May 30, 1967 R. C. BURNS ETAL 3,322,253

VIBRATION CONTROL APPARATUS FOR A MATRIX PRINTER

Filed Oct. 18, 1965

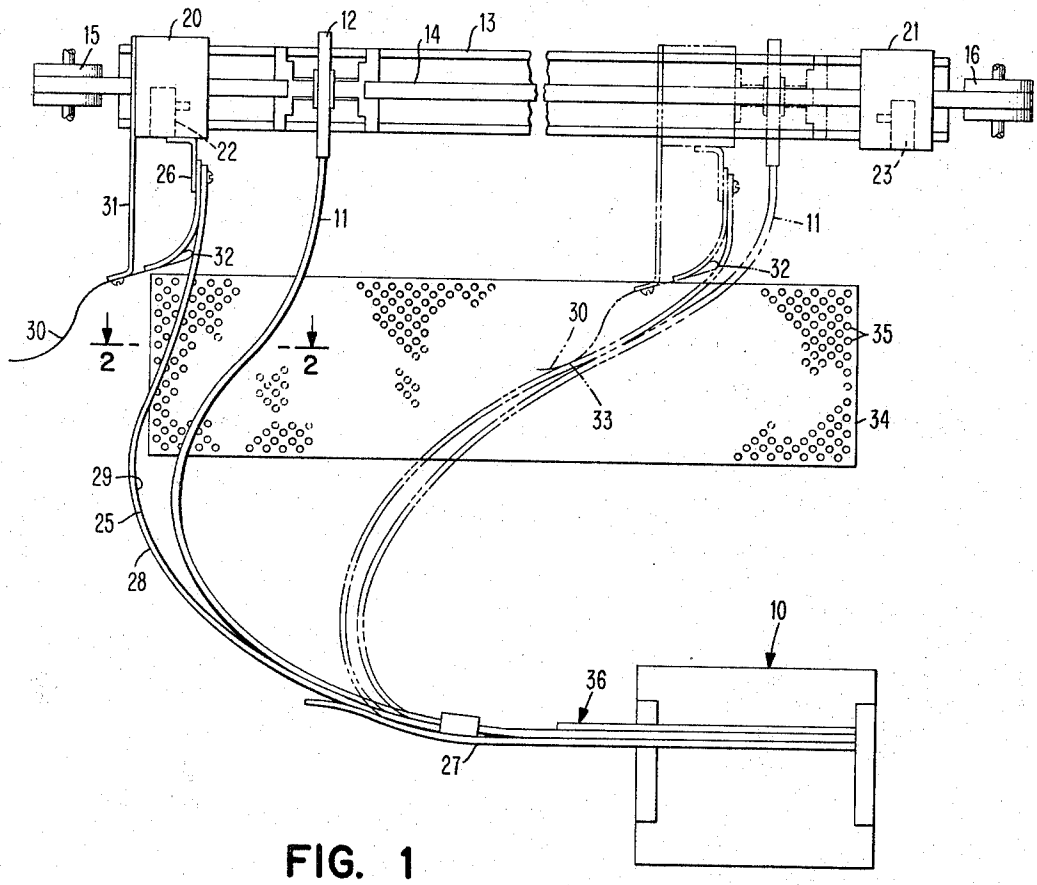

FIG. 1

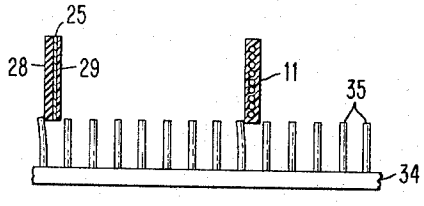

FIG. 2

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United States Patent Office 3,322,253 Patented May 30, 1967

3,322,253

VIBRATION CONTROL APPARATUS FOR A MATRIX PRINTER

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Filed Oct. 18, 1965, Ser. No. 497,386
11 Claims. (Cl. 197—1)

This invention relates generally to high speed printing apparatus and more particularly to the construction of a vibration control apparatus for the printing element in a serial matrix printer.

