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Rose

[11] **3,768,403**

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[54] **HIGH SPEED PRINTER WITH LEAFLIKE IMPACT MEANS**

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[73] Assignee: **Tally Corporation**, Kent, Wash.

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[52] **U.S. Cl.** ..... **101/93 C**, 173/119

[51] **Int. Cl.** **B41j 5/12**

[58] **Field of Search** ..... 101/93 C, 110, 111

[56] **References Cited**

UNITED STATES PATENTS

3,359,921	12/1967	Arnold et al.	101/93 C
3,386,376	6/1968	Mutz et al.	101/93 C
3,504,623	4/1970	Staller	101/93 C
3,228,325	1/1966	Miller	101/93 C
3,332,343	7/1967	Sims	101/93 C

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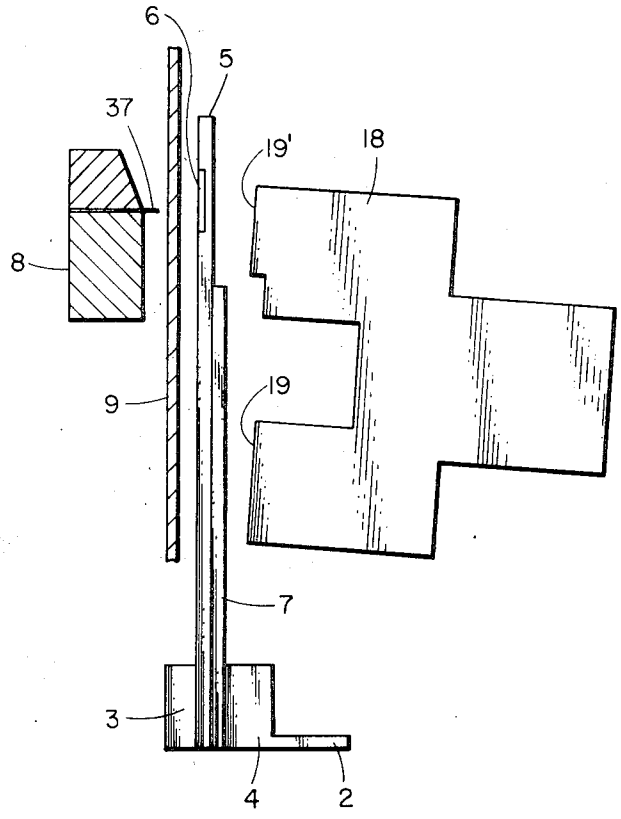
Assistant Examiner—E. M. Coven
Attorney—William C. Cahill et al.

[57] **ABSTRACT**

A printing hammer with a lesser length damper in juxtapositional relationship, which damper provides vibration damping of the printing hammer. High speed line printers utilizing impact printing means are often limited to a maximum speed due to the spring response and continued vibration of the printing hammers. The printing hammer taught by the instant invention incorporates a lesser length damper in juxtapositional relationship to provide vibration damping by having the damper vibrate at a natural frequency different from that of the printing hammer. During the actuation of the printing hammer, the mass of both the printing hammer and the damper strike the print surface. Subsequently, the printing hammer and the damper will vibrate in opposition to one another to rapidly effect a damping action. A damper length which is approximately 0.707 times the length of the printing hammer provides the damper with a natural frequency twice that of the printing hammer. Other means for providing differing vibration frequencies are anticipated.

