United States Patent [19]

Brooks

[11] **3,866,851**

[45] **Feb. 18, 1975**

[54] **HIGH SPEED IMPACT PRINTER**

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[73] Assignee: **Interface Mechanisms, Inc.,** Mountlake Terrace, Wash.

[22] Filed: **Oct. 3, 1973**

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[52] **U.S. Cl.** **242/75.43,** 242/156.2

[51] **Int. Cl.** **B65h 25/22**

[58] **Field of Search** 242/75.43, 45, 156.2

[56] **References Cited**

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Primary Examiner—Edward J. McCarthy
Attorney, Agent, or Firm—Cristensen, O'Connor, Garrison & Havelka

[57] **ABSTRACT**

A high speed mechanical impact printer using a continuously rotating print wheel. Paper label stock is contained on a supply reel and fed through a print station comprising the print wheel and a print hammer by a motor and roller means positioned beyond the print station. Substantially constant tension is maintained between the supply reel and the print station by a spring assisted tension means operating in conjunction with the supply reel. The print wheel is secured to a belt-driven, printer drive member through a compressible plastic ring. In printing, a hammer impacts the label stock and an ink ribbon against the rotating print wheel under logic control. After printing, the stock proceeds through a mechanical means which permits the operator to conveniently strip the most recently printed label from the stock backing so that he may attach it to a commercial item or the like.

8 Claims, 11 Drawing Figures

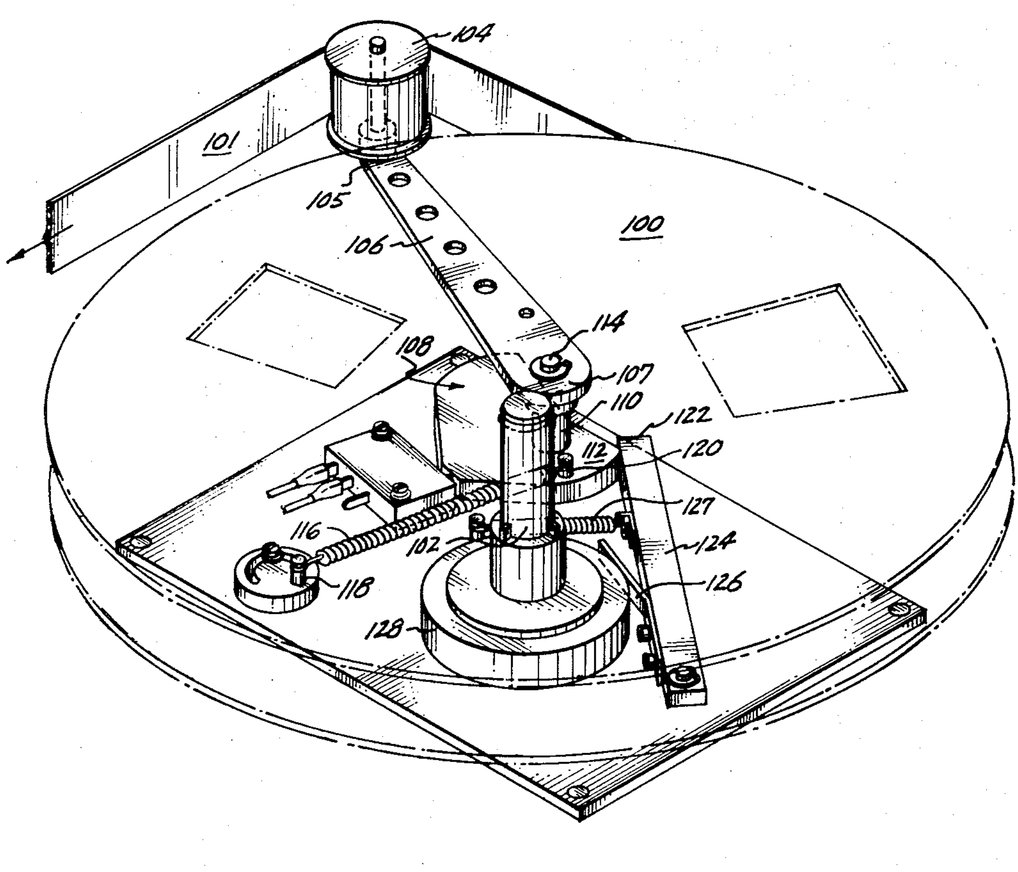
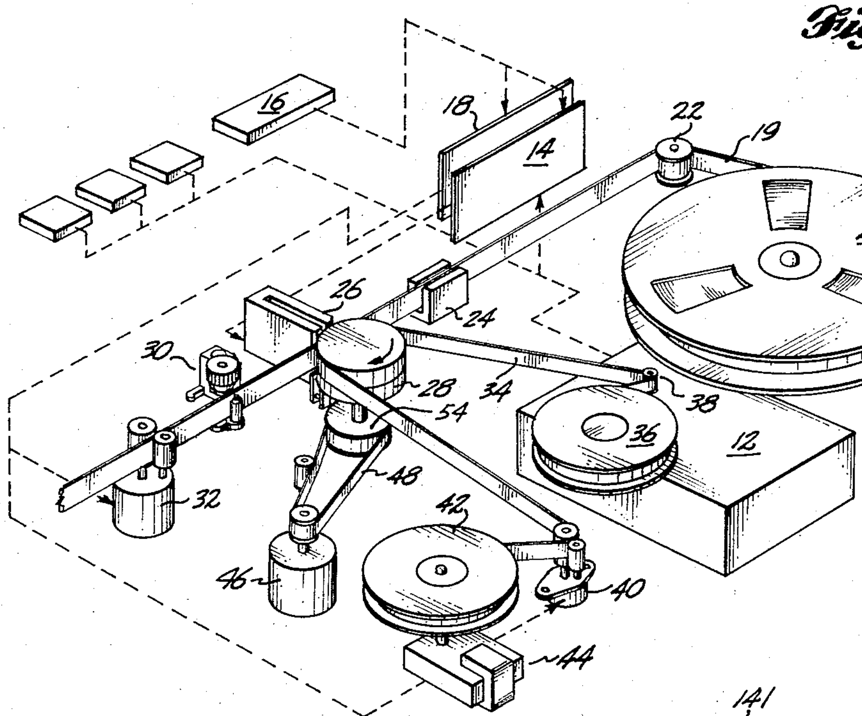