Printing machines are known in which the outlines of characters are formed by printing the appropriate dots of a bi-dimensional dot matrix having the same general size as the characters to be printed. One version of such a machine, sometimes called a wire printer, employs a matrix of individually operable dot printing wire elements or the like which are projected in combination simultaneously toward a platen to effect printing of the whole character on an interposed print medium. For printing a complete line of data, means are provided for effecting a relative longitudinal motion between the print matrix and the platen (and print medium) so that different characters are printed in series at successive positions along the print line.

In serial machines, the print head, having the wire matrix formed therein, is moved along the print line while the print wires are actuated successively to record the characters composing the line of print. The print head may be moved incrementally or continuously along the print line and then, upon completion of the line returned to the starting point for the next line, usually at the left side of the record member. The incremental motion is characteristically interrupted so that one of the members moves in steps along the print line. It can be appreciated that if printing with incremental motion is to be performed at high rates of speed, the moving parts must be accelerated from rest, advanced, then brought to rest rapidly in short intervals of time. In addition, it is essential that the print head be returned to the starting point for a new line immediately upon completion of a line with a minimum of elapsed time.

The attainment of fast operating speeds has, however, been severely limited heretofore by excessive vibration and oscillating flexural stresses created in the print tubes, especially during the retraction of the printing member from an extended position to its starting position. A further difficulty encountered was that the printing member would overtravel excessively during retraction and require additional time advancing up to the home position where printing could start on the new line. The construction of a satisfactory restraining device or arrangement by which vibration amplitude could be sufficiently controlled was further complicated by the requirement that the initial starting position for a print line be variable along the horizontal path of movement traveled by the printing member. A construction which was thus satisfactory for one starting position of the printing member was ineffective at another starting position. Since the initial or home position of the printing member varies, the rate at which lines are printed also varies (for a given character rate) so that the amplitude of vibrations either increased or decreased depending upon the coincidence of the printing rate with the resonant frequency of the printing member. Because of the variation in vibration amplitude, the necessary incrementing force for the printing member applied at the print head would also change thus creating

difficulty in keeping the increment time and distance carefully controlled.

Accordingly, it is an object of this invention to provide apparatus for a serial matrix printer which enables the printer to be operated at increased speeds with improved print registration and control.

Another object of this invention is to provide apparatus for limiting vibration in a serial matrix print member.

A further object of this invention is to provide a flexible restraining device for restricting objectionable vibrational and whiplash motion while yet permitting the necessary degree of movement for the printing member in a serial matrix printer.

A still further object of this invention is to provide a print member restraining device in a serial matrix printer which is flexible and resiliently supported, and which can be variably moved to different positions in accordance with the desired home position of the print member yet retaining its effectiveness.

The preceding and other objects are attained in accordance with the practice of the present invention by providing a flexible, elongate element adjacent the printing member when in the initial or home position. When the printing member is returned to the home position at the end of each printing line, it engages the element which serves to restrain undulations and vibrations of the printing member created by the fast return. The restraining element is supported at its two ends, one end being fixed adjacent the fixed end of the printing member and the other end being movably secured along the printing line so as to be variably settable at the left end of each printing line. The restraining element is approximately the same length as the printing member so as to have a configuration similar thereto intermediate the two ends and conform approximately to the curvature of the printing member in the home position. The restraining element has a vibration absorbing material thereon which serves to dampen vibrational movement set up in the element by impact with the printing member. In order to accommodate all home positions of the printing member, auxiliary resilient means are included to be effective at only selected ones of the positions to which the restraint element can be set. The auxiliary resilient means provide a change in the damping characteristics of the restraint element which is necessary because of the changing vibrational characteristics in the printing member at various home positions. The restraint element is coated on its surface adjacent the printing member with a friction reducing material so that the printing member is not subjected to sticking and undue wear. The restraint element, by being coextensive with the printing member, is able to limit vibrational amplitude throughout the length of the printing member.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings wherein:

FIGURE 1 is a plan view of a serial matrix printer showing the printing member and arrangement of a restraining element therefor in accordance with the principles of the invention; and

FIGURE 2 is a sectional view of the printing member and restraining element in conjunction with a vibration damping brush taken along the line 2—2 of FIG. 1.