2 Claims, 4 Drawing Figures



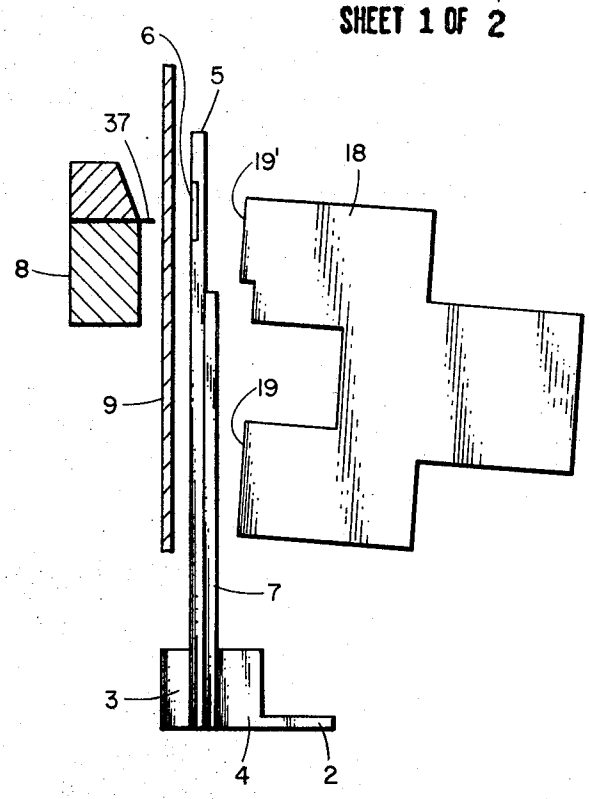


Fig. 1

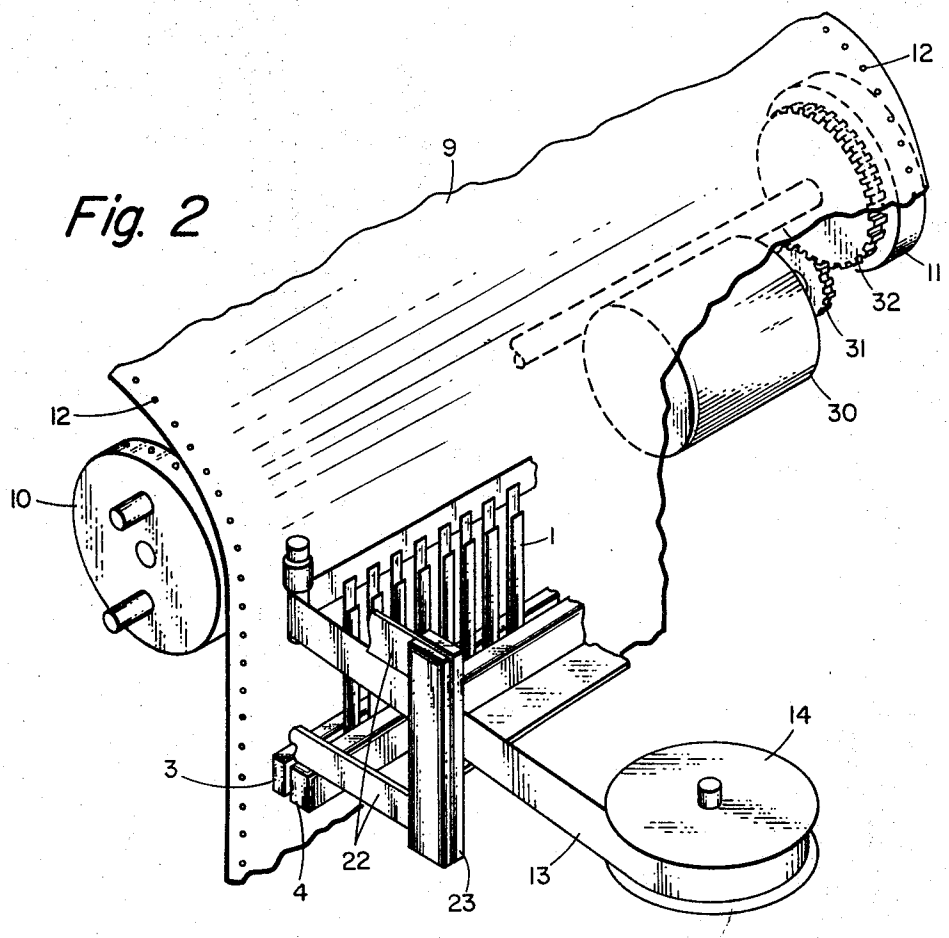
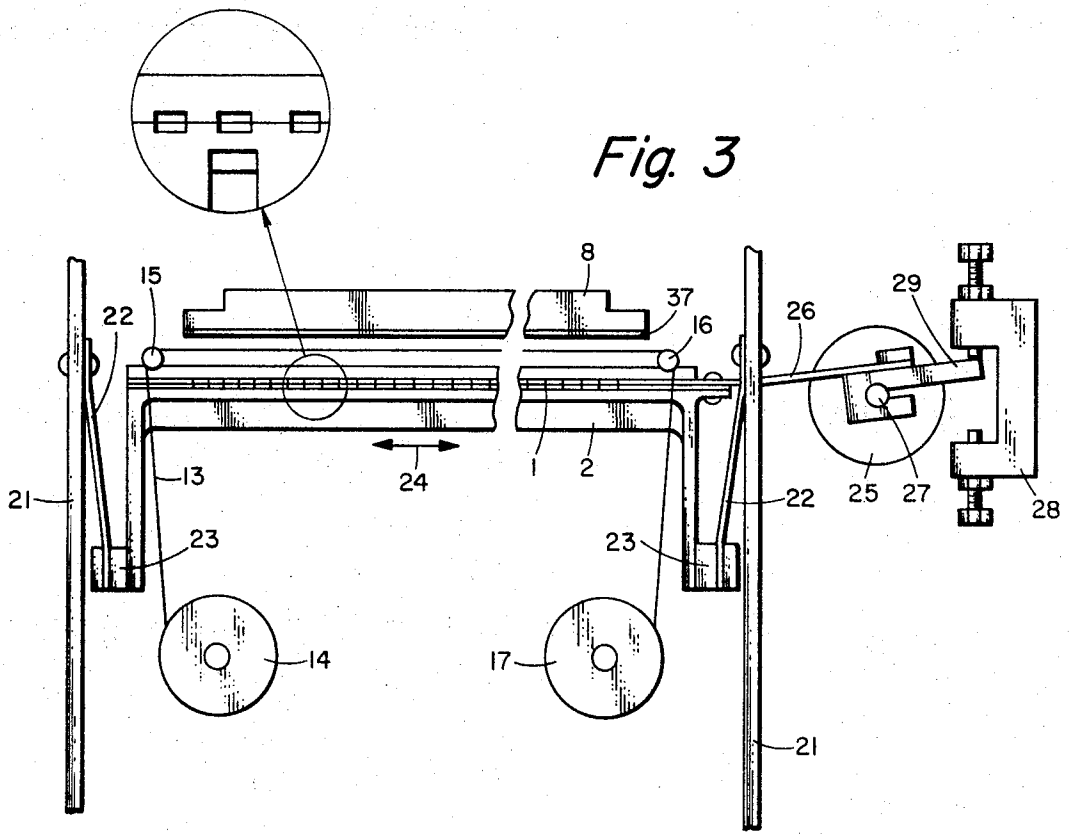


Fig. 2

Fig. 3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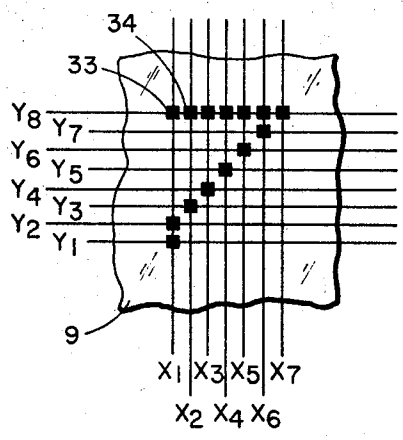
34
33
Y8
Y7
Y6
Y5
Y4
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9
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Fig. 4

HIGH SPEED PRINTER WITH LEAFLIKE IMPACT MEANS

This application includes an improvement of the line printer described in the co-pending U.S. Pat. application entitled "Impact Line Printer," Ser. No. 97,166, filed Dec. 11, 1970.

