

PATENT SPECIFICATION

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(54) PRINTER

(71) We, SHINSHU SEIKI KABUSHIKI KAISHA, a Japanese Company of 3-5, 3-chome, Owa, Suwa-shi, Nagano-ken, Japan, and KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese Company of 3-4, 4-chome, Ginza, Chuo-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:-

This invention relates to printers.

A printer used in an electronic type desk calculator is such that its driving motor is at rest when no printing cycle is performed and is energised during the printing cycle. During the printing cycle desired print characters on a plurality of print character rings are aligned in a printing position, and after a printing operation has been performed, the print characters are reset to an initial stand-by condition ready for the next printing cycle. A printer for a desk calculator needs to have a relatively fast printing speed, be reliable and inexpensive.

According to the present invention there is provided a printer comprising at least one print character ring having on its periphery a plurality of print characters and a detecting means for detecting rotation of the print character ring or rings for producing signals during a printing cycle which comprises a selecting operation for bringing a desired print character or print characters to rest in a printing position, a printing operation for printing said selected print character or print characters on a recording medium and a resetting operation for resetting said selected print character ring or rings to a stand-by condition, the detecting means being arranged to produce a timing signal having one pulse corresponding to each print character during the selecting operation and a reference signal having a greater pulse width than any pulse of the timing

signal during said resetting operation, said timing signal indicating a character position on the periphery of the print character ring or rings and said reference signal indicating termination of said resetting operation.

Preferably the printer includes a time counter for distinguishing between the reference signal and each pulse of the timing signal.

In one embodiment the printer includes a motor for rotating the print character ring or rings, the reference signal, in operation indicating the timing to deenergise the motor.

The detecting means may be arranged so that the reference signal corresponds to one of the print characters.

In a preferred embodiment the detecting means comprises a slotted disc and photo-electric means for detecting interruption of a light beam as the disc rotates to produce the timing signals and the reference signals.

The printer may include means for preventing generation of timing signals during resetting of the print character ring or rings.

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

Figure 1 is a schematic representation of a conventional printer,

Figure 2 is a timing chart to illustrate the operation of the printer of Figure 1,

Figure 3, consisting of Figures 3(a) to 3(e) illustrates control circuitry for the printer of Figure 1,

Figure 4 is a timing chart illustrating an operation of another form of conventional printer,

Figure 5, consisting of Figures 5(a) and 5(b), is a schematic representation of a printer according to the present invention,

Figure 6 is a timing chart illustrating the operation of the printer of Figure 5,

Figure 7, consisting of Figures 7(a) and 7(b) illustrates control circuitry for a printer according to the present invention,

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Figure 8 illustrates further control circuitry of a printer according to the present invention.

Figure 9 illustrates one form of print character ring for a printer according to the present invention.

Figure 10 illustrates an arrangement of another print character ring for a printer according to the present invention.

Figure 11 illustrates a modification of a printer of Figure 5.

Figure 12 is a timing chart illustrating the operation of the printer of Figure 11, and

Figure 13, consisting of Figures 13(a) to 13(c), illustrates control circuitry of the printer of Figure 11.

A conventional printer is illustrated in Figure 1. A driving motor 1 drives a motor gear 2, which, in turn, drives a reduction gear 3. The gear 3 rotates through one revolution each printing cycle. The printer has power transmission gears 4, 5, 6, 11, an intermittent driving gear 7 which has a toothed portion on a part of its periphery and a notched portion 19 on a root circle, an intermittent gear 8 again with a non-toothed portion, and a plurality of print character rings 9 (only one shown) each having a plurality of print characters on its periphery. A coil spring 10 has one end engaged with the gear 8 and the other end secured to a frame (not shown) of the printer. A printing gear 12 rotates at the same speed as the gear 7. A crank shaft 13 is engaged with the printing gear. A printing roller 14 is engaged with the crank shaft 13 and prints on paper 15 when it contacts the print characters on the print character rings 9. An inked ribbon 16 is used to apply ink to the print characters.

