

[54] **DEVICE FOR FEEDING A PRINTER HEAD**
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[52] U.S. Cl. **197/1 R**, 197/66, 197/82
[51] Int. Cl. **B41j 1/34**
[58] Field of Search 197/66, 63, 65, 70, 16, 197/19, 55, 1 R, 82; 101/93 C

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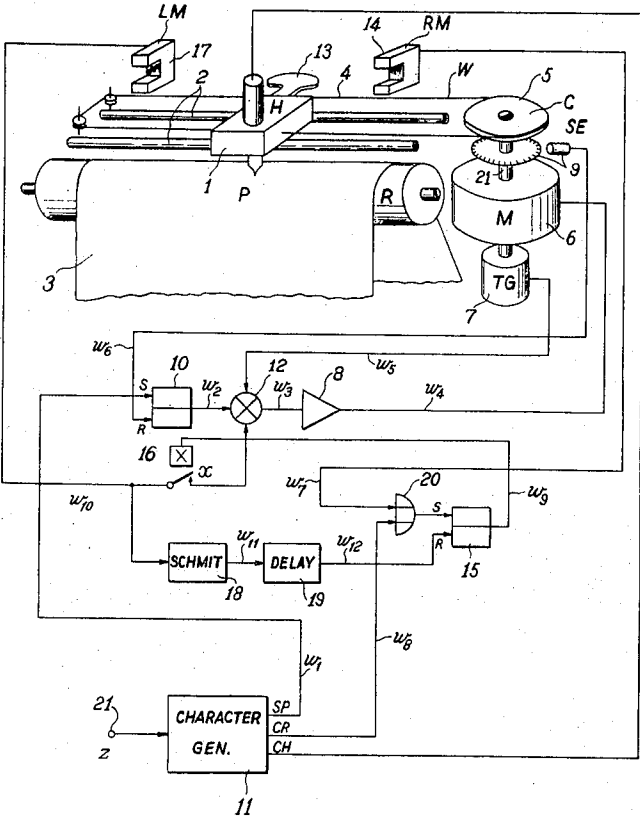
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ABSTRACT

A device for feeding a printer head, in which a non-contact switch is provided along a straight path of the printer head so as to couple with the printer head at its end position. When the noncontact switch is coupled with the printer head in access to the end position, the noncontact switch assumes a second output state different from a first state generated at no coupling between the noncontact switch and the printer head. Shock of the printer head at the return motion to the end position is effectively reduced by utilizing change of states of the output of the noncontact switch.

