

SPECIFICATION

Printer

This invention concerns a printer having a printing head which is arranged to print characters formed by dots on a recording paper.

According to the present invention there is provided a printer having a machine frame comprising spaced apart side frames which are secured together by a cross frame; a printing head which is carried by the machine frame and which is arranged to print characters formed by dots on a recording paper; a rotatable disc which is rotatably carried by the cross frame and which is provided with a cam; means for rotating disc; and reciprocation means which engage the said cam and in operation produce reciprocation of the printing head over the recording paper, the said reciprocation means and the said disc being disposed on opposite sides of the cross frame.

The side frames and cross frame may together form an H-shaped structure.

The side frames and cross frames may if desired be integral.

The said cam may be constituted by a cam groove. Moreover, the reciprocation means may comprise a lever which engages the cam groove, the lever being oscillated by rotation of the disc.

The disc may also be provided with a cam recess which engages a part of a shift means for effecting a relative shift between the printing head and the recording paper so as to effect a line change in the printing on the recording paper, rotation of the disc causing oscillation of the said part of the shaft means.

A paper feeding roller may be supported between the side frames, oscillation of the said part of the shift means causing intermittent rotation of the paper feeding roller.

The shift means may comprise a ratchet fixed to the paper feeding roller, a pawl engageable with the ratchet, a pawl-holding member which holds the pawl, a pressure member which imparts a frictional load on the pawl holding member, and a driving member which engages the said cam recess and which drives the pawl, movement of the driving member in one direction causing the pawl to rotate the ratchet and thus rotate the paper feeding roller, and movement of the driving member in the opposite direction effecting no rotation of the ratchet.

The pawl-holding member and the pressure member may be integral.

The disc may also be provided with a further cam constituted by a cam recess, there being a ribbon resetting member which engages the said further cam and which also engages a ribbon frame arranged to carry an ink ribbon, movement of the resetting member by the said further cam causing movement of the ribbon frame with respect to the printing head so as to change the part of the ink ribbon engaged by recording needles carried by the printing head.

There may be a ribbon feed device and a ribbon driving member which is rotatably mounted on

the cross frame and one part of which engages the said lever, another part of the ribbon driving member engaging the ribbon feed device, oscillation of said lever causing movement of the ribbon driving member and thus causing movement of the ribbon feed device.

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

Figure 1 is a cross-sectional view of a printer according to the present invention,

Figure 2 is a plan view of the printer of Figure 1,

Figure 3 is a perspective view of a disc forming part of the said printer,

Figure 4 is a perspective view of the said disc showing cam structure thereon,

Figure 5 is an exploded perspective view of a shift means for effecting a relative shift between a printing head of the printer and recording paper so as to effect a line change in the printing on the recording paper,

Figure 6 is a perspective view of a driving member forming part of the said shift means,

Figures 7 to 10 illustrate the operation of paper feeding,

Figure 11 is a side view showing the relationship between a ribbon feed device and the printing head,

Figure 12 is a perspective view of the ribbon feed device,

Figure 13 is a perspective view of a ribbon re-setting member,

Figure 14 is a perspective view of means for driving the said ribbon feed device,

Figure 15 is an exploded perspective view of a timing detecting means,

Figure 16 is a time chart showing the relationship between an output waveform of the said timing detecting means, and a timing signal, and

Figure 17 is a time chart showing the operation of the printer.

Terms such as "clockwise", "counter-clockwise", "upper" and "lower", as used in the description below, are to be understood to refer to directions as seen in the accompanying drawings.

In Figures 1 and 2 there is shown a printer having a machine frame which comprises spaced apart side frames 1, 2 which are secured together by a cross frame or bottom frame 3 so as to form an H-shaped structure. The rigidity of this H-shaped structure is strengthened by fixing between the side frames 1 and 2 a first guide shaft 4 and a platen 5.

A printing head 6 is mounted on a head stand 7. The head stand 7 is slidably mounted on a second guide shaft 8, the second guide shaft being fixed in a pair of bent portions 3a which form part of the cross frame 3. The head stand 7 also has a recess portion 7b through which extends the first guide shaft 4 so that the recess portion 7b is slidable thereover. The head stand 7 can thus slide in the directions indicated by the arrows a and b of Figure 2.

A paper feeding roller 9, which can be rubber or the like, is mounted on a roller for rotation about the axis of the latter. The feeding roller 9 is supported between the

frames 1, 2. The roller shaft 10 is rotatably mounted in spaced apart bearings 11 which are themselves fixed respectively in the side frames 1, 2.

A recording paper 12 is guided by paper guides 13, 14 and passes therefrom in an upward direction through a gap between the platen 5 and the printing head 6. An idler lever 15 is supported by recessed portions 2a of the side frames 1, 2. An idler roller 16 is held by the idler lever 15. The idler roller 16 is pressed against the recording paper 12 which is entrained over the paper feeding roller 9, the idler roller 16 being so pressed by reason of the provision of an idler spring 17 which engages an end portion of the idler lever 15.