Referring to FIG. 1, the serial matrix printer apparatus comprises generally a stationary control mechanism 10 and a flexible print wire harness 11, including a matrix print head 12. The print head is secured to a band 14 which can be moved incrementally or continuously along a horizontal supporting track 13 by any suitable mech-

anism such as electrostatic clutches **15**, **16**. During serial printing, the print head is incremented from the left toward the right by energizing clutch **16** and, upon completion of a printing line, the print head is returned toward the left by energizing clutch **15**. At each print position to which the print head is moved, the control mechanism **10** is actuated by appropriate input signals to simultaneously project selected print wires through the harness **11** and from the print head **12** to produce the character desired. The wire ends move an ink ribbon (not shown) against the platen-supported document to be printed thus leaving an impression of a character on the document.

The print head movement is limited by stops **20**, **21** and limit switches **22**, **23** which serve as auxiliary controls to terminate movement of the print head at each end of travel. The stops and limit switches are adjustable to different line lengths as may be required by the form being printed.

Adjacent the home position of the print harness at the left limit of travel, there is provided restraining element **25** which is secured to a bracket **26** on adjustable stop **20**. The restraining element is secured at its other end to fixed supports **27** and **36** on stationary control mechanism **10**. The flexible restraint element is preferably a thin, continuous strip formed of metal such as spring steel a few thousandths of an inch in thickness. The strip is approximately the same length as the print harness and is unsupported between its two ends so that it is thereby free to move horizontally. The restraint element has secured thereto on the outside, away from the print harness, a vibration damping material **28** such as foam polyurethane or other nonmetallic material. In order to minimize friction between the restraint element and the print harness, the element has bonded thereto on the inside, toward the harness, a friction reducing material **29** such as Teflon, a product of the E. I. du Pont de Nemours and Co., Inc. The layers of the laminated restraint member can be seen in FIG. 2.

At the end of each printing line (left to right serial printing), print wire harness **11** is returned to the left home position rapidly and suddenly stopped at the desired position. Limit stop **20** is positioned so that the print wire harness contacts the restraint element **25** substantially along the entire length of the harness. The flexibility of the restraint element allows it to conform to the curvature of the harness and the foam backing on the element damps vibrations set up in the restraint element. By proper positioning of the limit stop **20**, harness **11** including print head **12** can be accurately brought to the desired position by overtraveling a predetermined minimal distance and incrementing toward the right to the home position. It will be noted that the restraint element is substantially the same length and height as the print wire harness so that at the extreme left emergency stop position both the harness and the elements are in substantially parallel adjacent planes. This position establishes the proper length of the restraint element.

One of the requirements of the printing apparatus is that the print head be capable of starting from any print position as a home position. Thus, limit stop **20** is movable to the desired home position for the length of printing line required. Therefore, one end of the restraint element is also movable to the required position. However, as the length of the printing line is shortened (or a given character rate) the frequency of return, or line rate, is higher thus changing the frequency of vibration set up in print harness **11**. This change in forcing frequency is compensated, however, by the provision of an auxiliary resilient member **30** which is secured to brackets **31** and **26** supported on limit stop **20**. When the home position and limit stop **20** are in the approximate left two-thirds of the printing line, resilient spring **30** contacts restraint element **25** only at one point **32**. However, when the restraint element and limit stop **20** are moved further toward the right, for example, to the position shown in phantom, the auxiliary member **30**

contacts the restraint element at a second point **33**. Note that the acute angle between the mounting surface of resilient spring **30** and restraint element **25**, at the pont of contact **32**, decreases as limit stop **20** is moved from left to right thus varying the amount and direction of applied spring force at this point in the desired manner. The auxiliary member **30** thus provides decreasing stiffness at point **32**, but adds a second support point for the higher line rate operation of the print harness in order to reduce the changing amplitude of vibrational undulations set up in the print harness and restraint element.

