ELECTROMAGNETIC ACTUATING MEANS FOR PRINT HAMMERS

Inventors: Jonas E. Dayger, Binghamton; Albert A. Dowd, Vestal; Joseph A. Vrubic, Binghamton, all of N.Y.

Assignee: International Business Machines Corporation, Armonk, N.Y.

Filed: Dec. 28, 1970

Appl. No.: 101,654

Primary Examiner—William B. Penn
Attorney—Hanifin & Jancin and Francis V. Giolma

ABSTRACT

A print hammer is supported by a cantilever spring and carries a pawl which is actuated by electromagnetic means into the path of teeth on a continuously rotating reamer shaft to impel the hammer to impact a document and a ribbon against type characters on a type chain or the like. Movement of the print hammer resets the armature of the electromagnetic means.

9 Claims, 3 Drawing Figures
ELECTROMAGNETIC ACTUATING MEANS FOR PRINT HAMMERS

FIELD OF THE INVENTION

The invention relates generally to printers and it has reference in particular to a print hammer mechanism in which the drive is provided by a continuously rotating reamer shaft.

DESCRIPTION OF THE PRIOR ART

Print hammer mechanisms using reamer shaft drives are known such as, for example, described in U. S. Pat. No. 3,292,531, which issued on Dec. 20, 1966, to G. Mutz.

SUMMARY OF THE INVENTION

Generally stated, it is an object of the invention to provide an improved print hammer mechanism.

More specifically, it is an object of the invention to provide an improved reamer shaft drive print hammer mechanism.

Another object of the invention is to provide a print hammer mechanism requiring a minimum of operating power.

Yet another object of the invention is to provide a print hammer mechanism having a fail-safe characteristic.

Still another object of the invention is to provide a print hammer mechanism requiring a minimum of control circuitry.

It is also an object of the invention to provide a simple and accurate print hammer operating mechanism.

Another important object of the invention is to provide a print hammer mechanism which is consistent and reliable in its operation.

The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawing.

DESCRIPTION OF THE DRAWING

In the drawing

FIG. 1 is a partial schematic view in side elevation and partly sectioned of a print hammer mechanism embodying the invention in a preferred form,

FIG. 2 is a similar schematic view of a portion of a mechanism shown in FIG. 1 showing the initial drive connection between the print hammer and the reamer drive shaft, and

FIG. 3 is a similar schematic view of a portion of the mechanism shown in FIG. 1 adjacent the end of the drive connection between the pawl and the reamer drive shaft with the armature restored to its initial rest position and the print hammer still moving toward the print position.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, a row of print hammers represented by the Print Hammer 12 are disposed to impact a Document 13 and Ribbon 14 against moving type character bearing Elements 16 of a Type Cartridge 18. The Document 13 is positioned between Paper Guides 20a and 20b on one side and corresponding Paper Guides 22a and 22b on the other side. The Type Cartridge 18 comprises Support Members 24a and 24b extending along the print line and cooperating with

