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"PRINTER"

The present invention relates to a printer and, although the invention is not so restricted, it relates more particularly to a small-size printer for use with a desk-top calculator, electronic register or the like.

5 Printers which move a print wheel into a desired print position along a line of print and which rotate the wheel to select a desired print character and then effect printing of the character are often used in desktop calculators, electronic registers, etc. In general, a
10 printer of this kind has a rotating mechanism for selecting print characters that is independent of a mechanism for moving a print wheel along a line of print. Therefore, the structure is complicated, making it impossible to manufacture the printer in the small size which has been
15 required in the industry.

 A printer is disclosed in U.S. Patent Specification No. 4,437,776, where a worm meshes with a worm gear that is fixed to a print wheel. A rack comes into and out of mesh with the worm gear to effect rotation and translational
20 movement of the wheel by means of one mechanism.

Another printer is disclosed in Japanese Laid-Open Patent Specification No. 107379/1983, where a worm gear fixed to a print wheel is in mesh with two worms which rotate at different angular velocities to rotate the wheel and simultaneously move it along a line of print.

These printers have a greatly simplified mechanism to eliminate the aforementioned problem. However, in the former printer, when the rack comes into and out of mesh with the worm gear, their addendums abut against each other, making precise operation impracticable. In addition, a large amount of electrical power is consumed in order to move the print wheel along a line of print, because a mechanism is employed which returns the print wheel to its original state by making use of the tension of a spring in the same manner as in prior art apparatus. The latter printer also has several problems. Specifically, it uses a mechanism that moves a print wheel along a line of print by making use of the difference between two angular velocities. Therefore, it takes a long time to return the print wheel to its original angular position. Hence, the printer is not adapted for high-speed printing. Further, the driving means must be reversed to return the print wheel to its original angular position.

According to the present invention, there is provided a printer comprising first and second parallel worm members which are spaced apart from each other; a motor; first and second drive transmissions for respectively transmitting drive from the motor, or from means drivingly connected thereto, to the worm members; a carriage which carries a print wheel gear, the print wheel gear being disposed between and in mesh with both the worm members, the print wheel gear being drivingly connected to a print wheel; and control means for selectively controlling the transmission of drive through one or both of the first and second drive transmissions so that, when both worm members are rotated simultaneously for a predetermined length of time, the print wheel is rotated to an angular position at which printing of a selected character on the print wheel can be effected; when the first worm member is rotated but the second worm member is maintained stationary, the carriage together with the print wheel, is moved along a line of print in a given longitudinal direction; and when the first worm member is maintained stationary while the second worm member is rotated, the carriage, together with the print wheel, is

moved in the opposite longitudinal direction.

Preferably, the first and second drive transmissions respectively comprise first and second incompletely toothed wheels, there being first and second toothed levers
5 respectively which can be moved, under the control of the said control means, into and out of operative positions in which they respectively make up the toothless portions of the respective incompletely toothed wheels so as to permit the transmission of drive therethrough, drive through each respective
10 drive transmission being interrupted when the respective toothed lever is moved out of its operative position.

Preferably there are a return lever and a selector lever which are respectively provided with portions engageable with the first and second toothed levers respectively so as to move
15 the latter out of their operative positions, the first and second toothed levers being respectively urged towards their operative positions.

The selector lever may be urged in one angular direction by a return spring, the selector lever having a portion which is
20 engageable by an armature of an electromagnet, energization of the electromagnet causing rotation of the selector lever in the opposite angular direction.

The return spring may interconnect the return and selector levers.

25 The selector lever may have a portion engageable with locking means for locking both the worm members.

The selector lever may, moreover, have a portion engageable with a cam. The cam may be driven by a timing gear which forms part of the second drive transmission.

The selector lever may have a portion adapted to engage the return lever so as to rotate the latter in a direction in which the return lever moves the first toothed lever out of its operative position.

5 There may be a paper feed gear for feeding paper or other medium to be printed by the printer, the paper feed gear being drivable by the second worm member. The paper feed gear may be out of mesh with the second worm member, the selector lever being operable to bring the paper feed gear
10 into mesh with the second worm member.

There may be a hammer which is carried by the carriage and which is movable to cause a said selected character to effect printing.

15 The print wheel may be provided with a flexible part which is provided with print characters, the hammer, when in a printing position, being engageable with the rear of the flexible part to flex a portion of the latter so as to effect printing of a selected character. The flexible part may be an annular type belt, the hammer being mounted radially
20 inwardly of the type belt.

