

"PRINTER"

This invention concerns a printer and, although it is not so restricted, it more particularly concerns a serial printer capable of printing alpha-numeric characters.

5 Prior serial printers of the kind described generally select characters by vertically shifting and turning a type cylinder. Since the type cylinder has a large diameter and moves through large intervals, the carriage is also large. Such printers employ a shift selection mechanism
10 and a type selection mechanism which comprise a complex mechanism composed of electromagnets, clutches, cams, and levers, the mechanism being controlled by a complicated control process. For these reasons, it has been difficult to achieve a small, inexpensive serial printer.

15 In Japanese Laid-Open Patent Publication No. 57-109677, there is disclosed a printer which attempts to eliminate the above difficulties. This printer, however, employs a shift selection means for shifting a group of type wheels, there being a clutch means in addition to a carriage for
20 transmitting drive power for shift selection through a shift cam shaft to a shift cam in the carriage, and a detector has to be provided for detecting the extent to which the type wheel group has been shifted. Therefore, the mechanism of this printer is not simple.

In the serial printer shown in Japanese Laid-Open Patent Publication No. 57-173188, a hammer and a group of type wheels which face each other with print paper interposed therebetween are driven by independent stepping motors for effecting shift selection. Independent stepping motors are required due to the difference between intervals of feed of the hammer and of the type wheel group in a direction across the record sheet. However, this serial printer is expensive since it requires the use of costly parts such as stepping motors and a transmission mechanism using wires for shift selection. Furthermore, the control means for driving the two independent stepping motors is complex. This serial printer therefore cannot be designed for lower current consumption and particularly cannot be battery-driven as the stepping motors themselves are generally not an efficient drive means.

According to the present invention there is provided a printing mechanism comprising a carriage; a print wheel device which is carried by said carriage, the print wheel device comprising one or more print wheels and having a plurality of annular arrays, of angularly spaced apart characters, each said array being fixed with respect to the print wheel device; a print wheel shaft on which the print wheel device is mounted so as to be rotatable in unison therewith and so as to be slidable thereon; drive means for rotating the print wheel shaft so as to rotate the print wheel

device and thus bring a selected character of a desired angular position; movement effecting means for axially moving the print wheel device so as to bring a particular array to a desired axial position; and control means for controlling the drive means and the movement effecting means; the movement effecting means comprising shift cam means and a shift clutch, the shift cam means having a clutch-operated part which is operable by said shift clutch so as to clutch it to and de-clutch it from the print wheel shaft, the shift cam means also having a non-rotatable cam follower part which controls the axial position of the print wheel device and which is axially movable with respect to the print wheel shaft, the arrangement being such that, when the clutch-operated part is clutched to the print wheel shaft and the latter is rotated, the cam follower part, and hence the print wheel device, is moved axially.

In its preferred form, the printer of the present invention may be made small, of low cost, and capable of printing alpha-numeric characters. Moreover, it may have low current consumption and may be battery-driven so as to be portable.

The said clutch-operated part may be provided with a plurality of equi-angularly spaced apart cam portions each of which is adapted to engage the non-rotatable cam follower part whose axial position determines that of the type wheel device.

The shift clutch may comprise a shift ratchet, which is fixed to the print wheel shaft, and a shift pawl which is pivotally mounted on the shift cam means and which is engageable with the shift ratchet, there being means to permit and prevent such engagement.

The means for permitting and preventing the said engagement may comprise means for urging the shift pawl towards said engagement and an electromagnet which in one of its two states prevents such engagement.

The drive means may comprise a differential mechanism having a sun gear which is driven by a motor, planet gears which are driven by the sun gear, a carrier of the planet gears which is provided with a gear for driving the type wheel shaft, and an internal gear which drives a print effecting means.

The internal gear may be provided with a ratchet which is engaged with a first claw of a selector claw member when the latter is in a first position, the selector claw member having a second claw which is engaged with a print selector ratchet fixed to the print wheel shaft when the selector claw member is in a second position.

Preferably at least parts of the shift cam means and of the drive means are mounted within the carriage. Thus the carriage may entirely enclose the said parts. Preferably the shift clutch is also mounted within the carriage.

5 The carriage may be provided with a carriage plate in which the print wheel shaft is rotatably mounted, the print wheel device being disposed on one side of the carriage plate, and the said parts of the shift cam means and of the drive means being disposed on the opposite side of the carriage plate.

Preferably, the printing mechanism comprises a hammer which is operable for printing selected characters on a record sheet.

10 The hammer may be disposed radially inwardly of the print wheel device.

Preferably, the drive means and means for operating the hammer are operated by ON-OFF operation of a trigger electromagnet.

15 There may be a printing selector means which is at rest when the movement effecting means and the drive means are in operation and which causes a print effecting means to activate the printing hammer for printing a character when the movement effecting means and the drive means are at rest, the drive means, the movement effecting means, and the printing selector means being
20 disposed on the said opposite side of the carriage plate.

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The carriage may have a body which is so fastened to the carriage plate as to cover the movement effecting means, the drive means, the print effecting means, and the printing selector means.