5 Claims, 6 Drawing Figures



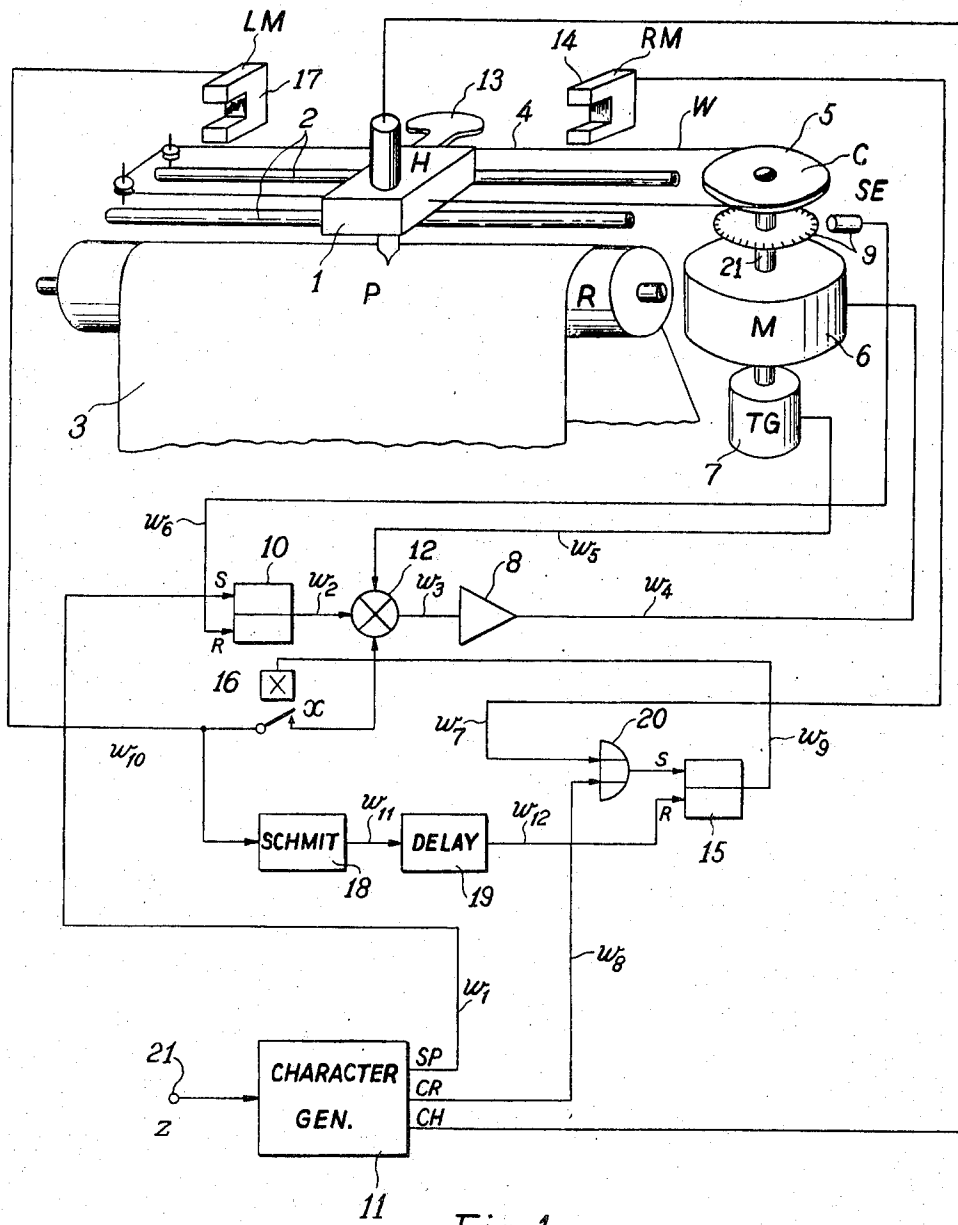


Fig. 1

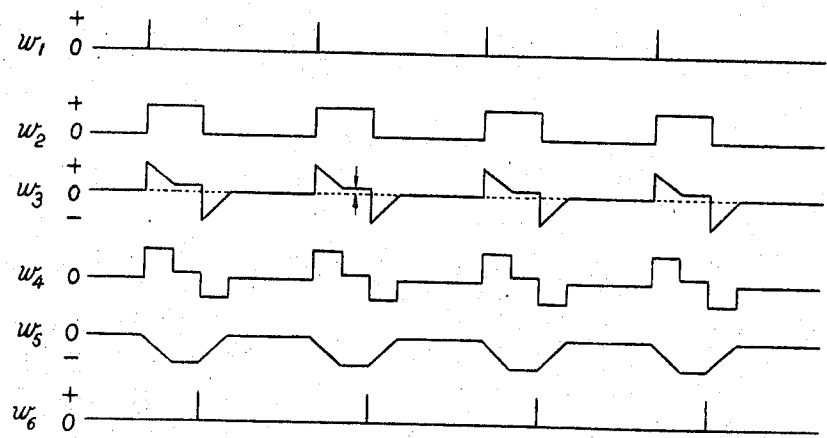


Fig. 2A

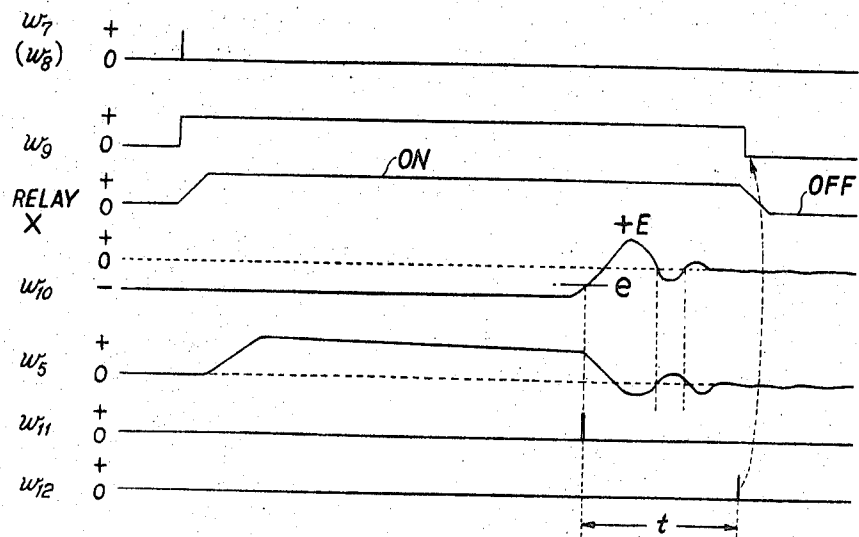


Fig. 2B

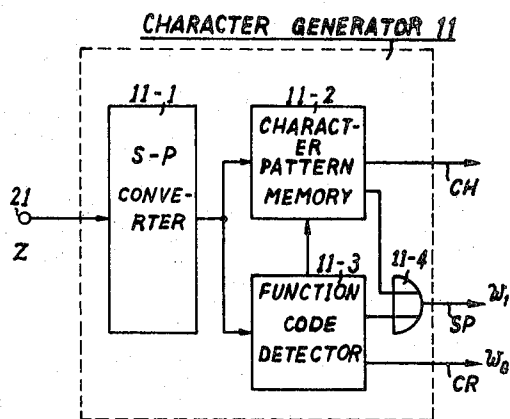


Fig. 3

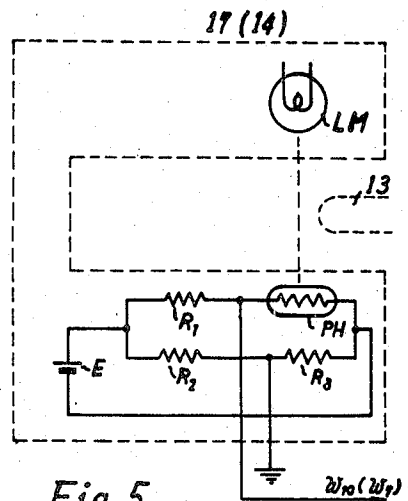


Fig. 5

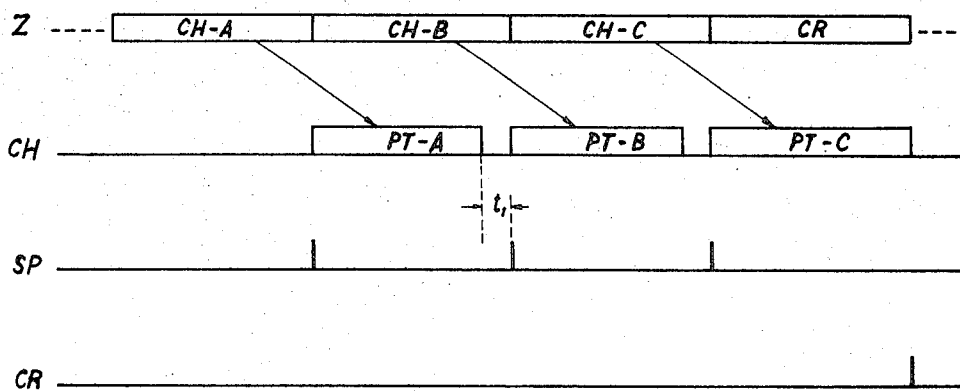


Fig. 4

DEVICE FOR FEEDING A PRINTER HEAD

This application is a continuation-in-part of my co-pending application, Ser. No. 100,116 filed on Dec. 21, 1970 and now abandoned.

This invention relates to a feed device of a printer head.

Conventional feed devices for a printer head used in a teleprinter etc. usually employ a ratchet-wheel system. However, this ratchet-wheel system has such disadvantages as difficulty of high speed spacing, numerous mechanical parts, troublesome maintenance, high noise and low reliability. Moreover, a dash pot is necessary at the starting position of a travelling path of the printer head to absorb the mechanical shock caused by the return of the printer head.

An object of this invention is to provide a feed device for a printer head capable of resolving the above-mentioned defects of conventional devices and having merits, such as simple construction, high operation speed, no noise and high reliability.

The principle, construction and operation of the feed device for a printer head of the present invention will be clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view including a circuit diagram illustrating one embodiment of this invention;

FIG. 2A shows time charts explanatory of a stepping operation in the embodiment shown in FIG. 1;

FIG. 2B shows time charts explanatory of a return operation in the embodiment shown in FIG. 1;

FIG. 3 is a block diagram illustrating an example of a character generator used in this invention;

FIG. 4 shows time charts explanatory of the operation of the example shown in FIG. 3; and

FIG. 5 is a circuit diagram illustrating an example of a limit switch employed in this invention.