Guide Members 26a and 26b to define a recess through which may travel spaced apart Type Belts 27a and 27b having Teeth 28a and 28b, respectively, on the back side for driving the belts, and arranged in spaced apart relation to receive the Type Elements 16 therebetweeen. The Type Elements 16 have outwardly extending fingers on opposite sides defining Recesses 16a and 16b therebetweeen disposed to receive edge portions of the Belts 27a and 27b, respectively, fitting exactly between Teeth 28a and 28b on their respective belts, for moving the Type Elements 16 along the print line. The Print Hammer 12 may comprise a Head Portion 12a having a relatively flat Surface Portion 12b for impacting the Document 13 against the type character bearing Element 16. The Striking Portion 12a is positioned to one side of the generally cylindrical Body Portion 12a of the hammer, which provides for oscillatingly supporting a Pawl Disc 15 in a generally cylindrical recess defined by arcuate Edge Portions 30a and 30b of the Body Portion 12a. The Print Hammer 12 is mounted by means of Head Support or Flex Pivot 32, which comprises a flat, elongated steel Spring Member 34, molded in a Plastic Body 36, comprising a polymer such as, for example, Acetal. This spring member provides transverse rigidity and serves as a flexible pivot and return spring for supporting and guiding movement of the Hammer 12 along a predetermined path. The Plastic Body 36 is notched to provide a Section 37 of reduced thickness adjacent the Lip 40. This localizes bending or flexing of the Spring 34 to the Section 37 of reduced thickness and prevents controlled bending, with a reduction in the whipping action often encountered in cantilever springs, resulting in much more uniform print hammer action. The Head Support 32 is secured at the lower end by means of a relatively tight fit in a Keyhole Opening 38 adjacent one Lip 40 of a generally C-shaped Support Plate 42 on which the hammer mechanism is mounted. The upper end of the Head Support 32 is secured to the Print Hammer 12, being secured in any suitable manner in a Slot or Recess 30d therein. A generally C-shaped Spring 44 biases the Pawl Disc 13 in a clockwise direction relative to the Print Hammer 12. The Pawl Disc 13 is provided with a projecting Tail Portion 13c to which a Pawl 45 is secured by means of an Elastomeric Bond 47, such as Nitrile. The Pawl 45 is disposed so that it may be actuated to engage a Tooth 48 of a Reamer Shaft 49 which is continuously rotated. Substantially enclosing the Reamer Shaft 49 is a Guard 50 which is generally cylindrical, but has an Opening 52 through which the Pawl 45 is enabled to engage the Teeth 48. Support Means 53 and 53a support the Guard intermediate its ends. The Guard 50 has an End Portion 54 which serves as a stop and an extractor for the Pawl 45 during its normal operation. The Guard 50 is also rotatably mounted and may be actuated in a counterclockwise direction to restore the Pawl 45 to its rest position, if necessary. A Back Stop 46 mounted on the Support Means 53a provides a return stop for the Pawl 45 when it is reset. Selective operation of the Pawl 45 to engage a particular Tooth 48 of the Reamer Shaft 49 is effected by Electromagnetic Control Means 55. This comprises a pair of spaced apart Pole Pieces 56a and 56b having a Permanent Magnet 57 positioned therebetweeen. Operating Windings 58a and 58b are positioned on extending Pole Portions of the Pole Pieces 56a and 56b and are connected by means of Conductors 59 to plug in
Type Terminals 60, which may be molded in the Support Plate 42, which can comprise any one of the well-known molded plastic materials. The Pole Pieces 56a, 56b, Permanent Magnet 57, and Operating Windings 58a and 58b may be molded with an enclosing plastic covering to provide an integral structure. The assembly may be positioned in a Recess 62 in the Support Plate 42. Cooperating with the Pole Pieces 56a, 56b and the Operating Windings 58a and 58b is an Armature 64 having a Pole Piece 64a spanning the Pole Pieces 56a and 56b. The Armature 64 is positioned in a Recess 66 in the Support Plate 42 and has a cylindrical Protuberance 64c, at one end positioned in a generally C-shaped Bearing Insert 68, embedded in the Support Plate 42 to permit limited rotational movement. The Armature 64 is biased by means of a semicircular Spring 70 located at the lower end by the Recess 71a at one end of Recess 71 in the Support Plate 42 and secured to the Armature 64 by being positioned in a recessed Channel 64d in the lower side of the Armature 64 and further restrained by Recess 64f. The Armature 64 is provided with an extending Tail Piece 64b which extends into a recess in the cylindrical Body Portion 12a of the Hammer 12 where it may be engaged by an upwardly-projecting Cam Portion 12d of the Hammer 12 for resetting the Armature 64 in response to movement of said Hammer 12 to strike the Document 13.

Referring to FIG. 1, which illustrates one side of a two-hammer Position Support Plate 42, the Permanent Magnet 57 keeps the Armature 64 in a normally attracted position despite the force exerted by the Armature Spring 70. While an electromagnet could be used as this holding means, the Permanent Magnet 57 is advantageous because:

1. It requires no power in the normally long hold periods;

2. Power failure does not cause the Armature 64 to drop thereby initiating erroneous printing and possibly damaging the Pawl 45 and the Reamer Teeth 48 because the Armature 64 would be in a non-hold position;

3. Its smaller dimensions make the packaging more compact; and

4. No wires or connections are required for the hold circuits, thereby simplifying the wiring of the machine and eliminating troublesome contacts.

As shown, the Operating Windings 58a and 58b operate as “Buck Out Coils” wound on the Magnet Pole Pieces 56a and 56b to decrease the holding force of the Permanent Magnet 57 when energized, thus permitting the Armature 64 to drop under the action of its Spring 70 and engage Tail 13 and Pawl 45 to move the latter into engagement with a Tooth 48 of Reamer Shaft 49. The Buck Out Coils 58a and 58b therefore merely have to supply the difference in power between the forces of the Armature Spring 70 and the Permanent Magnet 57 with a reasonable safety factor for proper operation.