Figure 1 illustrates the printer in an initial stand-by condition prior to a printing cycle. On receipt of a print command signal (Figure 2), the motor 1 is energised and the gear 7 starts to rotate in the direction of an arrow 17. The teeth on the gear 7 and those on the gear 8 are engaged with each other, and the gear 8 rotates in a direction of arrow 18 causing the spring 10 to be wound up. When the gear 8 rotates, the print character rings 9 also start to rotate and as they do so a timing signal T_0 - T_{12} is generated. Selection of a desired print character during this selecting operation is carried out by a print character selecting mechanism (not shown). When desired print characters on the print character rings 9 are in a printing position, the engagement between the gear 7 and the gear 8 is locked by the notched portion 19 of the gear 7. During the selecting operation, the printing roller 14 rotates in synchronism with the gear 7, and when the desired print characters on all the print character rings 9 are in the printing position, a printing operation is performed by causing the printing roller 14 to roll on the desired print characters

thus forming printing on the printing paper 15.

When the printing operation is completed, a resetting operation takes place in which locking of the gear 8 is released and the latter is returned to the stand by condition by the spring 10. The print character rings 9 will also be rotated to their stand-by condition with the gear 8. The timing signal is generated independently of the selecting operation so that during the resetting operation a return signal R is generated but this does not have a predetermined frequency.

A paper feeding operation is effected by a paper feeding mechanism (not shown) after the printing operation has been completed. Taking the mechanical load of the printer and the inertia of the motor into consideration, a detector consisting of a permanent magnet 20 on the gear 3 and a read switch 21 on the frame, provides a stop command signal before, during or after the paper feeding operation in order to de-energise the motor 1 by electric braking action at the end of the printing cycle. The printer is then ready for the next printing cycle.

Figure 3(a) illustrates a control circuit for controlling operation of the printer. The print command signal will appear at the output of the circuit until terminated by the application of the stop command signal.

A different form of control circuit is shown in Figure 3(c). Since the termination of a printing cycle occurs after a period α from the trailing edge of the last return signal R generated during the resetting operation, or after a period β from the leading edge of the stop command signal, a β -time counter, that is a time counter which can measure the period β , determines the end of the printing cycle by counting pulses of the clock signal.

In Figure 3(d) there is shown a control circuit for ensuring that during the re-setting operation, there is synchronisation between the print characters on the print character rings 9 and the timing signal, so that even if the print character rings are stopped in an arbitrary position (for instance occurring due to current interruption during operation of the printer), the print characters do not become out of phase with the timing signal. Figure 3(e) shows a control circuit for a similar purpose.

Figure 3(b) illustrates a motor control circuit, comprising an ON-OFF control transistor 42, transistors 43, 44 formed by a Darlington pair, a transistor 48 for de-energising the motor and an input terminal 41 for a motor-driving signal. When the motor-driving signal is at a low level, the transistors 43, 44 are conductive and the motor is energised. Thus the print character rings will rotate at a constant speed due to the provision of a mechanical governor (not

shown) during the selecting operation. When the motor-driving signal is at a high level as a result of the stop command signal, then the transistor 42 will become non-conductive due to the fact that the base current thereto is interrupted. The motor 1 will cease to be energised and at the same time current to the base of the transistor 48 will cause the motor to be short-circuited which will, in consequence, stop rapidly.

The necessity to provide the stop command signal has several drawbacks such as limitation of layout of the printer, reduction in reliability due to mechanical contacts of the read switch 21, higher cost by requiring the read switch 21, the permanent magnet 20 etc., higher assembly and adjustment costs, and more installing space. Further, this type of printer has a relatively low printing speed. When this conventional printer is used in an electronic desk calculator, the clock signal applied to the β -time counter is generated by a non-stationary multi-vibrator and frequency deviations occur due to its thermal characteristics. The number of steps or counts performed by the β -time counter is determined so as to obtain the period β . If the frequency of the clock signal is a minimum then the period β will increase and if the clock signal is a maximum the period β will decrease. In the former case, the time taken for the printing cycle will increase and the speed of the printer will be reduced.

