United States Patent

[11] 3,631,797

[72] Inventors **Lynn M. Johnston**
West Milton;
Chester G. Jones, Kettering; Frederick G. Krebs; Stephen D. Marcey; Harold D. Neal, all of Dayton, all of Ohio; Samuel A. Redman, Garden City, N.Y.

[21] Appl. No. **863,780**
[22] Filed **Oct. 6, 1969**
[45] Patented **Jan. 4, 1972**

[73] Assignee **The National Cash Register Company**
Dayton, Ohio

[54] **HAMMER FOR HIGH-SPEED PRINTER**
13 Claims, 3 Drawing Figs.

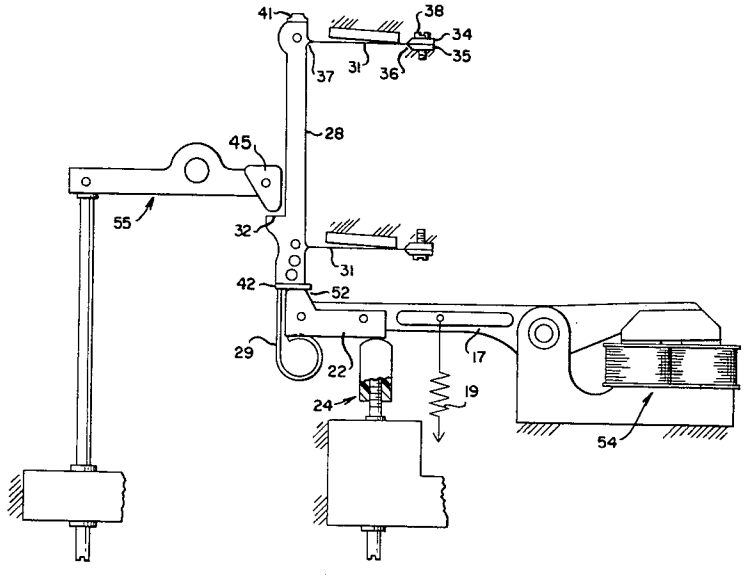
[52] **U.S. Cl.** ..... **101/93 C,** 29/428
[51] **Int. Cl.** **B41j 9/20,** B21p 17/00
[50] **Field of Search** ..... 101/93 C; 29/428

[56] **References Cited**
UNITED STATES PATENTS

3,164,085	1/1965	Hawkins	101/93 C
3,301,177	1/1967	Shepard	101/93 C
3,334,409	8/1967	Shneider et al.	101/93 C X
3,426,675	2/1969	Dalton	101/93 C
3,447,455	6/1969	Shneider	101/93 C
3,507,213	4/1970	Derc	101/93 C
3,523,992	8/1970	Bickoff	101/93 C X

Primary Examiner—William B. Penn
Assistant Examiner—E. M. Coven
Attorneys—Louis A. Kline and John J. Callahan

ABSTRACT: A resilient nonmetallic printer hammer made of composite material and having relatively large size and small mass is disclosed. The hammer employs a frontal insert member for printing contact and a rearward insert for energy dissipation and driving. An attached spring assists in hammer retraction and in frictional dissipation against a mating member at the rearward face.