The present invention pertains to hammers especially suited for line printers utilizing impact as a means for printing.

Line printers simultaneously form a line of characters and are generally high speed devices (500 lines or more per minute). These high speed printers, such as taught in the co-pending patent application entitled "Impact Line Printer," are mechanically capable of actuating the hammers to be commensurate with communication line information speeds (1,200 Baud and up). A limiting factor in increasing the pringing speed and yet obtain a clear copy is associated with the structure and operation of the hammer itself.

A primary object of the present invention is to provide a vibration damped impact printing hammer which does not damp the initial impact force.

Another object of the present invention is to provide a damped impact printing hammer which prevents multiple print impressions and ghosting.

Another object of the present invention is to provide a damped impact printing hammer which is commensurate with the speed of high speed line printers.

Still another object of the present invention is to provide a damped impact hammer which may be used in existing line printers.

These and other objects of the present invention will become apparent to those skilled in the art as the description thereof proceeds.

The present invention may be described by reference to the accompanying drawings, in which:

FIG. 1 illustrates a cross-sectional view of the damped hammer and the related apparatus.

FIG. 2 illustrates a portion of the paper feed mechanism and relationship of the paper to the hammers and ribbon.

FIG. 3 illustrates the relationship between the hammer and hammer support and the frame of the printer.

FIG. 4 illustrates a typical character printed by the system of the present invention.

Referring to FIGS. 1–3, a plurality of hammer units 1 are aligned with each other and are mounted in a hammer support 2. In the embodiment chosen for illustration, the hammer units 1 are mounted in the support 2 by clamping the respective hammer units 1 between opposed faces of clamping bars 3 and 4, the latter being an extension of support 2. The hammers 5 of hammer unit 1 are formed from appropriate steel to provide the facility to be drawn away from the paper surface, to be released, and to snap forward to strike the paper and return to its original position. The hammers may also be stamped from a single sheet of metal with each of the individual hammers forming fingers in comb-like fashion from a base which is clamped between clamping bars 3 and 4. Each of the hammers 5 is provided at the upper portion thereof with a striking surface 6 that comprises a rectilinear edge extending perpendicularly toward the platen when the hammer unit 1 is mounted in the printer. The utilization of an edge as the striking surface 6 facilitates the production of dots or marks in the matrix of a character, as will be described more completely hereinafter. Adjacent each hammer 5 is a damper 7 also mounted in support 2 by clamping bars 3 and 4. The length and weight of damper 7 should be designed such that damper 7 will have a natural frequency of vibration different from that of the hammer 5 in accordance with the laws of vibration of elastic bodies.

A platen 37 comprises a horizontally extending edge functioning as a striking surface. The platen 37 is gripped in a clamp 8 and is held in a position opposite to the striking surface 6 of the respective hammer unit 1. Flexible sheet material 9, such as paper, upon which characters are to be formed is fed through the printer as shown in FIG. 2 on a pair of sprockets 10, 11 engaging sprocket holes 12 provided in the paper. A conventional ink ribbon 13 is wound about a feed roll 14 and passes over guides 15 and 16 to a take-up roll 17.

Electromagnets 18 are provided for each of the hammer units 1. On energizing the electromagnet coil, both the hammer 5 and damper 7 are deflected toward the pole face 19, 19'. The distance between the platen edge and hammer 5 when the latter is in the quiescent vertical position is such that the striking face 6 of the hammer 5 will strike the platen edge during the first half of the vibratory cycle after the hammer 5 is released from the influence of the energized coil 18. When the electromagnet coils is de-energized, the magnetic field collapses, permitting both the hammer 5 and the damper 7 to travel toward the paper 9 and the platen 37. After the hammmer 5 strikes the paper 9 and platen 37, it will rebound and continue to vibrate with decreasing amplitude until the energy stored therein has been dissipated.