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

10 Figures 1 to 3 illustrate a first embodiment of a printer according to the present invention, Figure 1 being a diagrammatic perspective view of a portion of the printer, showing a shift selection mechanism in exploded form;

Figure 2 is a block diagram of the printer incorporating the structure of Figure 1;

Figure 3A is a timing chart illustrative of a stroke starting with a type position detection signal;

5 Figure 3B is a timing chart illustrative of a character selection stroke including a shift selection;

Figures 3C, 3D and 3E illustrate the mechanical movements of various parts which correspond to the signals indicated in the timing chart shown in Figure 3A;

10 Figure 4 is a schematic plan view of a second embodiment of a printer according to the present invention;

Figures 5 to 7 are perspective views of portions of the printer of Figure 4;

15 Figures 8(A) to 8(E) are side elevations illustrating the operation of a portion of the printer of Figure 4; and

Figure 9 is a timing chart of the operation of the printer of Figure 4.

20 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.

In Figure 1 there is shown a printer having a carriage 18 which is mounted on a printer body (not shown) for
25 sliding movement in the directions of a double headed arrow β across the record sheet. A type wheel shaft 12 extends through

the carriage 18 in the directions of the arrow β , the shaft 12 being rotatable about its own axis but axially immovable with respect to the carriage 18. A device constituted by a group of type wheels 10 is splined to the type wheel shaft 12 so as to be rotatable therewith and so as to be axially movable in the directions indicated by the double-headed arrow α . The type wheel group 10 has a plurality (e.g. four) annular arrays 10a of angularly spaced apart alpha-numeric characters or other type (not shown), the arrays 10a being disposed axially side by side. The type wheel group 10 is urged towards the right by a shift return spring 11 to force a boss 35 of the type wheel group 10 to abut an axially movable but non-rotatable shift cam follower 8 whose axial position is controlled by a shift cam 7. The shift return spring 11 is prevented from being removed by a detachable retainer 37 attached to one end of the type wheel shaft 12. The shift cam 7 is held by a carriage side plate 38 so as to be rotatable but immovable axially of the type wheel shaft 12, the latter being rotatably mounted in the centre of the shift cam 7. The shift cam follower 8 is slidably mounted on a shift guide shaft 36 so as to be prevented by the latter from being rotated, the shift guide shaft 36 having one end fixed to the carriage 18. The shift cam 7 has a number of equi-angularly spaced apart cam portions each of which has a sloping cam surface 7a adapted to be held in contact with a surface 8a of the follower 8, the number of

cam portions being the same as the number of type wheels (four in Figure 1). The shift cam follower 8, and hence the group of type wheels 10, can thus be held in a corresponding number of stable axial positions.

- 5 Designated in Figure 1 at 6-1 to 6-10 are components of a shift clutch 6 shown in Figure 1. The shift clutch 6 comprises a shift ratchet 6-1 which is splined to the type wheel shaft 12 and is secured in position by being a press fit thereon or by means of a retaining ring (not shown).
- 10 The shift cam 7 has a plate 7b, a shift pawl shaft 6-5 being fixed to the plate 7b on the right hand side of the latter remote from the cam surfaces 7a, the carriage side plate 38 being interposed therebetween. A shift pawl 6-2 is angularly movable about the shift pawl shaft 6-5. A
- 15 pin 6-6 is secured to a distal end of the shift pawl 6-2 and engages in an oblong hole 6-7 in a clutch disk 6-4. The degree of angular movement of the shift pawl 6-2 is determined by the shape of the oblong hole 6-7 and the angular range through which the clutch disk 6-4 can move.
- 20 The clutch disc 6-4 is limited in its angular movement since the shift pawl shaft 6-5 engages in another oblong hole 6-8 in the clutch disk 6-4. The oblong hole 6-8 is shaped such that, when the clutch disk 6-4 is stopped after having turned in the direction of an arrow γ , the shift pawl 6-2
- 25 engages the shift ratchet 6-1.

Under normal conditions (shown in Figure 1), the shift pawl 6-2 is urged by a shift pawl spring 6-3 in the direction of the arrow γ and the clutch disk 6-4 is also urged in the direction of the arrow γ because of the engagement between the pin 6-6 and the oblong hole 6-7. Hence one of a plurality of notches 6-11 defined in the outer periphery of the disk 6-4 is engaged by an armature member 5a of a shift trigger electromagnet 5 so as to maintain the shift pawl 6-2 out of engagement with the shift ratchet 6-1. The number of the notches 6-11 is equal to the number of the type wheels. A detent spring 6-9 has its distal end placed in one of a plurality of recesses 6-10 in the plate 7b when the clutch is not in operation (Figure 1) to thereby make the phase of the shift cam accurate and to stabilize the position of the shift pawl shaft 6-5. A shift reset detector 9 serves to detect a reference phase of the shift cam 7, that is, an axial shift reference position of the type wheel group 10.