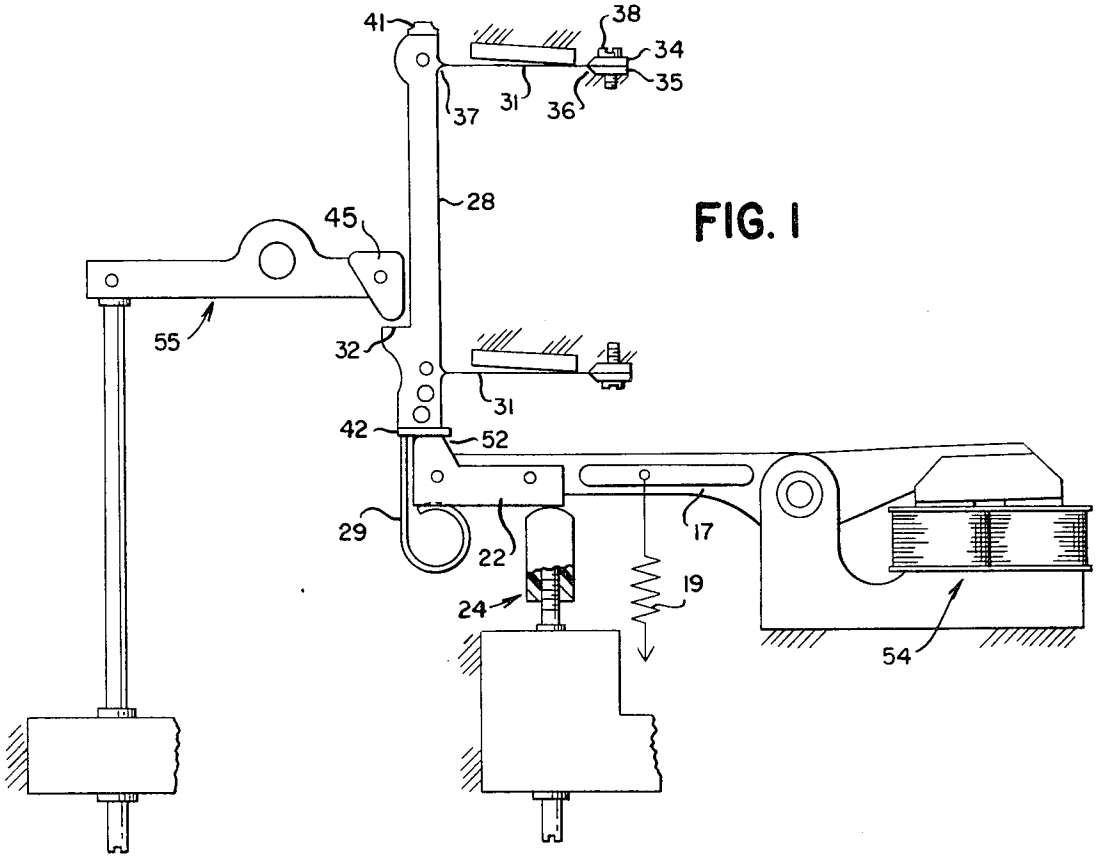


FIG. 1

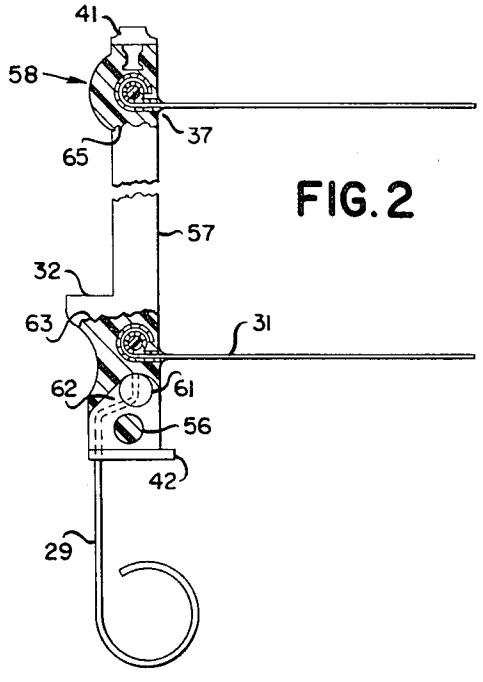
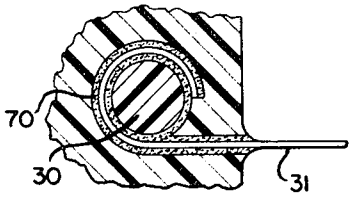


FIG. 2

FIG. 2A



INVENTORS
LYNN M. JOHNSTON
CHESTER G. JONES
FREDERICK G. KREBS
STEPHEN D. MARCEY
HAROLD D. NEAL
SAMUEL A. REDMAN

BY Louis A. Kline
John [illegible]

THEIR ATTORNEYS

WITNESS
Gerald B Hollins

HAMMER FOR HIGH-SPEED PRINTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to the impact-excited high-speed printer art and more precisely to high-speed printers employed as output devices for electronic data processing systems.