If the length and/or weight of the hammer 5 and the damper 7 are different from each other, and not related by odd harmonics of one another, the vibration of one will interfere with the vibration of the other. If the cross section and material of the hammer 5 and the damper 7 are the same and their lengths are in the ratio of approximately 1 to 707, respectively, the frequency of vibration of the first is half that of the latter, causing each to interfere with the other. Each time the vibratory movement of one interferes with the vibratory movement of the other, an impact will occur. Each of these impacts will necessarily dissipate energy from the hammer 5, causing its vibratory amplitude to decrease rapidly. Thereby, the total vibration time of the hammer 5 is substantially reduced and the hammer is damped.

A second function performed by the damper 7 is that of contributing its spring force to that of the hammer 5 to aid in accelerating the hammer 5 away from the pole face 19, 19' and toward the platon 9. By careful design, it is possible to reduce the mass of the hammer 5 to lighten the hammer assembly without jeopardizing the capability of the hammer 5 in striking the platen 37 as the hammer spring force required in conjunction with the damper 7 is less than if the damper 7 were not present.

A third function performed by the damper 7 is that of providing additional iron in the coil flux path during coil energization. This permits a more efficient use of the available flux. Further, the additional iron permits a greater displacement and/or misalignment between the hammer 5 and the electromagnet 18 without impairment or degradation of the printing operation.

The face 19 of the electromagnet 18 may be displaced from a vertical line such that it parallels the cen-

ter line of the hammer unit 1 when the latter has been attracted toward the energized electromagnet 18. A portion of coil face 19' may be raised toward the hammer unit 1 such that the profile of the coil face matches the profile of the damper 7 and the extended portion of hammer 5 comprising hammer unit 1. Such a design feature will aid in uniformly attracting the hammer unit 1 to the electromagnet 18.

The electromagnets 18, each co-operating with one hammer unit 1, may be mounted onto the frame 21 of the printer if it is desired that they remain stationary.

The hammer support 2 is also secured to the frame 21 but is mounted to permit horizontal reciprocal stepping. The movable mounting is provided by a plurality of two-dimensional semi-flexible straps 22 clamped at one end thereof to an upright 23 extending from the hammer support 2. As shown in FIG. 3, the opposite ends of the straps 22 are attached to the frame 21. Each of the straps 22 is made of spring steel which permits two-dimensional flexure perpendicular to the face of the strap while inhibiting flexure in any other direction. The mounting of the hammer support 2 in this fashion securely fixes the hammer units 1 at a predetermined vertical position while nevertheless permitting the hammer support 2 and hammer units 1 to be moved laterally of the paper 9. This lateral movement is indicated in FIG. 3 by the arrow 24. Lateral motion is imparted to the hammer support 2 and hammer units 1 by a stepping motor 25 connected to the hammer support 2 by a two-dimensionally, semi-flexible strap 26. While other means may be utilized to connect the hammer support 2 to the stepping motor 25, the strap 26 readily translates the rotary motion of the stepping motor shaft 27 into rectilinear motion and permits the stepping action of the motor 25 to simply and positively "step" the hammer support 2 and hammer units 1.

The stepping motor 25 is reversible and is stepped to a number of step positions corresponding to the number of horizontal dot or mark positions in the matrix forming a character. A mechanical stop 28 may be provided to engage the clamp extension 29 secured to the motor shaft 27.

The paper 9 is advanced through the utilization of a second stepping motor 30 which is connected through gears 31 and 32 to sprockets 10 and 11. The selected energization of stepping motors 25 and 30 combined with the energization of appropriate electromagnets 18 generate a matrix of step positions for the formation of characters.

The operation of the printer of the present invention may now be described with the aid of FIG. 4. In FIG. 4, a characer "7" is shown and is formed by the selective printing of marks or dots in a matrix. In the embodiment chosen for illustration, a seven by eight matrix has been chosen; it will be obvious to those skilled in the art that a greater or lesser number of step positions may be utilized in accordance with the requirements of the specific application.