Mounted coaxially on the type wheel shaft 12 for rotation in the direction of rotation of the type wheels are both a part 3-2, 4-2 of a type selection mechanism and also a part 17-1 of a type position detector 17. The type selection mechanism thus comprises a selection gear 3-2 and a selection ratchet 4-2 which are rotatable in unison with the type wheel shaft 12 and which are drivable by

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a selection drive gear 3-1. The selection drive gear 3-1 and the selection gear 3-2 together constitute a speed reducer. The selection ratchet 4-2 has as many teeth as there are angular positions for the type wheels. When a selection/print trigger electromagnet 4 (Figure 2) is energised by an appropriate signal a selection trigger lever (not shown) is turned so that a selection pawl 4-1, which is engaged with the selection trigger lever, is turned in the direction of the arrow ϵ . When the selection pawl 4-1, which forms part of the said type selection mechanism, is so turned in the direction of the arrow ϵ it engages the selection ratchet 4-2 for type selection. That is to say, the type wheel shaft 12 is normally driven in the direction of the arrow γ but can be stopped in an angular position in which a desired character on the type wheel group 10 will be in a printing position. The type position detector 17 including a detector plate 17-1 and a photo-interrupter 17-2 detects the extent of angular movement of the type wheel shaft 12 from a datum position and generates a type position signal, which corresponds to each type position, and a type position reference signal which is generated only once during one revolution of the type wheel shaft 12. The type position detector 17 includes, as indicated above, a detector plate 17-1 rotatable in unison with the type wheel shaft 12.

Operation of the above mechanism will be described below. Since the drive source for effecting shift selection, i.e. for shifting the type wheel group 10 to a position in which a particular array may be brought into alignment with a head 16a of a hammer 16 (Figure 2), is derived from the rotative power of the type wheel shaft 12, shift selection is required to be completed before a type selection stroke is finished. A specific example will be described with reference to the timing chart of Figure 3. In the present embodiment, there are four type wheels. A single type wheel bears twenty-four characters, and hence the four type wheels bear ninety-six characters in all. The shift cam 7 is assumed here to have a cam curve in which a reference stroke varies from S_1 to S_2 to S_3 to S_4 to S_1 during one revolution of the shift cam 7. The clutch disc 6-4 is normally urged in the direction of the arrow γ by the spring 6-3, and is prevented from rotating by the armature member 5a of the shift trigger electromagnet 5 except when the latter is energised. When the shift trigger electromagnet 5 is energised for one pulse of the type position detection signal after the type wheel shaft 12 has started to be turned, the armature member 5a of the shift trigger electromagnet 5 (Figure 1) is attracted to allow the clutch disk 6-4 to be turned through a prescribed angular interval in the

direction of the arrow γ (i.e. through 90° in the
 case illustrated). The shift pawl 6-2 is brought into
 engagement with the shift ratchet 6-1 to enable the shift cam 7
 to start turning with the type wheel shaft 12. The cam curve
 of the shift cam 7 has the four stable points S_1, S_2, S_3, S_4 ,
 and the type wheel shaft 12 angularly moves through a $1/4$
 of a rotation while the cam stroke and thus the type wheel
 group 10 is displaced between two adjacent stable points.
 During this time, $1/4 \times 24 = 6$ pulses of the type position
 detection signal are detected. When the type wheel group
 10 is shifted j steps ($j \leq 3$) $6 \times j$ pulses of the position
 detection signal are detected. The shift trigger electromagnet
 5 is energised each time 6 pulses of the type position
 detection signal are generated. This energisation occurs
 for only one pulse, since the response of the clutch movement
 is so fast that the clutch disc 6-4 begins to turn and the
 shift pawl 6-2 is brought into engagement with the shift
 ratchet 6-1 during one pulse energisation of the shift
 trigger electromagnet. During six pulses the shift cam 7 is
 moved through 90° and thus the group of type wheels 10
 is moved through one axial step.

Since no character can be selected while the shift
 clutch 6 is in operation, character selection is inhibited
 during $6 \times j$ pulses after the shift clutch 6 has been
 actuated. Figure 3A shows a stroke starting with a type position



detection signal TP_0 in a type wheel corresponding to S_1 until a type is selected which corresponds to TP_{17} in a type wheel corresponding to S_3 . The type position signal TP_0 is a signal generated first after the generation of the type position reference signal. TP_{17} is the 17th pulse after TP_0 . When selecting a type corresponding to TP_{10} in S_3 , for example, the type wheel shaft 12 should be turned for one more revolution to select TP_{34} , as shown in Figure 3B.

Figures 3C-3E show the mechanical movements of the parts 5a, 6-4, 10 and 17-1 which correspond to the signals indicated on the time chart shown in Figure 3A.

The photo-interrupter 17-2 generates type position detection signals 24 times and a type position reference signal once during one rotation of the type wheel shaft 12. The detector plate 17-1 has 24 slits along its periphery and one slit inside these slits. Each time that respective slits pass the optical axis, the output level of the photo-interrupter 17-2 is charged thereby to produce type position detection signals and the type position reference signal. As shown in Figures 3B-3D, upon generation of a type position detection signal TP_0 corresponding to a type P_0 on the type wheel corresponding to S_1 , the shift trigger electromagnet 5 is energized to attract the armature member 5a, whereby the shift clutch disc 6-4 is rotated for transmitting power. Thus, the type wheel group 10 starts to be shifted. This state is shown in Figure 3C.