The invention further pertains to a movable member used to accomplish individual printing operations within such a printing mechanism and to an improved structure for such movable member.

2. Description of the Prior Art

The prior art in high-speed printer mechanisms is replete with showings of print hammers which are metallic in composition and hammers which have achieved low moving mass by being small in physical size or by relieving the hammer cross section of as much material as possible. The present invention achieves the desirable combination of low mass, large size, and elastic resilience in a manner differing from those prior-art inventions and through the use of a nonmetallic hammer composition.

In prior-art print hammers having metallic body structure, there is little need for concern over the degree of rigidity or resilience displayed by the hammer body member, and there is little which can alter these properties in a practical embodiment; in the present invention, there is both need and opportunity for varying rigidity and resilience in the hammer.

Prior Art print hammers also encounter little need for special properties at interface regions where contact with other portions of the printing mechanism occurs; in the present invention, there is both need and opportunity for controlling the properties of the hammer structure in these regions.

In the prior art, it is common to control the mass of a print hammer and, to a degree, its resilient properties by shaping the cross section of the hammer into selected configurations; through the use of so-called structural shapes, it is possible to obtain larger strength-to-weight ratios in a hammer than a simple cross-sectional configuration provides.

SUMMARY

In the present invention, a lightweight printing hammer having controlled resilience, long operating life, low and controllable mass, and improved hammer retraction means is disclosed.

DESCRIPTION OF THE DRAWING

FIG. 1 is an overall view of a printer mechanism employing a print hammer made and operated in accordance with the present invention.

FIG. 2 is a cutaway view of a printer hammer usable in the FIG. 1 mechanism and fabricated according to the present invention.

FIG. 2A is an enlarged view of the hammer cutaway region of FIG. 2 and is illustrative of a mounting technique for a hammer made according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 of the drawing shows a printing hammer made in accordance with the present invention, together with the active and stationary members of the printing mechanism which form parts of the operating environment for the printing hammer. In FIG. 1, the numeral **28** refers to the print hammer, **55** refers to a print hammer stop assembly, **24** refers to the print hammer back stop assembly, and **54** refers to an electrical solenoid assembly which excites the printing mechanism.

In assembling a complete high-speed printer using the components shown in FIG. 1, it is advantageous for the print hammer **28** to have a length which is great enough to allow comfortable separation between the hammer-driving apparatus and the printing apparatus. If the print hammer **28** is of a short length, it is apparent from FIG. 1 that a significant

degree of component crowding occurs near the typefont; this crowding not only makes the printer design more complex and tedious but also increases problems associated with cooling and adjusting of the mechanism and handling of the work media. By using a relatively long hammer embodiment, as shown in FIG. 1, it is possible to locate desirable frame members between the hammer-actuating components and the typefont, so as to provide for a stable and desirable structure and for a uniform and controlled positioning of print hammers in relation to the typefont; these frame members may also serve as part of a print density control system. In FIG. 1, neither these frame members nor the print font carrier are shown; the print font carrier and the media to be printed are, however, located across the top of the illustrated parts, so as to be engageable by a frontal insert member portion **41** of the print hammer.

The prior art shows that the need for a long print hammer as described above has been widely recognized; in the prior art, as mentioned above, it has been common to employ metallic hammers having elaborate cross-sectional body shapes in order that desirable length and low mass may be combined. The mass of a print hammer becomes important when the performance goals of operating energy level and operating speed are considered; obviously, if a printer is to operate at a specified level of kinetic energy and at a specified hammer velocity, the mass of the hammer must be controllable, since mass velocity and energy are related by the well-known expression for kinetic energy:

$$KE = \tfrac{1}{2} MV^2$$

where

KE represents kinetic energy,

M represents mass, and

V represents velocity.