Figure 4 illustrates, by means of a timing chart, the operation of another type of conventional printer employing a clutch. In this type of printer current conduction to a motor starts with a print command signal and a clutch will be engaged during a time period σ . The clutch will be engaged upon energisation of an electro-magnet. Rotation of a print character ring shaft carrying a plurality of print character rings will occur simultaneously with the engagement of the clutch, and then a timing signal (T_0 - T_{12}) will be generated. The motor will be de-energised after a period ρ from the last of the return signals R generated when the print character rings are re-set to the stand-by condition. The clutch will be disengaged mechanically before the motor is de-energised and before the print character ring shaft comes to rest. When a period α has elapsed from the last of the return signals R, the printing cycle has been completed.

Figure 5 illustrates one embodiment of a printer according to the present invention. Like parts in Figures 1 and 5 have been designated by the same reference numerals. The gear 7 engages the gear 8 and as the latter rotates in the direction A of the arrow 18, the spring 10 is wound up. When the gear 8 rotates then the print character rings 9 will also rotate since they each are fric-

tionally engaged with a print character ring shaft 31 by a spring 39 (Figure 5(b)). A detecting plate 35 of a print character ring position detector 32 is mounted for rotation with the shaft 31 and has a plurality of splits 36 therein corresponding to the positions of print characters of the print character rings 9 and a relatively wide slit 36-S which is located to correspond to a stand-by condition of a print character ring. The detector 32 includes a luminous element 33, such as a luminous diode, and a photoelectric cell 34, such as a photo-transistor, to produce timing signals. During the selecting operation a print character selecting pawl 37 engages with a toothed wheel 38 on each print character ring upon energisation of an electro-magnet (not shown) when a desired print character thereon is in the printing position. When desired print characters on all the print character rings are in the printing position, the gear 7 and the gear 8 are disengaged from each other, and the latter is locked by the non-toothed portion 19 of the gear 7 with the spring 10 wound up. The printing roller 14 rotates in synchronism with the gear 7 during the selecting operation and, when all the desired print characters are in the printing position and the gear 8 is locked, the printing roller 14 will roll on the desired print characters in the printing position to perform the printing operation.

When the printing operation has been completed, the gear 8 is released because of the toothed portion of the gear 7 and the energy stored in the spring 10 causes the gear 8 to rotate in the direction B of the arrow 18 so that the gear 8, the print character rings 9 and the detecting plate 35 are re-set to the stand-by condition.

An abutment 30 is provided on each of the print character rings 9 to abut the respective pawl 37 to return it to the stand-by condition during the re-setting operation. Paper feeding is done by a paper feeding mechanism (not shown), after the printing operation has been performed. When the print character rings 9 return to the stand-by condition, a projection 57 on the shaft 31 and an abutment 58 secured to the frame collide with each other and as a result rebounding sometimes occurs. In order to prevent a reference signal S from being eliminated and a timing signal T_0 from being generated by the rebounding, the slits 36-S have a width equivalent to a time which is greater than the period from the leading edge of the print command signals to the timing signal T_0 , thus preventing the generation of noise.

It will be appreciated that the printer of Figure 5 has no detector such as a read switch 21 and a permanent magnet 20 of the conventional printer of Figure 1, and the stop command signal and the timing signal

are combined.

Figure 7(a) illustrates a circuit diagram for the completion of the printing cycle. Figure 7(b) illustrates a control circuit for obtaining synchronisation of the print characters with the timing signal. The timing signal T_0 - T_{12} is generated by the slits 36, and the reference signal S is generated by the slit 36-S generated by the resetting operation.

