

[54] **PRINTER**

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335/229, 230, 235

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[57] **ABSTRACT**

A printer is provided with a plurality of print hammers, each of which is maintained in a rest position engaging a deformed elastic body. Individual magnetic circuits in combination with a single permanent magnet are provided for selectively maintaining each of said print hammers in said rest position and for selectively releasing said print hammers to effect printing. Each magnetic circuit consists of a first portion including a device for adjusting the reluctance of said second portion upon release of the associated print hammer. The first and second portions are connected in parallel with a permanent magnet common to at least two print hammers. Each of said print hammers is released from its rest position by exciting a control coil in said magnetic circuit in a direction such that the magnetomotive force applied to said print hammer to hold said print hammer in position is decreased, the displacement of the print hammer being the product of the release of the energy of the elastic body.

11 Claims, 3 Drawing Figures

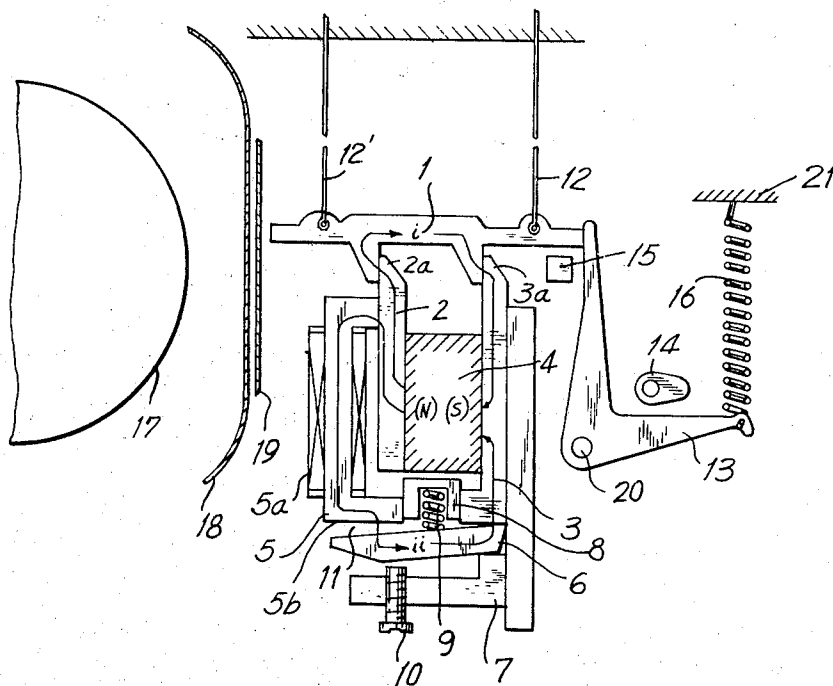


FIG. 1

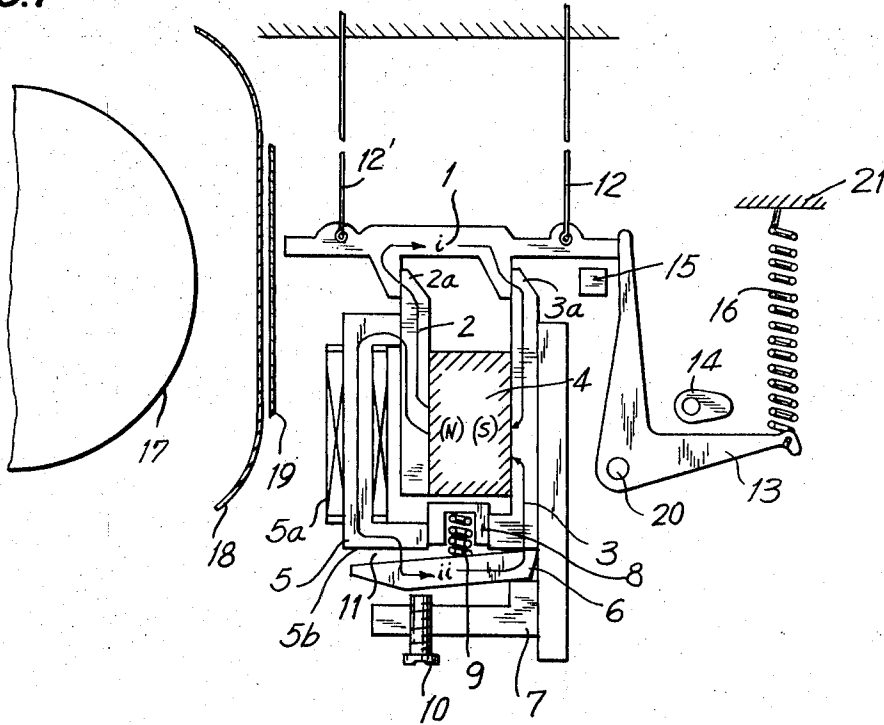
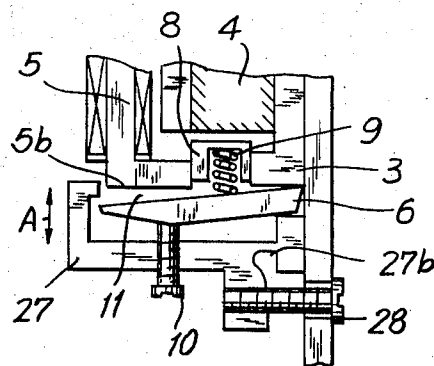


FIG. 2



BACKGROUND OF THE INVENTION

This invention relates generally to a control mechanism for the print hammers of an on-the-fly printer, and particularly to a control mechanism for such print hammers wherein displacement of any individual print hammer has no influence upon the operation of any other adjacent print hammer.

While the use of printers wherein the print hammers are held in a rest position by a permanent magnet and are forced into contact with a printing surface by a deformed elastic body have taken various forms, embodiments of such printers incorporating a single permanent magnet for a plurality of print hammers have yielded results which are less than completely satisfactory. Because the force which is utilized to overcome the deformed elastic body is the force of a permanent magnet, and because it is necessary to reduce the force in order to release the hammer, a change in the reluctance of the portion of the magnetic circuit including the permanent magnet and the print hammer occurs upon the release of each print hammer. The change in the reluctance of the magnetic circuit affects the operating