

[54] **LOW COST HAMMER UNIT**

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[58] Field of Search **101/93 C, 96; 335/297**

[56] **References Cited**

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[57]

ABSTRACT

A low cost print hammer unit comprises an assembly of electromagnet cores molded in a plastic body. A plurality of print hammers are pivotally supported in a non-magnetic member secured to the plastic body. The print hammers comprise unitary structures each having a hooked armature portion at one end and an angularly disposed extension with a hammer face at the other end for impacting a document for printing thereon.

8 Claims, 4 Drawing Figures

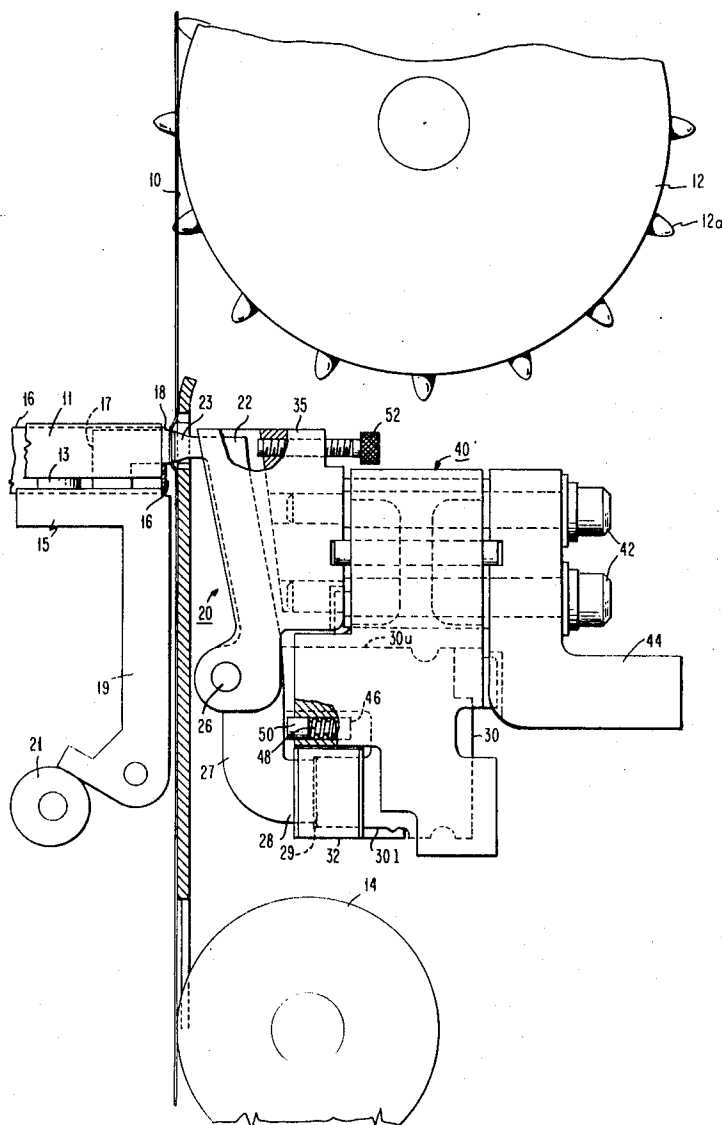
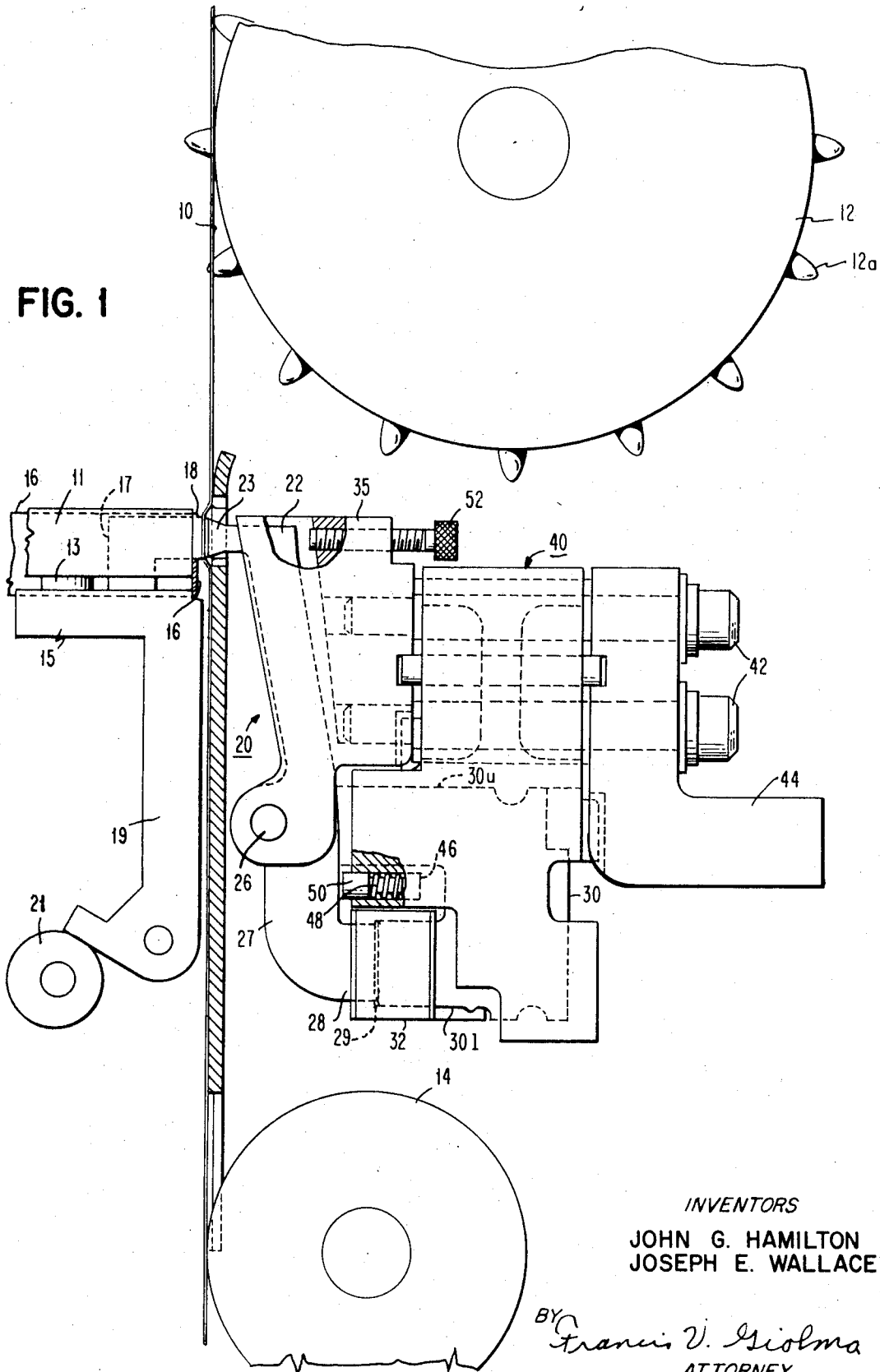