Although a given energy level for operating a print hammer may be attained equally well by operating a heavy and massive print hammer at a relatively slow velocity or by operating a lightweight low-mass print hammer at a high velocity, the lightweight hammer and a high operating velocity are much to be preferred where the printer employs constantly moving typefont that is engaged by hammer-driven paper. It is clear that print smear resulting from movement of the typefont while pressure from the hammer is applied is lessened by rapid movement of the hammer into and away from engagement with the typefont. Since the velocity of the print hammer is of this paramount importance in determining print quality, it becomes a matter of great interest in the art to fabricate a hammer which is low in mass yet rugged enough to provide useful life when operated at the high velocities and energy levels which produce desirable print quality.

In the prior art, several factors have restricted the composition of print hammers to a metal material. Among these factors is the need for dimensional stability in the hammer despite changes in atmospheric environment and despite high concentrations of stress in portions of the hammer which engage other parts of the printing mechanism. In prior art attempts to fabricate a hammer, it was found that nonmetallic materials did not offer the needed dimensional stability. The plastics which were often tried, for example, were subject to dimensional change from both temperature and humidity variations, and also the most desirable plastics lacked the needed rigidity.

Another factor restricting print hammers to metal composition in the prior art is the tendency of nonmetallic materials to experience fatigue failure when exposed to the repeated application of high stresses—a condition which is common for a print hammer. This fatigue failure was commonly encountered, as were the dimensional stability problems cited above, wherever the hammer material interfaced with another material or another member of the mechanism, as at impact surfaces and points of attachment to supporting structures.

In many prior art nonmetallic hammers, difficulty was encountered in attaching auxiliary members, such as supporting cantilever springs, to the print hammer body, both the nonrigid nature of the hammer body and high stress concentra-

tions induced by the rapid acceleration and deceleration of the hammer being effective to induce failure into the hammer structure itself or into the attached member at a point close to the hammer structure.

In the prior art attempts to employ a nonmetallic print hammer, it was found, also, that many of the more desirable materials for use in the hammer body are also materials to which effective bonding is difficult, such materials being in the thermoplastic family; that is, they may be repeatedly cycled between the viscous and resilient states, and including poly amides such as nylon. Bonding to materials in the thermosetting family (such materials as Bakelite) has been possible with reasonably good results in the past. However, it has been found that other problems, such as materials failure at the engaging faces of the hammer, prevented hammers made in this manner from being desirable.

The print hammer **28** shown in FIGS. **1** and **2** of the drawing is an embodiment which overcomes the difficulties encountered in prior art nonmetallic print hammers. In FIGS. **1** and **2**, the illustrated print hammer **28** successfully employs a plastic nonmetallic body portion, labeled **57** in FIG. **2**, which may be composed of either thermoplastic material which has been found particularly successful is described.

In the FIG. **2** view of the print hammer, part of the hammer body thickness is cut away on the viewing side by cutting lines **63** and **65**, in order that interior construction details may be observed. In this view, it is shown that a rearward insert member **62** is located at the driven end of the print hammer **28**. This insert member **62** is composed of a rearward facing portion **42**, which is suitable for impact driving and for frictional motion against the driving member at the interface **52** shown in FIG. **1**; a hole **56** is molded into the insert member **62** so as to be filled by the hammer body material during molding and thereby hold the insert in position; the insert member **62** so as to be filled by the hammer body material during molding and thereby hold the insert in position; the insert member **62** also includes a raised boss portion **61**, which is capable of being surrounded by the hammer body material so as to locate the insert member **62** and further lock it into position. A spring member **29**, which is named the pigtail spring and is capable of engaging the driving arm **17** of the electrical solenoid assembly **54** and holding it and the print hammer **28** in forced contact during portions of the operating cycle, is also incorporated into the insert member **62**; anchoring for the pigtail spring **29** within the insert member **62** is provided by a curving shape in this spring, which is illustrated in FIG. **2**, and by molded insert material surrounding this spring. It has also been found that satisfactory performance is obtained from the pigtail spring **29** if this curving anchor shape, as shown in FIG. **2**, is reduced in complexity to being a simple radius.

An examination of FIG. **1** reveals that, during rotating motion of the driving or connecting arm **17**, frictional sliding occurs at the interface **52**; that is, at the junction of the rearward facing portion of the insert member **62** and the driving arm covering boot **22**.