point of the permanent magnet which is used to control a plurality of individual hammers, each associated with a separate print column. Normally, the reluctance of the hold portion of the magnetic circuit is increased when the associated print hammer is released, thus decreasing the permeance coefficient of the permanent magnet. This decrease in the permeance coefficient of the permanent magnet effects an increase in the magnetomotive force of the magnet at the hammer hold portion of the adjacent columns in which the hammer has not yet been released, hence increasing the force holding said adjacent print hammers at their rest positions, thus altering the control parameters and conditions of said adjacent print hammers. The foregoing defect is avoided by providing a hammer mechanism wherein the operating point of the permanent magnet is not changed when a print hammer of one of the print columns is operated.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, a printer is provided having a plurality of print hammers displaceable between a rest position and a printing position, an elastic body maintained in a deformed state by each of said print hammers at its rest position, and a magnetic circuit control means for maintaining each of the print hammers at its rest position and for selectively releasing the associated print hammer on command. Each said magnetic circuit control means includes a control coil, a first portion including a portion of the print hammer, and a second portion including means for varying the reluctance of said magnetic circuit control means upon release of the associated print hammer. The first and second portions of each magnetic circuit control means are connected in parallel with a permanent magnet common to a plurality of said magnetic circuits. Each magnetic circuit control means is adapted so that the associated print hammer is normally retained in said rest position by the magnetomotive force applied thereto, said magnetomotive force being decreased upon the excitation of said control coil, said print hammer being displaced

from said rest to printing positions by the stored energy of said elastic body. The variable reluctance means adjusts the reluctance of the magnetic circuit control means so that when said print hammer is released from said rest position, the operating point of said permanent magnet is maintained is substantially the same state as when all hammers are in the rest position.