The print character rings 9 rotate in one direction during the selecting operation and in the opposite direction during the resetting operation and return signals generated during the resetting operation are eliminated by a shielding portion 53 of a shield plate 51 forming part of the detectors 32. An opening 52 is in line with the line joining the luminous element 33 and the photoelectric cell 34 in the stand-by condition and during the generation of the printing signals. The shield plate 51 is then moved in the direction of arrow 55 so that during the re-setting operation the opening 52 is out of line with the line joining the luminous element 33 and the solar cell 34. The movement of the shield plate 51 is controlled by a cam portion 54 so that the luminous element 33, photoelectric cell 34 and openings 52 are in line again when the print character rings 9 have been returned to the stand-by condition so that the reference signal S is generated. When the number stop and revolution of the motor is so large, the opening portion will sometimes be kept stopped after passing through the slit 36-S in the stand-by condition.

As shown in Figure 6 a period γ between the timing signal T_{12} and the reference signal S is longer than the period δ so that a γ -time counter will detect if the time period since the last timing signal T_{12} exceeds the period γ and cause generation of the reference signal S thus de-energising the motor rapidly and bringing the printing cycle to an end.

The timing signal from the next printing cycle is shown in dotted lines in Figure 6, the next print command signal being generated simultaneously with the generation of the reference signal S so the motor will rotate continuously.

Figure 7(a) illustrates control circuitry including the γ -time counter which is used to distinguish the timing signal T_0 to T_{12} and the reference signal. The end of generation of the timing signal is easily judged by comparing the period with which each timing signal is generated with the interval between the timing signal T_{12} and the reference signal S . The γ -time counter is set so as to generate a signal with a longer period than the period δ or δ' of the timing signal and shorter than the interval between the timing signal T_{12} and the reference signal. Power to

the motor is terminated by the timing signal which is generated after the output signal from the γ -time counter is generated. In Figure 7(a) flip-flop circuits FF_4 , FF_5 are reset by the print command signal and output Q_5 of the flip-flop circuit FF_5 is high level to supply power to the motor. The γ -time counter, which counts in response to the clock signal, is reset each time the timing signal is applied. The γ -time counter does not produce a signal C_{out} even if it counts the clock signal during the period δ of the timing signal. After the γ -time counter is reset by the timing signal T_{12} , since there is enough time until the next reset signal is applied, the γ -time counter counts the clock signal until the signal C_{out} is produced. When the signal C_{out} is produced by the γ -time counter the flip-flop circuit FF_4 is reset and the outputs Q_4 , Q_5 are reversed. When the reference signal S appears, the γ -time counter is reset and a low level signal appears at the output Q_5 of the flip-flop circuit Q_5 to terminate power to the motor. Thus one printing cycle is completed. When the next print command signal is applied the flip-flop circuits FF_4 , FF_5 are reset again and power is supplied to the motor to repeat the above operation.

Figure 7(b) illustrates the synchronisation of the print characters with the printing signals even when the printer may stop in an arbitrary position. A reference signal S is detected by the circuit shown in Figure 7(a) when the power source driving the printer is turned on and so a normal printing cycle can then take place.

Figure 8 illustrates a circuit for detecting a reference signal S' by means of a γ' -time counter after the timing signal T_0 - T_{12} has been generated. Since the motor starts to rotate simultaneously with a print command signal, a given period is required to identify the reference signal S' but after the driving motor rotates, the establishment of a period γ' corresponding to the period δ' in Figure 6, which is smaller than the period γ is made possible.

The number of counting steps in the γ' -counter and the use of integrated circuitry leads to a reduction of the area of the components. In the illustrated embodiment the γ' -time counter requires only 13 counting steps corresponding to the time signal T_0 - T_{12} .

Due to the fact that the detection of the determination of a printing cycle is conducted without time loss resulting from the use of clock signals, the above described printer has the advantage that printing speed can be improved and, in the case of continuous printing, starting time of the motor can be reduced.

Figure 8 shows a circuit in which a first signal group will be discriminated from a

second signal by confirming that a timing signal has been generated and then operating the γ' -time counter.

Figure 9 shows one form for the print character ring 9 which obviates the necessity for the shield plate 51 of the detector 32. This print character ring rotates in the same direction during the printing operation and the resetting operation. The detecting plate 35 has a slit 36 generating the printing signals and a slit 36-S generating the reference signal S. A shield portion 51' extends from the last slit 36 corresponding to the timing signal T_{12} to the slit 36-S.

