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Cattaneo

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[54] **BALLISTIC PRINT HAMMER AND TYPE-BEARING ELEMENT COMBINATION FOR ON-THE-FLY PRINTER**

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Related U.S. Application Data

[63] Continuation of Ser. No. 50,659, June 29, 1970, abandoned.

[30] **Foreign Application Priority Data**

June 28, 1969 Italy 18918/69

[52] **U.S. Cl.** ..... **197/53,** 101/93 C, 101/111

[51] **Int. Cl.** **B41j 7/34**

[58] **Field of Search** ..... 101/93 C, 111; 197/53, 197/18

[56] **References Cited**

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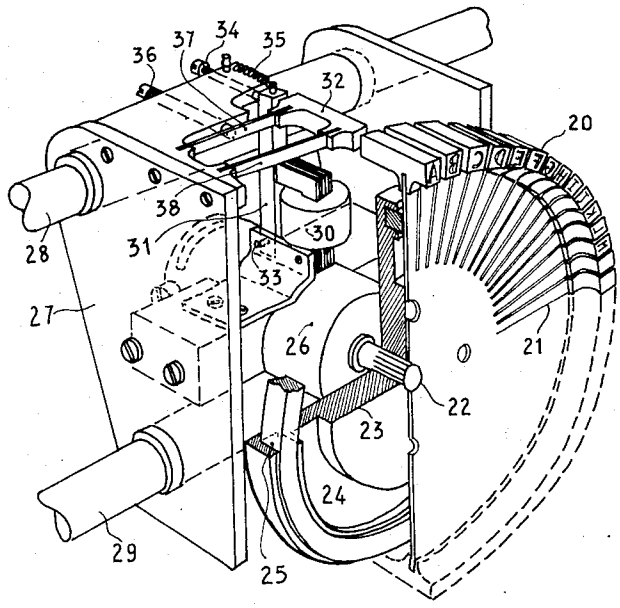
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Assistant Examiner—E. M. Coven
Attorney, Agent, or Firm—Fred Jacob

[57] **ABSTRACT**

A printer of the kind having a print hammer and movable type-carrying members, wherein, to avoid problems of interference, each type character is associated with an element of mass m and is actuated to effect printing by the print hammer through a ballistic interposer having substantially the same mass m, and wherein the ballistic interposer is projected against the element associated with each character to transfer thereto its entire dynamic energy and is thereby arrested.

6 Claims, 6 Drawing Figures



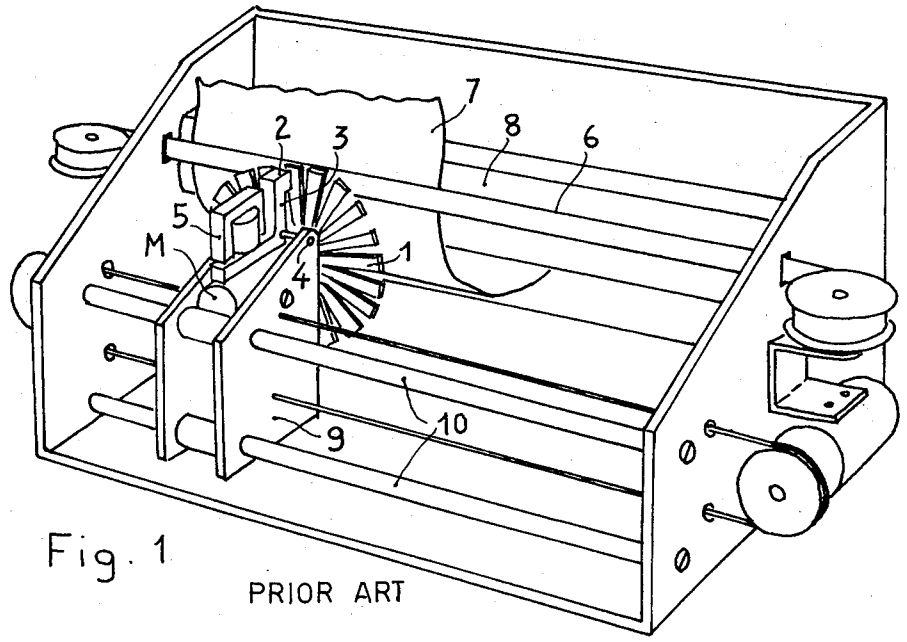
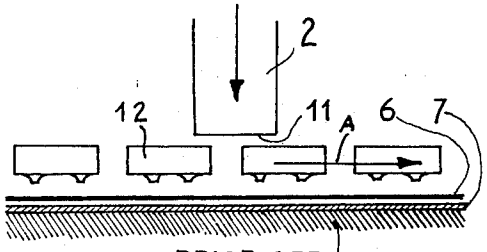
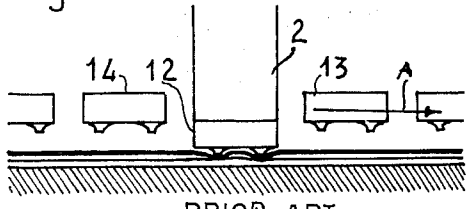