Accordingly, it is an object of this invention to provide an improved printer wherein a hammer is held at a rest position by the magnetic force generated by a permanent magnet while storing energy in an elastic body such as a spring.

Another object of the invention is to provide an improved hammer control mechanism for a printer which may be actuated by relatively small control current.

Still another object of the invention is to provide a printer having a plurality of hammers controlled by a common permanent magnet and individual column circuit control devices wherein the operation of one of said hammers does not affect the operation of any of the adjacent hammers.

Still another object of the instant invention is to provide a printer having a plurality of hammers controlled by a permanent magnet and individual column magnetic circuit control devices, wherein the release of one hammer by altering the magnetic field holding such hammer will have no influence on the operating point of the permanent magnet.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a partially sectioned side elevational view of the operative portion of one column of a printer including variable reluctance means constructed in accordance with the instant invention;

FIG. 2 is a side elevational view of a second embodiment of the variable reluctance means constructed in accordance with the instant invention; and

FIG. 3 is a side elevational view of still another embodiment of an operative portion of one column of a printer including variable reluctance means constructed in accordance with the instant invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, one column of a multi-column printer is depicted. The printer includes a hammer 1 mounted for longitudinal displacement on suspending springs 12. A magnetic circuit for the control of the displacement of the hammer is provided having a first portion consisting of yokes 2 and 3 having attractive faces 2a and 3a respectively for holding hammer 1 in a rest position, as illustrated in FIG. 1, by means of the magnetic field caused by the flux from a permanent magnet 4 and depicted as loop *i*. A second portion of said magnetic circuit illustrated by loop *ii* is formed by permanent magnet 4, a portion of yoke 2, a control coil

5a wound about a yoke 5, gap 11 between attractive face 5b of yoke 5 and attractive plate 6, and is completed by a portion of yoke 3. The rear end of hammer 1 is disposed in contact with transmitting lever 13, which lever is pivoted about pivot 20 and which lever further engages and deforms drive spring 16 when the hammer is in the rest position as illustrated in FIG. 1. The drive spring is further supported by a reference member such as fixing plate 21. The stroke of transmitting lever 3 is limited by a stopper 15 which is struck by said lever before the hammer strikes recording paper 19 and inked ribbon 18 against print drum 17. It is noted that the print energy can be adjusted by changing the distance over which the spring force is applied to the hammer by positioning stopper 15. Reset cam 14 is provided for returning the print hammer and spring to a rest position after the hammer is operated and the printing is completed by rotating cam 14 against the lower portion of the transmitting lever 13 to thereby deform the spring into the rest position. Printing is effected by engagement of the front end of hammer 1 against recording paper 19 to force the recording paper against an ink ribbon 18 and the surface of a character-carrying drum 17. Drum 17 is continuously rotating and has a series of characters circumferentially spaced in alignment with the column represented by FIG. 1. In practice, one such circumferential array of characters would be provided for each column of the printer. The characters may consist of symbols, numbers or letters as desired.

The attractive plate 6 is maintained at a distance from the attractive face 5b of yoke 5 by means of a spring 9 which spring is secured by a cap 8 formed of an insulating material. The width of the gap 11 formed between attractive face 5a and attractive plate 6 is regulated by a gap adjusting screw 10 which is secured by a stand 7, which stand further provides a surface for pivotally supporting attractive plate 6 between stand 7 and yoke 3.

The operation of the arrangement in accordance with the invention is best understood by reference to FIG. 1 which is depicted at the rest position of hammer 1. At this position, hammer 1 is held by the attractive faces 2a and 3a of yokes 2 and 3 due to the holding force generated by the magnetic flux loop *i* which includes the hammer, yokes 2 and 3 and permanent magnet 4. The holding force applied to hammer 1 is sufficient to overcome the driving force of drive spring 16 and is further sufficient to hold the hammer in position despite the influence of changes in temperature, vibration and the like. As hereinabove noted, a second loop *ii* is formed, including permanent magnet 4 and is connected in parallel with the first loop *i*. The flux in loop *i* is much smaller than the flux in loop *ii* because of the gap 11, permitting effective use of the permanent magnet within its limited capacity.