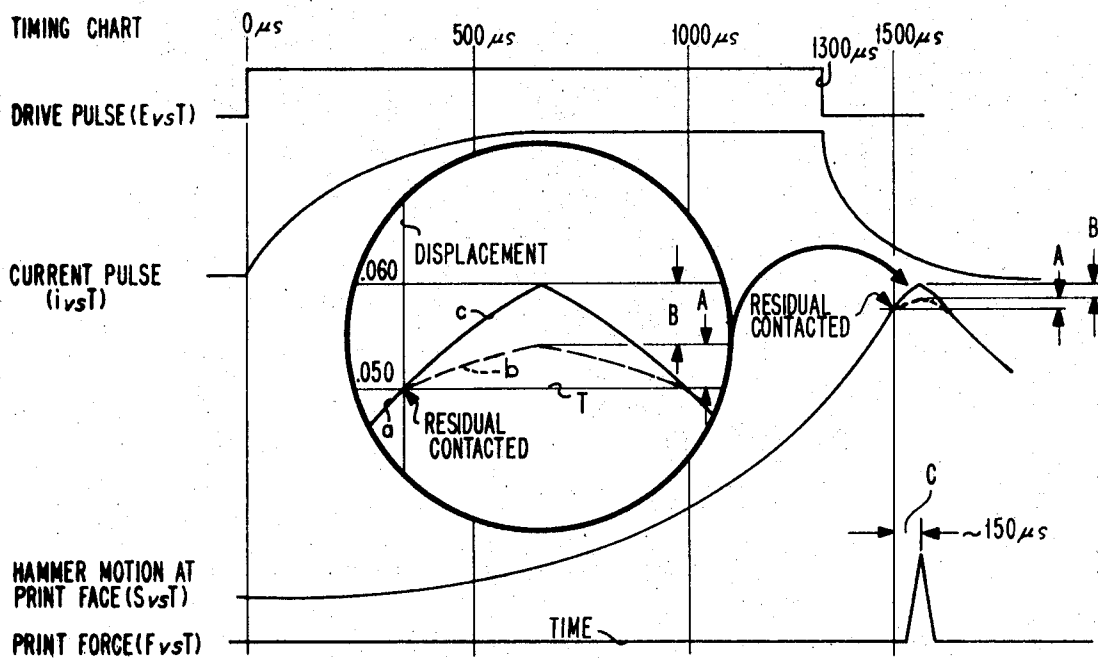
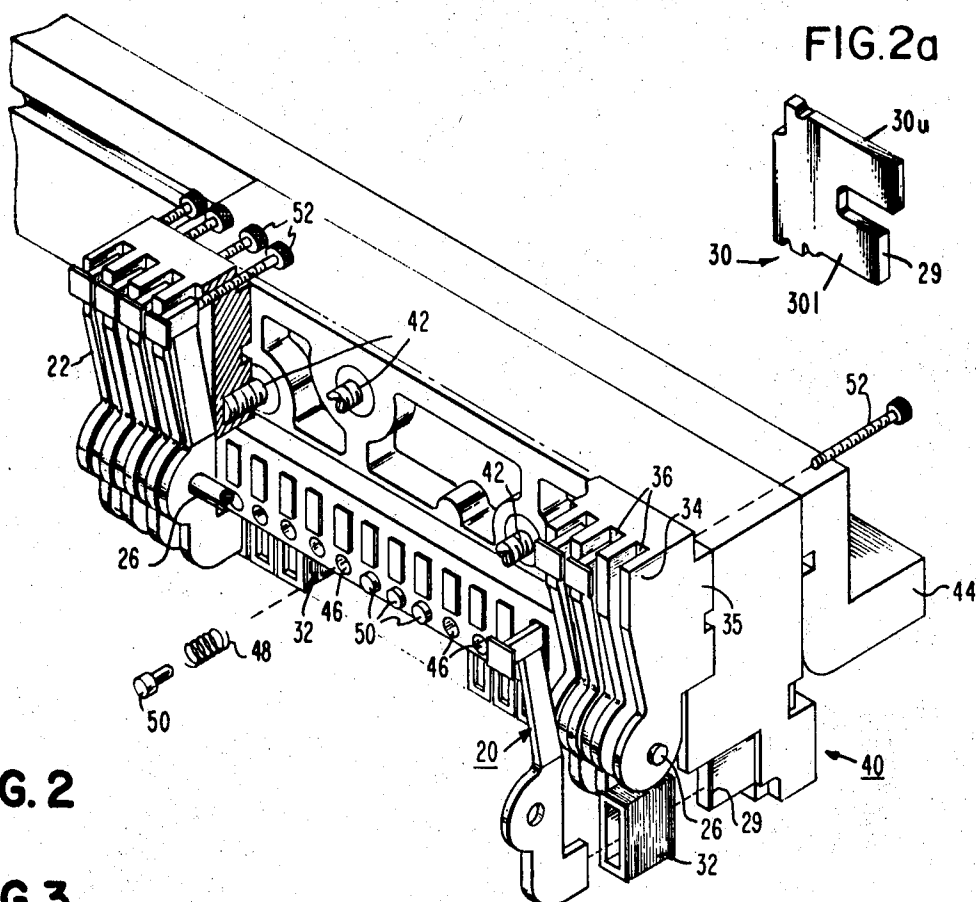
FIG. 1