A spring 63 of the print character ring 9 has one end secured to a hook portion 62 of the print character ring 9 and its other end held by a stationary plate 61 rotating with the shaft 31, so that the printing character ring 9 will be rotated by the spring 63 upon rotation of the shaft 31.

When the print character ring 9 stops, the spring 63 will be wound up by the shaft 31, and when printing is completed and locking of the print character ring is released, then the ring is rotated in the same direction as during the selecting operation by the spring 63 until it has returned to the stand-by condition. No return signal R will be generated. When the print character ring is close to the stand-by position namely a reference signal S will be generated by the slit 36-S and thus no shield plate is required.

Figure 10 illustrates an arrangement where there is no recess in which the spring 39 engages with the shaft 31 to transmit rotation of the shaft 31 to the print character ring 9. In this case, it is necessary to rotate the print character ring 9 by two revolutions during each printing cycle, approximately one revolution taking place during the selecting operation and one during the resetting operation.

Cost may be reduced by replacing the spring 39 with a leaf spring and an energy loss due to winding up coil springs is eliminated by removing the spring 10. Since the shaft 31 rotates two revolutions, the shield plate 51 will be required for eliminating the return signal.

Figure 11 illustrates a modification of a printer of Figure 5. In this embodiment the detecting plate of a plurality of slits 36-1 to 36-12 corresponding to the positions of the print characters on the print character rings and a wider slot 36-13 for producing a wider time or reference signal. In other respects the printer of Figure 1 is similar and operates in the same manner as the printer of Figure 5.

Figure 12 is a time chart illustrating the operation of the printer of Figure 11. Figure 13(a) illustrates a control circuit for detecting synchronisation between print characters on print character rings and the timing

signal. Figure 13(b) illustrates a control circuit for producing a stop command signal and a motor driving signal and Figure 13(c) illustrates control circuitry for detecting the termination of a printing cycle. In Figure 13(a), the thirteenth timing signal is a reference signal, its pulse width being greater than the period α . A δ -time counter measures a period δ to detect that the pulse width of the reference signal is greater than the period δ . A letter counter will be re-set from an output C OUT1 of the δ -time counter so that synchronisation of the print characters with respect time signals can be obtained. A stop signal C OUT-2 is produced after the period γ has elapsed from the leading edge of the reference signal. This stop signal is produced by a γ time counter. A motor driving signal (Q_6) is obtained from a print command signal to a stop command signal.

WHAT WE CLAIM IS:

1. A printer comprising at least one print character ring having on its periphery a plurality of print characters and a detecting means for detecting rotation of the print character ring or rings for producing signals during a printing cycle which comprises a selecting operation for bringing a desired print character or print characters to rest in a printing position, a printing operation for printing said selected print character or print characters on a recording medium and a resetting operation for resetting said selected print character ring or rings to a stand-by condition, the detecting means being arranged to produce a timing signal having one pulse corresponding to each print character during the selecting operation and a reference signal having a greater pulse width than any pulse of the timing signal during said resetting operation, said timing signal indicating a character position on the periphery of the print character ring or rings and said reference signal indicating termination of said resetting operation.

2. A printer as claimed in claim 1 including a time counter for distinguishing between the reference signal and each pulse of the timing signal.

3. A printer as claimed in any preceding claim including a motor for rotating the print character ring or rings, the reference signal, in operation, indicating the timing to de-energise the motor.

4. A printer as claimed in any preceding claim in which the detecting means comprises a slotted disc and photoelectric means for detecting interruption of a light beam as the disc rotates to produce the timing signals and the reference signals.

5. A printer as claimed in claim 4 including means for preventing generation of timing signals during resetting of the print character ring or rings.



second signal by confirming that a timing signal has been generated and then operating the γ -time counter.