With reference to FIG. 1, a printer head 1 moves in the right and left directions on guide rails 2 so as to print characters on a printing paper 3 by a known technique, such as a pen, inkjet or electrostatic recording. In response to the printing of a character, the printer head 1 is moved as described below, by a step of one character spacing, in the right direction to be ready for printing a next character. The printer head 1 is coupled with a capstan 5 by a cable 4, so that the printer head 1 is shifted by the drive of the capstan 5. Accordingly, the capstan 5 is rotated through an angle corresponding to a step of a character spacing to shift the printer head 1 by the step of a character.

This step rotation of the capstan 5 is performed by a high speed incremental servo mechanism comprising a dc rate servo loop and a position loop. The dc rate servo loop, which is one of electro-mechanical negative feedback circuits, comprises a low inertia motor 6 (e.g.; a print motor), a speed generator or tachometer 7, a high-gain dc amplifier 8 and an adder 12. The motor 6 is a reversible motor having a direction of rotation determined by the polarity of a voltage applied thereto. The speed generator 7 develops an output voltage having a magnitude proportional to the speed of rotation of the speed generator 7 and a polarity representative of the direction of rotation of the speed generator 7. The position loop comprises a shaft encoder 9 generating a pulse for each rotation of a predetermined angle corresponding to the step of a character, and a bistable circuit 10 for controlling the start and stop of

the motor 6. The bistable circuit 10 is composed of a flip-flop circuit, by way of example as shown in "Computer Handbook" pages 12-14, McGraw Hill (1962), and produces an output w_2 having two stable states respectively corresponding to the positive high potential and the zero potential in response to a pulse w_6 applied by the shaft encoder 9 or in response to a pulse w_1 applied by the character generator 11. The output w_2 is applied to an adder 12 to shift the printer head 1 by a step corresponding to one character position as mentioned above.

With reference to FIGS. 1, 2A and 2B, operation of this embodiment is performed as follows. When a telegraph signal z is applied to an input terminal 21, a character generator 11 applies a character pattern to the printer head 1 through a line CH. The character generator 11 is composed of a read-only memory, by way of example, which converts the telegraphic signal z into a character pattern such as a dot-matrix character corresponding to the telegraphic signal z applied. A type pattern corresponding to the telegraphic signal z is printed on the printing paper 3 in accordance with a suitable printing method as mentioned above. When each printing operation is completed, a spacing pulse w_1 generated from the character generator 11 is applied through a line SP to the set terminal of the bistable circuit 10 to set the bistable circuit 10, so that the output signal w_2 of the bistable circuit 10 assumes the high positive potential as shown in FIG. 2A from the zero potential. This output signal w_2 is applied to an adder 12, which generates an output w_3 applied to the dc amplifier 8. The adder 12 is employed for adding, in reverse polarity, the feedback signal w_5 to the signal w_2 for shift spacing or a later described signal w_{10} for resetting the printer head 1. The adder 12 is an element of the above mentioned dc rate servo. The adder 12 is, for example, a resistance network comprising three resistors which are respectively inserted in three inputs thereof and jointly connected to one another to obtain the output w_3 . The dc amplifier generates an output signal w_4 and the motor 6 is driven by the output w_4 of the dc amplifier 8. Because of the high gain of amplifier 8, signal w_3 drives the amplifier 8 into saturation so that the amplifier output signal w_4 has the rectangular waveform shown in FIG. 2A.

On the shaft 21 of the motor 6, the speed generator 7, the shaft encoder 9 and the capstan 5 are fixed. The output w_5 of the speed generator 7 is fed back to the adder 12 in a reverse polarity to the signal w_2 so as to improve the rapid start and stop characteristics of the motor 6. As mentioned above, the dc rate servo loop formed by the motor 6, the speed generator 7, the dc amplifier 8 and the adder 12 is a negative feedback loop. Accordingly, the signal w_5 fed back to the adder 12 must have a polarity reverse to that of the signal w_2 or w_{10} for the rate servo loop to function properly. Since the signals w_2 and w_{10} are not generated at the same time, the feedback signal w_5 and one of the signals w_2 or w_{10} are applied to the inputs of the adder 12. An example of the above feedback loop is disclosed in a publication "COMPUTER DESIGN", Dec. 1968, pages 36-43. An example of the adder 12 is a summing network disclosed in the same publication, or a circuit disclosed in the publication "HANDBOOK OF OPERATIONAL AMPLIFIER APPLICATIONS," BURR-BROWN (1963), pages 16-17.