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LOW COST HAMMER UNIT

CROSS-REFERENCE TO RELATED APPLICATION

This invention is related to the invention of the co-pending application Ser. No. 156,779 of John Mako and Joseph E. Wallace, filed June 25, 1971 and assigned to the assignee of this invention.

DESCRIPTION OF PRIOR ART

Print hammer structures have heretofore comprised separate electromagnetic actuators and print hammers coupled either by push rods, as in the James M. Cunningham U.S. Pat. No. 3,241,480, which issued on Mar. 22, 1966, or directly, as in the Derc U.S. Pat. No. 3,507,213, which issued on Apr. 21, 1970, or a unitary structure such as shown in the Potter U.S. Pat. No. 3,349,696, which issued on Oct. 31, 1967.

SUMMARY OF THE INVENTION

Generally stated, it is an object of the invention to provide a new and novel low cost print hammer unit.

More specifically, it is an object of this invention to provide a print hammer unit having improved performance and which may be readily produced in large quantities at a relatively low cost.

Another object of the invention is to provide an integrated print hammer unit having a single moving part which is simple to manufacture and is efficient in operation.

Yet another object of the invention is to provide for so positioning a single moving element print hammer that a residual compresses to decelerate one end of the moving element while the other end flexes and continues to move to impact a document for performing a print operation thereon.

It is also an object of the present invention to provide a print hammer having a hooked end portion which enters within an operating winding while an angularly disposed extension impacts a document to print thereon.

It is also an important object of this invention to provide for using in a printer a unitary print hammer with a residual, the elasticity of the print hammer and the residual being such that the print energy and momentum are absorbed at such a rate as to provide proper energy and momentum for printing on different thicknesses of forms with a fixed platen setting and without external print impression control.

Another important object of the invention is to provide an elastic print hammer and residual in a printer which are so related that the elasticity of the hammer beam and the residual provide an equivalent free flight (dynamic hammer displacement greater than the static hammer displacement) such that printing occurs beyond the nominal platen setting.

Another important object of this invention is to provide a print hammer unit having a plurality of magnetic core members molded in a plastic block and a non-magnetic member secured thereto which has spaced webs defining slots for a plurality of print hammers, one associated with each core member, and receiving a common pivot shaft for all of the hammers.

Yet another important object of this invention is to provide a one-piece print hammer having a hooked armature portion at one end and a resilient angularly disposed extension at the other end with a print hammer face on the side opposite the hooked armature portion.

Still another object of the invention is to provide a print hammer module having a plurality of print hammer armature members spaced one or more than one print position apart and having single or multiple width hammer faces to cover the print positions.

Another important object of the invention is to provide a one-piece print hammer in which a hooked armature portion on one side of a pivot moves within an operating winding to impact a resilient residual while a hammer face at the end of an elastic extension on the other side of the pivot continues to move in the opposite direction as the extension flexes to impact a document for printing, thus, utilizing the kinetic energy of the resilient extension under control of the residual.

It is also an important object of this invention to provide for using a plurality of print hammers having armature portions with angularly related print hammer extensions so as to permit close spacing of the hammer unit with the document on which printing is to be performed.

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

DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is an enlarged partial end elevational view in section of a print mechanism embodying the invention in one of its forms,

FIG. 2 is an isometric view exploded in part showing a print hammer assembly embodying the invention of FIG. 1, and

FIG. 2a is an isometric view of a Magnetic Core member of FIGS. 1 and 2,

FIG. 3 is a timing chart showing the relations between the operating current, impact of the armature against the residual, and impact of the hammer face with the document for printing.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawing, it will be seen that a Document 10 is disposed to be advanced by Feed Rolls 12 and 14 past a type carrier, which by way of example, may comprise a relatively thin metal Band 16 passing about a pair of spaced apart wheels represented by the one Wheel 11, which is rotatably supported by a shaft 13 on a base 15, upon which is mounted a Platen 17 for backing up the Band 16. The Base 15 may be adjustably supported being, for example, mounted on a Lever 19, adjusted by a Cam 21. Raised Type Characters 18 are located along the Band 16 adjacent to one edge for printing on the document. The Document 10 is disposed to be fed vertically by the Feed Roll 12 having, for example, a plurality of Sprocket Pins 12a disposed to mesh with holes at the edges of the Document. The Type Characters 18 are moved transversely along the print line of the document being, for example, formed on the endless Band 16, which moves into the plane of FIG. 1, as shown, and is backed up by the Platen 17.