Fig. 1
PRIOR ART



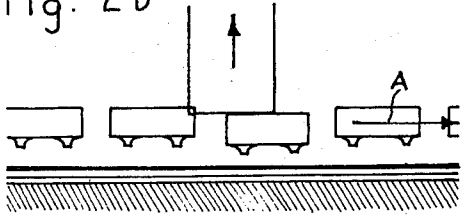
PRIOR ART

Fig. 2a



PRIOR ART

Fig. 2b



PRIOR ART

Fig. 2c

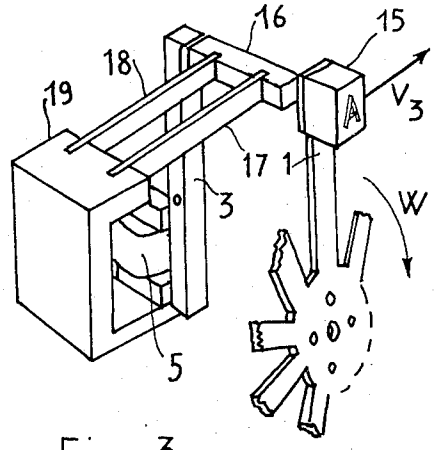


Fig. 3

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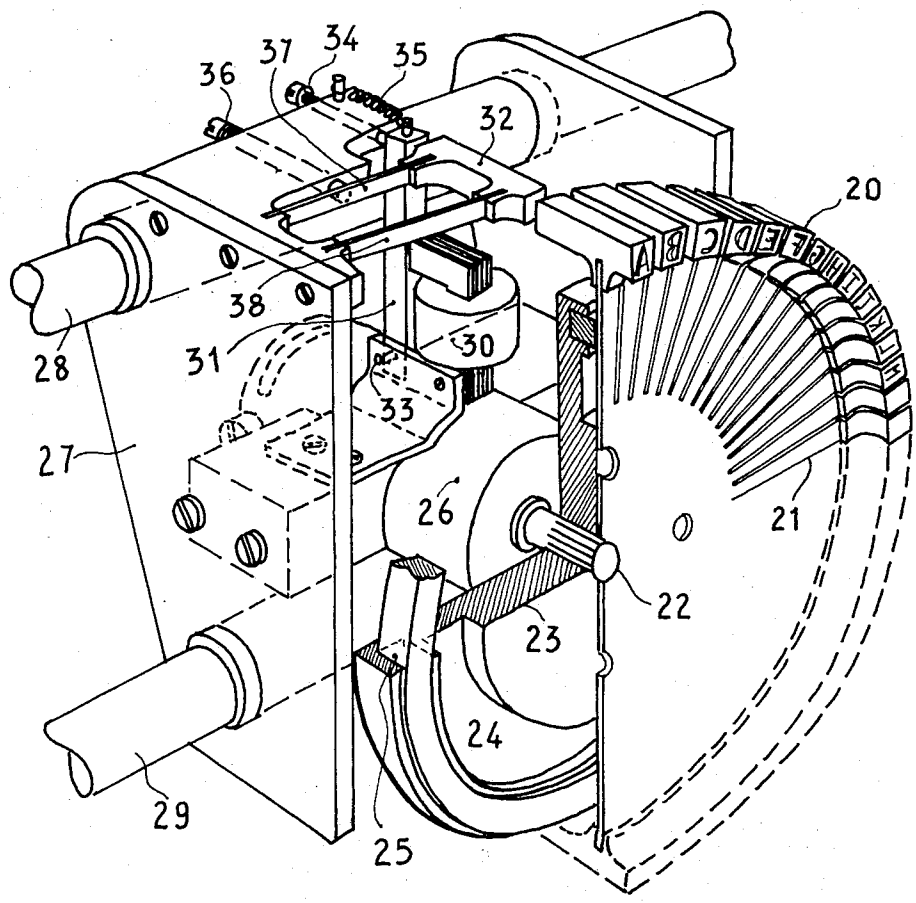