It has been found that attention is required to the materials used in the hammer insert portion **62** and the connecting arm boot **22** in order that desirable frictional dissipation may occur without also incurring high wear rates and accompanying premature part failure. The material used in the print hammer body portion **57** has been found to offer a high frictional coefficient when mated with many materials at the interface **52** but has also been found to induce high wear upon the mating part. A satisfactory compromise between high frictional coefficient and low wear rate has been found to occur if the hammer insert member **62** is made from a material having inherent lubricating properties and also having impact resistance; in the preferred embodiment of the invention, a thermoplastic acetal resin having a 14 percent filler composed of fluorinated ethylene-propylene resin has been found acceptable for the insert member **62**. This material is available from E. I. du Pont de Nemours and Company under the name "Delrin A. F." and contains "Delrin" acetal resin with a 14 percent filling of "Teflon" fibers. "Delrin" and "Teflon" are trademarks of E. I. du Pont de Nemours and Company.

In fabricating the driven end insert for the hammer, it has been found that an injection molding process according to the following is practical.

1. Employ a molding press of the screw type.
2. Employ a four-cavity mold.
3. Use temperatures of 230° F. for the cavity, 370° F. for the cylinder front, 360° F. for the cylinder rear, and 390° F. for the cylinder nose.
4. Use pressures of 500 p.s.i. for injection and 1,200 p.s.i. for the main ram.
5. Use time of 10 seconds for injection and 15 seconds for cure.
6. One hundred parts require about 0.023 pound of the Delrin A. F. material.

Although nylon possesses desirable strength, weight, and molding properties for fabrication of the hammer body portion **57** in FIG. **2**, pure nylon is found to undergo excessive dimensional change upon exposure to moisture and to have an undesirably low modulus of elasticity for this application. In order that some of the desirable properties of nylon may be available without handicap by these undesirable properties, dispersion of a filling agent into the nylon has been found possible.

A nylon product having a filling material already dispersed therein is commercially available from the manufacturers. This product employs lengths of fiber glass about one thirty-second inch long as a filling agent which is capable of enhancing moisture stability, modulus of elasticity, and mold shrinkage in the parent nylon material. A typical example of this nylon product and one which is suitable for use in the present invention is one which contains 40 percent glass filler and is available from a division of Rexall Drugs Incorporated located in Evansville, Ind., U.S.A.

Before molding the print hammer body portion **57** of the print hammer **28**, which surrounds the cantilever spring members **31**, it has been found desirable to coat the imbedded surfaces of the springs with adhesive material and to locate the springs with a pin in the molding die. Following removal from the molding die, the locating pin void is filled with plastic material such as nylon; in FIG. **2A** of the drawing, the locating pin void filler is identified by the numeral **30**, and the adhesive used in bonding the cantilever springs to the hammer body structure is identified by the numeral **70**.

It has been found possible to satisfactorily fabricate the print hammer structure of the FIGS. **1** and **2** embodiment by employing the following process.

1. Drying the cantilever spring adhesive coating. To achieve drying, it has been found desirable to use a combination of room temperature drying followed by oven drying, in order that complete removal of the adhesive solvent may occur and solvent entrapment not take place.
2. Mounting the adhesive-coated spring members on a holding pin within a 10 cavity molding die.
3. Placing the frontal and rearward insert members of the hammer into the molding die.
4. Forcing molten hammer body material into the molding die. In molding the springs **31** into the hammer composed of this material, it has been found desirable to maintain the die temperature at 160° F. and the nylon injecting nozzle at a temperature of 570° F., and to inject with a pressure between 450 and 550 p.s.i. These parameters have been found satisfactory when a screw molding press and a 10 cavity die are employed. Slight variations in these parameters may be desirable if different molding equipment is employed, as will be apparent to a person skilled in the art.
5. Plugging the hole left within the hammer by the spring mounting pins of the molding die. This plugging can be accomplished in desirable fashion by coating both the interior of the hole and the exterior of a nylon plugging rod with a quantity of adhesive, then inserting the nylon rod into the hole, and trimming the rod ends to length.