A Pawl Stop 54 is provided on one end of the Guard 50 to limit the travel of the Armature 64 in the clockwise direction and thereby prevent the Pawl 45 from bottoming between the Teeth 48 of the Reamer Shaft 49. It also minimizes Armature 64 impact on Cam Portion 12d of Hammer 12. As shown, this Pawl Stop 54 is provided by one end of the generally cylindrical Guard 50 surrounding the Reamer Shaft 49. In addition to providing the Armature Stop function described, it also serves as a means for moving the Pawl 45 out of the Reamer Teeth 48 as the Hammer 12 moves toward Type Element 16, and as a safety guard on the Reamer Shaft 49, as well as providing manual reset for the Armature 64, as will be described later.

The hammer assembly consists of the Print Hammer 12 supported by the Head Support 32, which is attached to the Mounting Plate 42, forming a flexible pivot, which allows the Hammer 12 to swing forward in a counterclockwise direction as it is driven by the Pawl 45. A Cam Surface 12d engages the Tail Piece 64b of the Armature 64, as the Hammer 12 is being driven forward to impact the Document 13, to reset the Armature by pressing against the inclined surface on the underside of the Armature Tip 12b, as shown in FIGS. 2 and 3.

When a Reamer Tooth 48 engages the Pawl 45, it drives the Hammer 12 forward through the Elastomorphic Coupling 47 and the Hammer Pawl Disc 13 to which the Pawl 45 is secured. As stated previously, motion of the Hammer 12 resets the Armature 64, after which the Hammer 12 flies forward in free flight, as shown in FIG. 3, driving the Document 13 and Ribbon 14 against the Type 16. During rebound of the Hammer 12, the Pawl Spring 44 restrains the Pawl 45 against the Armature 64, and as the armature has been reset, the Pawl 45 clears the teeth of the Reamer Shaft 49 as it moves to its normal position. This position is located by a Back Stop 46 which terminates the rebound motion, during which the Pawl 45, being urged toward the Armature 64 by the Pawl Return Spring 44, latches on the Armature 64 at Shoulder 64e, and thus is prevented from rebounding toward the Type 16. The Elastomorphic Coupling 47 of the Pawl 45 and Hammer 12 (which may comprise rubber or a rubberlike composition) serves three purposes:

1. When the Armature 64 drops the Pawl 45, it strikes against the Pawl Stop 54 and the Elastomorphic Coupling 47 goes into compression, serving as a damping means to prevent rebound;

2. When the Reamer Tooth 48 strikes the Pawl 45, the design of the Elastomeric Coupling 47 is such that the Pawl 45 stays in contact with the Reamer Tooth 48 instead of taking off like a baseball being struck by a bat. The purpose of this action is to keep the Pawl 45 under control of the Reamer Shaft 49 within the area of potential contact with one another; and

3. When the Pawl 45 strikes the Back Stop 46 in the rebound operation after printing, the Elastomeric Coupling 47 is again compressed and serves a damping agent which allows the Pawl 45 to latch properly with the Armature 64.

Should, through some malfunction, the Armature 64 fail to hold during its restoring operation, the Projection 64b of the Armature 64 will drop behind the restoring Cam Surface 12d in the Head 30 thereby preventing the Hammer 12 and its Pawl 45 from returning from its normal position. This feature is supplied to prevent repeated erroneous printing and damage to the Pawl 45 or the Reamer Teeth 48 by the Armature 64 being incorrectly returned to its released position. In order to manually restore the Hammer 12, the Pawl Stop 54 or Guard Ring 50, which is located in a Counterbore 51a in an End Support Plate 50, is rotated in a counterclockwise direction. This forces the Armature 64 to the restore position, which will allow the Hammer 12 to return to its normal position. Means such as the Spring 53 may be provided to bias the Guard 50 clockwise to the
position shown against a Stop as at 50a. Should the Armature 64 still fail to hold, the Armature 64 will again latch behind the Head of the Hammer 12 after the next Reamer Tooth engagement. Such a condition would be most unusual and would require a manual intervention.

In order to insure precise location of Hammer Face 12b at time of Type impact, a Projection 12c on one side of the Hammer 12 rides in a comb-like Guide 72 as it moves in towards the Paper or Document 13. This Projection 12c serves to engage an impression control comprising a Spring Finger 73, which increasingly limits the force delivered to forms less than six parts, but does not engage when a six-part form is to be printed. With the type faces at a constant level, the variation in forms thickness automatically determines the amount of impression control. This Impression Control 73 has a second function, which is to insure that the Hammer 12 strikes the Type 16 squarely on the forms of different thicknesses by rotating the hammer head slightly to precisely compensate for different angular motions of the head caused by the pivoted hammers striking different thicknesses against a fixed type level. From the above description and the accompanying drawing it will be apparent that the present invention has the following advantages:

1. The use of a Reamer Shaft 49 permits variations in armature drop timing which would otherwise cause serious misregistration at the speeds the machine is operating. Variations of ±0.350 microseconds can be accepted with the Pawl 45 still dropping into the proper tooth and with the Hammer 12 being driven in proper relation to the type motion. Therefore, no flight time adjustments are needed;
2. The power for resetting the Armature 64 is supplied by the Reamer Shaft 49 as the coupling design prevents the Pawl 45 from leaving the Tooth 48 until the reset operation is practically complete;
3. After armature restoration, the Hammer 12 continues in free flight with the momentum and energy determined by the mass of the hammer assembly and the velocity of the Reamer Shaft 49. It is believed that higher energy and momentum are possible with this design over that obtainable with magnetically-driven hammers;
4. The extremely short actuating impulse to the Buck Out Coils 58a and 58b (less than 300 microseconds) permits a matrix drive arrangement of the electronic driving circuits (not shown). For example, 40 drivers are used to control 144 hammers;
5. The design permits the mounting of the hammers and magnets in a single row at 10 to the inch spacing. The Hammer Plate 42 carries 2 hammer mechanisms, one on each side, on 0.100 inch centers conveniently mounted in a plug-in mode with all hammer wiring being carried by printed circuits in the plug-in receptacle. These plates are identical for all print positions;
6. The power required by the Buck Out Coils 58a and 58b is far less than normally required to actuate a hammer position with conventional work magnets;
7. The Reamer Shaft 49 provides "unlimited" continuous power for driving the Hammers 12;
8. By using an Interposer Pawl 45 for hammer driving, a small, light mass is moved a short distance for rapid operation;
9. The mass of the hammer head is concentrated behind the Impacting Face 12b giving a maximum effective mass to the print head;

10. The Hammer Head 12a is supported by a Head Support 32 which consists of a Spring Member 34 reinforced by a polymer such as Acetal so that flexure is localized at an optimum point and oscillations in the balance of the spring are minimized. The polymer serves the additional purpose of anchoring the head to the spring and the spring to the support plate;
11. All major forces pass through the center of mass of the hammer head, thus minimizing oscillation caused by eccentric forces; and
12. Reamer elements are identical one-position modules, comprising individual toothed discs, which are staggered one-quarter tooth so as to provide sequential firing of groups of print hammers in synchronism with Type Elements 16 whose pitch is such that only every fourth Type Element is in position for printing at any time. This staggering may be accomplished by providing four different key ways in each element.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a printer having means for moving a plurality of type character bearing elements along a print line adjacent a document on which a printing operation is to be performed, a print hammer movable to impact said document and type character bearing elements for printing on said document, a single spring support having a localized bending zone connected to said print hammer for supporting said print hammer in an initial position and guiding said hammer for movement relative to said document, a continuously rotating reamer shaft disposed adjacent said print hammer and having a plurality of peripheral pawl means carried by said print hammer movable from a normal position to engage a tooth of said reamer shaft to impel said hammer toward said document, and electromagnetic control means having an armature operable to engage and move said pawl means from said normal position to a tooth engaging position for moving said print hammer to impact said document and type character bearing elements and said electromagnetic control means having a control winding disposed to be pulsed to effect operation of said armature.

2. The invention as defined in claim 1 characterized by said print hammer spring support comprising a cantilever spring having a reduced section to localize bending.

3. The invention as defined in claim 2 characterized by said cantilever spring comprising a flat metallic spring element molded in a polymer plastic body having said reduced section.

4. The invention as defined in claim 3 characterized by said pawl means comprising a pawl mounted on a pawl support which is oscillately mounted on said cantilever spring.

5. The invention as defined in claim 4 further characterized by said pawl being pivotally mounted on said pawl support.
6. The invention as defined in claim 5 characterized by said pivotal mounting comprising an elastomeric bond providing a resilient damped connection between the pawl and said pawl support.

7. The invention as defined in claim 3 characterized by spring means biasing said armature toward said pawl means, said electromagnet control means including a permanent magnet for holding said armature in an initial set position against the bias of said spring means and a control winding disposed to be energized to reduce the holding force of said permanent magnet and permit said spring to bias said armature to move said pawl means into engagement with a tooth on said reamer shaft, and a cam portion on the print hammer positioned to engage a portion of said armature when said print hammer is impelled toward said document to restore said armature to said initial set position.

8. The invention as defined in claim 6 characterized by a guard member substantially surrounding said reamer shaft and having a cam surface positioned to engage said pawl as said hammer approaches the print position, said cam surface lifting said pawl out of engagement with said reamer, and said guard ring being manually rotatable to actuate said armature to said initial set position.

9. The invention as defined in claim 7 characterized by said armature extension engaging said cam portion of said print hammer to prevent return of said print hammer to its initial position until said armature is restored to its said set position.