Fig. 4

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BALLISTIC PRINT HAMMER AND TYPE-BEARING ELEMENT COMBINATION FOR ON-THE-FLY PRINTER

This is a continuation of application Ser. No. 50,659, filed June 29, 1970 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to high-speed impact, or "on-the-fly," printers used in data processing systems and particularly to high-speed serial, parallel, or serial-parallel impact printers.

One form of such impact printers are known as "bed printers," which print by means of one or more print elements or hammers, and a support plane, platen, or fixed printing bed. A type-bearing element consisting, for example, of an assemblage of flexible character tongues supported by a belt is interposed between a hammer and the printing bed and is suitably moved so that all the characters of the type-bearing element are positioned, one after the other, at a predetermined print position.

As is known, one of the major problems in this form of printer arises from interference between the print hammer and the type-bearing element, with the consequent risk of jamming or breaking the parts. This risk has been reduced by suitably spacing the support tongues of the characters along their direction of motion, although, as is known, such spacing introduces a substantial reduction in the printing speed.

Therefore, it is the object of this invention to eliminate these disadvantages of such impact printers without reducing their performance.

SUMMARY OF THE INVENTION

The above-described interference problem is eliminated in the printer of the instant invention, by suitably designing the masses of the characters and the print hammer, thereby obtaining the additional advantage that the support tongues of the characters can be made sufficiently close together such as to provide even higher printing speeds.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be described with reference to the accompanying drawing, wherein:

FIG. 1 is a perspective view of a prior art impact printer;

FIGS. 2*a*, 2*b*, and 2*c* are top views which show schematically the successive steps of a printing operation in the printer of FIG. 1;

FIG. 3 is a perspective view of a portion of a printer in accordance with the invention; and

FIG. 4 is a detailed perspective view of the preferred embodiment of the printer of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a prior art serial platen printer. Each of the different type characters of the print assemblage is arranged on the outer end of a flexible support tongue 1 and disposed along a circumference of the assemblage.

The assemblage of tongues 1 forms a "daisy," which is rotated at constant speed by means of a motor M.

Due to the rotation of the daisy the respective ends of the tongues are positioned one after the other in registration by an electromagnet 5.

Print hammer 3 is provided with suitable resilient return springs to urge the hammer toward a "home" position and with appropriate damping means to eliminate vibrations and rebounds. These construction details are not shown in the drawing since they are not necessary for an understanding of the invention.

The flexible support tongues 1 are of rectangular cross-section and have a very small moment of inertia in the direction perpendicular to the plane of the type-bearing daisy. Thus, the energy of elastic deformation required to bring the end of the tongue into contact with the print-receiving member is very small. The printing is carried out by exciting electromagnet 5 at selected times, so that head 2 of hammer 3 urges the outer end of the selected tongue, which bears the character to be printed, against an inked ribbon 6, the print-receiving member 7 and a printing bed, or platen, 8 behind member 7. The printing mechanism, comprising hammer 3 and type-bearing daisy is arranged on a carriage 9, which slides along guides 10. This printing mechanism is moved either incrementally or continuously so as to enable the successive printing in the various printing positions along a print line.

