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J. P. ECKERT, JR

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HYDRAULICALLY ACTUATED PRINT HAMMER FOR HIGH SPEED PRINTERS

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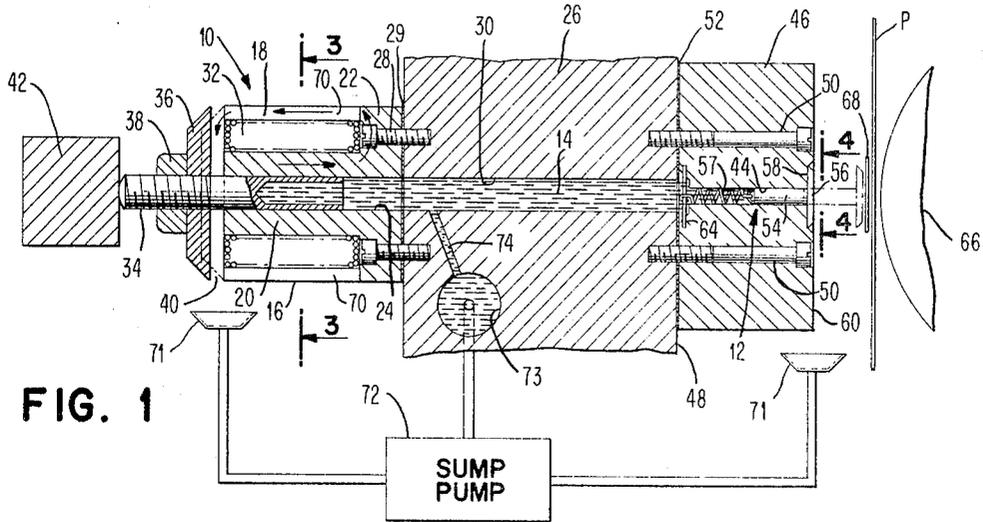


FIG. 1

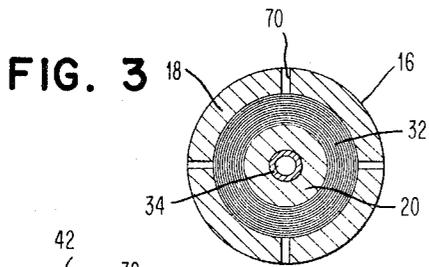


FIG. 3

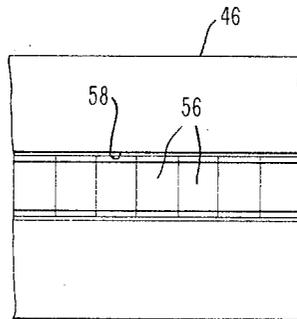


FIG. 4

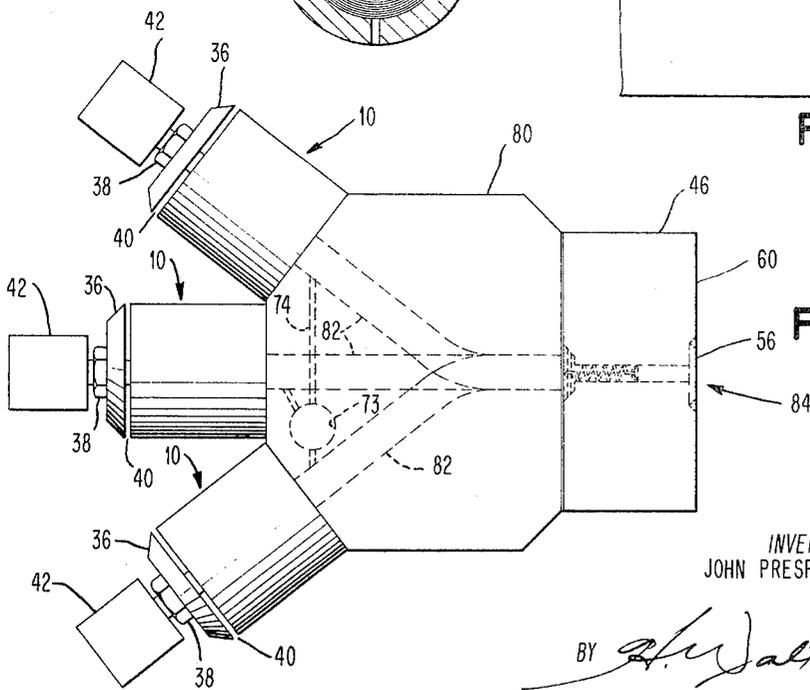


FIG. 2

INVENTOR  
JOHN PRESER ECKERT, JR.