 The hammer is preferably carried by a hammer lever which is rotatably mounted on the carriage, there being urging means for urging the hammer away from the printing position and means for moving the hammer lever so as to bring the hammer into
25 the printing position. The last-mentioned means may comprise

a rocking lever having a portion which is engageable with a first part of a fixed means, so as to move the hammer lever to bring the hammer into the printing position, the rocking lever also being engageable with a second part of the fixed means so as to be swung thereby into a position in which it is out of contact with the hammer lever.

The fixed means may be a toothed rack which is fixed to a frame of the printer and which extends in the direction of movement of the carriage, the said first part being constituted by rack teeth surfaces which are arranged to effect horizontal rocking movement of the rocking lever, and the said second part being constituted by rack teeth surfaces which are arranged to effect vertical rocking movement of the rocking lever.

The print wheel may have vertically separated first and second portions which carry different characters respectively, means being provided for effecting vertical movement of the print wheel so as to bring either the first portion or the second portion of the print wheel into the printing position.

There may be a shift lever which supports the print wheel and is rotatably mounted on the carriage, the shift lever being engageable with a fixed part so as to be rotated thereby on predetermined longitudinal movement of the carriage, the shift lever and the carriage having mutually engageable surfaces such that such rotation of the shift lever causes vertical movement thereof.

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

Figure 1 is a plan view of a printer according to the present invention,

5 Figure 2 is an exploded perspective view of the printer shown in Figure 1,

Figure 3 is a side elevation in cross section of the printer shown in Figure 1,

10 Figure 4 is a plan view of a print wheel mechanism incorporated in the printer shown in Figure 1,

Figure 5 is an exploded perspective view of a power-transmitting mechanism incorporated in the printer shown in Figure 1,

15 Figure 6 is a plan view of a cam for guiding a selector lever,

Figure 7 is a top view of a paper-feed mechanism incorporated in the printer shown in Figure 1,

20 Figures 8(a)-8(c) are views illustrating the operation of selecting a print character, the operation of printing characters along a line of print, and the operation of returning the carriage to its home position, respectively,

Figures 9(a)-9(d) are views illustrating the operation of a return lever; and

25 Figures 10(a)-10(c) are views illustrating the operation of shifting a print wheel.

Terms such as "left" and "right" as used in the description below, are to be understood to refer to directions as seen in the accompanying drawings.

5 The complete structure of a printer according to the present invention is shown in Figures 1 and 2. The printer has a frame 1 to which a guide rail 2 is firmly fixed (by means not shown). A carriage 10 is so mounted that it can move along a line of print while guided by the guide rail 2. As can be seen from Figures 2 and 3, a shaft 11 protrudes upwardly from the top surface of the carriage 10, the shaft 11 extending perpendicularly to the direction of movement of the carriage 10. A sleeve 17 is loosely mounted on the shaft 11. A print wheel 13a for numerals and another print wheel 13b for symbols are fixed to the top end of the sleeve 17, while a print wheel gear 12 is fixed to the bottom end of the sleeve 17 so as to rotate with the print wheels 13a, 13b. The two print wheels 13a and 13b are hereinafter sometimes collectively referred to as the print wheel 13. The print wheel 13 is so held that it can be caused to slide vertically by a shift lever 18 that is rotatably and slidably mounted on the shaft 11 and is loosely inserted between the print wheel 13 and the gear 12. The lever 18 takes the form of a plate. As will be clear from the description below, the printer is so operated that the carriage 10 is moved along a line of print while the print wheel 13 is being rotated.

25 The shift lever 18 acts to bring a selected one of the

two print wheels 13a and 13b into a print position.

The lever 18 is provided with a hole 20 through which the sleeve 17 extends. Two protrusions 21a and 21b (Figures 2 and 10) extend radially from the side surface of the lever

5 18 about the hole 20. One of the protrusions, namely the protrusion 21a, extends perpendicularly, whereas the other protrusion, namely the protrusion 21b, extends obliquely.

Two projections 19, having inclined surfaces which face away from each other, are formed at opposite sides of the lower

10 surface of the lever 18. The shift lever 18 is placed on trapezoidal guide members 22 which are provided on the carriage 10 and which have upwardly inclined surfaces 22a

and top surfaces 22b. The inclined surfaces 22a are disposed on opposite sides of the shaft 11 on the carriage 10, and
15 face away from each other. The projections 19 are sandwiched between the lever 18 and the guide members 22. Each time the carriage 10 moves past a point close to its home position lying at the left end as viewed in the figures, the protrusions

21a and 21b which are integral with the shift lever 18 are
20 alternately caused to bear against a protrusion 7 (Figures 1 and 10) that is formed on the frame 1 near the home

position of the carriage. Thus, the lever 18 is swung right and left and, at the same time, it is moved up and down by the inclined surfaces 22a to bring a selected one of the print
25 wheels 13a and 13b to a print position.