During the forward incrementing of the print wire harness at the time of printing, the sudden stopping and starting of the print head at the print line creates a second mode of vibration at the character rate. This vibration is of varying amplitude dependent upon the frequency with which the incrementing occurs. Vibration due to forward incrementing is damped by providing a light resistance element **34** constantly in contact with the print wire harness during operation. The resistance element is a brush-like device made of plastic material, such as polyurethane, with bristles **35** in contact with the bottom edge of harness **11**, and is shown most clearly in FIG. 2. The plastic brush is also effective following the return sweep of the print harness for subduing minor vibrational amplitudes.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a machine having an elongate printing member movable from an extended position to a retracted position, vibration control apparatus comprising:

an elongate, flexible element in juxtaposition with said member when in said retracted position and having a surface which is engaged by said member upon retraction; and

a damping material secured to said element for absorbing vibrations occurring therein.

2. In a printing machine having an elongate, flexible printing member having one end fixed and the other end movable from an extended position to a retracted position, said printing member being unsupported between its ends, vibration control apparatus comprising:

an elongate, flexible element in juxtaposition with said member when in said retracted position and having a surface which is engaged by substantially said entire unsupported length of said member; and

a coating of flexible, vibration-absorbing material secured to said element adjacent said surface.

3. In a printing machine, the combination comprising:

a printing member having one end fixed and the other end movable along a printing line between protracted and retracted positions and being unsupported between its ends;

means for moving said member between said positions; and

flexible means supported for impact by said member when moved to said retracted position for limiting the amplitude of vibrations in said member created by the movement thereof.

4. Apparatus as described in claim **3** further comprising:

a coating of flexible nonmetallic material on said flexible means for damping vibrations occurring therein.

5. In a printing machine, the combination comprising:

an elongate printing member having one end fixed and the other end movable from a protracted to a retracted position and being unsupported between said ends;

means for retracting said member;

an elongate, flexible element of length substantially equal to the unsupported length of said member and

supported at its ends for impact by said member when moved to said retracted position; and

means along said element for absorbing vibrations created in said element by said impact.

6. Apparatus as described in claim 5 further including resilient support means at one end of said element effective for absorbing the shock developed by said impact.

7. Apparatus as described in claim 5 further comprising a plurality of flexible bristles adjacent said member and engageable thereby during and following said retraction for damping vibrations occurring in said member.

8. In a printing machine, the combination comprising:

an elongate printing member having one end fixed and the other end movable along a printing line between a protracted position and variable retracted positions;

means for moving said member to said retracted positions;

elongate, flexible, impact receiving means supported adjacent said retracted positions for impact by said member along its length when moved to said retracted position, said impact receiving means being movable to correspond to said variable positions; and

vibration absorbing material on said impact receiving means for damping vibrations developed therein by said impact.

9. Apparatus as described in claim 8 further comprising:

auxiliary support means operable when said impact receiving means is adjacent predetermined ones of said variable positions for providing a resilient support of a corresponding variable effect along said impact receiving means.

10. Apparatus as described in claim 8 further comprising:

a plurality of flexible bristles adjacent the path traveled by said member between said protracted and retracted positions and engageable with said member to damp vibrations in said member.

11. Apparatus as described in claim 8 further comprising:

a friction-reducing coating on said impact receiving means; and

a plurality of flexible bristles adjacent the path traveled by said member between said protracted and retracted positions and engageable with said member to damp vibrations in said member.

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