Because the signal w_2 is applied to the adder 12 having a positive polarity, the feedback signal w_5 is applied to the adder 12 having a negative polarity. The motor 6 accelerates the load coupled therewith to a speed established by the voltage w_2 and then drives the speed generator 7, which in turn feeds back a negative voltage w_5 to the adder 12. This negative voltage w_5 is in proportion to the number of revolutions of the motor 6. The motor 6 continuously accelerates the load until the feedback voltage of the speed generator 7 becomes equal to the input voltage w_2 . At this time, acceleration ceases and the speed of the motor 6 remains constant.

When the motor 6 rotates through a predetermined angle corresponding to half a character spacing, a pulse w_6 is generated from the shaft encoder 9 to reset the bistable circuit 10, the output of which is charged to zero from the high potential as shown in FIG. 2A. Therefore, the input signal to the dc amplifier 8 is only supplied from the speed generator 7, and motor 6 rapidly decelerates due to the backward driving torque until it stops with an additional half revolution, so that one character step rotation is performed. This step rotation is transferred to the capstan 5 so that the printer head 1 is shifted by a step of one character space in the right direction by the cable 4.

In a manner similar to the above-mentioned operation, the printer head 1 is shifted by a step of one character space for each input signal z . When a shutter 13 provided on the printer head 1 reaches a noncontact switch 14, this noncontact switch 14 generates a pulse w_7 , and the combination of the shutter 13 and the noncontact switch 14 comprises a limit switch. The signal w_7 is unnecessary for the normal printing operation. However, in a case where the printer head has been shifted to the rightmost position or the below mentioned carriage return signal has been lost for any reason, the signal w_7 is employed to generate a carriage self-return signal for resetting the printer head 1 to provide normal printing on the printing paper 3. When a return carriage signal for restoring the printer head 1 is applied to the input terminal 21 at a condition where the printer head 1 positions at the right end or between the noncontact switches 17 and 14, the character generator 11 generates a pulse w_8 for the carriage return on a line CR. The pulse w_8 is employed for restoring the printer head 1 to the normal printing condition. The pulse w_7 or w_8 sets a bistable circuit 15, which controls the return motion of the printer head 1, so that an output w_9 of the bistable circuit 15 energizes a relay 16 so as to close its contact x . The output of the noncontact switch 17 has three signal conditions, namely, a negative voltage, the zero potential and a positive voltage, and they change continuously in accordance with the relative positions of the noncontact switch 17 and the shutter 13. Accordingly, an output w_{10} of a noncontact switch 17 is applied to the adder 12 through the contact x of the relay 16. In this case, since the noncontact switch 17 is not coupled with the shutter 13, the output signal w_{10} of the switch 17 is a negative voltage as shown in FIG. 2B. Accordingly, when the contact x of the relay 16 is closed in response to the output signal w_9 of the bistable circuit 15, the signal w_{10} having a negative polarity is applied to the adder 12.

The noncontact switch 17 generates a negative voltage when the shutter 13 of the printer head 1 is not coupled with this noncontact switch 17, while the negative voltage is changed to zero and then a positive voltage

in response to coupling of the shutter 13 with this noncontact switch 17. In other words, the combination of the shutter 13 and the noncontact switch 17 comprises a limit switch. As mentioned above, since the feedback signal w_5 is applied to the adder 12 in a polarity reverse to the signal w_2 or w_{10} , if the signal w_{10} is applied to the adder 12 having a negative polarity, the feedback signal w_5 assumes a positive polarity so that the motor 6 rotates in a clockwise direction to shift the printer head to the left. On the other hand, if the signal w_{10} or w_2 is applied to the adder 12 having a positive polarity, the signal w_5 assumes a negative polarity so that the motor 6 rotates in the counterclockwise direction to shift the printer head to the right. Accordingly, when the signal w_{10} is now applied to the adder 12 having a negative polarity, the motor 6 starts a rotation in a direction reverse to the abovementioned forward spacing so as to shift the printer head 1 to the left margin. When the shutter 13 is coupled with the noncontact switch 17 at the termination of the return motion of the printer head 1, an output w_{10} of the noncontact switch 17 is changed from the negative polarity to zero and then the positive polarity. Accordingly, the motor 6 is repeatedly stopped after damped motions, in which the motor 6 is alternately driven in the forward direction and in the backward direction as understood from the wave form of the output w_{10} shown in FIG. 2B during the coupling of the shutter 13 with the noncontact switch 17. In this case, the speed generator 7 generates the output w_5 in a polarity, which is the reverse of the polarity of the output w_{10} .