Mounted at one end of the carriage 10 is a hammer lever 23 which extends above the print wheel 13. The carriage 10 is provided with a shaft 25 which is fixed thereto, the hammer lever 23 being rotatably mounted on the shaft 25. The hammer lever 23 is provided with a recess 23a near the position at which the front end of the hammer lever 23 meets the centre axis of the print wheel 13. A flexible annular type belt 14 having print characters 15 (Figure 4) thereon extends around the print wheel 13. A hammer 24 is arranged to bear against the back surface of a selected one of the print characters 15 on the print wheel 13. A hammer 24 may be actuated to flex a portion of the type belt 14 so as to cause a selected print character 15 to protrude outwardly from the back surface of the type belt 14 and thus into the printing position. The hammer 24 is mounted within the print wheel 13 so as to be rotatable in the plane in which the print wheel 13 is mounted. A spring 28 always urges the front end of an arm 24a of the hammer 24 in a counter-clockwise direction as viewed in the figures so that it always faces away from the paper to be printed in the direction of rotation of the print wheel 13. Thus the spring 28 urges the hammer 24 towards an initial or inoperative position, i.e. away from a printing position. At the beginning of the printing process, the arm 24a is opposite to a protrusion 16 which is formed on the rear surface of the print character 15 placed there at that time.

Protruding outwardly from the hammer lever 23 near the position at which it is mounted is a shaft 27 which is formed integrally with the hammer lever 23. The shaft 27 extends in a direction perpendicular to the direction in which the carriage 10 moves. A lever 26 which makes a rocking movement is rotatably mounted on the shaft 27, the rocking lever 26 having a projection 26a. The rocking lever 26 is mounted so that it can swing in the same plane as the hammer 24 so as to actuate the latter and can also swing perpendicularly to the plane in which the hammer 24 swings so as to avoid actuating the latter. As the carriage 10 moves forward, i.e. to the right as viewed in the figures, the projection 26a of the rocking lever 26 comes into mesh with the left hand surface of one of a plurality of teeth 5a of a rack 5, the rack 5 being fixed to the frame 1 and extending in the direction of movement of the carriage 10. Thus the hammer lever 23 is caused to make horizontal rocking motion relative to the print wheel 13. As the carriage 10 moves rearward, i.e. to the right, upwardly inclined guide surfaces 5b (Figure 4), which are formed at the right hand side of the teeth 5a, merely swing the rocking lever 26 vertically. The guide surfaces 5b face away from the home position of the carriage 10. An ink roller 29, mounted on the shift lever 18, is supplied with ink from an ink cartridge 29a (Figure 2).

A first worm 30 and a second worm 40 of double-helical type are mounted parallel to the guide rail 2 and to the rack 5. The worms 30 and 40 are in mesh with the aforementioned print wheel gear 12 on the carriage 10 to rotate the print wheel 13 to select a desired print character. The two worms 30, 40 function to move the carriage 10 along a line of print and to return the carriage to its home position, and at the same time, to feed the paper to be printed by virtue of the fact that the worm 40 engages with an incompletely toothed paper feed gear 80 (described later). The worms 30 and 40 have their respective shafts 31 and 41 protruding from one side of the frame 1. As shown in Figures 2 and 8, first and second incompletely toothed wheels 32 and 42 are mounted on the ends of the shafts 31 and 41, respectively. The first incompletely toothed wheel 32 on the shaft 31 of the first worm 30 is in mesh with an intermediate gear 53 which rotates with another intermediate gear 52. The intermediate gear 52 is in mesh with a gear 51 mounted on the shaft of an electric motor 50. The second incompletely toothed wheel 42 on the shaft 41 of the second worm 40 is in mesh with a timing gear 60 (described later). The timing gear 60 is in mesh with the intermediate gear 52 and has twice the number of teeth of the incompletely toothed wheel 42. Power from the electric motor 50 is thus transmitted to the incompletely toothed wheels 32 and 42 such that they rotate clockwise and counter-clockwise, respectively. First and second toothed levers 34

and 44 (Figures 5 and 8) having one tooth 33 and one tooth 43, respectively, which make up the toothless portions of the incompletely toothed wheels 32 and 42, respectively, are rotatably mounted on the shafts 30, 31 of the worms 30, 40, respectively. Springs 35, 45 urge the first toothed lever 34 and the second toothed lever 44 clockwise and counter-clockwise, respectively. The first and second toothed levers 34, 44 are retained by stoppers 36, 46 respectively (Figure 8) at positions at which they make up the toothless portions.