Printing is performed on the Document 10 by using an impact paper, ribbon or inked type, by means of a plurality of print hammers such as the Hammer 20, which is shown as comprising an Extension 22 having a Hammer Face 23 at the upper end and an Armature

Portion 27 at the lower end. The Hammer 20 is pivotally mounted by means of a Pivot 26, and the Armature Portion 27 of the Print Hammer 20 includes a Hooked Armature Portion 28 at the end with a rounded configuration which is disposed to be actuated by a substantially U-shaped Magnetic Core Member 30 having an Operating Winding 32 so positioned thereon that it extends beyond the end of the Core Member 30, and so that the Hooked Armature Portion 28 enters the winding and the air gap between the Hooked Armature Portion 28 and the end of the Lower Leg 301 of Core Member 30 is completely within the confines of the Winding 32. A Residual 29 comprising a layer of polyurethane approximately 0.003 in. thick is secured to the face of the Lower Leg 301.

The Print Hammer 20 may be mounted as illustrated in FIGS. 1 and 2 by means of a common Pivot Shaft 26, located adjacent the end of the Upper Leg 30u of the Core Member 30, and which extends through openings in a plurality of Ribs 34 of a Hammer Support Block 35, which define Slots 36 therebetween for receiving the upwardly extending Extension Portions 22 of the Print Hammers 20. The Hammer Support Block 35 may comprise a body of aluminum or other suitable non-magnetic material. The Main Body 40 comprises a body of molded plastic material such as a glass-filled phenolic composition or the like. Screws 42 secure the Support Block 35 and the Main Body 40 to a substantially L-shaped Support Bracket 44 for attachment to the frame of the printer.

The Main Body 40, as shown in FIG. 1, has a plurality of the substantially U-shaped Core Members 30 molded therein in spaced relation, with the Upper Leg 30u of each Core Member 30 slightly projecting therefrom and the Lower Leg 301 of the core member projecting therefrom sufficiently to receive the Operating Winding 32, and project into the winding about two-thirds of the way. The Main Body Member 40 may be provided with a plurality of Openings 46 in alignment with the U-shaped Core Members 30 for receiving Springs 48 and Plungers 50, which provide a biasing force for operating on the Armature Portions 27 to assist in restoring the Armature Portions 27 to their rest position with the Print Hammer Faces 23 spaced from the Document 10. The Hammer Support Block 35 may be also provided with a plurality of openings for receiving threaded Stop Screws 52, which provide a flight time adjustment stop for the Print Hammers 20. In one embodiment the air gap between the Hooked Armature Portion 28 and the Lower Leg 301 of the Core Member 30 is 0.025 in. and the static gap between the Hammer Face 23 and the Document 10 is 0.050 in. The Extension 22 has a width of 0.15 in., a thickness of 0.05 in., and is 1.175 in. long. The Armature Portion 27 has a width of 0.320 in., a thickness of 0.085 in. and an effective length of 0.574 in. With this arrangement the dynamic travel distance of the Hammer Face is on the order of 0.060 in., which includes 0.010 in. of equivalent free flight after the Armature Portion 27 has impacted the Residual 29.

Referring to FIG. 3, it will be seen that the Print Hammer 20 may be operated by means of a Drive Pulse applied to the Operating Winding 32. A current on the order of 3 to 5 amperes with a Winding 32 having approximately 200 turns has been found satisfactory. As shown by the curves, the Print Hammer 20 starts to move and the drive pulse is terminated before the

Hooked Armature Portion 28 impacts the Residual 29 of polyurethane or the like on the Lower Leg 301 of the U-shaped Core Member 30. The Hooked Armature Portion 28 continues to move, compressing the Residual 29. The Hammer Face 23 continues to move even further after the Hooked Armature Portion 28 of the Armature has stopped moving, since the elongated Extension 22 of the print hammer is elastic. In effect, the Extension 22 has a reduced cross-section and is sufficiently long so that it flexes and the Hammer Face 23 continues to move to effect printing on the Document 10 both during compression of the Residual 29 and subsequently during bending of the Print Hammer Extension 22.