FIGS. 2*a*, 2*b*, 2*c*, illustrate the printing operation in three successive steps, and emphasize the relative positions assumed by the type-bearing tongues 1 and head 2 of print hammer 3 to demonstrate the interference problem. The instant of the start of excitation of electromagnet 5 is shown in FIG. 2*a*. In the home position, the striking surface 11 of head 2 is at a sufficient distance from platen 8 that type-bearing tongues 1 can pass by freely without striking head 2. The direction of motion of tongues 1 is indicated by the arrow A. When a particular tongue 12, bearing the character selected to be printed, reaches a position suitably ahead of the printing position, electromagnet 5 is excited, forcing head 2 to begin to move toward platen 8. This is the situation illustrated in FIG. 2a.

During its movement toward platen 8 head 2 strikes against tongue 12, forcing tongue 12 against inked ribbon 6, print-receiving member 7 and platen 8, FIG. 2*b*. At this moment tongue 12 is in precise printing position and head 2 is close to platen 8, interposing itself between adjacent moving tongues 13 and 14.

If, due to some defect (a timing error, weakening of the return springs, friction, etc.) the retraction of head 2 is not carried out promptly, the next-following type-bearing tongue 14 strikes against head 2, causing jamming of the type-bearing elements, as shown in FIG. 2*c*.

This danger is only partly reduced by chamfering either the edges of head 2 or of type-bearing tongues 1; therefore, this does not provide a satisfactory solution to the problem. However, in accordance with the instant invention the problem is solved by suitably designing the masses of the type-bearing elements and the print hammer.

From the fundamental laws of mechanics it is known that in a perfectly elastic and central impact the momentum of an isolated system is maintained. Moreover in such as elastic, central impact between two equal masses, one of which is stationary, the velocity of the first is entirely transferred to the second, while the first

stops. The printer portion of FIG. 3 is an embodiment of such principle.

Each type character, FIG. 3, is disposed on a type-bearing element **15,** which has a suitable mass m_1. Element **15** is affixed by welding, brazing or other convenient method to the outer end of a flexible support tongue **1.** The assemblage of flexible tongues **1,** forming a type-bearing daisy, is rotated at constant angular velocity W. Print hammer **3** acts on element **15,** preferably by means of an interposer, or ballistic, element **16,** which has a suitable mass m_2 and is guided appropriately. For example, as shown, ballistic element **16** is supported and guided by two flexible fingers **17** and **18,** which are held by a suitable support **19** so that ballistic element **16** can move without friction. In addition, flexible fingers **17** and **18** exercise a slight elastic return force when ballistic element **16** is displaced from its normal rest position.

The ballistic element **16** is projected against element **15,** FIG. **3,** by excitation of electromagnet **5,** which actuates hammer **3.** After hammer **3** strikes ballistic element **16** and imparts to it a predetermined velocity V_2 toward type-bearing element **15,** the stroke of hammer **3** is arrested, either by means of suitable stopping devices, not shown, or by closure of the air gap of the electromagnet **5.**

The ballistic element **16** continues the stroke with a velocity V_2 which can be considered constant, neglecting the slight reaction of fingers, **17** and **18** and strikes against type-bearing element **15.** Although, element **15** has a considerable peripheral velocity V_3 perpendicular to the path of motion of ballistic element **16,** its velocity component V_1 in the direction of motion of element **16** is zero before the impact.

The total momentum inherent in the system of the two masses in the direction of motion of ballistic element **16** is $m_2 V_2$ immediately before the impact and becomes $m_2 V'_2 + m_1 V'_1$ immediately after the impact. Therefore, the following equation must be satisfied:

$$m_2 V'_2 + m_1 V'_1 = m_2 V_2 \qquad (1)$$

Assuming, reasonably, a perfectly elastic, central impact, the total kinetic energy of the system is constant. Before the impact this total kinetic energy is:

$$1/2 m_1 V^2_3 + 1/2 m_2 V^2_2$$

After the impact the total system kinetic energy is:

$$1/2\ m_1 (V^2_3 + V'^2_1) + 1/2\ m_2 V'^2_2$$

Since the total system kinetic energy before and after impact is constant, the following equation must be satisfied:

$$1/2\ m_1 V^2_3 + 1/2\ m_2 V^2_2 = 1/2 m_1 (V^2_3 + V'^2_1) + 1/2\ m_2 V'^2_2 \qquad (2)$$