Referring to FIG. 4, the horizontal or lateral step positions are designated step positions $x1, x2, \ldots, x7$, while the vertical step positions have been designated $y1, y2, \ldots, y8$. Assuming that the character "7" is to be printed, the paper 9 will be stationary and dot or mark position $x1, y8$ will be between the striking surface of the platen 37 and the hammer unit 1. The electromagnet 18 will be energized and subsequently deenergized, causing the hammer 5 to be drawn away from the paper 9 and then released. The momentum of the hammer 5 will cause it to strike the ribbon 13 and force it against the paper 9 and both the paper and ribbon against the platen 37. Since the striking surface 6 of the hammer 5 is oriented at right angles to the edge of the platen 37, a relatively small mark or dot 33 will be formed. The stepper motor 25 will then be energized and the hammer unit 1 moved to the horizontal step position $x2$. The electromagnet 18 will again be energized and the hammer 5 and platen 37 will form the mark 34 in position $x2, y8$. The stepping motor 25 will continue to step, causing the hammer support 2 and hammer units 1 to step to successive step positions until the hammer unit 1 reaches horizontal step position $x7$. After the mark is printed at that position, the stepping motor 30 will be energized, causing the paper 9 to be slightly advanced. Vertical step position $y7$ is now aligned between the striking surface of the hammer units and platen. The stepping motor 25 will again be energized in the reverse direction, causing the hammer units 1 to step to the left as shown in FIG. 4 with the hammer units 1 being energized at the appropriate step positions for the formulation of the character "7." The hammer units 1 therefore continue to step back and forth laterally or horizontally across the paper 9 with the electromagnet 18 associated with the hammer unit 1 energized at the appropriate time. At the end of each horizontal sweep from left to right or right to left, the paper 9 is advanced or stepped to bring the next row of mark positions in the matrix into striking position between the hammer units 1 and platen 37. It may be noted that only one electromagnet energizes a given hammer unit, regardless of the hammer unit position; thus, while the hammer support 2 and hammer units 1 are stepped or oscillated back and forth, the electromagnets 18 associated with each hammer unit 1 remain stationary. While the hammer units 1 are then sometimes slightly misaligned with their corresponding electromagnets, they nevertheless remain within the area of influence of that electromagnet to the extent that the hammer unit 1 is actuated by the energization and deenergization of its corresponding electromagnet. Since the electromagnets 18 remain stationary, the mass that is accelerated and decelerated during the stepping action of the hammer units 1 is greatly reduced and the speed with which the hammer units may be stepped is increased correspondingly. The use of the semi-flexible straps 22 greatly reduces friction that otherwise would occur if the hammer support 2 were guided by more conventional means, such as rollers, sliding guides, etc. Further, the tolerances are very inexpensively but accurately maintained through the utilization of the straps 22. Similarly, the strap 26 used by transmitting the stepping motion to the hammer units eliminates problems that otherwise would occur with more conventional motion transmitting media, such as the imprecision of chain drives or the backlash of rack and pinions.

I claim:

1. In a printer for printing characters by an impact printing technique, the improvement comprising: a plurality of cantilevered fingers extending from a base and forming impact hammers, each including a flat surface extending substantially its entire length and each formed from magnetically attractable material and having a length to provide a predetermined natural vibratory frequency; a plurality of cantilevered fingers ex-

tending from said base and forming dampers of magnetically attractable material, each damper including a flat surface extending its entire length, the flat surface of each damper contacting the flat surface of a different one of said hammers throughout the length of said damper, clamping means clamping each damper in contact with a different one of said hammers at said base, said dampers having a length to provide a natural vibratory frequency different from said predetermined frequency; a plurality of electromagnets, each positioned adjacent a different one of said hammers to attract, when energized, the adjacent hammer and damper in contact with said adjacent hammer.

2. The combination set forth in claim **1**, wherein each of said dampers is approximately 0.707 times the length of said dampers.

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