From the above description and the accompanying drawing it will be realized that the Operating Winding 32 is located such that the working gap is approximately one-third of the distance from the armature end of the coil. This allows more efficient use of the magnetic energy, yet minimizes possible mechanical interference between the Hooked Armature Portion and the winding. It also permits adjustment of the air gap between the Lower Leg 301 and the Hooked Armature Portion 28 over a wide range to vary the hammer velocity, which is not possible with magnetic structures having the air gap outside the operating winding, because of increased leakage flux with increased air gap. Since the print hammer has only one moving part, the simple design lends itself to a very low production cost. The Residual 29, in addition to minimizing the residual magnetic flux, is designed to have a certain elasticity to achieve a predetermined amount of hammer "equivalent free flight" during compression of the residual. The elasticity of the Hammer Extension 22 is also utilized to control the amount of "equivalent free flight" developed. When the Hooked Armature Portion 28 strikes the Residual 29, it not only compresses the Residual 29, but the inertia of the Hammer will also deform the Hammer Extension an amount dependent on the elasticity of the Extension. Accordingly, the Print Hammer 20 is designed to have the Extension 22 substantially double the length of the Armature Portion 27 and on the order of half the cross-section so as to provide, as shown in FIG. 3, a predictable amount of rigid body motion (a) followed by controlled motion of the Armature portion (b), and bending of the elastic Hammer Extension to provide an "equivalent free flight" or Print Hammer Face displacement (c) beyond the static operating position before the print force is reduced to no longer produce legible printing. For example, as shown in FIG. 3, of the hammer travel after the Armature impacts the Residual, approximately one-third (A) is due to residual compression and two-thirds (B) is due to flexing of the Extension, of the total travel during the 150 microseconds (C) during which the Residual is compressed and the Hammer Extension is bent. Interaction between adjacent units is reduced by placing the pole face area and the air gap within the Operating Winding. The Print Hammer 20 is designed with an angularly related upward Extension 22 so as to permit close spacing of the hammer unit to the Document 10 and yet provide a substantially straight document path, as shown. The driving circuit for the Operation Winding 32 is designed, such as by the use of a Zener diode, to allow a controlled current and flux decay once the voltage pulse is turned off. This permits operation of the Print Hammer with a drive pulse width less than the

flight time of the Print Hammer (the time the Print Hammer takes to move and impact the Document after application of a voltage pulse to the winding), which increases the efficiency and decreases settle-out time of the device. The energy required for printing is reduced since the Hammer is driven into the Document and Ribbon. In addition, since the Hammer and Armature are one member, all the mechanical energy developed by the Armature is available for printing.

While the above description pertains primarily to a Print Hammer design in which the Print Hammer flexes to utilize equivalent free flight for printing, a rigid hammer construction can be utilized by making the Hammer Extension 0.300 in. wide and 0.050 in. thick, and moving the Platen 17 and Type Carrier 16 toward the Print Hammer to reduce the static gap spacing of the Hammer to less than 0.050 in. Printing using the more rigid hammer may be accomplished without the Hooked Armature Portion 28 impacting the Residual 29.

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 details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An actuator comprising a magnetic core member having a pair of spaced apart legs, an operating winding on one of said legs extending beyond the end of said one leg, a print hammer comprising an armature having a central body portion with a hooked end portion positioned adjacent said end of said one leg and within the extending portion of said winding, a pivot adjacent the end of the other leg of said core member, and an extension at the end of said hammer opposite said hooked end portion having a hammer face thereon.
2. The invention as defined in claim 1 characterized

by said extension being at least greater than the length of said hooked end portion and being of less cross section so as to be more flexible than the armature body portion.

3. The invention as defined in claim 2 characterized by said actuator having a residual disposed between the end of said one leg and said hooked end portion of said Armature to be impacted by said hooked end portion before said hammer face impacts said document to be printed on.

4. The invention as defined in claim 3 characterized by said residual being of a resilient plastic material permitting continued controlled movement of said hammer face after impact of said hooked end portion with said end of said one leg to provide an equivalent free flight, a predetermined print force and impression control.

5. The invention as defined in claim 4 characterized by a plurality of U-shaped magnetic core members molded in a plastic body in spaced apart side-by-side relation, with an attached non-magnetic member having spaced apart ribs between said core member defining slots to receive said print hammers, and a common pivot extending through said ribs to position said armature portion in operating relation with said core member.

6. The invention as defined in claim 5 characterized by a restore spacing housed in a hole in said plastic body member to engage said armatures.

7. The invention as defined in claim 6 characterized by flight time adjustment stop screws mounted in said non-magnetic member and projecting into each hammer receiving slot at the back end of the hammer face of each print hammer.

8. The invention as defined in claim 4 characterized by said operating winding being energized by a current pulse of less duration than the flight time of said print hammer so that the print hammer continues to move to impact the document after the current pulse is terminated.

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