

"IMPACT TYPE DOT PRINTER"

This invention relates to impact type dot printers.

An impact type dot printer has various advantages.

Namely, it is possible to form letters, graphs and so forth at a high printing speed. In addition, printing can be made on a plurality of sheets of paper at the same time by the use of non-carbon or carbonless copying paper. The most commonly used impact type dot printer is a wire printer which has seven or more printing wires the ends of which are arranged in a row in the direction of feed of recording paper. Known wire printers, however, have a complicated construction and require a large number of parts. In addition, the weight of the printing head is considerable and a driving mechanism and power source to match such a heavy head are required.

Another known impact type dot printer is the helical platen type dot printer. A helical platen type printer has a platen or rotary drum having one or more helical projections formed on the peripheral surface thereof, and a cross bar hammer disposed opposite to the platen along the length of the latter so as to strike the projections. In this helical platen type dot printer, the cross bar hammer is linear and extends along the axis of the platen and is adapted to strike the helical projections without being scanned in a direction perpendicular to the direction of feed of the recording paper. Therefore, to form a letter constituted by a dot matrix of 7 rows and 5 columns, for instance, the recording paper must be advanced 7 times.

Thus, the printing speed is impractically low. In addition, since the position of collision (intersection) between the cross bar hammer and the helical projections of the platen moves successively in the lateral direction as the platen rotates, the cross bar hammer causes an unacceptable torque on the end portion of the platen when it collides with a given helical projection. In consequence, operation is rendered unstable. In addition, there is a practical limit to the length of the cross bar hammer, i.e. the number of characters which can be printed by a single cross bar hammer is limited. To increase the number of characters per line of printing, it is necessary to provide a plurality of cross bar hammers.

According to one aspect of the present invention there is provided an impact type dot printer comprising: a rotatable platen provided on its outer peripheral surface with a plurality of projections extending substantially parallel to the axis thereof; a printing head adapted to be moved in a direction perpendicular to the direction of feed of a recording medium, the printing head including a single printing hammer provided with a striking member selectively positionable opposite the projections, and an electromagnetic driving device for driving the printing hammer during a printing operation to contact a selected projection to form a dot on the recording medium; a slotted disc arranged to rotate at a

rotational speed related to the rotational speed of the platen and having a plurality of groups of slots therein, each group consisting of a plurality N of slots the number of which corresponds to the number of rows of the dot matrix characters to be formed;

5 a detector arranged to detect the slots in the slotted disc and to produce a row detect signal which comprises a plurality of groups of pulses corresponding to the plurality of groups of slots in the slotted disc, the arrangement being such that Y groups of pulses are produced for each complete rotation

10 of the platen; a timer circuit for detecting the intervals between the pulses of the row detect signal and for producing a column detect pulse each time a long interval between groups of pulses is detected; and a control circuit for operating the electro-magnetic drive means in synchronism

15 with the row detect signal and in conjunction with the column detect pulses.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a schematic front elevational view of one

20 embodiment of an impact type dot printer according to the present invention;

Figure 2 is a sectional view taken along the line II-II of Figure 1;

Figure 3 is an enlarged front elevational view of

25 a slotted disc of the printer of Figure 1 for row detection;

Figure 4 is a circuit diagram of a driving control circuit of the printer of Figure 1;

Figure 5 is a timing chart illustrating the operation of the driving control circuit of Figure 4; and

5 Figure 6 is an enlarged sectional view showing letters formed by the printer of Figure 1.

Reference in the following description to "left", "right", "front", "rear" etc. refer to the directions as seen in the drawings.

10 One embodiment of an impact type dot printer according to the present invention will be described with reference to Figures 1 to 6.

Referring first to Figures 1 and 2, a drum-shaped platen 1 is fixed to a platen shaft 2 and is rotated substantially continuously in the clockwise direction as viewed in Figure 2. 15 The platen 1 has a length substantially corresponding to the lateral width of recording paper 17. A plurality (12 shown in the illustrated embodiment) of linear projections 3, each projection extending substantially parallel to the axis of the platen, are formed on the outer periphery of the platen. 20 A printing head 4 is disposed opposite to the platen 1 so as to move in the axial direction of the platen i.e. in the direction perpendicular to the direction of feed of the recording paper 17, at a position ahead of the platen 1.

