥) to data when the print head in the conventional rhombic arrangement shown in FIG. 8 is used, crosshatching (▧) to data when the print head in the arrangement according to the first embodiment depicted in FIG. 3 is used, and fine hatching (▨) to data when the print head in the arrangement according to the second embodiment illustrated in FIG. 4 is used. The number of print wires and the string of characters to be printed are the same as those described above in connection with FIG. 5.

As is clearly envisaged from these characteristic diagrams, 12 wires are simultaneously actuated at the maximum in the zigzag arrangement and about 20% of the entire dots are printed by simultaneous actuation of 6 or more print wires.

In the conventional rhombic arrangement shown in FIG. 8, it is observed that the maximum number of print wires actuated at the same time is reduced to 7 but the frequency of occurrence of simultaneous actuation of 4 or more print wires is still significantly high.

In contrast, the arrangement according to the first embodiment can reduce the frequency of occurrence of simultaneous actuation of 4 or more print wires compared to the conventional rhombic arrangement. In case of the arrangement according to the second embodiment, the maximum number of print wires to be actuated at the same time can be reduced to 6 and the frequency of occurrence of simultaneous actuation of 3 or more print wires can be reduced more than the arrangement according to the first embodiment.

As has been described above, the wire dot print heads according to each embodiment of the

present invention can reduce the strike force to be applied at once to a platen and hence the printing noise by varying printing timings and reducing the number of print wires to be actuated at the same time. By varying the printing timings to reduce the number of print wires to be actuated at the same time as described above, it is possible to reduce the generation of heat by a print head and thus to improve the throughput.

In the embodiments described above, the arrangement of the lower half print wires 11m-11x was offset, by way of example, by P/2 relative to the arrangement of the upper half print wires 11a-11l. It is however not absolutely necessary to set the degree of offset at P/2 pitch. In essence, it is only necessary to avoid aligning the end guides 11 on the same line in the vertical direction Y of the font. They may therefore be arranged, for example, with the offset degree of 1/3 pitch or 3/4 pitch.

Claims

1. A wire dot print head comprising:
 - a plurality of print wires (10);
 - a like number of end guides (11) for guiding the corresponding print wires, whereby the print wires are placed in a desired arrangement at a free end of the print head and any plural ones of the print wires are prevented from alignment on the same line in a direction perpendicular to an advancing direction of the print head; and
 - a means (1-6) for driving the print wires.
2. The print head of claim 1, wherein the arrangement of the print wires at the free end of the print head is rhombic.
3. The print head of claim 2, wherein the print wires are horizontally divided at predetermined intervals into left and right print wire groups at the free end of the print head, the print wires in each print wire group are offset from one another by a distance twice a standard dot-to-dot pitch P in a vertical direction, and the left and right print wire groups are offset from each other by the standard dot-to-dot pitch P.
4. The print head of claim 3, wherein, in each of the left and right print wire groups, an upper half print wire group and a lower half print wire group are horizontally offset from each other by half of the standard dot-to-dot pitch P.
5. The print head of claim 4, wherein, in the upper half print wire group and the lower half print wire group, the print wires are horizontally offset from one another by the distance twice

the standard dot-to-dot pitch P .

6. The print head of claim 4, wherein, in the upper half print wire group and the lower half print wire group, the print wires are horizontally offset from one another by the distance four times the standard dot-to-dot pitch P .

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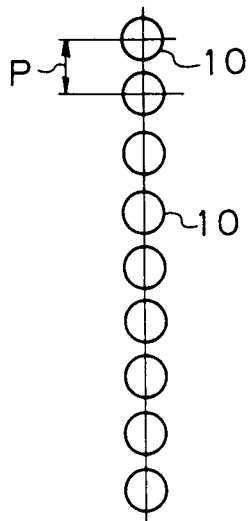
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Fig. 1

(a)



(b)

	1	2	3	4	5	6	7	8
1		●	○	○	○	○		
2		●					○	
3		●					○	
4		●	○	○	○	○		
5		●					○	
6		●					○	
7		●	○	○	○	○		
8								
9								