An ink ribbon 19 is reeled onto a ribbon feed device 18. The ribbon 19, which is inserted between the recording paper 12 and the printing head 6, passes through the gap between the printing head 6 and the platen 5. The printing head 6 is provided with a plurality of recording needles 20 which are arranged to extend perpendicularly to the gap between the printing head 6 and the platen 5. Electro-magnetic means (not shown) are provided which, when energised, are arranged to force predetermined recording needles 20 in the direction of the platen 5 so that these recording needles 20 force the ribbon 19 against the recording paper 12 supported by the platen 5, with the result that characters formed by dots are printed on the recording paper 12. Thus as the printing head 6 is moved rectilinearly at a constant speed in the direction of the arrow *a*, the recording needles 20 are selectively operated to form characters by dots on the recording paper 12. When the printing head 6 is moved rectilinearly in the direction of the arrow *b*, the paper feeding roller 9 rotates by a fixed amount in the direction of an arrow *c* (Figure 1) so that the recording paper 12 is moved in such a way that a line change is effected in the printing on the recording paper 12. The means by which this is done are described below.

A rotatable disc 27 is rotatably mounted on a disc shaft 35 which is itself mounted in and at right angles to the main portion of the cross frame 3, the disc 27 being mounted immediately beneath the main portion of the cross frame 3. A motor 21 has a motor shaft 26 on which is fixed a motor wheel 22. The motor wheel 22 is arranged to drive a first wheel 23 which in turn drives a second wheel 24. The second wheel 24 has a bevel wheel portion 24a which meshes with a bevel wheel portion 25a of a third wheel 25, the third wheel 25 being carried by a rotary shaft which extends perpendicularly to the cross frame 3. The third wheel 25 has a spur wheel portion 25b which engages a spur wheel 27a of the disc 27, with the result that the latter is rotated by the motor 21 in the direction of arrow *d* of Figure 2.

Mounted immediately above the main portion of the cross frame 3 is a lever 28 which is rotatably mounted on a lever shaft 29 for oscillation about the latter; the lever shaft 29

being itself mounted on the cross frame 3. A lever driving pin 31, on which is rotatably mounted a sleeve 32, is fixed to the lever 28. The lever driving pin 31, which is provided with the sleeve 32, is mounted within and engages a cam groove 27b in the disc 27. As shown in Figure 3, the cam groove 27b forms a closed loop, and consequently when the disc 27 is turned through one complete revolution in the direction of the arrow *d* of Figure 2, the lever 28, which is rotatable about the axis of the lever shaft 29, effects one complete oscillation.

The cross frame 3 is provided with an aperture (not shown) through which the lever driving pin 31 extends and which is so shaped as to permit oscillating motion of the lever driving pin 31. A head driving pin 30 is fixed to the end of the lever 28 remote from the lever shaft 29, the head driving pin 30 engaging a straight grooved portion 7c which is provided in a part of the head stand 7. Accordingly, the oscillating movement of the lever 28 produces rectilinear reciprocating motion of the printing head 6 which is mounted on the head stand 7; this rectilinear reciprocating motion being in the direction of the arrows *a* and *b* of Figure 2. Thus in operation the printing head 6 is reciprocated over the recording paper 12.

The shape of the cam groove 27b is such that, when the printing head 6 moves in the direction of the arrow *a*, the printing head 6 is moved linearly and at constant velocity except at the end portions of its movement during which there is no printing. Thus printing is carried out only in the region in which the printing head is moved at a constant linear speed.

A spring member 36 extends between the side frame 2 and a ribbon driving pin 34, the ribbon driving pin 34 being mounted on the lever 28. The sleeve 32 on the lever driving pin 31 is thus pressed against an outer wall 27c of the cam groove 27b.

In view of manufacturing tolerances, it is necessary to provide play between the sleeve 32 on the lever driving pin 31 and the cam groove 27b. The amount of play at the head driving pin 30, therefore, in comparison with the amount of play at the lever driving pin 31, is in the ratio of a dimension *Y* to a dimension *X*. However, by reason of the fact that the sleeve 32 of the lever driving pin 31 is pressed by the spring member 36 against the outer wall 27c of the cam groove 27b, during rotation of the disc 27, the sleeve 32 continues to contact the outer wall 27c so that effectively there is no play.

On the other hand, if a spring member 36 were not provided and the printing head 6 was being moved in the direction of the arrow *a* to effect printing, and if the printer were subjected to external vibration, this vibration would be transmitted to the printing head 6 and consequently the sleeve 32 would no longer be in

contact with the outer wall 27 and would move away therefrom to an extent determined by the amount of play.

- Since the cam groove 27c is designed to
- 5 ensure that the printing head 6 can move in the direction of the arrow *a* at a constant speed while the sleeve 32 rotates along the outer wall 27c, the normal linear motion at constant velocity of the printing head 6 cannot be performed if the
 - 10 sleeve 32 ceases to be in contact with the outer wall 27c. If this occurs, the dots constituting printing characters are not made at a constant interval in the horizontal direction, which causes a deterioration in the standard of printing.
 - 15 Since there is a sudden change of direction when the movement of the printing head 6 in the direction of the arrow *b* is suddenly changed into movement thereof in the direction of the arrow *a* to effect printing, the printing head 6 and head
 - 20 stand 7 undergo a damped vibration approximately at the start of the printing, such damped vibration arising from the energy in the elastic portions of the head stand 7 and of the printing head 6. Thus if the spring member 36
 - 25 were not provided, the sleeve 32 would successively come out of contact with and return into contact with the outer wall 27 and would move through a distance corresponding to the above-mentioned play, thus causing deterioration
 - 30 of printing quality to the same extent as would be caused as a result of external vibration. The spring member 36 therefore needs to have a spring force sufficient to overcome external vibration and to overcome the damped vibration of the printing
 - 35 head 6 and of the head stand 7 which occurs when the movement of the printing head 6 is changed from movement in the direction of the arrow *a* to movement in the direction of the arrow *b*. This will ensure that the sleeve 32 is in contact
 - 40 with the outer wall 27c of the cam groove 27b throughout the time that printing is occurring while the printing head 6 moves in the direction of the arrow *a*.