A selector lever 70 (Figures 5 and 8) is operable to withdraw the toothed levers 34 and 44 from the toothless portions of the incompletely toothed wheels 32 and 42, respectively, directly or via a return lever 63. The selector lever 70 is pivotally mounted on a shaft 3 mounted on the frame 1, and has five arms. The first arm, indicated by numeral 71, extends into the region in which a trigger lever or armature 79, movable by a trigger electromagnet 78, operates to actuate the arm 71. The second arm, indicated by numeral 72, can enter the region in which the second toothed lever 44 rotates, to withdraw the tooth 43 from the toothless portion. The third arm constituted by an operating arm 73, is further rotated by a cam 61 (Figures 5 and 6) formed on the back of the timing gear 60. The operating arm 73 has a shoulder 73a which is adapted to rotate the return lever 63 counter-clockwise. The fourth arm, indicated by numeral 74,

(Figures 2 and 8(c)) is pressed against a lock lever 84 which is mounted on the paper-feed gear 80. The lock lever 84, when in a locking position, makes the shafts 31, 41 of the worms 30, 40 stationary. The fifth arm, indicated by numeral 75, is provided to enable the selector lever 70 to be rotated counter-clockwise via a return spring 65 which is stretched between the arm 75 and the return lever 63.

As shown in Figure 2, a pin 73b, formed at the front end of the operating arm 73 of the selector lever 70, bears on the cam 61. As can be seen from Figure 6, the cam 61 has a substantially elliptical form having two grooves 61c through which the pin 73b can pass. When the trigger lever 79 is pressed against the arm 71 of the selector lever 70, the pin 73b makes sliding contact with the surface of the cam 61 which extends from a point 61a lying on the major axis of the ellipse to a point 61b lying on the minor axis thereof. The grooves 61c are so designed that when the trigger electromagnet 78 is energized for a time that is twice as long as usual, i.e. the time taken by the timing gear 60 to rotate through 180°, they allow the pin 73b to be inserted into the grooves 61c so that the timing gear 60 is further rotated clockwise.

The aforementioned return lever 63 is adapted to act on the first toothed lever 34 to withdraw it from the toothless

portion of the first incompletely toothed wheel 32. The return lever 63 is mounted on the shaft 62 of the timing gear 60 so as to be slidable and rotatable thereon. When the carriage 10 reaches the starting point of a line of print, i.e.

5 the leftmost position as viewed in the figures, a protrusion 28a of the carriage 10 (Figures 2 and 9) formed in this position pushes the return lever 63 upwards against the action of a spring 64. Then the spring 65 rotates the return lever 63 clockwise as viewed in the figures until the
10 return lever 63 rides on a step 4 (Figure 9) formed on one side surface of the frame 1. In these circumstances, the return lever 63 is not in engagement with the first toothed lever 34. When the return lever 63 is urged counter-clockwise by the operating lever 73, it disengages from the step 4
15 and moves downwardly into engagement with the first toothed lever 34.

The paper-feed mechanism is equipped with the structure shown in Figures 1, 2 and 7. More specifically, a paper-feed worm shaft 81 has three helical grooves 82 which are spaced
20 90° from each other on a circle not lying on the path in which the carriage 10 travels. Rotary driving force is transmitted to the worm shaft 81 from the second worm 40 via the incompletely toothed paper feed gear 80 which is attached to one end of the worm shaft 81 for feeding the paper. Usually,
25 the lock lever 84 that acts on a retaining portion 83a (Figure 7) of a disk 83 maintains the paper feed gear 80

at a position where it is not in mesh with the second worm 40. When the selector lever 70 rotates through a large angle to push the lock lever 84 by means of its second arm 73, the disengaged incompletely toothed paper feed gear 80 is brought into mesh with the second worm 40 by a spring 89 acting on the disk 83, whereby the paper feed gear 80 is rotated. Then a helical gear 87, that engages the helical grooves 82, rotates a paper-feed roller 85 (Figure 1) on a shaft 86 of a gear 87 to the next line of print.

The printer further includes a pressure roller 88 (Figure 3) which rolls on the paper-feed roller 85, a surface 90 (Figure 1) for guiding the paper, a platen surface 91 (Figure 3) that is opposite to the print wheel 13, and a rotary encoder 92 (Figure 3) that is in mesh with the first worm 30 and rotated by it. The manner in which the printer operates is described below.