If, now, the two masses m_1 and m_2 are equal, and designated by the symbol m, equations (1) and (2) can be simplified to:

$$m (V'_2 + V'_1) = m V_2$$

$$1/2m (V^2_3 + V^2_2) = 1/2m (V^2_3 + V'^2_1 + V'^2_2)$$

and as known, the equations are satisfied when either V'_1 or V'_2 is zero. Therefore, ballistic element **16** stops at the instant of impact without interposing itself into the path of the next-arriving tongue **1.** Thus, the interference problem is completely eliminated.

The above-mentioned simplifying conditions of an isolated system and an elastic, central impact can be substantially attained in practice, using some construction techniques, which provide for the actual behavior of the printer not differing substantially from the theoretical.

It has been found by experiment that the energy required for printing a character with an inked ribbon commonly used in typewriters varies between 30,000 and 80,000 ergs., according to the surface of the type character (dimensioned approximatively like a typewriter character), the quality of the print-receiving member, and the number of copies to be printed. Moreover, the most suitable imprinting velocity must not be greater than 5 – 10m/sec.

At lower velocities of 2–5m/sec a better printing quality is obtained by virtue of less embossing of the print-receiving member. However, because the printing is "on-the-fly;" i.e., with the type-bearing element rotating continuously relative to the print-receiving member, at these lower printing velocities the contact time between character and print-receiving member is increased, whereby the printing is characterized by a more accentuated shading and by a broadening of the printed image in the direction of rotation of the type-bearing element.

From these premises it has been determined that the mass m_1 at the outer end of each type bearing tongue **1** can be established at 0.5 grams as a compromise solution.

The consequent projection velocity required is approximatively 5m/sec. The mass of ballistic element **16** can then be 0.5 grams, or can be slightly less so as not only to avoid the danger of interference but to provide a small inherent component of return speed for ballistic element **16** after the impact.

To achieve impacts which are as central as possible, particularly in the presence of imprecise timing, the respective masses m_1 and m_2 of the type-bearing tongues and the interposed ballistic element may be slightly displaced in the striking direction, and the striking surface of at least one of these two members, for example that of the ballistic element, may be somewhat convex.

The above-described considerations are applied to the exemplary printer of FIG. **4.** 64 individual type-bearing elements **20** are attached by brazing to the outer ends of a set of flexible tongues **21** to form a daisy mounted for rotation on a drive shaft **22.** This daisy member is disposed adjacent a central stiffening plate **23.**

Stiffening plate **23** extends radially close to the outer end of tongues **21** and is provided with two annular grooves **24** and **25.** In outer groove **25** is arranged a ring of suitable resilient material, which ring protrudes slightly out of groove **25** to form a support for type-bearing tongues **21,** thereby slightly preloading such tongues. This resilient ring is provided for damping the elastic vibrations of each tongue **21** about its home position when it returns to this home position after a

printing operation. In addition such resilient ring establishes a well-defined, stable home position for tongues **21**, which position is not influenced by small dynamic imbalances in the daisy, imbalances which otherwise would cause vibrations of the tongues.

The daisy and stiffening plate **23** are driven in rotation on shaft **22** by a motor **26**, supported on a carriage member **27**. Carriage member **27** slides along guides **28** and **29** to occupy successively all printing positions provided along the print line. On carriage member **27** there is also arranged an actuating electromagnet **30**, whose movable armature **31** acts to suitably project an interposer ballistic, element **32** against a type-bearing element **20**.

Armature **31** is pivoted on a pin **33** and is maintained in a rest position against a stop device, which is preferably resilient and adjustable by means of a screw **34**. Armature **31** is urged against the stop device by a spring **35**. A similar resilient stop device, adjustable by means of a screw **36**, is provided for ballistic element **32** and acts, for example, on a flat spring **37**. Spring **37**, together with a spring **38**, form a resilient support device for ballistic element **32**.

The devices for timing and selecting the angular position of the type-bearing daisy are not illustrated here, their functions and structures being well known in the art.