As shown in Figure 4, the disc 27 is provided,

- 45 on its side opposite to that having the cam groove 27b, with a first cam recess 27d and with a second cam recess 27c. A permanent magnet 37 is embedded in the disc 27 so as to be fixed therein.

- 50 Reference will now be made to Figures 5, 6 and 7. The roller shaft 10 is fixed to a ratchet 38 so that the paper feeding roller 9 (shown in Figure 5), the roller shaft 10 and the ratchet 38 all rotate in unison. A detent lever 39 is rotatably mounted
- 55 on a shaft 40, the detent lever 39 having a pin 41 which is fixed thereto and which is engageable with a plurality of equi-angularly spaced apart circumferential grooves 38a of the ratchet 38, the sides of each groove 38a bounding a substantially
- 60 triangular shaped recess in the ratchet 38. One end of the detent lever 39 is engaged by a detent spring 42 which urges the detent lever 39 counter-clockwise about the axis of the shaft 40.

Even if external force is used to rotate the

- 65 ratchet 38 e.g. by pulling the recording paper 12,

- the detent spring 42 will ensure that the pin 41 will always enter a circumferential groove 38a, thereby ensuring that the ratchet 38 is always stopped at one of a plurality of predetermined
- 70 positions. The position of the shaft 40, which provides a rotational mounting for the detent lever 39, and the shape of the circumferential grooves 38a of the ratchet 38 are selected so that the ratchet 38 can rotate both forwardly and
- 75 backwardly.

A pawl holding member 44 is rotatably mounted on a shaft 43 which is itself mounted in the side frame 1. A pressure member 45, which may be constituted by a plate spring, has U-shaped grooves 45a which are respectively

- 80 engaged by projections 44a on the pawl holding member 44. A retaining ring 46 engages the shaft 43 so that the pressure member 45 exerts pressure against the pawl holding member 44 in the direction of the thickness of the pressure
- 85 member 45. The pawl holding member 44 is thus pressed against the side frame 1 by the spring force of the pressure member 45 in the direction of the thickness of the latter, so that when the
- 90 pawl holding member 44 rotates about the axis of the shaft 43 a braking torque is imparted to the pawl holding member 44.

The pawl holding member 44 is made integrally with a pawl shaft 44b on which a pawl

- 95 47 is rotatably mounted. A driving member 48, which forms part of a paper shift means, is, like the pawl holding member 44, rotatably mounted on the shaft 43, and a retaining ring 50 engages the shaft 43 so as to prevent the driving member
- 100 48 from being removed from the latter. Oscillation of the driving member 48 causes intermittent rotation of the paper feeding roller 9.

As best shown in Figure 6, the driving member 48 is provided with a cylindrical pawl driving

- 105 portion 48a which engages a groove portion 47a (Figure 5) of the pawl 47. A roller shaft 49 is rotatably mounted in an apertured portion 48c of the driving member 48, the roller shaft 49 engaging the first cam recess 27d of the disc 27.
- 110 A spring 51 (Figure 7) engages a portion 48b of the driving member 48 and also engages the shaft 40. The driving member 48 has a portion 48d (Figure 6) which is engageable with a bent
- 115 portion 52a (Figure 7) of a first trigger member 52 so as to enable the driving member 48 to be brought to rest.

When the driving member 48 is mounted on the shaft 43, a part of the roller shaft 49 touches the first cam recess 27d of the disc 27 by passing

- 120 through a notched portion 1a in the side frame 1. The spring 51, which extends between the shaft 40 and the portion 48b of the driving member 48, urges the driving member 48 to turn in a counter-clockwise direction *h*.

The operation of feeding the recording paper 12 will now be described with reference to Figures 7, 8, 9 and 10.

As shown in Figure 8, when the driving member 48 is rotated as far as possible in the

- 130 clockwise direction indicated by arrow *g* by

reason of the engagement between the roller shaft 49 and the first cam recess 27*d* of the disc 27, a gap *H* is produced between the bent portion 52*a* of the first trigger member 52 and the portion 48*d* of the driving member 48. When this occurs, and a current flows through an electro-magnet coil 53, the first trigger member 52 rotates in a clockwise direction against the action of a return coil spring 54.

- 10 As shown in Figure 9, the first trigger member 52 is thus attracted towards the electro-magnet coil 53, with the result that the bent portion 52*a* of the first trigger member 52 is disengaged from the portion 48*d* of the driving member 48. Thus
15 when the disc 27 starts to rotate, the spring 51 causes the driving member 48 to begin to rotate in the direction of the arrow *h*, while the roller shaft 49 will move in contact with the first cam recess 27*d*. At this time, however, as a result of the brake torque between the pawl holding member 44 and the side frame 1, the pawl holding member 44 is held at rest, while the pawl driving portion 48*a* engages with the groove portion 47*a* of the pawl 47 to make the pawl 47
25 rotate in a clockwise direction about the axis of the pawl shaft 44*b* during rotation of the driving member 48.