As noted above, character-carrying drum 17 rotates at a predetermined speed. When the selected character approaches alignment with hammer 1, a signal is applied to control coil 5a. The direction of the signal applied to control coil 5a is such as to increase the quantity of magnetic flux flowing in magnetic flux loop *ii*. When the magnetic flux in loop *ii* is increased, the flux in loop *i* is decreased, thus decreasing the holding force on the hammer, allowing the holding force to be overcome by the force of drive spring 16 acting upon said hammer. The print hammer is driven in the direction of

the character on the print drum by the spring and continues to be supplied with energy until the transmitting lever 13 is brought into contact with stopper 15. As the print hammer strikes against the character drum the printing function is performed. The print hammer rebounds off the print drum to return to the rest position, spring 16 being returned to the rest position by reset cam 14.

As has been pointed out above the printer illustrated in FIG. 1 represents only one column of a line printer. The printer includes a plurality of columns each including a print hammer. Although each hammer has a separate magnetic circuit for that column, the magnetic circuits of all or a portion of the columns share the use of the same permanent magnet 4. Thus, when one such hammer is released in the manner hereinabove discussed, the reluctance of the associated magnetic circuit including the permanent magnet is changed, altering the operating point of the permanent magnet. Alteration of the operating point of the permanent magnet affects the other columns which have hammer magnetic circuits cooperating with the same permanent magnet, the hammers of which have not yet been released from their respective hammer hold positions. The alteration in the operating point of the permanent magnet increases the amount of magnetic flux flowing through the hammer hold portion of the magnetic circuits of the adjacent columns which have not yet been released. This increase in the amount of flux in the adjacent columns causes an increase in the force of loop *i* in the other columns and a stronger signal must then be applied to the control coils of the adjacent columns in order to allow the hammers of such adjacent columns to be released. Moreover, even if the power is sufficient to release the hammer of the adjacent columns an increased time is required to supply the current needed for releasing such adjacent hammers. Variations in the time between the application of a print command and the release of the associated hammer depending on whether another hammer has previously been released results in a reduction in printing quality.

The above-mentioned defects are eliminated in the instant invention by providing a variable reluctance means as part of magnetic flux loop *ii*. When the print hammer is released from the hammer hold position such release is effected by an increase in the flux in loop *ii* by the application of a signal to control coil 5a. The increase of flux in loop *ii* causes attractive plate 6 to be attracted closer to attractive face 5b, thus narrowing the gap 11 therebetween. As the print hammer is released from the hammer hold portion and is moved toward the character, most of the magnetic flux generated by permanent magnet 4 flows into loop *ii*. Because of the deflection of the attractive plate 6 towards attractive face 5b, the reluctance seen by the permanent magnet 4 remains constant and the operating point of the permanent magnet is maintained substantially constant regardless of the position of the print hammer. Accordingly, the print hammers can be controlled with a minimum of electric power and the time between print command and the striking of the hammer against the character is maintained constant for all of the hammers regardless of the conditions of the other columns so that printing quality is enhanced.

Reference is now made to FIG. 2 wherein means are provided for adjusting the variable reluctance means to