Although the printer shown in FIG. **4** relates to a serial printer and, particularly, one employing a daisy-shaped type-bearing element, it is evident that the same design principles can be applied to parallel and serial-parallel printers, as well as to printers employing different type-bearing elements, such as print bars, belts, chains and the like, wherein the characters to be printed are supported by flexible tongues, without departing from the scope and the objects of the invention.

Moreover, it is to be understood that the characters of the printer of the invention, and the masses associated therewith, instead of being supported and guided by flexible tongues, can be disposed and guided within special sliding seats provided in a rigid element, each one of them being provided with elastic return devices.

I claim:

1. In a high speed on-the-fly printer mechanism wherein each of a plurality of different type-bearing elements is supported on a respective one of a plurality of elongated flexible tongues, and wherein one end of each of said tongues is affixed to a movable member adapted to be driven to move said type-bearing elements in a path in a first direction through a printing position opposite a platen member in which position the elements are struck while being so driven, an actuating apparatus comprising: hammer means selectively actuable for moving in a second direction transverse to said first direction, an interposer element disposed between said hammer means and said type-bearing elements in said printing position and having a portion thereof interposed to be struck by said hammer means when actuated and a portion aligned for striking on-the-fly one of said type-bearing elements being moved along said path through said printing position, and arresting means located to arrest said hammer means after striking said interposer element and prior to said interposer element striking said type-bearing element so that said interposer element is projected ballistically to move substantially in said second direction upon said portion thereof being struck by said hammer means to strike said one of said type-bearing elements with said another portion, the mass of said interposer element being no greater than the mass of each of said type-bearing elements, whereby said interposer element upon striking one of said type-bearing elements will transfer its momentum to said type-bearing element without moving into said path.

2. The printer of claim **1**, wherein said interposer element is resiliently supported.

3. The printer of claim **1**, wherein said movable member is circular in shape and said type-bearing elements are driven in a circular path through said printing position.

4. The printer of claim **3**, further including a stiffening plate mounted on said movable member for providing partial support for said type-bearing elements.

5. A high-speed on-the-fly printer mechanism comprising:

a plurality of different type-bearing elements,

a plurality of elongated flexible tongues each supporting a respective one of said type-bearing elements,

a movable member, one end of each of said tongues being affixed to said movable member, whereby said type-bearing elements are driven successively in a path in a first direction through a printing position and are flexurally supported by said tongues for movement in a second direction transverse to said first direction,

an interposer element disposed opposite said printing position, and means for selectively actuating said interposer element for movement ballistically in said second direction transverse to said first direction to strike the one of said type-bearing elements being moved in said path through said printing position on-the-fly, the mass of said interposer element being no greater than the mass of each of said type-bearing elements, whereby said interposer element upon striking said one of said type-bearing elements will transfer its momentum to said one of said type-bearing elements without moving into said path.

6. A high-speed on-the-fly printer comprising in combination:

a platen,

a movable member having a plurality of type-bearing elements mounted thereon, one adjacent the other, for successive movement in a path past a printing position on said platen, supporting means for flexurally mounting each of said type-bearing elements on said movable member providing for relative movement with respect to said movable member of said type-bearing elements toward and away from said platen,

an interposer element disposed in spaced relation with said platen and on the opposite side of said type-bearing elements from said platen, said interposer element being resiliently supported for relative movement toward and away from a type-bearing element disposed adjacent said platen printing position,

a hammer disposed adjacent said interposer member on the opposite side of said interposer member from said type-bearing elements, and

actuating means for moving said hammer to strike said interposer member which in turn is so located as to strike one of said type-bearing elements on-the-fly as the type-bearing element is moved by said movable member past said printing position on said platen, the movement of said hammer being arrested after said hammer strikes said interposer member and prior to said interposer member striking said one of said type-bearing elements so that said interposer member moves ballistically between said hammer and said one of said type-bearing elements, each of said type-bearing elements and said interposer element being so formed that the mass of said interposer element is no greater than the mass of each of said type-bearing elements, whereby said interposer element upon striking said one of said type-bearing elements will transfer its momentum to said one of said type-bearing elements without moving into said path.

* * * * *