- As shown in Figure 9, when the driving member 48 rotates in the direction of the arrow *h*,
30 the pawl holding member 44 remains at rest, and the pawl driving portion 48*a* makes the pawl 47 rotate about the axis of the pawl shaft 44*b* of the pawl holding member 44. The end portion 47*b* of the pawl 47 is brought to rest by a respective
35 groove portion 38*a* of the ratchet 38. When this occurs, the pawl 47 cannot rotate further about the axis of the pawl shaft 44*b*. When therefore the driving member 48 rotates further in the direction of the arrow *h*, the pawl holding member
40 44 rotates around the shaft 43 almost in unison with the driving member 48, being driven by the pawl driving portion 48*a*. As a result of this operation, the ratchet 38 rotates through a fixed angle in a counter-clockwise direction so that the
45 recording paper 12 is moved to effect a line change.

- When the driving member 48 has been rotated in the direction of the arrow *h* to the extent shown in Figure 10, and the disc 27 rotates further, the
50 first cam recess 27*d* acts on the roller shaft 49 so as to cause the driving member 48 to rotate in the direction of the arrow *g*. When this occurs, by reason of the brake torque produced between the side frame 1 and the pawl holding member 44,
55 the pawl holding member 44 remains at rest. During the rotation of the driving member 48, the pawl driving portion 48*a* makes the pawl 47 rotate about the axis of the pawl shaft 44*b* in a counter-clockwise direction. As indicated in
60 Figure 7, the pawl 47 continues to rotate in a counter-clockwise direction until it is brought to rest by a portion 44*c* of the pawl holding member 44, the arrangement being such as to release the pawl 47 from engagement with the ratchet 38.
65 When the driving member 48 rotates further,

since the pawl 47 has been brought to rest by a portion 44*c* of the pawl holding member 44, the pawl holding member 44 and the pawl 47, by reason of the drive from the pawl driving portion 48*a*, rotate in the direction of the arrow *g* in unison with the driving member 48. Thus the parts are restored to the positions shown in Figure 8.

- As will be appreciated from what is shown in
75 Figure 8, the spring 51 which extends between the driving member 48 and the shaft 40, by reason of the operation of the first cam recess 27*d* on the roller shaft 49, stores energy during the time that the driving member 48 rotates in the
80 direction of the arrow *g* and releases the stored energy during the time that the roller shaft 49 operates along the first cam recess 27*d* and the driving member 48 rotates in the direction of the arrow *h*, thus effecting feeding of the recording
85 paper 12.

- If the first cam recess 27*d* is provided with a plurality of portions of the same shape, the recording paper 12 can be quickly fed a plurality of times within one printing cycle during which
90 the disc 27 makes one complete revolution only. By employing the electro-magnet 53 to effect selective operation of the first trigger member 52, it is possible to select a desired feed of the recording paper 12. For example, it may be
95 arranged that the recording paper 12 is fed only once after each printing, or there may be a quick feed thereof a plurality of times during the period that the disc 27 is rotated through one complete revolution.

- 100 If the disc 27 is moved from a non-printing rest position, shown in Figure 7, to the position shown in Figure 8 in which the pawl 47 is not in engagement with the ratchet 38, the ratchet 38 can rotate both forwardly and backwardly, and
105 the recording paper 12 can be pulled out by hand in the direction of arrows *i* and *j*.

- Normally, when the recording paper 12 is pulled out by hand in a conventional printer in which a pawl and ratchet are used, it is necessary
110 to release the pressure of the idler roller 16 against the paper feeding roller 9. This is because, in a conventional printer, the pawl is always in engagement with the ratchet. It was therefore difficult in the conventional printer to release the
115 pressure of the idler roller, and a special mechanism had to be employed to do so. In the case of the machine shown in the drawings of the present application, however, such a disadvantage is overcome because the pawl 47
120 can be moved out of engagement with the ratchet 38. Moreover, since the mechanism for releasing the engagement between the pawl 47 and the ratchet 38 is very simple, and its operation is also simple, the mechanism is highly reliable.

- 125 As shown in Figure 12, a projection 1*b* of the side frame 1 and a projection 2*b* of the side frame 2 respectively extend through apertured portions 56*a* and 56*b* of a ribbon frame 56. The ribbon feed device 18 is mounted on the ribbon frame 56
130 so that the ribbon feed device 18 can rotate with

respect to recessed portions 1c, 2c of the side frames 1, 2 in the direction of arrows *k*, *l* (shown in Figure 11). A pair of spool wheels 57 are rotatably mounted on the ribbon frame 56 and a respective ribbon spool 58, onto which the ribbon 19 is wound, is mounted on each of the spool wheels 57. The ribbon 19 is guided by a pair of arms 56c of the ribbon frame 56 so that the ribbon 19 passes through a gap between the platen 5 and the printing head 6. One end of a shift spring 59 engages the ribbon frame 56 to urge the latter to turn in the direction of the arrow *k*.