Selection of Print Characters

When a print character is selected, the trigger electromagnet 78 is not energized. In these circumstances, as shown in Figure 8(a), the spring 65 urges the selector lever 70 counter-clockwise. The operating arm 72 of the selector lever 70 is disposed outside the region in which the second toothed lever 44 turns, while the operating arm 73 of the selector lever 70 is not in contact with the return lever 63. Thus, the first and second toothed levers 34, 44 bear on the stoppers 36, 46 respectively, such that their teeth 33 and 43 fill the

toothless portions of the first and second incompletely toothed wheels 32 and 42. That is to say, the first and second toothed levers 34, 44 are in operative positions in which they permit the transmission of drive through the drive transmissions which respectively include the toothed wheels 32, 42. Accordingly, the first worm 30 receives rotary driving force from the gear 51 on the shaft of the motor 50 via the first incompletely toothed wheel 32 and the intermediate gear 53. The second worm 40 receives rotary driving force from the gear 51 via the second incompletely toothed wheel 42, the timing gear 60, and the intermediate gear 52. In these circumstances in which both the worms 30, 40 are rotated simultaneously for a predetermined length of time, the print wheel 13 is therefore rotated until the designated print character 15 is brought opposite to the platen surface 91 and into a printing position, while the print wheel gear 12 that is in mesh with the worms 30 and 40 maintains the carriage 10 stationary in that position.

Movement along a Line of Print and Printing

When the designated print character 15 has been so brought into the printing position, the trigger electromagnet 78 is energized (by means not shown) for the time taken by the timing gear 60 to make a 1/4 revolution. Then, as shown in Figure 8(b), the trigger lever 79 attracted by the electromagnet

78 rotates the selector lever 70 clockwise via the actuated arm 71. This causes the operating arm 72 to be inserted into the region where the second toothed lever 44 rotates, bringing the lever 44 to a stop. The tooth 43 of the lever 44 is withdrawn from the toothless portion of the second incompletely toothed wheel 42, whereby the lever 44 comes out of mesh with the timing gear 60. Meanwhile, the return lever 63 does not engage with the operating arm 73, although the selector lever 70 rotates as described above. The lever 63 therefore remains situated on the step 4 of the frame 1 and is not in contact with the first toothed lever 34. The first incompletely toothed wheel 32 therefore receives rotary driving force from the motor 50 via the intermediate gear 53.

Thus, the print wheel gear 12 is driven by the first worm 30 that continues rotating, so that the gear 12 rolls on the second worm 40 which is made stationary. During one rotation of the first worm 30, the carriage 10, in unison with the rotation of the worm 30, is moved to the right into the next print position. At the same time, the projection 26a of the rocking lever 26 is pushed by a tooth 5a of the rack 5 towards the print wheel 13. The hammer lever 23, which is carried by the rocking lever 26, is thus rotated counter-clockwise. Then, the hammer 24, which is at the front end of the hammer lever 23 and which is biased

clockwise by the spring 28, is pressed against the rear surface of the designated print character 15, thereby impacting the print character 15 against the paper.

5 This condition continues until the projection 26a of the rocking lever 26 gets over the last-mentioned tooth 5a of the rack 5. During this period, the print wheel 13 rotates further clockwise. The hammer 24 rotates with the wheel 13 about the axis of the recess 23a at the front end of the hammer lever 23 while the front end of the arm 24a of the
10 hammer 24 is maintained in abutment with the back surface of the print character 15. In this way, the character 15 is rolled and pressed on the paper to provide a clear printed character or the like on the paper.

As the carriage 10 continues to move to the
15 right, the projection 26a of the rocking lever 26 falls between teeth 5a of the rack 5. The spring 28 which acts on the hammer lever 23 then rotates the hammer lever 23 clockwise, moving the hammer 24 away from the back surface of the print character 15. Then, the hammer 24 is then rotated further
20 clockwise by the action of the spring 28 and returned to the condition shown in Figure 4, so as to be in an initial position preparatory to the next printing.

After the timing gear 60 makes a 1/4 revolution in this manner, the trigger electromagnet 78 is again de-energized (by means not shown). This causes the pin 73b (Fig. 6) at the front end of the operating arm 73 of the selector lever 70 to move
5 on the elliptically shaped cam 61 formed on the back surface of the timing gear 60 from the point 61a lying on the major axis to the point 61b lying on the minor axis. Subsequently, the pin 73b moves away from the surface of the cam 61 while following an orbit A without moving into the groove 61c. Then, the selector
10 lever 70 rotates counter-clockwise and returns to its original position, when the second toothed lever 44 returns to the toothless portion of the second incompletely toothed wheel 42. Thus, the second toothed lever 44 comes into mesh with the timing gear 60, thereby ensuring that both the worms 30 and 40 are rotated.
15 In this way, the apparatus is set up for the selection of the next print character.