provide precise adjustment thereof. Like reference numerals are used to denote like elements illustrated in FIG. 1. A stand 27, formed of a non-magnetic material, is provided for gap adjusting screw 10 which stand includes a stopper portion 27a for adjusting the minimum gap between the attractive plate 6 and the attractive face 5b when the attractive plate 6 is attracted to said attractive face during application of a print command signal. Adjusting screw 10 is included for selecting the width of the gap 11 during the period when the hammer is in the rest position. The minimum width of the gap 11 when the attractive plate 6 is moved toward control coil 5 during movement of the hammer is adjusted by means of screw 28. The stopper portion 27a of stand 27 is moved in the direction of arrow A about a pivot defined by thinned portion 27b of stand 27. Accordingly, by selecting the gap width at the time when the print hammer is released from the hammer hold position and the attractive plate 6 is attracted to the attractive face 5b, it is possible to adjust the reluctance of the hammer magnetic circuit defined by loop *ii* so that the reluctance seen by the permanent magnet remains essentially constant before and after release of the print hammer, thus maintaining constant the operating point of permanent magnet 4.

Reference is now made to FIG. 3 wherein like reference numerals are used to denote like elements. In FIG. 3, the two parallel magnetic loops are defined, but the control signal supplied to coil 5a is supplied in loop *i* to decrease the flux of loop *i* by applying a magnetic field in a direction opposite to that produced by the permanent magnet. As is appreciated by the skilled artisan, by use of the variable reluctance means hereinabove described the same beneficial effect is achieved and permanent magnet 4 is maintained at a substantially constant operating point.

As is understood, a printer constructed in accordance with the instant invention wherein the print hammer is supplied with energy of a deformed elastic body according to a print command, is operated so that the actuation of one print column does not influence any other columns. Thus print hammers can be controlled by the use of very small amounts of electric power to thus realize stable action of the hammers without the necessity of supplying complicated controls.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A printer comprising at least two print hammers each displaceable between a rest and a print position; an elastic body maintained in a deformed position by each of said print hammers at its respective rest position; and magnetic circuit control means for holding each said hammer at said rest position and releasing same for selective displacement to said print position

by the energy of said deformed elastic body, including a permanent magnet common to at least two of said print hammers for producing the magnetomotive force for holding said print hammers at their rest positions, a portion of each of said print hammers forming a part of the associated magnetic circuit control means when at their rest positions, a control coil associated with each print hammer and positioned so that the magnetomotive force applied to said print hammer is decreased upon the application of a signal to the associated control coil to release said print hammer to effect printing, and means for varying the reluctance of each of said magnetic circuit control means upon the release of the associated print hammer to maintain the operating point of said permanent magnet substantially constant before and after the release of said associated print hammer from its rest position.

2. A printer as recited in claim 1, wherein each said magnetic circuit control means includes a first portion including said portion of said print hammer and a second portion including said variable reluctance means, said first and second portions being connected in parallel with said permanent magnet and each other.

3. A printer as recited in claim 2, wherein said variable reluctance means includes means defining a gap in said second portion and means responsive to the magnetomotive force generated by the application of said signal to said control coil for adjusting the width of said gap so as to narrow said gap upon the release of the associated print hammer.

4. A printer as recited in claim 3, wherein said variable reluctance means includes a fixed magnetic circuit member magnetically coupled to said control coil and defining an attractive face and an attractive plate mounted for displacement toward and away from said attractive face to define said gap, said attractive plate being displaced toward said attractive face in response to the magnetomotive force of said control coil.

5. A printer as recited in claim 4, wherein said variable reluctance means includes means for biasing said attractive plate in a position defining a maximum gap width.

6. A printer as recited in claim 5, wherein said variable reluctance means includes means for selectively setting said maximum gap width.

7. A printer as recited in claim 6, wherein said attractive plate is pivotally mounted, said means for selectively setting said maximum gap being a setting screw.

8. A printer as recited in claim 6, wherein said variable reluctance means includes stopper means in the path of said attractive plate toward said attractive face to define a minimum gap width.

9. A printer as recited in claim 8, wherein said variable reluctance means includes means for selectively positioning said stopper means to set said minimum gap width.

10. A printer as recited in claim 4, wherein said variable reluctance means includes stopper means in the path of said attractive plate toward said attractive face to define a minimum gap width.

11. A printer as recited in claim 10, wherein said variable reluctance means includes means for selectively positioning said stopper means to set said minimum gap width.

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