The ribbon frame 56, which is rotated by the shift spring 59 in the direction of the arrow *k*, is brought to rest, in the position shown by solid lines in Figure 11, by a first rest portion 61a of a second rest member 61 which is rotatably mounted on a shaft 60. The ribbon 19 has two colours which are respectively provided on its upper and lower sides. In the position shown by the said solid lines, the upper colour can be printed by the printing head 6. However, when current flows through a shift electro-magnet coil 62, the second rest member 61 is attracted to a position indicated by a two-point dash line, and the ribbon frame 56 is rotated in the direction of the arrow *k* by the shift spring 59 so that, as indicated by the two-point dash line, the second portion 61b of the second rest member 61 brings the ribbon frame 56 to rest. When the ribbon frame 56 is in the position indicated by the two-point dash line, the lower colour on the ribbon 19 can be printed by the printing head 6.

As shown in Figure 13, a resetting member 63 has a shaft portion 63a, the re-setting member 63 being rotatably mounted on a shaft 64 (Figure 12). The shaft portion 63a cooperates with the second cam recess 27e (shown in Figure 4) of the disc 27 so as to perform an oscillating motion. When the lower colour of the ribbon 19 is to be printed, current is caused to flow through the shift electro-magnet coil 62 so as to release the ribbon frame 56 from engagement with the first rest portion 61a of the second rest member 61. As the re-setting member 63 is engaged with the ribbon frame 56, the ribbon frame 56 rotates in the direction of the arrow *k*, the rotation of the ribbon frame 56 being controlled by the second cam recess 27e until the second rest portion 61b of the second rest member 61 engages the ribbon frame 56.

The characters to be printed are then printed by the printing head 6 in the colour of the lower portion of the ribbon 19 when the ribbon frame 56 is in the position shown by the two-point dash line of Figure 11. After printing, the resetting member 63 pushes the ribbon frame 56 downwardly, along the second cam recess 27e and in the direction of the arrow *l* against the action of the shift spring 59. If the ribbon frame 56 is moved in the direction of the arrow *l* lower than the position shown by the solid line, the first rest portion 61a is re-engaged with the ribbon frame 56 by the spring force of a return coil spring 65 (Figure 11) which engages the second rest

member 61.

As indicated in Figures 12 and 14, when a pawl driving member 66, on which a pawl member 68 is mounted, is oscillated about a pivot 67, the spool gear wheel 57 rotates and the ribbon 19 is wound around the ribbon spool 58 so as to effect feeding of the ribbon 19. A ribbon driving member 69 is rotatably mounted on a pivot 70, and the ribbon driving pin 34, which is fixed on the lever 28, is engaged in a slot 69a which is provided in the ribbon driving member 69. The ribbon driving member 69 has a bent portion 69b which is engageable with a bent portion 66a of the pawl driving member 66. When the lever 28 rotates in the direction of an arrow *m* shown in Figure 14, the ribbon driving member 69, which is engaged with the lever 28 by the pin 34, rotates counter-clockwise with the result that the pawl driving member 66 is also rotated counter-clockwise against the action of a ribbon feed spring 71. When, however, the lever 28 rotates in the direction of an arrow *n* shown in Figure 14, the pawl driving member 66 is moved so as to wind up the ribbon 19 by reason of the energy stored in the ribbon feeding spring 71. The clockwise rotation of the pawl driving member 66 arises from the rotation of the lever 28 produced by the ribbon driving member 69. Since the pivot 67, which acts as the centre of rotation of the pawl driving member 66, is disposed on the same axis as the pivot 70, which acts as the rotational centre of the ribbon driving member 69, almost no relative slip occurs between the bent portions 66a and 69b. Although the spring force of the ribbon feeding spring 71 is relatively large and there is therefore considerable contact tension between the bent portions 66a, 69b, there is hardly any relative slip and therefore hardly any abrasion. Since the energy for feeding the ribbon 19 is stored in the ribbon feeding spring 71 as a result of the rotation of the lever 28 in the direction of the arrow *m*, a relatively large rotation angle of the pawl driving member 66 can be obtained during one revolution of the disc 27 so that the load on the motor 21 can be evened out.

When the ribbon 19 is fed by the clockwise rotation of the pawl driving member 66, the movement of the pawl driving member 66 is controlled by the rotation of the lever 28 in the direction of the arrow *n* by the operation of the ribbon driving member 69, with the result that the ribbon 19 is fed without sagging and without driving it violently.

As shown in Figures 1 and 2, a reed switch 73 is soldered on a base plate 72. The base plate 72 has a U-shaped grooved portion 72a (Figure 2) which is disposed in a grooved portion 35a (Figure 1) of the shaft 35 on which the disc 27 is mounted. The base plate 72 is fixed in position by means of a screw 74 which is mounted on an L-shaped bent portion 3b of the cross frame 3. The reed switch 73 is turned ON when the permanent magnet 37, which is provided in the disc 27, comes near the reed switch 73. The reed switch 73 is thus turned ON and OFF during one rotation

of the disc 27. This provides a signal for detecting the position of the printing head 6.