A schmitt trigger 18 generates a pulse w_{11} when the output w_{10} of the noncontact switch 17 reaches a predetermined level e . This pulse w_{11} is delayed, by a time t , in a delay circuit 19 so as to obtain a pulse w_{12} . This pulse w_{12} resets the bistable circuit 15 to open the contact x of the relay 16, so that the return motion of the printer head 5 is completed. The delay time t of the delay circuit 19 is determined as a time terminated after the stop of the damped motion of the motor 6 and the printer head 5. As understood from the above operation, the return motion of the printer head 1 to the leftmost position is carried out without any substantial mechanical shock being imparted by the printer head 1 and such is accomplished without the use of a dash pot.

With reference to FIG. 3, an example of the character generator 11 comprises a series-parallel signal converter 11-1, a character pattern memory 11-2, a function code detector 11-3 and an OR circuit 11-4. The serial-parallel signal converter 11-1 converts serial telegraphic signals z to parallel telegraphic signals. The character pattern memory 11-2 is a read-only memory, which generates character patterns PT-A, PT-B, PT-C . . . on the line CH in response to the telegraphic signals CH-A, CH-B, CH-C, . . . as shown in FIG. 4. After a time t_1 from the generation instant of each character pattern, the space pulse w_1 is generated from the character pattern memory 11-2 and applied to the OR circuit 11-4. The function code detector 11-3 generates the space pulse w_1 and the carriage return pulse w_8 in response to each space character and each carriage return character respectively. The function code detector 11-3 temporarily stops the operation of the character pattern memory 11-2 when it generates the outputs thereof. An example of the character generator 11 is

disclosed in the publication "ELECTRONICS," May 29, 1959, page 83.

With reference to FIG. 5, an example of the noncontact switch 17 or 14 comprises a lamp LM, a photoconductor PH, resistors R_1 , R_2 and R_3 and a dc source E. The photoconductor PH and the resistors R_1 , R_2 and R_3 forms a bridge circuit. The conductivity of the photoconductor is changed in accordance with the illumination from only the lamp LM. Accordingly, when the shutter 13 is inserted between the lamp LM and the photoconductor PH, the output w_{10} or w_7 varies as shown in FIG. 2B.

What I claim is:

1. A device for feeding a printer head, comprising: feeding means for feeding the printer head along a straight path in a forward direction and a backward direction, said feeding means comprising a rotary capstan, a cable coupled to said capstan, a motor connected to said capstan to rotatally drive the same, and a shaft encoder for encoding the rotated angle of the motor;

drive means for driving the motor to effect stepwise motion of the printer head in the forward direction by the use of a step pulse and the output of the shaft encoder and to effect movement of the printer head in one motion in the backward direction by the use of a return pulse; a noncontact switch arranged along the straight path to coupled with the printer head as the printer head moves therealong, said noncontact switch having a first state wherein the noncontact switch delivers an output signal to said motor to feed the printer head in the backward direction when the noncontact switch is not coupled with the printer head, having a second state wherein the noncontact switch delivers another output signal to said motor to feed the

printer head in the forward direction when the noncontact switch is coupled with the printer head in advance of the printer head reaching an end position, and having a third state wherein the noncontact switch does not deliver any output signal when the printer head is returned to said end position; and

switch means connected between the output of the noncontact switch and the drive means to be closed in response to the return pulse and to be opened when said noncontact switch is in said third state to control the pulses applied to said motor.

2. A device for feeding a printer head according to claim 1, further comprising detection means connected to said noncontact switch to detect the change of said states of the output of the noncontact switch from the first state to the second state, and delay means for delaying the opening of the switch means by a time longer than an initial damped fluctuation of the output of the non-contact switch after the detection means detects said change of states.

3. A device for feeding a printer head according to claim 2, in which the detection means includes a schmitt trigger.

4. A device for feeding a printer head according to claim 1, in which the noncontact switch comprises a pair of a lamp and a photoconductor opposed to each other at an air gap, and a shutter fixed to the printer head so as to coupled with the air gap at the end position of the printer head.

5. A device for feeding a printer head according to claim 1, further comprising a speed generator driven by said motor to control the drive means by the use of the output of the speed generator so as to apply a suitable brake action to the drive means.

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