6. Drying and curing the adhesive bonds, both the spring-to-hammer bond and the nylon plugging rod bond.

7. Smoothing the hammer surface around the plugged die holes by clipping, scraping, and grinding.

8. Testing a sample quantity of hammers for spring pullout strength.

At the forward end of the print hammer **28** shown in FIGS. **1** and **2**, it has been found desirable to employ an insert member which has a hard texture resistant to impacting with the print font and the media to be printed. For this purpose, it has been found that an insert made of metal is most satisfactory. One form which this insert may assume is shown in the embodiment illustrated in FIGS. **1** and **2**; in these FIGS., the numeral **41** identifies this frontal or printing by way of the plastic body material flowing around an anchorable end of the insert member during molding of the hammer body **57**. The insert **41** is loaded in to the molding die prior to injection of the heated body material.

In fabricating the insert member **41**, any conventional metal fabricating process may be employed, such as casting, machining, or forging; in the embodiment shown in FIGS. **1** and **2**, however, it has been found practical to fabricate the insert member **41** form powdered metal. In the powdered metal fabrication process, the conventional sequence involving fabrication process, the conventional sequence involving fabrication in a die within a press, sintering at elevated temperature, and sizing in a second die is employed, along with a milling operation to form the plastic imbeddable rear tang of the insert member **41**. It has also been found desirable to grind the face of the insert member **41** in order that a proper surface smoothness and surface geometry for engagement with the typefont may be produced.

The numeral **32** is FIGS. **1** and **2** identifies a penetration stop engaging face on the print hammer **28**. As FIG. **1** illustrates, this face **32** engages an adjustable but stationary stop member **45** of the print hammer stop assembly **55** when the print hammer **28** is displaced to a position near its maximum limit of travel. Engagement of this penetration stop member **45** by the face **32** limits the excursion of the print hammer **28** and the force with which it strikes the typefont media combination. Since it is desirable for this penetration stop member **45** to have precise and positive influence upon the print hammer excursion, the penetration stop face **32** is made an integral and tightly joined part of the print hammer body structure.

Satisfactory life and performance are obtained for the penetration stop face **32** when it is made of the same material as the hammer body; that is, nylon having dispersed particles of fiber glass in the present embodiment. The penetration stop member **45**, with which the face **32** engages in FIG. **1**, is fabricated from an impact-resistant energy-absorbing urethane material and is shaped to present a relatively large surface for impact to the hammer's penetration stop face.

One of the necessary characteristics for an "on-the-fly" printing system which operates without halting the moving typefont is for the print hammer to be capable of rapid entry into and egress from the moving typefont and media material, in order that printing may occur with a minimum of smear. In the printer mechanism of the FIG. **1** embodiment, the resilient characteristics of the plastic print hammer **28** are helpful in achieving this rapid entry and egress. Although a complete understanding of the hammer's behavior during typeline contact and egress is complex and a subject for detailed study, it is known that energy for the egress motion is stored in the resilient structure of the print hammer body in the region affected by the penetration stop face **32**, and in the region affected by the penetration stop face **32**, and in the region compressed by typeline contact, and to a lesser degree in the deformation of the pigtail spring member **29**.

It is notable that none of these energy storage mechanisms involve a force which acts to oppose excitation of the hammer by the solenoid assembly **54**, as would be true if hammer egress were completely dependent upon a return spring connected between a print hammer and an immovable frame. Since the ability of a solenoid to generate mechanical force is at its lowest point when the solenoid armature is in the quiescent resting position, wherein a large airgap exists between movable and stationary magnetic poles, the addition of a return spring opposing force is especially undesirable in influencing solenoid performance. The pigtail spring **29** serves not only to aid retraction of the print hammer **28** from printing engagement but also to guide the print hammer **28** back into engagement with the solenoid armature driving arm **17**, to oppose rebounding of the print hammer **28** in contact with the armature arm **17** during quiescence of the mechanism.

In the illustrated embodiment of the print hammer, it has been found desirable to provide the pigtail spring **29** with a force constant which is great enough to retain the hammer **28** and the armature arm **17** in contact during acceleration of these members toward the media to be printed (not shown but located across the top of the hammer in FIG. **1**). This force constant is, in addition, made small enough to permit the hammer **28** to separate form the armature arm **17** and continue in flight toward the printable media upon the solenoid assembly **54** becoming fully closed and the armature arm **17** being decelerated.