Carriage Return and Paper Feed

When the carriage 10 reaches the right hand end after the procedure described above, or when the need to move to another
20 line arises during such a procedure, the trigger electromagnet 78 is energized (by means not shown) for a time which is twice as long as the time taken to move the carriage along a line of print, i.e., the time taken by the timing gear 60 to rotate through 180°. Then, the selector lever 70, against which the trigger
25 lever 79 is pressed, rotates clockwise in the same way as in the

foregoing operation. This causes the operating arm 72 of the selector lever 70 to maintain the second toothed lever 44 stationary, interrupting the transmission of rotary motion to the second worm 40.

5 In these circumstances, while the timing gear 60 is making its first 1/4 revolution, the pin 73b at the front end of the operating arm 73 of the selector lever 70 moves from the point 61a lying on the major axis of the elliptically shaped cam 61 to the point 61b lying on the minor axis thereof. As the timing
10 gear 60 continues to turn, the pin 73b enters the groove 61c as indicated by the orbit B in Fig. 6, whereby to permit further clockwise rotation of the selector lever 70. Then, as shown in Fig. 8(c), the selector lever 70 rotates the return lever
15 63 counter-clockwise by means of the shoulder 73a of the operating arm 73. As shown in Fig. 9(a), the return lever 63, which has been in engagement with and situated on the step 4 of the frame 1, then rotates and comes out of contact with the step 4. Thereafter, the spring 64 causes the lever 63 to drop toward the frame 1
20 (Fig. 9(b)). The front end of the lever 63 is placed in the region where the first toothed lever 34 rotates to thereby make the first toothed lever 34 stationary (Fig. 8(c)). Then, the tooth 33 of the first toothed lever 34 is withdrawn from the toothless portion of the first incompletely toothed wheel 32. As a result, the transmission of rotary motion via the intermediate
25 gear 53 is interrupted.

This condition lasts even after the timing gear 60 has rotated through 180° and the trigger electromagnet 78 has been de-energized. However, when the pin 73b at the front end of the operating arm 73 is released from the groove 61c in the cam
5 61, the selector lever 70 is rotated again counter-clockwise by the action of the spring 65. Then, the second toothed lever 44 is rendered movable, and its tooth 43 is returned to the toothless portion of the second incompletely toothed wheel 42. Then, the second incompletely toothed wheel 42 is brought into mesh with
10 the timing gear 60 to rotate the second worm 40.

Accordingly, the print wheel gear 12 receives a rotary driving force that is opposite in direction to the previous rotary driving force from the second worm 40. Then, the print wheel gear 12 rolls on the first worm 30 which is kept stationary,
15 so that the carriage 10 is returned by the worm 30 to its home position at the left hand end of the structure shown in the drawings. When the carriage 10 arrives at the said left hand end, a protrusion 28a, formed at one end of the carriage 10, pushes the return lever 63 upward onto the step 4 through a hole 6 in the frame 1
20 from the back side, as shown in Figs. 9(c) and (d). This makes the second toothed lever 44 movable, restoring it to its original state as shown in Fig. 8(a).

When the carriage 10 is moving back to the left, the projection 26a of the rocking lever 26 which is engageable with the teeth 5a
25 of the rack 5 passes over the inclined surfaces 5b (Fig. 4) on

the right hand sides of the teeth 5a while swinging vertically about the shaft 27. Hence, the return operation is smoothly performed without actuating the hammer lever 23.

When the selector lever 70 moves through a large angle clockwise, the front end of the operating arm 73 pushes the lock lever 84 downward, disengaging the front end of the lock lever 84 from the retaining portion 83a formed in the disk 83 (Fig. 8(c)). Then, the paper-feeding, incompletely toothed wheel 80, which has not been in mesh with the second worm 40, is rotated by the spring 89 acting on the disk 83, whereby the worm shaft 81 comes into mesh with the helical teeth of the second worm 40. Then, the selector lever 70, released from the cam 61, rotates in the opposite direction, thus initiating rotation of the second worm 40. The incompletely toothed wheel 80, which is driven by the second worm 40, also starts to turn, driving the helical gear 87 meshing with the helical grooves 82. As a result, the paper-feed roller 85 (Fig. 1) on the shaft 86 of the gear 87 feeds the paper to the next line of print. This operation continues until the carriage 10 returns to its home position, whereupon the paper-feeding, incompletely toothed wheel 80 comes out of mesh with the second worm 40 because of the presence of the toothless portion. Then, the incompletely toothed wheel 80 is again maintained stationary by the lock lever 84 so as to halt the feeding of the paper.