Fig. 2

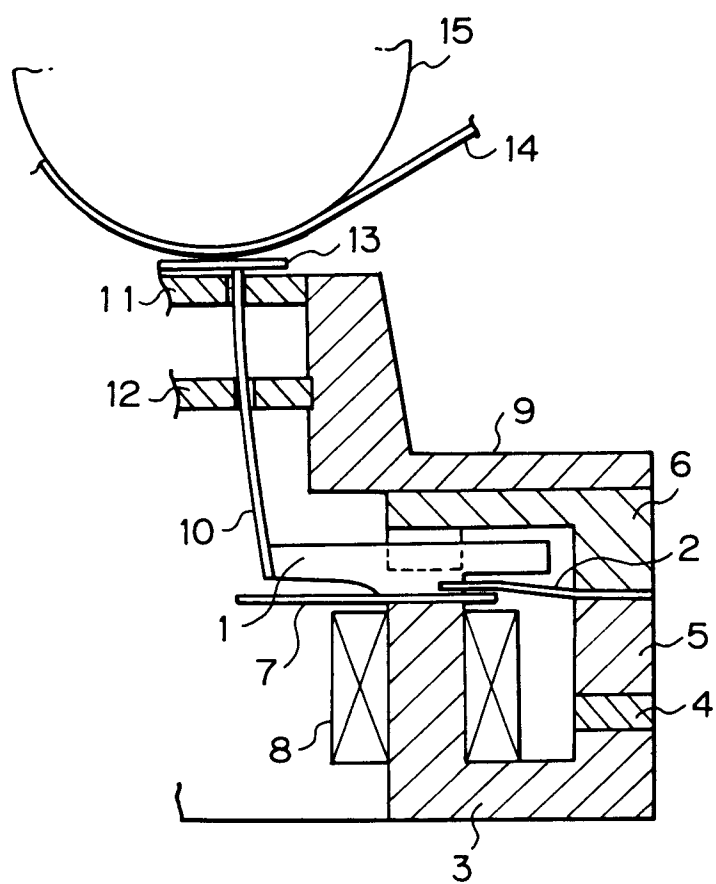


Fig. 3

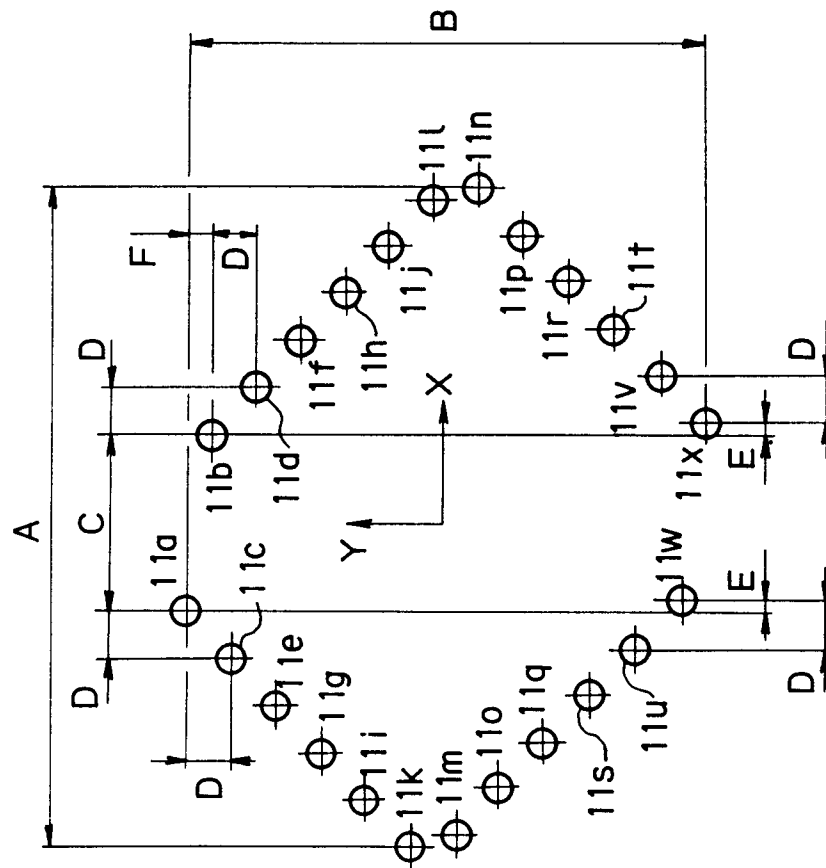


Fig. 4

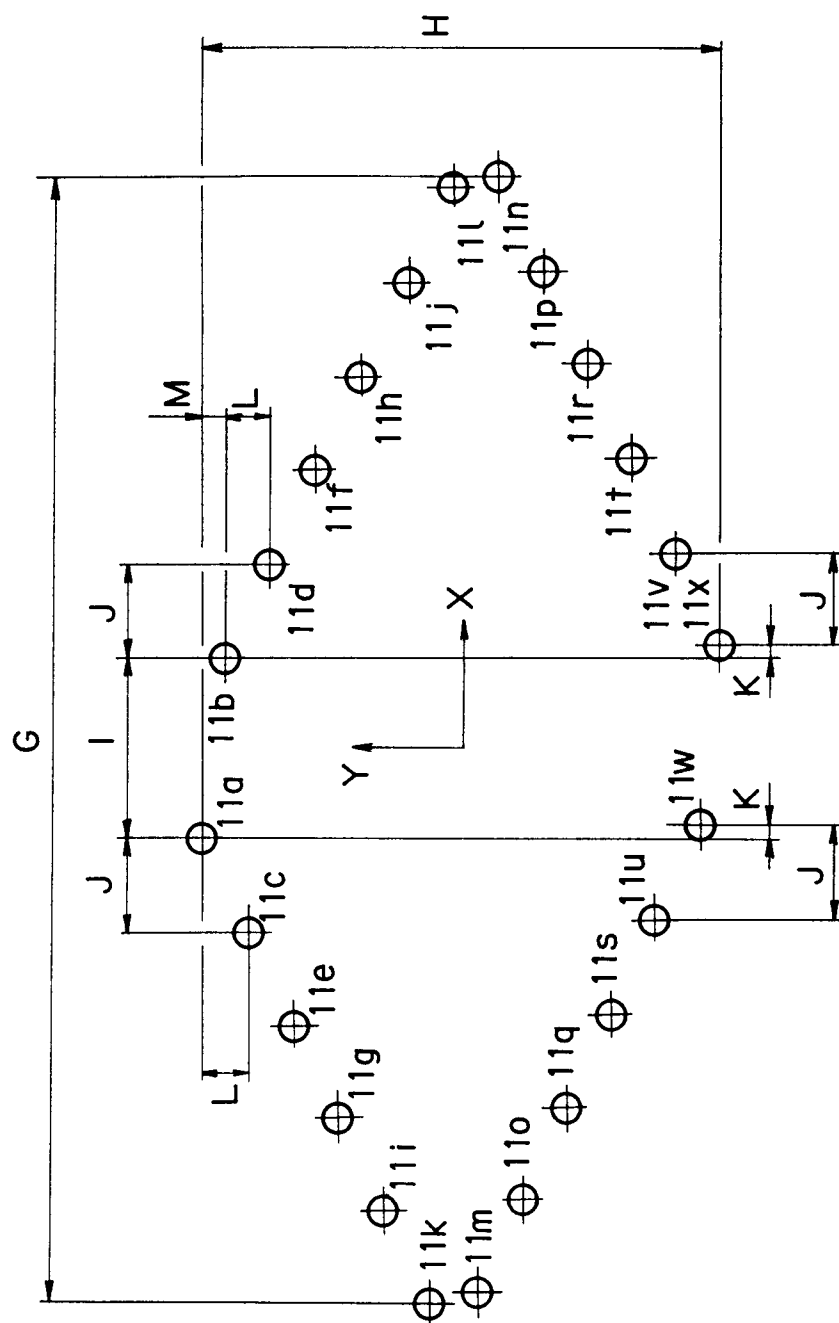


Fig. 5

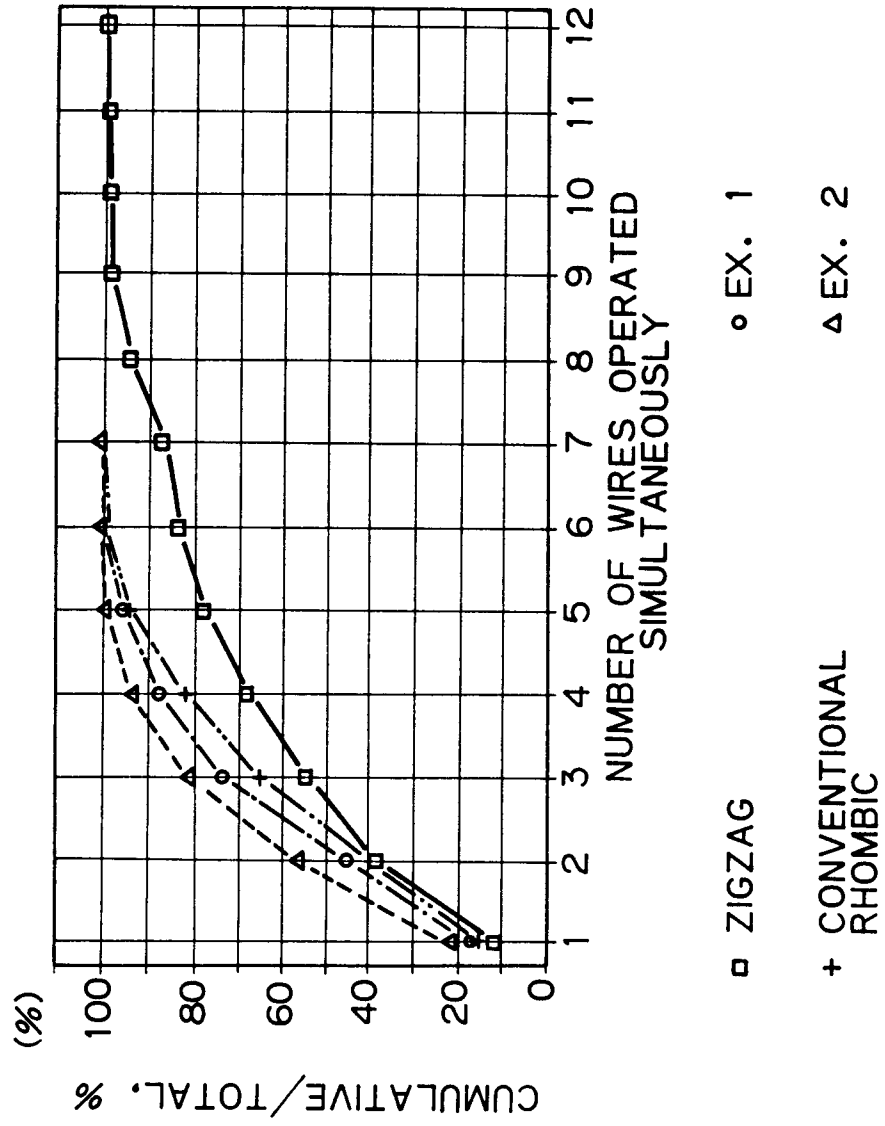


Fig. 6