The type wheel shaft 12 is then rotated through 90° and at this time the shift trigger electromagnet 5 is energized again. The type wheel shaft 12 is then rotated through 180° , namely to the type position P_{12} corresponding to TP_{12} , and the type wheel group 10 is shifted to the position corresponding to S_3 . This state is shown in Figure 3D. Without energization of the shift trigger electromagnet 5 at this time, the type wheel group 10 is held in the position corresponding to S_3 .

The type wheel shaft 12 is then further rotated until it reaches the type position corresponding to TP_{17} . This stage is shown in Figure 3E. When the selection/print trigger electromagnet 4 is energized in this state, the type selection is effected. Printing is thus possible of a type corresponding to TP_{17} on the type wheel corresponding to S_3 .

Figure 2 shows an embodiment of a serial printer incorporating the construction shown in Figure 1. Drive power from a motor 1 mounted on the carriage 18 is applied through a speed reducer means 2 and a speed reducer means 3 to a type selection clutch 13 and to a print clutch 14. When a selection/print trigger electromagnet 4 is energized to apply electromagnetic force to energize either the type selection clutch 13 or the print clutch 14, the type wheel shaft 12 stops its turning movement

to effect type selection. The electromagnet 4 is operable either to energise the clutch 13 or to energise the clutch 14 but not to energise both simultaneously. Thus when the type selection clutch 13 is energised, drive from the motor 1 is transmitted to the shaft 12 which will rotate until the selection/print trigger electromagnet 4 is de-energised to initiate a one-cycle printing stroke. When this happens, the shift clutch 6 shifts the type wheel group 10 to a position in which the appropriate type wheel, i.e. the appropriate annular array of characters, is aligned with the head 16a of the hammer 16. The type wheel shaft 12 continues to turn until the selection/print trigger electromagnet 4 is first energized, during which time the shift trigger electromagnet 5 is energized to actuate the shift clutch 6 to shift the type wheel group 10 in the operation described above, the shaft 12 being stopped by the selection pawl 4-1 at a position at which a desired character is in the printing position. Once the desired character has been brought to the printing position, the clutch 13 is de-clutched and the clutch 14 is energised to effect printing as described below.

In the embodiment of Figure 2, rotative power from the shift cam 7 is picked up by a paper feed drive gear 30. When a stepping motor 21 is reversed to return the carriage 18 to a standby position after one line has been printed by

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the printer, the paper feed drive gear 30 and a paper feed transmission gear 31 are brought into mesh with each other to allow the rotative power of the shift cam 7 to drive a paper feed shaft 34 through a train of gears 30, 31, 32, 33. Therefore, by turning the shift cam 7 through a prescribed interval while the carriage 18 is in a standby position, the printer can feed paper in various line-to-line pitches or at a fast rate.

When a print clutch 14 is energised, a printing cam 15 is driven so as to cause the hammer 16 to push out one piece of type from the inner side of the respective type array, the said one piece being inked by an ink roll (not shown). As a result, the respective character is printed on a paper or other record sheet 27.

It is possible to print characters laterally of the record sheet 27 by moving the carriage 18 in the directions indicated by the double headed arrow β . Forward or reverse rotation of the stepping motor 21 is transmitted to a wire 23 which is wound on a drum 22 and connected to the carriage 18 so as to move the latter. The rotation of the motor 21 is transmitted to paper feed rollers 25 to rotate the rollers 25 stepwise when the carriage 18 returns to the standby position after one line has been printed by the printer, and thus to feed the record sheet 27. Paper feed may also be effected manually by a knob 50.

In the construction shown in Figures 1-3, the shift selection mechanism for the type wheel group 10 is composed of a pawl-and-ratchet clutch mechanism 6, a trigger electromagnet 5, and a cam mechanism 7, 8. Therefore, no expensive parts are required. The type position detector 17 acts both as a shift position detector, and most parts of the shift selection mechanism are disposed coaxially on the horizontal type wheel shaft 12. Accordingly, the printer can be reduced in size, can be assembled with ease, and can be manufactured at less cost due to a reduced number of parts. The drive source for shift selection and the drive source for character selection and printing comprise a common small-size DC motor 1 so that the low current consumption is achieved. As a consequence, the printer of Figures 1-3 is highly suitable as a type printer which is small, inexpensive, can be battery-driven, and is capable of printing alpha-numeric characters.

It will also be appreciated that in the construction of Figures 1-3 the plate 7b of the shift cam 7, the shift clutch 6, the speed reducer 3-1, 3-2, and the printing cam 15 are mounted within and are entirely enclosed by the carriage 18, all these parts being disposed on one side of the carriage plate 38 while the type wheel group 10 and end portion 16a of the hammer 16 are disposed on the opposite side thereof.