In the time following closure of the solenoid assembly **54**, while the hammer **28** continues its travel toward the media to be printed, the pigtail spring **29** is being elongated in preparation for its role in assisting the return of the hammer **28** form printing engagement. This elongation is accomplished by the continuing forward motion of the hammer **28** as it continues to travel under its own inertia toward the printable media. Since inertia energy from the print hammer is the only source of force which elongates the spring **29**, in its illustrated location between the movable hammer **28** and the movable armature arm **17**, the force of the spring **29** does not oppose movement of the solenoid in the conventional manner so as to slow response of the solenoid.

Several additional construction features of the print hammer **28** shown in FIG. **2** of the drawing are important in providing a print hammer capable of operating at the energy level and the life duration desired for the printing mechanism—energy levels near 200,000 ergs and life over 200million cycles, respectively.

At the region of the print hammer **28** identified as **58** in FIG. **2**, where the forward cantilever spring **31** joins the print hammer body **57**, it has been found that orientation and positioning of the spring as shown are desirable in order that premature failure not be caused in the spring. For instance, it is found that, if the curl of the imbedded portion of the cantilever spring is reversed, so that the straight portion of the spring, the straight portion which extends outside the hammer body, is located closest to the end of the forward hammer **28** by the hammer insert member **41** impacting with the print font is conducted to the spring in sufficient magnitude to cause early fracture of the spring material, it has been found desirable both to orient the spring **31** in the manner shown, with the straight portion remote form the insert member **41**, and also to provide for some hammer body material to be molded between the spring **31** and the moldable end of the hammer insert member **41** as shown.

In addition to the above failure which has been encountered in the hammer springs, it has also been found that, during flexing of the spring while starting and stopping hammer motion, failure often occurs in the spring at points where it enters the hammer body or where it enters a frame attachment assembly. Investigation reveals the concentration of stresses occurring close to a support member to be the cause of this failure. The fillets **36** (FIG. **1**) and **37** (FIGS. **1** and **2**), which are added to the base and hammer members of the mechanism, are effective to reduce these concentrations of stresses in the spring material. These fillets provide a transition region in which rigidity of the spring support is decreased gradually and as a function of distance from the hammer or support member. The fillets at the spring support member are formed into two

plastic nonrigid support members **34** and **35**, which are clamped to each side of the spring by a machine screw **38**.

What is claimed is:

1. A print hammer for a high-speed printing mechanism comprising the combination of:

a print hammer having a thermoplastic resin body portion, the body portion having along one axis thereof a slender shape with length greater than the width and height of said body portion;

cantilever flexure spring support means, including a pair of flexure springs attached respectively to said body portion near its lengthwise ends and flexible in the direction of length of said body portion, for supporting and guiding movement of said thermoplastic resin body portion;

a first face member metallic insert covering the impact end of said body portion for said print hammer, said first face member metallic insert including means extending into said thermoplastic resin body portion for attaching said first face member metallic insert to said thermoplastic resin body portion;

a second face member nonmetallic insert having a softer composition than said first face member metallic insert and covering the end opposite said first face member metallic insert of said body portion of said print hammer, said second face member non metallic insert including means extending into said thermoplastic resin body portion for attaching said second face member non metallic insert to said thermoplastic resin body portion;

tension spring means having one end thereof permanently attached within said body portion at its where said second face member non metallic insert is attached for urging said print hammer in one direction along said body portion axis of slender shape; and

actuator for said print hammer in contact therewith at the second face member non metallic insert end, said tension spring means having its other end in abutting cooperating relationship with said actuator for urging said actuator into contact with said second face member non metallic insert end of said hammer.

2. A print hammer as in claim **1** wherein said second face member nonmetallic insert is composed of plastic.

3. A print hammer as in claim **1** wherein said first face member metallic insert is composed of powdered metal and said second face member non metallic insert is composed of a thermoplastic acetal resin containing particles of fluorinated ethylenepropylene resin as a filler.