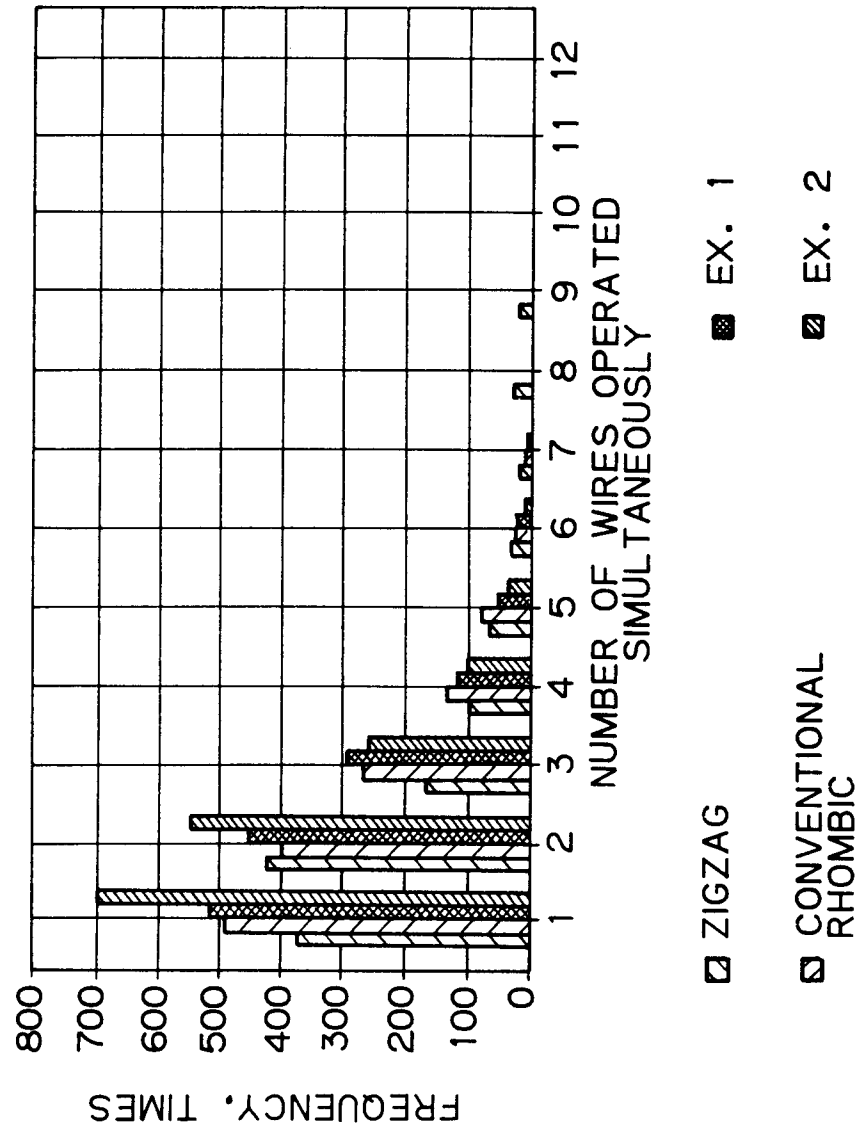


Fig. 7

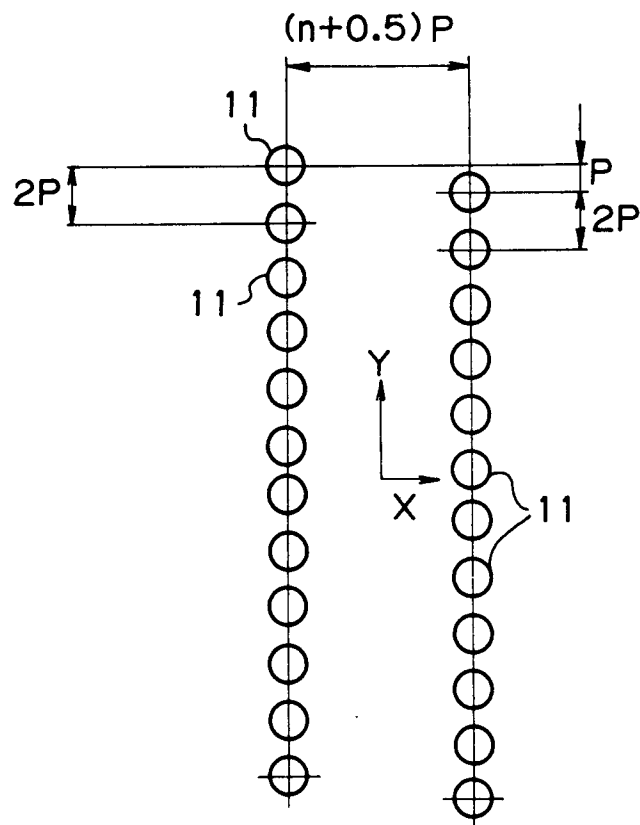
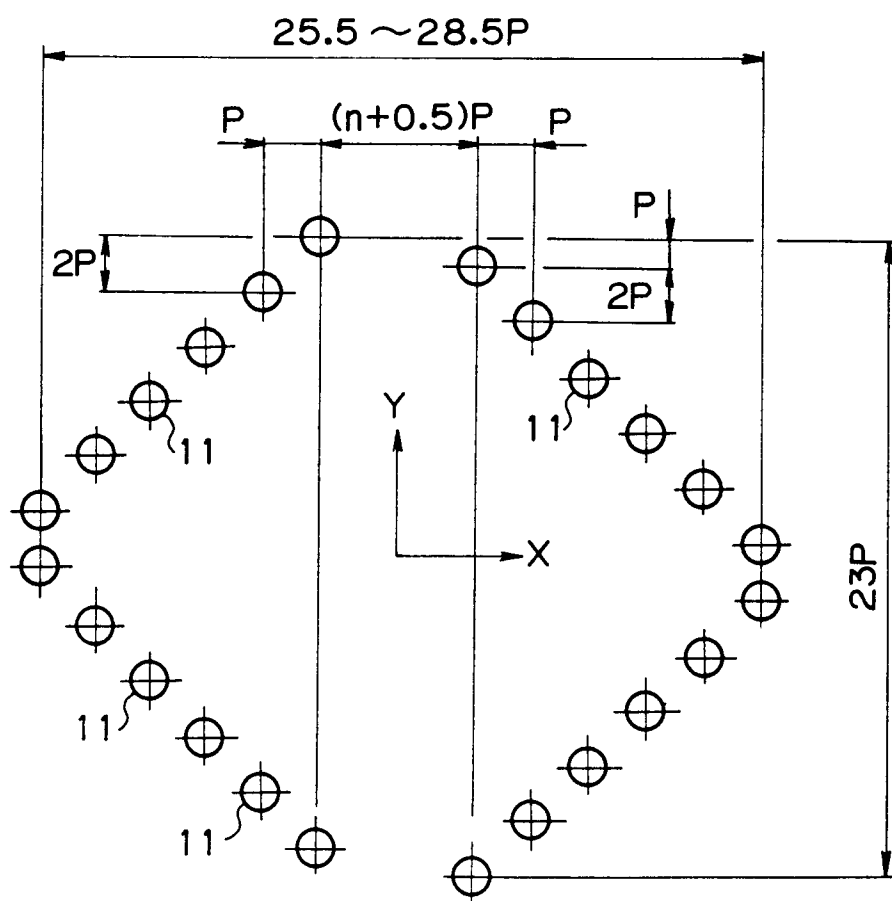


Fig. 8





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Application Number

EP 91 11 5131

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 189 (M-237)18 August 1983 & JP-A-58 090 965 (MASASHI) 30 May 1983 * abstract **	1-5	B 41 J 2/255
A	— — —	6	
A	IBM TECHNICAL DISCLOSURE BULLETIN. vol. 31, no. 3, August 1988, NEW YORK US pages 351 - 354; 'Dot element arrangement for dot matrix printer' * page 352 **	1-6	
A	— — — PATENT ABSTRACTS OF JAPAN vol. 13, no. 593 (M-914)27 December 1989 & JP-A-1 249 459 (MAKOTO) 4 October 1989 * abstract ** — — — — —		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 41 J
Place of search		Date of completion of search	Examiner
The Hague		29 November 91	ADAM E.M.P.
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