In Figures 4 and 5, there is shown a second embodiment of a serial printer according to the present invention, the serial printer having an electric motor 101 which is secured by set screws 101-2 to a carriage plate 119. The carriage plate 119 consists of one single metal plate. The motor 101 has a motor shaft 101-1 on which a gear train and a cam are mounted. A type wheel shaft 112 is supported only by being inserted in a hole 119-1 formed in the carriage plate 119 while the printer is being assembled. After the printer has been assembled as described later, the shaft 112 is further inserted in a hole 118-4 formed in a carriage body 118 so that it may be firmly anchored in the printer. A claw shaft 158 for levers (described later) is secured to the carriage plate 119 by metal deformation. The carriage plate 119 is further provided with a groove 119-4 and tapped holes 119-2 and 119-3. A guide shaft 129 is inserted in the groove 119-4 so that it is free to move laterally but not vertically. The carriage body 118 is moulded entirely from a plastics material into the form of a housing that has a volume capable of receiving gear trains and levers as indicated by the broken lines in Figure 5.

The carriage body 118 is formed with holes 118-1 and 118-2, in which is mounted a guide shaft 128, a recess 118-5 in which a boss 116-2 of a hammer 116 is received, and tapped holes 118-3 and 118-4. Thus, the

motor 101, a gear train which is associated with the motor 101, the type wheel shaft 112, the gear train which is associated with the type wheel shaft 112, the hammer 116, a shift trigger electromagnet 105, and a shift position detector 109 are secured to the carriage plate 119 to form a sub-assembly. The shift trigger electromagnet 105 and the detector 109 are shown in Figure 4 and will be described later.

After completing the said sub-assembly, the tapped holes 118-3 and 118-6 in the carriage body 118 are aligned with the tapped holes 119-2 and 119-3, respectively, in the carriage plate 119. Then, the carriage body 118 and the carriage plate 119 are joined together using screws. In this way, the gear trains and the other components are covered by the carriage body 118. The carriage plate 119 is further provided with a hole 119-5 through which the hammer 116 can pass.

In the operation of the serial printer shown in Figures 4 and 5, the motor 101 drives the type wheel shaft 112 via reduction gears 102 and 103, the gear 102 also serving as a selector driving gear 143 (described later). The gear 103 is a selector gear. A set of type wheels 110 can be rotated together with the type wheel shaft 112 in one direction only, but the wheels 110 are free to move axially on the type wheel shaft 112 as indicated by the double headed arrow α . The wheels 110 are always biased axially

(towards the left as seen in Figure 4) by a spring 111 (Figure 4). A selection and printing trigger mechanism 104 is provided with the shift trigger electromagnet 105 which, when energized, acts to halt the type wheels 110 that are usually rotating. Then, the power that was delivered to the type wheel shaft 112 by the motor 101 is directed to a printing selector mechanism 113 which is usually at rest, whereby the mechanism 113 begins to turn. Then, if the electric current flowing through the electromagnet 105 is cut off, the printing selector mechanism 113 drives another printing selector mechanism 114 which is usually at rest. Then, the mechanism 114 begins to rotate, driving a printing cam 115. This causes the hammer 116 to push out one piece of type of the type wheels 110 from the inner side, the one piece being inked with an ink roll (not shown). The result is that a character is printed on a printing paper 127 on a platen 126. This will be described later in more detail.

The shift trigger electromagnet 105 for the type wheels 110 brings a shift selection mechanism 106 into engagement with the type wheel shaft 112 to rotate the selection mechanism 106 that is usually at rest and not in contact with the shaft 112. Then, a shift cam 107 is driven, moving a shift cam follower 108 towards the right and in an axial direction indicated by the arrow α . The shift cam follower 108 is not allowed to rotate. Since the shift cam follower 108 is in contact with the structure provided

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with the type wheels 110, it moves the type wheels 110, which are biased by the spring 11, in a direction towards the right as seen in Figure 4. Thus, the front end 116-1 of the hammer 116 is aligned with a desired type.

5 The shift trigger mechanism is omitted in Figure 5 so that the main portions of the printer can be seen.

A shift position detector 109 serves to detect the angular position of the shift cam 107, i.e. the position of the type wheels 110 in the directions indicated by the arrow α . A type position detector 117 acts to detect the angular position of the type wheels 110. The components 101-117 are carried in the carriage body 118. It is possible to print characters laterally of the paper 127 by moving the carriage body 118 in the directions indicated by the double headed arrow β . Forward or reverse rotation of a stepping motor 121 is transmitted to a wire 123, which is wound on a drum 122 and connected to the carriage body 118, in order to move the carriage body 118. The rotation of the stepping motor 121 is transmitted to paper feed rollers 125 via a paper feed selector mechanism 124 to rotate the rollers 125 in stepwise fashion, for feeding the paper 127. The printer further includes a frame 120 and an FPC (flexible printed circuit) 130, for supplying electric power and electrical signals to various electric components on the carriage body 118.