25 A carriage 5 carrying the printing head 4 is made of a

light-weight non-magnetic material and is slidably supported by guide shafts 6, 7. A printing hammer 8 for forming dots on the recording paper 17 in cooperation with the projections 3 on the platen, upon collision with the projections when driven by an electromagnetic driving device 9, is provided at a rear side of the carriage 5.

The printing hammer 8 and the electromagnetic device 9 have the following construction. The printing hammer 8 comprises a leaf spring 10 secured at its lower end to the carriage 5, and a striking member 11 fixed to the upper end of the leaf spring 10. The striking member 11 extends substantially in the same direction as the direction of feed of the recording paper 17 so as to be oppositely adjacent to one of the projections 3 positioned ahead of the striking member, and has a length which is only slightly greater than the height of the letters to be printed.

The electromagnetic driving device 9 includes an outer magnetic pole 12 in the form of a cylinder open at one end, a relatively strong permanent magnet 13 made of, for example, samarium cobalt and fixed to the bottom of the magnetic pole 12, an inner magnetic pole 14 fixed to the permanent magnet 13 and a moving coil 15 fixed to the leaf spring 10 and disposed in the magnetic gap between the magnetic poles 12, 14. An ink ribbon 16 is disposed between the striking member 11 of the printing hammer 8 and the platen 1. The recording paper

17 is fed in the direction shown by an arrow shown in Figure 2 through the gap between the ink ribbon 16 and the platen 1, while being guided by paper guides 18, 19.

A rotary shaft 20 is rotated by a motor (not shown).

5 The rotary shaft 20 carries a slotted disc 21 and a pinion 22. The pinion 22 meshes with a gear 23 fixed to the platen shaft 2. A detector 25 has a light-emitting element and a light-receiving element which are arranged opposite to one another with the periphery of the respective slotted
10 disc 21 therebetween. As shown in Figure 3, the slotted disc 21 is provided adjacent its periphery with a plurality of groups 27 (three shown in the illustrated embodiment) of slots, each group consisting of a plurality of slots 28 arranged at a constant pitch, the groups 27 being separated
15 from each other by regions having no slots. The number of slots 28 in each group 27 corresponds to the number of rows M of a character of a M-row, N-column dot matrix. In the illustrated embodiment, the number of slots 28 in each group 27 is 7. The detector 25 is adapted to produce a
20 row detect signal b as shown in Figure 5.

The arrangement is such that the platen 1 makes a 30° rotation while the slotted disc 21 makes a 120° rotation. Therefore, in this embodiment, the reduction ratio between the pinion 22 and the gear 23 is selected to be $1/4$. The
25 row detect signal b is a signal having one cycle constituted

by 7 equi-spaced row detect pulses $Pb_1, Pb_2, \dots, Pb_7$ followed by a pulse-free region. The row positions of the dots are determined by respective row detect pulses $Pb_1, Pb_2, \dots, Pb_7$, which are generated when the projections 3 of the platen 1 are rotated to positions corresponding to first, second, ..., seventh rows.

The printing head 4 is adapted to be moved along the guide shafts 6, 7 by means of a shift drive device (not shown). The speed of movement of the printing head 4 during the printing operation, i.e. the speed when the printing head 4 is moved from a home position (not shown) to the right, is related to the rotational speed of the platen 1.

As shown in Figure 6, the striking member 11 of the printing hammer 8 has a length at least corresponding to the height of characters to be printed, and is inclined at an angle θ to the direction of feed of the recording paper. The angle θ of inclination of the striking member 11 is dependent upon the shift speed of the printing head 4. In the illustrated embodiment, this angle θ is about 7° to 8° . The reason why the striking member 11 is inclined will be fully understood from the following description.