Shift of Print Wheel

When the carriage 10 is moved back to its home position from

the right hand side by the returning operation described above,
one protrusion 21a extending perpendicularly from the shift lever 18
strikes against the protrusion 7 from the right hand side, the
protrusion 7 being provided on the frame 1 at a position immediately
5 before the home position. The shift lever 18 is then rotated
clockwise about the sleeve 17 (Fig. 10(a)) and guided onto the
upwardly inclined surfaces 22a formed on the carriage 10. The
shift lever 18 is thus forced upwardly onto the top surfaces
22b while rotating. The shift lever 18 elevates the supported
10 print wheel 13 to place the print wheel 13b for symbols (Fig. 10(b))
at the position which has been occupied by the print wheel 13a
for numerals.

In these circumstances, the carriage 10 repeats the operations
for selecting print characters and for printing characters to
15 print characters on the next line of print while moving from
its home position to the right and maintaining the print wheel 13b
for numerals at the print position. When the carriage 10 moves
three or four print positions from the starting point of the
line of print, i.e., when the carriage has just moved past two
20 or three print positions at which symbols are ordinarily printed,
the other protrusion 21b that has been protruded laterally by
the rotation of the shift lever 18 bears on the protrusion 7
on the frame 1, rotating the shift lever 18 counter-clockwise
(Fig. 10(c)). The shift lever 18 then moves down while guided
25 by the inclined surfaces 22a of the guide members 22. The print

wheel 13a for numerals is returned to the position previously taken up by the print wheel 13b for symbols (Fig. 10(c)), thus making preparations for subsequent printing of numerals.

In the procedure described above, the operations for selecting
5 print characters, printing characters along the same line, returning the carriage, and feeding the paper are carried out using the two worms 30 and 40 which rotate in opposite directions. The same operations may, however, also be performed by forming the worms 30,40 with oppositely directed helical portions and rotating
10 the two worms 30,40 in the same direction.

As described thus far, in the apparatus described above, the gear 12 rotating with the print wheel 13 is in mesh with the two worm members 30,40 which are selectively rotated and stopped under the control of a control means constituted by the
15 trigger electromagnet 78. Print characters are selected by rotating the two worm members 30,40 simultaneously. The carriage 10 is moved along a line of print by halting one worm member 40. The carriage 10 is returned to its home position by halting the other worm member 30. In this way, all the operations of the printer
20 can be performed simply by selectively actuating one or other or both of the two worm gears while rotating the motor in the same direction at all times. Thus, the mechanism of the printer can be greatly simplified. In addition, the carriage 10 does not have to be moved along a line of print against the action of
25 a return spring or the like. Consequently, the motor 50 and

its associated components, which have previously occupied a large space and accounted for a considerable proportion of the price of the printer, can be minimized in size. This contributes to miniaturization of the whole printer, as well as ensuring lower
5 cost and lower consumption of electrical power.

Furthermore, since the gear 12 fixed to the print wheel 13 is in mesh with the two worm members 30,40, the motion of the print wheel 13 can be completely controlled. Therefore, the positions of the print characters 15 can be always detected
10 readily and certainly using simple detecting means (not shown) for detecting the number of rotations made by one worm and for detecting the position of the print wheel 13. Additionally, a control circuit (not shown) for these operations can be made substantially simpler. Further, since the print character-pressing
15 means, constituted by the hammer 24, on the moving member, constituted by the carriage 10, is swung by the toothed guide means, constituted by the rack 5, disposed parallel to the worm members 30,40 to print characters, it is possible to print characters simultaneously with the shift of the carriage along a line of
20 print. This permits a substantial reduction in the time taken to print characters. Additionally, since characters are printed while rolling the print wheel 13, it is possible to form vivid and good printed images on the printing medium.

In our co-pending application No. 8901449.2 which is divided out from the present application, we have disclosed and claimed a printer having a print wheel which drives a flexible member, the flexible member being provided with print characters; a hammer which, when in a printing position, is engageable with the flexible member to flex a portion of the latter so as to effect printing of a selected character, the hammer being carried by a hammer lever which is rotatably mounted on a carriage; urging means for urging the hammer away from the printing position; a toothed rack which is fixed to a frame of the printer and which extends in the direction of movement of the carriage; and a rocking lever which is engageable with a first tooth surface of the rack so as to bring the hammer into the printing position, the rocking lever also being engageable with a second tooth surface of the rack so as to be swung thereby into a position in which it cannot effect movement of the hammer.