When the disc 27 is in a position corresponding to the beginning of printing during which the printing head 6 moves into the direction of the arrow *a*, the reed switch 73 is positioned close to the permanent magnet 37. At this time, the base plate 72 is rotated around the disc shaft 35 and is fixed at the position where the reed switch 73 is turned ON. Since the reed switch 73 is disposed adjacent to the disc 27, any variation in the position of the permanent magnet 37 with respect to the reed switch 73 during rotation of the disc 27 is small and therefore does not affect the operation of the reed switch 73.

Moreover, the reed switch 73 can be adjusted by rotating the disc 27 about the axis of the disc shaft 35, so that this adjustment can easily be performed through a small angle.

The motor 21 is provided with a time detecting means 75 (Figure 15), the time detecting means 75 comprising a rotor 76 constituted by a permanent magnet having a plurality of alternative N and S poles on the periphery of the rotor. The rotor 76 is securely fixed on the motor shaft 26 (Figure 2) and rotates in unison with the latter.

A yoke 78, within which is mounted a detecting coil 77, is disposed about the external periphery of the permanent magnet rotor 76. The yoke 78 is provided internally with a plurality of angularly spaced apart comb-toothed portions 78*a*, 78*b*, the number of which corresponds to the N and S poles of the permanent magnet rotor 76. As shown by the dotted line and arrows, magnetic flux produced by a N-pole enters a comb-toothed portion 78*a*, passes through a portion of the yoke 78 and through a comb-toothed portion 78*b*, and is returned to an S-pole. Accordingly, this magnetic flux forms a closed loop around the detecting coil 77. Since the density of this magnetic flux varies when the permanent magnet rotor 76 rotates, an induced voltage is produced in the detecting coil 77, and this induced voltage is shaped almost like a sinusoidal wave. If the permanent magnet rotor 76 is rotated through one complete revolution, the number of sinusoidal waves which are produced amounts to half as many as the number of poles.

As shown by the uppermost graph of Figure 16, the output waveform of the timing detecting means 75 is initially sinusoidal, its shape when rectified being shown in the middle graph. The rectified waveform is then given the square shape shown in the lowermost graph of Figure 16 so as to be suitable for use as timing signals. The number of timing signals produced during one rotation of the permanent magnet rotor 76 corresponds to the number of poles of the permanent magnet rotor 76.

The uppermost graph of Figure 17 has an ordinate representing the position X of the printing head 6, and an abscissa representing the rotation angle H of the disc 27. The starting point

of the movement of the printing head 6 in the direction of the arrow *a* is taken as 0 (zero). As will be seen from the uppermost graph of Figure 17, in the initial stage, when the printer is not being driven, the printing head 6 is disposed almost in the middle of its range of movement, namely at the position X_a, while the rotation angle H of the disc 27 is 0 at this time.

When a printing signal is supplied to the printer control circuit, a signal for energising the motor 21 is produced, and the current in the motor 21 is turned ON. Drive is transmitted from the motor 21 to the disc 27 so as to rotate the latter in the direction of the arrow *b*. The printing head 6 moves linearly from the position X_a and in the direction of the arrow *b* in accordance with the movement of the lever 28 which takes place as a result of the rotation of the disc 27. When the rotation angle, or angular position, of the disc 27 reaches H_a, the movement of the printing head 6 is changed from movement in the direction of the arrow *b* to movement in the direction of the arrow *a*. Since the motor 21 has rotated a predetermined number of times before the rotation angle of the disc 27 reaches H_a, the sinusoidal wave of the output waveform obtained from the detecting coil 77 has a sufficient voltage level, and a predetermined timing signal is obtained. The printing head 6 therefore moves linearly in the direction of the arrow *a* with a constant velocity except when it is near the positions 0 and X_b, printing being effected only during the said linear movement.

The relative position of the reed switch 73 with respect to the permanent magnet 37 which is fixed on the disc 27 is so arranged that a position detecting signal is produced when the printing head 6 starts to move in the direction of the arrow *a* with constant velocity, that is to say when the rotation angle of the disc 27 reaches the value H_c.

The printing head 6 moves through a space of one dot in response to one revolution of the motor 21. If the timing signal which is produced immediately after the front edge of the position detecting signal has passed, is represented as T₀, and counting is successive, the timing signal and the position X of the printing head 6 can be maintained so that they always correspond to each other. In the printing operation, during which the rotation angle H of the disc 27 almost passes through the range H_a to H_b, the printing time for one dot printed by the printing head 6 is taken as corresponding to the interval *p* between the timing signal T_n and the value T_{n+1}, and this is equal to double the unit pulse interval *q*. Consequently, the number of poles provided on the permanent magnet rotor 76 is arranged to be such as to produce timing signals at intervals amounting to half the time taken by the printing head 6 to print one dot. If it is necessary to print a dot during the time T_n, current is supplied to the electro-magnetic means of the printing head 6 for a unit pulse interval *q* from time T_n and time Q_n. In this case, the timing signal produced is arranged at the middle of the interval between T_n

and T_{n+1} . However, it is also possible to divide this interval into any number of equal parts.

Similarly, the current flow may be arranged to have a width equal to the unit pulse interval q , but

- 5 it is also possible to provide current flow for any integral number of times the unit pulse interval q . Moreover, a timing signal may be produced immediately after the front edge of the position detecting signal has passed, this being
10 represented as T_0 , but it is also possible to produce a timing signal after counting any arbitrary number as T_0 .