The moving coil 15 shown in Figure 2 is connected to a driving control circuit shown in Figure 4. This driving control circuit includes a timer circuit 29, a character generator 30, a shift register 31, a column address counter

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32, a buffer circuit 33, a driver circuit 34, a counter 35,
AND gates 36, to 40, an OR gate 41, delay circuits 42 to
45, and flip-flop circuits 46, 47. The column address
counter 32 is adapted to produce an output signal S
5 corresponding to a counted number, and the column of the
character generator 30 is determined by this output signal
S. The column address counter 32 also produces output
signals h, k.

The output signals h, k take the logical values
10 of "1" and "0" until the number N of the column of the dot
matrix, i.e. 5, is counted. As the number of columns is
counted, the logical values of these signals are inverted
to "0" and "1" respectively. The logical value of the counter
35 is inverted from "0" to "1" as the number of rows
15 M of the dot matrix, i.e. 7, is counted and is reset to "0"
after a time delay which is determined by means of the
delay circuit 44.

The timer circuit 29 detects the pulse distance
between the pulses Pb_1 , $Pb_2 \dots Pb_7$ of the row detect signal
20 b and is arranged to produce a column detect pulse Pc
when a long pulse interval between pulses Pb_7 and Pb_1 is
detected. Thus, a column detect signal c is produced
electrically from the row detect signal b.

The flip-flop circuit 46 is set by the rise of a
25 printing start position detect signal e, and is reset by the

fall of the column detect signal c. The flip-flop circuit 47 is set and reset by the rise of a signal m from the AND gate 36 and by the fall of a signal l from the AND gate 39.

5 The operation of the printer of Figures 1 to 6 will now be described.

 The printing head 4 is initially located at the left-hand side of the platen 1. The printing operation is performed in the following manner as the printing head
10 4 is moved from the home position at the left-hand side of the platen 1 to the right. First of all the platen driving motor is energised by a start signal a shown in Figure 5A, so that the drive shaft 20 is rotated and the platen shaft 2 is rotated through the pinion 22 and the gear 23, so that
15 the platen 1 is rotated continuously in the clockwise direction as viewed in Figure 2, at a predetermined speed. As a result, the detector 25, starts to produce the row detect signal b and the timer circuit 29 produces the column detect signal c.

20 Then, as a printing head shift command signal d is generated as shown in Figure 5D, the printing head 4 starts to shift from the home position towards the right. As the printing head 4 runs a predetermined distance from the home position, the printing start position detect signal e
25 is produced as shown in Figure 5E by a sensor (not shown).

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In consequence, the flip-flop circuit 46 shown in Figure 4 is set by the printing start position detect signal e, so that an output signal f from the flip-flop circuit 46 is inverted to logical value "1" as shown in Figure 5F. This
5 output signal f is supplied to one of the input terminals of the AND gate 36 through the OR gate 41, and thus the AND gate 36 is opened.

Characters such as letters, numerals, symbols and the like corresponding to data transferred, for example,
10 from a computer have already been memorised in the character generator 30 in the form of a dot matrix pattern. The character generator 30 is adapted to produce pattern signals of the column of the appointed address corresponding to the column to the column address signal S, in accordance with
15 the latter. Since in this state the value counted by the column address counter 32 is zero, the character generator 30 is producing the pattern signal of the first column of the dot matrix pattern of the character corresponding to the transferred data, and the output signals h, k from the
20 column address counter 32 take the logical values of "1" and "0" respectively, as shown in Figures 5H and 5K. In this state, the pulse Pc_1 of the column detect signal c is produced by the timer circuit 29 and is supplied to the AND gate 36 so that the AND gate 36 produces an output with a logical
25 value of "1". At the same time, the flip flop circuit 46 is