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CLAIMS

1. A printer comprising first and second parallel worm members which are spaced apart from each other; a motor; first and second drive transmissions for respectively transmitting drive from the motor, or from means drivingly connected thereto, to the worm members; a carriage which carries a print wheel gear, the print wheel gear being disposed between and in mesh with both the worm members, the print wheel gear being drivingly connected to a print wheel; and control means for selectively controlling the transmission of drive through one or both of the first and second drive transmissions so that, when both worm members are rotated simultaneously for a predetermined length of time, the print wheel is rotated to an angular position at which printing of a selected character on the print wheel can be effected; when the first worm member is rotated but the second worm member is maintained stationary, the carriage, together with the print wheel, is moved along a line of print in a given longitudinal direction; and when the first worm member is maintained stationary while the second worm member is rotated, the carriage, together with the print wheel, is moved in the opposite longitudinal direction.
2. A printer as claimed in claim 1 in which the first and second drive transmissions respectively comprise first and second incompletely toothed wheels, there being first and second toothed levers respectively which can be moved, under the control of the said control means, into and out of operative positions in



which they respectively make up the toothless portions of the
respective incompletely toothed wheels so as to prevent the
transmission of drive therethrough, drive through each respective
drive transmission being interrupted when the respective toothed
5 lever is moved out of its operative position.

3. A printer as claimed in claim 2 in which there are a return
lever and a selector lever which are respectively provided with
portions engageable with the first and second toothed levers
respectively so as to move the latter out of their operative
10 positions, the first and second toothed levers being respectively
urged towards their operative positions.

4. A printer as claimed in claim 3 in which the selector lever
is urged in one angular direction by a return spring, the selector
lever having a portion which is engageable by an armature of
15 an electromagnet, energization of the electromagnet causing rotation
of the selector lever in the opposite angular direction.

5. A printer as claimed in claim 4 in which the return spring
interconnects the return and selector levers.

6. A printer as claimed in any of claims 3 to 5 in which the
20 selector lever has a portion engageable with locking means for
locking both the worm members.

7. A printer as claimed in any of claims 3 to 6 in which the
selector lever has a portion engageable with a cam.

8. A printer as claimed in claim 7 in which the cam is driven
25 by a timing gear which forms part of the second drive transmission.



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9. A printer as claimed in any of claims 3 to 8 in which the selector lever has a portion adapted to engage the return lever so as to rotate the latter in a direction in which the return lever moves the first toothed lever out of its operative position.
- 5 10. A printer as claimed in any preceding claim in which there is a paper feed gear for feeding paper or other medium to be printed by the printer, the paper feed gear being drivable by the second worm member.
11. A printer as claimed in claim 3 and in claim 10 in which
10 the paper feed gear is out of mesh with the second worm member, the selector lever being operable to bring the paper feed gear into mesh with the second worm member.
12. A printer as claimed in any preceding claim comprising a hammer which is carried by the carriage and which is movable
15 to cause a said selected character to effect printing.
13. A printer as claimed in claim 12 in which the print wheel is provided with a flexible part which is provided with print characters, the hammer, when in a printing position, being engageable with the rear of the flexible part to flex a portion of the latter
20 so as to effect printing of a selected character.
14. A printer as claimed in claim 13 in which the flexible part is an annular type belt, the hammer being mounted radially inwardly of the type belt.
15. A printer as claimed in claim 13 or 14 in which the hammer
25 is carried by a hammer lever which is rotatably mounted on the



carriage, there being urging means for urging the hammer away from the printing position and means for moving the hammer lever so as to bring the hammer into the printing position.

16. A printer as claimed in claim 15 in which the last-mentioned
5 means comprises a rocking lever having a portion which is engageable with a first part of a fixed means so as to move the hammer lever to bring the hammer into the printing position, the rocking lever also being engageable with a second part of the fixed means so as to be swung thereby into a position in which it is out of
10 contact with the hammer lever.

17. A printer as claimed in claim 16 in which the fixed means is a toothed rack which is fixed to a frame of the printer and which extends in the direction of movement of the carriage, the said first part being constituted by rack teeth surfaces which
15 are arranged to effect horizontal rocking movement of the rocking lever, and the said second part being constituted by rack teeth surfaces which are arranged to effect vertical rocking movement of the rocking lever.

18. A printer as claimed in any preceding claim in which the
20 print wheel has vertically separated first and second portions which carry different characters respectively, means being provided for effecting vertical movement of the print wheel so as to bring either the first portion or the second portion of the print wheel into the printing position.

25 19. A printer as claimed in claim 18 in which there is a shift



lever which supports the print wheel and is rotatably mounted on the carriage, the shift lever being engageable with a fixed part so as to be rotated thereby on predetermined longitudinal movement of the carriage, the shift lever and the carriage
5 having mutually engageable surfaces such that such rotation of the shift lever causes vertical movement thereof.

20. A printer as claimed in claim 1 substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