BY

AGENT

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**HYDRAULICALLY ACTUATED PRINT HAMMER FOR HIGH SPEED PRINTERS**

John Presper Eckert, Jr., Gladwyne, Pa., assignor to Sperry Rand Corporation, New York, N.Y., a corporation of Delaware

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11 Claims. (Cl. 101-93)

The invention hereinafter described and claimed has to do with high speed printers, and more particularly to such printers wherein printing slugs or hammers are driven forwardly against a type carrying element to effect an imprint on an intermediately positioned web.

The need for increasingly high speed printers for use with modern computers has inspired a number of inventions reaching for a printing speed comparable to the output speed of such computers. In this regard so called "on the fly" printers have come closest to solving the problem, and therefore, have come into wide use.

In these printers a wheel or drum carrying type characters on its periphery is rotated at a constant speed. As the desired characters to be printed pass through the printing position, printing hammers or slugs are actuated to drive the paper and inked ribbon against the moving type thus to print the characters. Usually one hammer is provided for each printing position and one line of information is printed with each complete rotation of the drum. Other means for presenting type characters in the printing position, such as belts or bars, are used but need no detailed description here. The primary factor to be considered in any of these printers is the speed at which the type elements pass through the printing station.

It is important that the hammers move with sufficient power and speed to produce an imprint of the characters without damage to the paper or the ribbon, and without smearing due to the relative movement of the type and paper. Much effort has been spent to overcome this problem and some success has been attained. However, much still remains to be done.

It is the primary object of the present invention to provide an improved print hammer actuator taking a giant step in overcoming the difficulties mentioned above.

Another object of the invention is to provide an improved high speed printer wherein printing is effected by the interaction of two fluid coupled masses.

Still another object of the invention is to provide a printing device wherein printing is effected by the action of an electro-fluid power transducer upon a printing hammer or slug.

A further object of the invention is to provide such a printing device which is characterized by its ability to produce clear, smearless printing even at high relative speeds between the paper being printed upon and a moving type carrier.

A still further object of the invention is the provision of such a printing device which is capable of assembly in closely arranged arrays for printing characters in a line on normal centers.

In accordance with the above objects and first briefly described in its basic form, the invention comprises a printing element, a reluctance driver, and hydraulic means coupling said printing element with said driver whereby, electrical energization of said driver is effective through said hydraulic coupling to project said printing element against a type character to imprint the character on a web positioned between the printing and character elements.

In the drawings:

FIGURE 1 is a sectional view through printing appa-

ratus incorporating the novel imprinting means of the invention;

FIGURE 2 is an end view showing an assembly of a plurality of printers arranged for printing a line of characters;

FIGURE 3 is a sectional view taken along line 3-3 of FIGURE 1; and

FIGURE 4 is a view taken along line 4-4 of FIGURE 1.

Now with reference to the details of the drawings and first to FIGURE 1, it is seen that the basic elements of the invention comprise the reluctance driver 10, the low mass printing hammer or slug 12, and the low mass hydraulic coupling 14.

More specifically, in this preferred form of the invention, the reluctance driver 10 is an electromagnet comprising a cup-shaped housing 16 having spaced outer and inner ring-shaped walls 18 and 20 respectively, interconnected by a base 22, thus to form a U-shaped wall in cross-section and having an axial bore 24 extending therethrough. The housing is mounted on a support frame 26 of the printing apparatus, as by screws 28, with a suitable sealant 29 between the housing and frame. The bore 24 is aligned with a fluid passageway 30 extending through the frame 26.

An electrically conductive coil 32 surrounds the inner wall 20 substantially filling the space between the ring-shaped walls. The terminals (not shown) of the coil are connected to suitable well known circuits.

A hollow shaft plunger 34 is slidably mounted in bore 24 with its outer end passing through and fixed to a circular armature 36 as by the nut 38 threaded on the outer end of the plunger. The actuator plunger may conveniently be made of stainless steel to avoid adverse magnetic effects, if desired. The armature normally is spaced from the housing with a slight gap 40 between them as determined by the position of bar 42 extending between fixed portions (not shown) of the frame 26.

The housing 16 and the armature 36 form the magnetic elements of the reluctance driver 10. Since they are circular in shape and can be made on automatic machines, an alloy sold under the trade name "HYPER CO" and manufactured by the Westinghouse Corporation can be economically used. This material has very high saturation flux density and a resistivity high enough for the thin walled cup design employed.