- When a timing signal dividing the interval from T_n to T_{n+1} is not utilised, it is necessary to
15 employ a circuit to control the length of current flow to the printing head 6, and this circuit may for example include a single stable multi-vibrator utilizing T_n as a standard. In such cases, when there is any increase in the fluctuation of the
20 length of the current flow, there is a corresponding decrease in the stability of actuation.

- When the current to the motor 21 is turned OFF, the motor 21 will rotate for a short period of
25 time. In order to take account of the number of revolutions of the motor 21 which will occur during this period, the current flow signal for controlling the motor 21 is turned OFF by a timing signal T_s so that the printing head 6 will come to rest at its initial position X_a .
30

- The timing and length of current flow to the electro-magnet coil 53 (Figure 7) and to the shift electro-magnet 62 (Figure 11) are also controlled by utilizing an arbitrary timing signal T_p as a
35 standard.

The embodiment of the present invention illustrated in the drawings, and described above has a number of advantages.

- Thus in the said embodiment, the disc 27 is
40 disposed below the cross frame, or bottom frame, 3 while the lever 28 is disposed above the latter. If, in contrast to this, the disc 27 and the lever 28 were both disposed on the same side of the cross frame 3, it would be impossible for the lever shaft
45 29, about which the lever 28 is pivoted, to be located inwardly of the outside diameter of the disc 27. However, if the lever shaft 29 is disposed outwardly of the outside diameter of the disc 27, the following fault occurs. If the length of the
50 reciprocating motion of the printing head 6 and the lead of the cam groove 27b are fixed, the rotation angle of the lever 28 is smaller than in the case illustrated in Figure 2 so that the length of the lever 28 in the direction Y increases. As a
55 result the printing head 6 must be moved further towards the left, as seen in Figure 2, so that the whole length of the printer is increased.

- Another advantage of the illustrated embodiment is that the first cam recess 27d,
60 which is provided for paper feeding, is provided on the disc 27. This permits easy transmission of movement to the driving member 48 from a surface perpendicular to the axis of rotation of the paper feeding roller 9.

- 65 A further advantage is that by providing the

second cam recess 27e, the ribbon frame 56 can be easily pushed down by the fewest number of parts.

- Moreover, the ribbon feed device can be driven
70 by the fewest number of parts as a result of the drive transmitted from the lever 28 to the ink ribbon driving member 69.

- As will be appreciated, it is a major advantage that all the motions which are fundamentally
75 necessary for the operation of the printer are derived from the movement of one single rotating disc.

- A further advantage is that the recording paper
80 12 can be freely pulled out in either direction without providing an elaborate paper-feeding mechanism.

The invention enables a small size printer to be made having few parts, the printer being of low cost and accurate in operation.

- 85 In contrast, in the past, the need to provide a printer with a mechanism for reciprocating the printing head, a mechanism for starting a new line on the recording paper, and an ink ribbon feeding mechanism have involved the use of complicated
90 mechanisms each of which has comprised many parts, and this has prevented such printers from being miniaturised. Moreover the prior art printers could not be used in electronic table calculators, because they were large and expensive. The
95 present invention thus enables one to provide a low priced small printer having a simple structure, the printer having a small number of parts capable of operating accurately.

Claims

- 100 1. A printer having a machine frame comprising spaced apart side frames which are secured together by a cross frame; a printing head which is carried by the machine frame and which is arranged to print characters formed by dots on a recording paper; a rotatable disc which is
105 rotatably carried by the cross frame, and which is provided with a cam; means for rotating the disc; and reciprocation means which engage the said cam and in operation produce reciprocation of the printing head over the recording paper, the said reciprocation means and the said disc being
110 disposed on opposite sides of the cross frame.

2. A printer as claimed in Claim 1 in which the side frames and cross frame together form an H-shaped structure.

3. A printer as claimed in Claim 1 or 2 in which the side frames and cross frame are integral.

4. A printer as claimed in any preceding claim in which the said cam is constituted by a cam
120 groove.

5. A printer as claimed in Claim 4 in which the reciprocation means comprises a lever which engages the cam groove, the lever being oscillated by rotation of the disc.

- 125 6. A printer as claimed in any preceding claim in which the disc is also provided with a cam recess which engages a part of a shift means for effecting a relative shift between the printing head and the recording paper so as to effect a line



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and T_{n+1} . However, it is also possible to divide this interval into any number of equal parts. Similarly, the current flow may be arranged to have a width equal to the unit pulse interval q , but it is also possible to provide current flow for any integral number of times the unit pulse interval q . Moreover, a timing signal may be produced immediately after the front edge of the position detecting signal has passed, this being represented as T_0 , but it is also possible to produce a timing signal after counting any arbitrary number as T_0 .

When a timing signal dividing the interval from T_n to T_{n+1} is not utilised, it is necessary to employ a circuit to control the length of current flow to the printing head 6, and this circuit may for example include a single stable multi-vibrator utilizing T_n as a standard. In such cases, when there is any increase in the fluctuation of the length of the current flow, there is a corresponding decrease in the stability of actuation.

When the current to the motor 21 is turned OFF, the motor 21 will rotate for a short period of time. In order to take account of the number of revolutions of the motor 21 which will occur during this period, the current flow signal for controlling the motor 21 is turned OFF by a timing signal T_s so that the printing head 6 will come to rest at its initial position X_a .