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The construction of the parts 105, 106, 107, 108, 110 will not be described in detail since it is substantially the same as that of the parts 5, 6, 7, 8 and 10 of Figure 1.

5 The structure of the main portions of the speed reducing and triggering means is next described with reference to Figures 5-7, in which Figure 5 shows an exploded view of the structure of components other than levers of the main portions of the speed-reducing and triggering means near the carriage. Figure 6 shows some of the components shown in
10 Figure 5 in assembled condition and Figure 7 shows the positions of the levers.

When the motor shaft 101-1 of the motor 101 is rotated in the direction indicated by the arrow A, a toothed wheel 140 securely fixed to the front end of the motor shaft
15 101-1 is turned in the same direction. The toothed wheel 140 constitutes the sun gear of a planetary gear train that forms a differential mechanism. Various gears are mounted on the motor shaft 101-1. The planetary gear train consists of planet gears 141 each of which is mounted on a shaft 143-1,
20 a selector driving gear 143 to which each shaft 143-1 is fixed, an internal gear 142 as well as the sun gear 140. The selector driving gear 143 drives the selector gear 103, while the internal gear 142 drives the printing cam 115 via a one-third revolution clutch that is composed of
25 parts 145-150 as described later. A selector claw member 155

(Figure 7) has a claw 155-1 to prevent an internal gear ratchet 144 from rotating, the internal gear ratchet 144 being formed integrally with the internal gear 142. In these circumstances, the planet gears 141 are rotated in the direction indicated by the arrow B, so as to rotate the selector driving gear 143 in the direction indicated by the arrow C via the shaft 143-1. Then, the selector driving gear 143 drives the selector gear 103, moving the type wheel shaft 112 in the direction indicated by an arrow D. This rotates the type wheels 110 in the same direction. The selector claw member 155 has another claw 155-2 (shown only in Figures 8(A)-8(E) which limits the rotation of a type selector ratchet 151 formed integrally with the selector gear 103. If the internal gear ratchet 144 is disengaged from the claw 155-1, rotation of the gear 140 mounted on the motor shaft 101-1 drives the internal gear 142 in the direction indicated by an arrow E.

A trigger mechanism is composed of a trigger plate 152, and a trigger electromagnet comprising a trigger coil 153 and a trigger yoke 154.

ON-OFF operation of the trigger electromagnet 153, 154 effects type selection and printing.

When the coil 153 is energized, the trigger plate 152 is attracted in the direction indicated by an arrow F, to the yoke 154 which is rotating with the type wheel shaft 112. Then, the rotating yoke 154 turns the trigger

plate 152 in the direction indicated by the arrow D, which then moves the selector claw member 155 and an operating lever 156 (Figure 7) in the direction indicated by an arrow G.

5 The axial positions of ratchets and levers are now described by referring to Figures 6 and 7. The claw 155-1 comes into engagement with both the internal gear ratchet 144 and one ratchet 146-1 which is formed in a control disk 146, the latter also having ratchets 146-2 and 146-3 (Figure 8(A)). The control disk 146 constitutes one part of the one-third revolution clutch 145-150. The front end 156-1 of the operating lever 156 engages with the second ratchet 146-2 of the control disk 146. Another claw 155-3 of the selector claw member 155 engages with a return cam 150 which is formed integrally with the main portion 149 of the one-third revolution clutch. A bistable spring 159 (Figure 7) is provided to make the operation of the claw member 155 certain.

Referring to the exploded view of Figure 5, there are shown the shaft 101-1 of the motor, the gear 140 mounted on the motor shaft 101-1, and the type wheel shaft 112. Formed integrally and connected together are the selector driving gear 143, the shafts 143-1 of the planet gears 142, the internal gear ratchet 144, the ratchet 145 of the one-third revolution clutch, the main portion 149 of this clutch, the return cam 150, the printing cam 155, the selector gear 103, and the ratchet 151.

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The operation of the main portions of the printer is now described by referring to Figures 8(A)-8(E).

Figure 8(A) shows the condition in which the selector ratchet 151 is rotating, i.e. the state ready for a selecting operation. In these circumstances, the ratchets 144 and 146-1 are retained by the claw 155-1 of the selector claw member 155, and the claw 155-2 is not in contact with the selector ratchet 151. The main clutch portion 149 (Figure 5) has a shaft 149-1 on which the clutch claw 147 is mounted. The clutch claw 147 is biased by the clutch spring 148 in the direction indicated by the arrow I. A claw pin 147-2 is loosely inserted in a hole 146-4 formed in the control disk 146 to impart a torque to the main clutch portion 149 in the direction indicated by the arrow I (see Figure 5).