Figure 9 shows one form for the print character ring 9 which obviates the necessity for the shield plate 51 of the detector 32. This print character ring rotates in the same direction during the printing operation and the resetting operation. The detecting plate 35 has a slit 36 generating the printing signals and a slit 36-S generating the reference signal S. A shield portion 51' extends from the last slit 36 corresponding to the timing signal T_{12} to the slit 36-S.

A spring 63 of the print character ring 9 has one end secured to a hook portion 62 of the print character ring 9 and its other end held by a stationary plate 61 rotating with the shaft 31, so that the printing character ring 9 will be rotated by the spring 63 upon rotation of the shaft 31.

When the print character ring 9 stops, the spring 63 will be wound up by the shaft 31, and when printing is completed and locking of the print character ring is released, then the ring is rotated in the same direction as during the selecting operation by the spring 63 until it has returned to the stand-by condition. No return signal R will be generated. When the print character ring is close to the stand-by position namely a reference signal S will be generated by the slit 36-S and thus no shield plate is required.

Figure 10 illustrates an arrangement where there is no recess in which the spring 39 engages with the shaft 31 to transmit rotation of the shaft 31 to the print character ring 9. In this case, it is necessary to rotate the print character ring 9 by two revolutions during each printing cycle, approximately one revolution taking place during the selecting operation and one during the resetting operation.

Cost may be reduced by replacing the spring 39 with a leaf spring and an energy loss due to winding up coil springs is eliminated by removing the spring 10. Since the shaft 31 rotates two revolutions, the shield plate 51 will be required for eliminating the return signal.

Figure 11 illustrates a modification of a printer of Figure 5. In this embodiment the detecting plate of a plurality of slits 36-1 to 36-12 corresponding to the positions of the print characters on the print character rings and a wider slot 36-13 for producing a wider time or reference signal. In other respects the printer of Figure 1 is similar and operates in the same manner as the printer of Figure 5.

Figure 12 is a time chart illustrating the operation of the printer of Figure 11. Figure 13(a) illustrates a control circuit for detecting synchronisation between print characters on print character rings and the timing

signal. Figure 13(b) illustrates a control circuit for producing a stop command signal and a motor driving signal and Figure 13(c) illustrates control circuitry for detecting the termination of a printing cycle. In Figure 13(a), the thirteenth timing signal is a reference signal, its pulse width being greater than the period α . A δ -time counter measures a period δ to detect that the pulse width of the reference signal is greater than the period δ . A letter counter will be re-set from an output C OUT-1 of the δ -time counter so that synchronisation of the print characters with respect time signals can be obtained. A stop signal C OUT-2 is produced after the period γ has elapsed from the leading edge of the reference signal. This stop signal is produced by a γ time counter. A motor driving signal (Q_0) is obtained from a print command signal to a stop command signal.

WHAT WE CLAIM IS:

1. A printer comprising at least one print character ring having on its periphery a plurality of print characters and a detecting means for detecting rotation of the print character ring or rings for producing signals during a printing cycle which comprises a selecting operation for bringing a desired print character or print characters to rest in a printing position, a printing operation for printing said selected print character or print characters on a recording medium and a resetting operation for resetting said selected print character ring or rings to a stand-by condition, the detecting means being arranged to produce a timing signal having one pulse corresponding to each print character during the selecting operation and a reference signal having a greater pulse width than any pulse of the timing signal during said resetting operation, said timing signal indicating a character position on the periphery of the print character ring or rings and said reference signal indicating termination of said resetting operation.

2. A printer as claimed in claim 1 including a time counter for distinguishing between the reference signal and each pulse of the timing signal.

3. A printer as claimed in any preceding claim including a motor for rotating the print character ring or rings, the reference signal, in operation, indicating the timing to de-energise the motor.

4. A printer as claimed in any preceding claim in which the detecting means comprises a slotted disc and photoelectric means for detecting interruption of a light beam as the disc rotates to produce the timing signals and the reference signals.

5. A printer as claimed in claim 4 including means for preventing generation of timing signals during resetting of the print character ring or rings.

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6. A printer substantially as herein described with reference to and as shown in the accompanying drawings.

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