reset by the fall of the pulse Pc_1 from the timer circuit 29, so that the output signal f from the flip-flop 46 takes a logical value of "0". In consequence, the AND gate 36 produces a pulse Pm_1 which appoints the first column of the dot matrix pattern, as shown in Figure 5. As a result, the pattern signal of the first column of the data transmitted to the character generator 30 in Figure 4 is written in and memorized by the shift register 31, and the flip-flop circuit 47 is set by the rise of the pulse Pm_1 to make the flip-flop circuit 47 produce an output signal r having a logical value of "1". Then, the detector 25 shown in Figure 1 produces row detect pulses $Pb_1, Pb_2, \dots, Pb_7$ of the row detect signal b as shown in Figure 6B. The row detect pulses $Pb_1, Pb_2, \dots, Pb_7$ are supplied to the AND gate 37. Since the logical values of the two input terminals of the AND gate 37 have logical values of "1", the row detect pulses $Pb_1, Pb_2, \dots, Pb_7$ are allowed to pass through the AND gate 37. Then, the pattern signal which has been written in the shift register 31 is read out from the latter in accordance with the formation order, i.e. the order or rows, by the row detect pulses $Pb_1, Pb_2, \dots, Pb_7$, and is delivered to one of the input terminals of the AND gate 38. Simultaneously with the reading out operation referred to above, the row detect pulses $Pb_1, Pb_2, \dots, Pb_7$ are delivered to the other input terminal of the AND gate 38 through the delay circuit 43. Therefore,

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the AND gate 38 produces as an output signal n driving pulses corresponding to the pattern signals of the first column, with a slight phase lag relative to the generation of the row detect pulses $Pb_1, Pb_2 \dots Pb_7$. For instance, assuming here that the data transmitted to the character generator 30 corresponds to a letter A, the AND gate 38 produces driving pulses $P_{31}, P_{41} \dots P_{71}$ as shown in Figure 5N. These driving pulses are so intended that they are produced when any one of the projections 3 of the platen 1 rotating continuously in the direction of the arrow shown in Figure 2 is positioned at positions of the third row, the fourth row....the seventh row ahead of the striking member 11 of the printing hammer 8 as viewed in Figure 6. The striking member 11 which is inclined at the angle θ is continuously moving in the direction of the arrow as viewed in Figure 6 by the shift operation of the printing head 4. Therefore, when the driving pulses $P_{31}, P_{41} \dots P_{71}$ are produced, the projection 3 and the striking member 11 successively cross each other on the third, fourth, seventh rows of the first column. Referring to Figure 4 as the AND gate 38 produces the driving pulses $P_{31}, P_{41} \dots P_{71}$, the driver circuit 34 is activated by the driving pulses $P_{31}, P_{41} \dots P_{71}$ so that driving current pulses are supplied to the moving coil 15. The moving coil 15 makes a magnetic cooperation with the magnetic flux in the gap between

the magnetic pole 12 and the magnetic pole 14 which is magnetized by the permanent magnet 13, and is displaced to the left as a result of the magnetic cooperation.

In consequence, the hammer member 8 is displaced to the left overcoming the force of the leaf spring 10, and the striking member 11 instantaneously collides with the projection 3 of the rotating platen 1, so that the dot of the first column of the letter A is formed on the recording paper 17 at the position where the projection 3 and the striking member 11 cross and collide with each other, as shown in Figure 6.

The description of the printing operation is suspended here, and an explanation will be made as to why the striking member 11 of the printing hammer 8 is inclined. As has already been described, the striking member 11 of the printing hammer 8 operates while it is being moved to the right on the recording paper as viewed in Figure 6. Assuming here that the striking member 11 crosses the projection 3 at right angles, the position of crossing of the projection 3 and the striking member 11 is shifted gradually downwards in accordance with the rotation of the projection 3 and, at the same time, deviated slightly to the right in accordance with the rightward movement of the striking member 11. In consequence, the dots in the column or vertical direction are arrayed obliquely and the letter formed on the paper is inclined. Therefore the striking member 11 is inclined at an angle of about 7° to 8° , so that the dots in the column direction are arrayed along

a straight line in the direction of feed of the recording paper. This angle, however, can be modified slightly depending upon the design of the letters to be formed. For instance, if the letters are to be formed obliquely, the angle θ may be selected to be much greater.