Figure 8(B) shows the manner in which the rotation of the trigger plate 152 in the direction indicated by the arrow D (see Figure 7) has rotated the selector claw 155 and the operating lever 156 in the direction indicated by the arrow G. The selector ratchet 151 is retained by the claw 155-2. The internal gear ratchet 144 and the control disk 146 have been disengaged from the claw 155-1 and so the power of the motor 101 and the force exerted by the clutch spring 148 start to rotate the internal gear ratchet 144 and the disk 146, respectively, in the direction

indicated by the arrow E. Then, the internal gear ratchet 144 turns continuously, but the ratchet 146-2 can rotate only through an angle J after it is disengaged from the claw 155-1, because the front end 156-1 of the operating lever 156 retains the ratchet 146-2, thus temporarily halting the rotation. While the control disk 146 is moving through the angle J, the printing cam 115 and the hammer 116 hold the main clutch portion 149 in position and prevent it from rotating (see Figure 5). Since the outer periphery 146-5 of the control disk 146 is made larger somewhat than that of the internal gear ratchet 144, the claw 155-1 will not impede the rotation of the ratchet 144. Also, a tooth 147-1 of the clutch claw 147 will not be brought into contact with the clutch ratchet 145 simply by the rotary movement of the control disk 146 through the angle J. If the trigger coil 153 (Figure 5) is kept energized, this condition is maintained. If the coil 153 is de-energized, the printer is brought into the condition shown in Figure 8(C).

Referring next to Figure 8(C), the de-energization of the coil 153 permits a spring 157 to return the operating lever 156 in the direction indicated by the arrow H. At this time, the outer periphery 146-5 of the control disk 146 prevents the selector claw 155 from returning in the direction indicated by the arrow H. When the front end 156-1 of the lever 156 comes out of

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contact with the ratchet 146-2, the disk 146 is rotated through an angle K in the direction indicated by the arrow E by the action of the clutch spring 148 (Figure 5).

At the same time, the clutch claw 147 also rotates such that its tooth 147-1 enters the path which the clutch ratchet 145 follows. Then, the continuously rotating ratchet 145 causes the clutch claw 147 to rotate the main clutch portion 149 (Figure 5) in the direction indicated by the arrow E. That is, the printing cam 115 also rotates, driving the hammer 116. The rotation is continued until the printing operation is finished.

Then, as shown in Figure 8(D), the return cam 150 comes into contact with the claw 155-3 of the selector claw member 155 to turn the member 155 in the direction indicated by the arrow H. Then, the claw 155-1 comes into engagement with the ratchet 146-2 of the control disk 146 and retains the disk 146 before the claw 155-2 of the claw member 155 disengages from the selector ratchet 151, as shown in Figure 8(E). The printing cam 115, the hammer 116, and a hammer spring 160 (Figure 5) which have finished the printing step bring the main clutch portion 149 to the retaining step. Since the clutch portion 149 is urged in the direction indicated by the arrow E by the spring 160, the control disk 146 which has been shifted by the angle K from the main clutch portion 149 as shown in Figure

8(C) is restored to its original position. The clutch claw 147 then moves out of engagement with the clutch ratchet. Subsequently, the printer returns to the condition shown in Figure 8(A).

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Figure 9 shows a timing chart of operation of the printer of Figure 4. Designated in Figure 9 at T.P., R.P. are a timing pulse and a reset pulse for the type detector. Twelve timing pulses are generated per rotation of the type wheel group 110. In the stroke (A), a type is selected and printed which is ten pulses behind in the direction of rotation on a type wheel which is two steps next in the direction across the character positions. By energizing the character position shift trigger twice, the type wheel group 110 is shifted two steps, and the stepping motor 121 is energized to shift up the carriage 118. The type is selected by energizing the selection/print trigger 104 after ten pulses. The type is printed by de-energizing the selection/print trigger 104 upon completion of the character position shift or the carriage shift-up (character position shift) which is later than the other. In the case illustrated in Figure 9, this is done upon completion of the character position shift. In the stroke (B), a shift-up is started simultaneously with the rising of a first timing pulse after the printing stroke is finished and a type which is five pulses behind on the same type wheel

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is selected and printed. The selection/print trigger is turned on at T.P. 3 and remains energized until after the carriage shift-up is completed. The selection/print trigger is energized immediately after the carriage shift-up has been completed, thus effecting printing. Since the print stroke follows a most time-consuming stroke completion in the selection stroke, there is no wasteful wait time, and high-speed printing is possible without adding a new trigger. Since a hold current can be lowered as indicated by the broken line in the stroke (B), the printer consumes little energy.

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Thus in the construction of Figures 4-8, there is provided a printer which is capable of high-speed printing, is small in size, is quite inexpensive, and is of a low power requirement.

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The type wheels are selected, printed and shifted by one drive source, and the selection and printing of the type wheels is alternately switched by the same switching means. Therefore, the printer mechanism is simplified, resulting in a reduced number of parts.

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As can be seen, moreover, from the description of Figures 5 to 8, the selector mechanism for selecting a desired one from the types on the type wheels, the hammer mechanism, the type wheel shift mechanism for changing the position of the hammer with respect to the position of

the type arrays on the type wheels, the hammer driving mechanism, and the selector mechanism for switching between the type selecting operation and the printing operation are all disposed on the carriage plate or in the carriage body. In this way, almost all the mechanisms necessary for the printer are concentrated in the carriage. Consequently, power is transmitted between the mechanisms without substantial loss, thus necessitating only a limited power for reliable transmission between the mechanisms. Further, since almost all the mechanisms needed for the printer are concentrated in the carriage, they can be assembled into a unit. Hence, the printer can be manufactured quite efficiently. Furthermore, since these mechanisms other than the type wheels are covered by the carriage, the printer keeps out dust.