The printing slug 12 is slidably mounted in a bore 44 extending through a block 46 fixed to the right hand face 48 of frame 26 in suitable manner, such as by screws 50, and with a suitable sealant 52 therebetween. Each slug comprises a short shaft or plunger 54 having an enlarged type engaging head 56 normally held by the coil spring 57 against a recessed seat 58 cut in the outer face 60 of block 46. One end of the spring is secured to the inner end of the plunger 54 and its other end to a pin 64 extending across the bore 44. It will be noted that bore 44 is of smaller diameter than passageway 30 the reason for which is explained later. Preferably the head 56 is rectangular in shape to fit closely into the recess 58 thus to prevent rotation from its proper position. Alternatively, key means (not shown) might be provided between the plunger 54 and the bore 44.

Printing apparatus with which the invention might be used includes the type wheel or drum, fragmentarily illustrated at 66, bearing the characters to be imprinted. Positioned between the drum and the printing heads 56 are the web of paper P and the ink ribbon 68. Both the paper and the ribbon may be fed by conventional means, not shown, and forming no part of the present invention.

The fluid coupling comprises the liquid 14 filling the

space between the plungers 34 and 54, including bores 24, 30 and 44.

Ideally the construction and arrangement of parts is such as to produce a print hammer movement of four times the armature displacement. For example, a gap of ten mils should produce a forty mil movement of the hammer at high velocity. This is accomplished by a four to one displacement ratio between the fluid in bores 30 and 44 respectively.

In its operation, and unlike most printer actuator designs in which the hammer flies free, and only its mass strikes the paper, the present hydraulic design causes the hammer to hit the paper with two fluid coupled masses. When the coil 32 is energized it produces a strong magnetic field in which the flux flows through the cup-shaped housing across the circular gap and through the armature in the direction of the arrows (FIGURE 1). The armature (the first mass) is drawn sharply to the right against the housing, pulsing the fluid coupling to drive the printing slug (the second mass) against the type drum to effect printing of a character on the paper web.

Coil 32 is energized only momentarily and its return to the retracted position is assured by the return of the print head plunger to its rest or retracted position under the urge of coil spring 62 and the rebound pressure of the fluid column on plunger 34. Return movement of the plunger 34 and armature 36 is limited by contact with stop bar 42.

In order to reduce the "shorted turn" effect of the magnetic cup-shaped housing one or more radial cuts 70 (FIGURE 3) may be provided in the outer wall 18.

The parts will fit well enough so that fluid leakage will be negligible during the actual stroke of the actuator piston. The lost fluid may be recovered by suitable pans, such as shown at 71, and fluid conduits to be returned to a sump 72. A tiny pump at the sump then puts fluid under moderate pressure back into the system through the passageway 73 and tiny bleed holes 74 which connect to each fluid passage. Great pressure is not required for this purpose since considerably more time is available to bleed the fluid back into the system than was used to squeeze it out. Thus, in spite of the pressure on the fluid when it is squeezed out, up to several hundred pounds per square inch, a much lower pressure, perhaps ten pounds per square inch, is sufficient to put it back and insure an air free system.

The magnetic cup may be as thin as twenty-five to thirty mils at its edge. The outer edge of the armature might even be thinner. This thin section, aside from reducing loss due to eddy currents, keeps the armature mass to a bare minimum.

An advantage of this design, in connection with medium speed mechanical printers, is the low mass of the entire actuator assembly. This will enable such an assembly to be moved sideways for time sharing of one actuator with several different print columns.

Life and reliability is better than present actuators because the self adjusting characteristic of the hydraulic coupling can prevent bottoming and thus pounding of the actuator magnetic surfaces. This self adjusting feature is reminiscent of a hydraulic valve lifter in an automobile engine. Further, the coil type retraction spring used with the hammer affords longer life and less wear than other designs.

As shown in FIGURE 2, the design readily lends itself to assembly in line arrays wherein the electromagnets are spaced around a framing member 30 thus to permit the ends of the fluid passageways 82 to be aligned as at 84 on the preferred 0.1" spacing. The fluid coupling between the hammer and the armature may assume other than a straight condition. As seen here, the fluid passageway between them may be curved with no loss of effectiveness.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A hydraulically actuated printing apparatus comprising: a low mass print hammer; means mounting said hammer for reciprocal movements between a retracted rest position and an advanced printing position; an electromagnet having an armature separated therefrom by a small air gap; means confining a low mass hydraulic fluid column coupling said hammer and said armature whereby said armature is effective through said fluid coupling when said electromagnet is energized to draw said armature through said small air gap immediately to drive said hammer at high velocity through a greater distance than the movement of said armature to its advanced printing position.