The description of the printing operation will now be resumed. Referring to Figure 4, as the aforementioned writing in the shift register 31 by the pulse Pm_1 and the AND gate 36 is completed, the pulse Pm_1 is counted by the column address counter 32 through the delay circuit 42. The content of the column address counter 32 is increased by unity so that the character generator 30 produces the pattern signal for the second column. The output pulses from the AND gate 37, i.e. the row detect pulses $Pb_1, Pb_2 \dots Pb_7$ are counted by the counter 35 and, as the counted number reaches 7, i.e. as the dot-forming operation is finished, an output signal g from the counter 35 takes a logical value of "1" as shown in Figure 5G. At this time, the output signal h of the column address counter 32, which is the input signal to one input terminal of the AND gate 40, is held at a logical value of "1" so that an output signal j from the AND gate 40 takes a logical value of "1" and is supplied to the AND gate 36 via the OR gate 41. The AND gate 36 produces, as shown in Figure 5M, a pulse Pm_2 which appoints the second column of the dot matrix, and the counter 35 is reset through the delay circuit 44. Then, the dots of the second column are

formed in the same manner as described above in relation to the first column.. Namely, the formation of the dots of the second column is performed by the cooperation between the striking member 11 and the projection 3 next to the projection used in the formation of dots of the first column. This operation is repeated to form dots of the third, fourth and fifth columns, thereby completing the formation of the letter in a 7 x 5 dot matrix as shown in Figure 6.

Referring again to Figure 4, as the column address counter 32 counts up to 5, the logical signals h, k, therefrom are inverted to take logical values of "0" and "1" respectively. In consequence, the pulse Pg_5 from the counter 35 after the printing operation for the fifth column makes the AND gate 39 produce an output pulse P_l as shown in Figure 5L. The column address counter 32 and the flip-flop circuit 47 are reset by the fall of this output pulse P_l . In consequence, the output signals h, k from the column address counter 32 resume logical values "1", "0", so that the output signal "r" from the flip-flop 47 takes the logical value of "0". Also, the pulse P_l is delayed by the delay circuit 45 to become a pulse P_l' as shown by a broken line. This delay pulse P_l' is supplied to the AND gate 36 through the OR gate 41. Therefore, if the AND gate 36 receives a column detect pulse Pc_0 after completion of printing of a letter, the AND gate 36 does not produce any pulse as will be seen

from Figure 5M, but produces the output pulse Pm_1 when the next column detect pulse Pc_1 is received. Namely, the next character is printed after formation of a space corresponding to one dot column, as will be seen from Figure 6.

The printing hammer 8 is driven at a high frequency of 1800 Hz or higher when the dots are continuously formed, so that the response vibration frequency approximates to the resonance frequency of the leaf spring 10.

10 Attention is drawn to the fact that this specification describes matter for which protection is sought in British Application No. 80/29365 (Serial No. 2,061,828).



C L A I M S

1. An impact type dot printer comprising: a rotatable platen provided on its outer peripheral surface with a plurality Y of projections extending substantially parallel to the axis thereof; a printing head adapted to be moved in a direction perpendicular to the direction of feed of a recording medium, the printing head including a single printing hammer provided with a striking member selectively positionable opposite the projections, and an electro-magnetic driving device for driving the printing hammer during a printing operation to contact a selected projection to form a dot on the recording medium; a slotted disc arranged to rotate at a rotational speed related to the rotational speed of the platen and having a plurality of groups of slots therein, each group consisting of a plurality N of slots the number of which corresponds to the number of rows of the dot matrix characters to be formed; a detector arranged to detect the slots in the slotted disc and to produce a row detect signal which comprises a plurality of groups of pulses corresponding to the plurality of groups of slots in the slotted disc, the arrangement being such that Y groups of pulses are produced for each complete rotation of the platen; a timer circuit for detecting the intervals between the pulses of the row detect signal and for producing a column detect pulse each time a long interval between groups

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of pulses is detected; and a control circuit for operating the electro-magnetic drive means in synchronism with the row detect signal and in conjunction with the column detect pulses.

- 5 2. An impact type dot printer as claimed in claim 1 and substantially as herein described with reference to and as shown in the accompanying drawings.
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