C L A I M S

1. A printing mechanism comprising a carriage; a print wheel device which is carried by said carriage, the print wheel device comprising one or more print wheels and having a plurality of annular arrays, of angularly spaced apart characters, each said array being fixed with respect to the print wheel device; a print wheel shaft on which the print wheel device is mounted so as to be rotatable in unison therewith and so as to be slidable thereon; drive means for rotating the print wheel shaft so as to rotate the print wheel device and thus bring a selected character to a desired angular position; movement effecting means for axially moving the print wheel device so as to bring a particular array to a desired axial position; and control means for controlling the drive means and the movement effecting means; the movement effecting means comprising shift cam means and a shift clutch, the shift cam means having a clutch-operated part which is operable by said shift clutch so as to clutch it to and de-clutch it from the print wheel shaft, the shift cam means also having a non-rotatable cam follower part which controls the axial position of the print wheel device and which is axially movable with respect to the print wheel shaft, the arrangement being such that, when the clutch-operated part is clutched to the print wheel shaft and the latter is rotated, the cam follower part, and hence the print wheel device, is moved axially.

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2. A printing mechanism as claimed in claim 1 in which the said clutch-operated part is provided with a plurality of equi-angularly spaced apart cam portions each of which is adapted to engage the non-rotatable cam follower part.

5 3. A printing mechanism as claimed in claim 1 or 2 in which the shift clutch comprises a shift ratchet, which is fixed to the print wheel shaft, and a shift pawl which is pivotally mounted on the shift cam means and which is engageable with the shift ratchet, there being means to
10 permit and prevent such engagement.

4. A printing mechanism as claimed in claim 3 in which the means for permitting and preventing the said engagement comprise means for urging the shift pawl towards said engagement and an electromagnet which in one of its two
15 states prevents such engagement.

5. A printing mechanism as claimed in any preceding claim in which the drive means comprise a differential mechanism having a sun gear which is driven by a motor, planet gears which are driven by the sun gear, a carrier of the planet gears
20 which is provided with a gear for driving the type wheel shaft, and an internal gear which drives a print

6. A printing mechanism as claimed in claim 5 in which the internal gear is provided with a ratchet which is engaged with a first claw of a selector claw member
25 when the latter is in a first position, the selector claw member having a second claw which is engaged with a print selector ratchet fixed to the print wheel shaft when the selector claw member



is in a second position.

7. A printing mechanism as claimed in any preceding claim in which at least part of the shift cam means and of the drive means are mounted within the carriage.

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8. A printing mechanism as claimed in claim 7 in which the carriage entirely encloses the said parts.

9. A printing mechanism as claimed in any preceding claim in which the shift clutch is also mounted within the carriage.

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10. A printing mechanism as claimed in any of claims 7-9 in which the carriage is provided with a carriage plate in which the print wheel shaft is rotatably mounted, the print wheel device being disposed on one side of the carriage plate, and the said parts of the shift cam means and of the drive means being disposed on the opposite side of the carriage plate.

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11. A printing mechanism as claimed in any preceding claim having a printing hammer which is operable for printing selected characters on a record sheet.

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12. A printer as claimed in claim 11 in which the hammer is disposed radially inwardly of the print wheel device.



13. A printing mechanism as claimed in claim 11 or claim 12 in which the drive means and means for operating the hammer are operated by ON-OFF operation of a trigger electromagnet.

5 14. A printing mechanism as claimed in any of claims 11-13 when dependent on claim 10, comprising a printing selector means which is at rest when the movement effecting means and the drive means are in operation and which causes a print effecting means to activate the printing hammer for
10 printing a character when the movement-effecting means and the drive means are at rest, the drive means, the movement effecting means, and the printing selector means being disposed on the said opposite side of the carriage plate.

15 15. A printing mechanism as claimed in claim 14 wherein the carriage has a body which is so fastened to the carriage plate as to cover the movement effecting means, the drive means, the printing effecting means, and the printing selector means.

20 16. A printing mechanism as claimed in claim 11 wherein power is transmissible from a common source to the drive means and to a hammer driving means in alternation under the control of a switching means, and wherein the hammer is drivable by the hammer driving means under the control of a hammer switching means, and wherein there are provided a first trigger means
25 for triggering the drive means, a second trigger means for triggering the shift clutch, and a third trigger means for

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5 triggering the hammer switching means, said second trigger means being independent of said first and third trigger means, said first and third trigger means being triggerable by a single trigger electromagnet, and said second trigger means being triggerable upon de-energisation of said first trigger means after it has been energised by energisation of said trigger electromagnet.

10 17. A printing mechanism substantially as hereinbefore described with reference to and as shown in Figures 1-3, or in Figures 4-9 of the accompanying drawings.