4. A print hammer as in claim **3** wherein said second face member nonmetallic insert is composed of thermoplastic acetal resin containing fluorinated ethylenepropylene resin particles in a proportion near 14 percent by weight.

5. A print hammer as in claim **1** wherein said thermoplastic resin body portion for said print hammer comprises nylon containing randomly distributed particles of fiberglass.

6. A print hammer as in claim **1** wherein said tension spring means includes a wire spring shaped substantially in the configuration of a rounded capital letter P with its stem portion being permanently attached within said body portion.

7. A print hammer as in claim **6** said tension spring means extending into said thermoplastic resin body portion.

8. A print hammer as in claim **1** wherein said thermoplastic body portion includes print hammer penetration stop face member means integral with said body portion and extending away form said body portion for engaging a print hammer penetration stop member.

9. Organic material print hammer slug apparatus of the ballistic type for a high speed printing mechanism which also includes a continuously moving typefont and a movable print hammer driving member, said print hammer slug apparatus comprising the combination of:

a print hammer slug body member, said body member having a composition that includes nylon filled with short randomly oriented particles of fiberglass and having a shape that incorporates body length substantially greater than body height and width;

supporting and guiding means including a pair of steel cantilever flexure springs, attached at one end thereof within said body member, for supporting said body member lengthwise perpendicularly adjacent to said continuously moving typefont;

metal face member insert means for covering the end of said body member adjacent said continuously moving typefont, said face member insert means including attachment means extending into said body member, said face member insert means being composed of powdered metal;

plastic face member opposite said continuously moving typefont, said plastic face member insert means including attachment means extending into said body member and an external planar face that is substantially perpendicular to the length of said body member for engaging said movable print hammer driving member; and

tension spring means fixedly connected to said body member and in loose abutting relation to said print hammer driving member for resiliently holding said members in touching engagement at said plastic face member planar face during an operating cycle portion.

10. Organic material print hammer slug apparatus as in claim **9** wherein said tension spring means includes a single-strand wire spring having a curving portion at one end thereof and having the other end thereof permanently attached within said body member at the body member end where said plastic face member insert is located.

11. Organic material print hammer slug apparatus as in claim **9** wherein said plastic face member insert includes a face member insert having a composition that includes thermoplastic acetal resin material having fluorinated ethylenepropylene resin material particles dispersed therein.

12. Organic material print hammer slug apparatus as in claim **9** wherein said body member nylon material contains fiberglass particles in a concentration near 40 percent by weight.

13. In combination with a print hammer slug member, a hammer return spring for inducing and maintaining frictional engagement between a print hammer slug member driving member and said print hammer slug member in a high-speed ballistic printer mechanism, said hammer return spring being composed of: a unitary strand spring steel wire body for said hammer return spring;

curving end portion means imposed upon one end of said spring steel wire body for anchoring said return spring within said print hammer slug member;

a substantially closed circular curve portion imposed upon the remaining end of said spring steel wire body, the substantially closed circular curve being coplanar with said curving end portion means and having a radius of curvature at least five times the radius of the spring steel wire composing said spring steel wire body; and

a substantially straight shank portion located on said spring steel wire body between said curving end portion means and said substantially closed circular curve portion, said shank portion being substantially coplanar with both said curving end portion and said substantially closed circular curve, said shank portion having a length that is between one-half and six times the radius of curvature of said substantially closed circular curve portion;

whereby said hammer return spring, when said curving end portion means is anchored within an end of said print hammer slug member, has the appearance of a rounded capital letter P standing upon the end of said print hammer slug member; and

whereby said print hammer slug driving member may be frictionally engaged between said substantially closed circular curve portion of said hammer return spring and an end of said print hammer slug member by resilient force form said hammer return spring.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,631,797 Dated January 4, 1972

Inventor(s) Lynn M. Johnston, et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 30, after "its" insert -- end -- ; line 34, before "actuator" insert -- an -- ; line 58, after "6" insert -- wherein -- ; line 58, after "means" insert -- wire spring is attached within said second face-member insert means -- . Column 8, line 13, after "member" insert -- insert means for covering the end of said body member -- .

Signed and sealed this 17th day of October 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.