2. A printing apparatus according to claim 1 wherein said fluid column has a larger cross-sectional area at the armature end than at the hammer end whereby the movement of said armature is amplified to move said hammer a greater distance than the movement of said armature.

3. A hydraulic printing apparatus according to claim 1 and further including means for continuously supplying fluid to said fluid column to replace fluid lost through leakage.

4. A printing apparatus according to claim 1, wherein: said print hammer comprises a shaft having an enlarged head for effecting the printing; and further including a frame member having a bore therethrough of substantially the same diameter as said shaft and in which said shaft is mounted for said reciprocal movements toward and away from said printing position; and wherein said bore forms a part of said fluid column confining means and has a larger diameter portion whereby movement of said fluid at said larger diameter portion by said armature acts against said shaft to move said hammer through its greater distance at high velocity to its advanced printing position.

5. A printing apparatus according to claim 4, and further including; spring means for urging said hammer away from said printing position to its retracted rest position when said electromagnet is deenergized.

6. Printing apparatus according to claim 4, wherein said electromagnet comprises: an electrically conductive coil; a cup-shaped housing having U-shaped side walls for receiving said coil, said housing having a central bore of larger diameter than the bore of said hammer shaft and forming the said larger diameter portion of said fluid column confining means; said armature having a shaft of substantially the same diameter as, and extending into said housing bore for reciprocal movements therein; and wherein energization of said electromagnet draws said armature through said small air gap toward said housing whereby said armature shaft is effective to drive said low mass fluid column through said bores to move said low mass hammer into its advanced printing position at high velocity.

7. A printer according to claim 6 wherein the walls of said housing, and the said armature surround said coil and provide the flux path of said electromagnet when its coil is energized thereby to draw said armature toward said housing to effect the printing movement of said hammer.

8. A printer according to claim 7 and further including: means for adjusting the space between said armature and said housing.

9. A hydraulically actuated printing means for use in a printer wherein the medium to be printed upon and an inked member are moved into engagement with type characters moving at high speed by a hammer movable between an advanced printing position and a retracted rest position, comprising: a low mass print hammer having a shaft and a print effecting end; an electromagnet comprising an electrically conductive coil, a fixed magnetic member, and a movable magnetic member spaced from said fixed member by a small air gap and having a shaft; a closed passageway receiving said shafts in its opposite ends, said passageway having a smaller diameter at said hammer shaft receiving end than at said movable

magnetic member shaft receiving end; a low mass hydraulic fluid filling said passageway to couple said hammer shaft with said movable member shaft in spaced relationship whereby energization of said coil produces a magnetic field wherein the flux flow is through said magnetic members in a direction moving said movable magnetic member through said small air gap in a manner causing its shaft to drive said fluid column against said hammer shaft to project the hammer at high velocity from its retracted rest position to its advanced printing position wherein its print effecting end moves the medium to be printed upon and the inked member against a type character to effect an imprint thereof on said medium and rebound therefrom by the force of its impact on the medium; and means cooperating with said rebound force to return said hammer to its retracted rest position when said coil is deenergized.

10. A printing means according to claim 9, and further comprising: a plurality of said print hammer actuators wherein said hammers are arranged in a row to print a line of characters, and said fluid columns approach its coupled hammer from successively different angles whereby said hammers may be arranged on close centers while permitting ample spacing between said electromagnets.

11. A hydraulically actuated printing apparatus for use in a printer wherein the medium to be printed upon is moved into engagement with a type character moving at high speed by a hammer, comprising: a low mass print hammer having a shaft and an enlarged head for effecting the printing; means mounting said hammer for reciprocal movements between a retracted rest position and an advanced printing position; said hammer mounting means comprising a frame member having a bore therethrough of one diameter in which said hammer shaft is mounted for said reciprocal movements toward and away from said

printing position; an electromagnet comprising an electrically conductive coil, a cup-shaped coil housing having U-shaped side walls for receiving said coil, and a central bore of larger diameter than said hammer shaft bore, and an armature spaced from said housing by a small air gap but reciprocally carried thereby on a shaft slidably fitting into said housing bore; means forming a passageway confining a hydraulic fluid column and coupling said hammer and said armature by way of said bores whereby when said electromagnet is energized said armature is drawn through said small air gap toward said housing and in response thereto said armature shaft is effective immediately to drive said fluid column to project said hammer at high velocity into its advanced printing position through a greater distance than said air gap; and spring means for urging said hammer toward its retracted rest position when said electromagnet is deenergized.

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