The timing and length of current flow to the electro-magnet coil 53 (Figure 7) and to the shift electro-magnet 62 (Figure 11) are also controlled by utilizing an arbitrary timing signal T_p as a standard.

The embodiment of the present invention illustrated in the drawings, and described above has a number of advantages.

Thus in the said embodiment, the disc 27 is disposed below the cross frame, or bottom frame, 3 while the lever 28 is disposed above the latter. If, in contrast to this, the disc 27 and the lever 28 were both disposed on the same side of the cross frame 3, it would be impossible for the lever shaft 29, about which the lever 28 is pivoted, to be located inwardly of the outside diameter of the disc 27. However, if the lever shaft 29 is disposed outwardly of the outside diameter of the disc 27, the following fault occurs. If the length of the reciprocating motion of the printing head 6 and the lead of the cam groove 27b are fixed, the rotation angle of the lever 28 is smaller than in the case illustrated in Figure 2 so that the length of the lever 28 in the direction Y increases. As a result the printing head 6 must be moved further towards the left, as seen in Figure 2, so that the whole length of the printer is increased.

Another advantage of the illustrated embodiment is that the first cam recess 27d, which is provided for paper feeding, is provided on the disc 27. This permits easy transmission of movement to the driving member 48 from a surface perpendicular to the axis of rotation of the paper feeding roller 9.

A further advantage is that by providing the

second cam recess 27e, the ribbon frame 56 can be easily pushed down by the fewest number of parts.

Moreover, the ribbon feed device can be driven by the fewest number of parts as a result of the drive transmitted from the lever 28 to the ink ribbon driving member 69.

As will be appreciated, it is a major advantage that all the motions which are fundamentally necessary for the operation of the printer are derived from the movement of one single rotating disc.

A further advantage is that the recording paper 12 can be freely pulled out in either direction without providing an elaborate paper-feeding mechanism.

The invention enables a small size printer to be made having few parts, the printer being of low cost and accurate in operation.

In contrast, in the past, the need to provide a printer with a mechanism for reciprocating the printing head, a mechanism for starting a new line on the recording paper, and an ink ribbon feeding mechanism have involved the use of complicated mechanisms each of which has comprised many parts, and this has prevented such printers from being miniaturised. Moreover the prior art printers could not be used in electronic table calculators, because they were large and expensive. The present invention thus enables one to provide a low priced small printer having a simple structure, the printer having a small number of parts capable of operating accurately.

Claims

1. A printer having a machine frame comprising spaced apart side frames which are secured together by a cross frame; a printing head which is carried by the machine frame and which is arranged to print characters formed by dots on a recording paper; a rotatable disc which is rotatably carried by the cross frame, and which is provided with a cam; means for rotating the disc; and reciprocation means which engage the said cam and in operation produce reciprocation of the printing head over the recording paper, the said reciprocation means and the said disc being disposed on opposite sides of the cross frame.

2. A printer as claimed in Claim 1 in which the side frames and cross frame together form an H-shaped structure.

3. A printer as claimed in Claim 1 or 2 in which the side frames and cross frame are integral.

4. A printer as claimed in any preceding claim in which the said cam is constituted by a cam groove.

5. A printer as claimed in Claim 4 in which the reciprocation means comprises a lever which engages the cam groove, the lever being oscillated by rotation of the disc.

6. A printer as claimed in any preceding claim in which the disc is also provided with a cam recess which engages a part of a shift means for effecting a relative shift between the printing head and the recording paper so as to effect a line



change in the printing on the recording paper, rotation of the disc causing oscillation of the said part of the shift means.

5 7. A printer as claimed in Claim 6 in which a paper feeding roller is supported between the side frames, oscillation of the said part of the shift means causing intermittent rotation of the paper feeding roller.

10 8. A printer as claimed in Claim 7 in which the shift means comprises a ratchet fixed to the paper feeding roller, a pawl engageable with the ratchet, a pawl-holding member which holds the pawl, a pressure member which imparts a frictional load on the pawl holding member, and a driving member which engages the said cam recess and which drives the pawl, movement of the driving member in one direction causing the pawl to rotate the ratchet and thus rotate the paper feeding roller and movement of the driving member in the opposite direction effecting no rotation of the ratchet.

20 9. A printer as claimed in Claim 8 in which the pawl-holding member and the pressure member are integral.

25 10. A printer as claimed in any preceding claim in which the disc is also provided with a further cam constituted by a cam recess, there being a ribbon resetting member which engages the said further cam and which also engages a ribbon frame arranged to carry an ink ribbon, movement of the resetting member by the said further cam causing movement of the ribbon frame with respect to the printing head so as to change the part of the ink ribbon engaged by recording needles carried by the printing head.

30 11. A printer as claimed in Claim 5 or in any claim appendant thereto comprising a ribbon feed device, and a ribbon driving member which is rotatably mounted on the cross frame and one part of which engages the said lever, another part of the ribbon driving member engaging the ribbon feed device, oscillation of said lever causing movement of the ribbon driving member and thus causing movement of the ribbon feed device.

40 12. A printer substantially as hereinbefore described with reference to and as shown in the accompanying drawings.