Fig. 1.



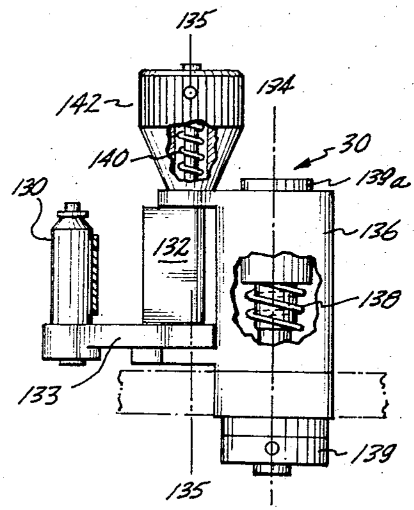


Fig. 2.

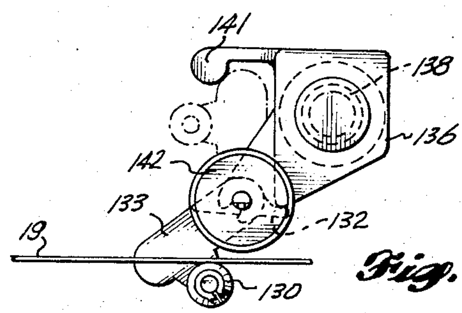


Fig. 3.

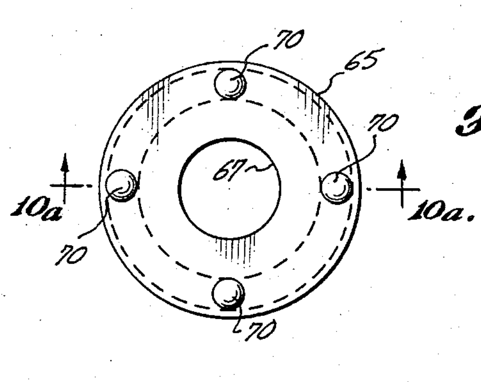
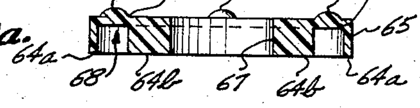


Fig. 10.

Fig. 10a.



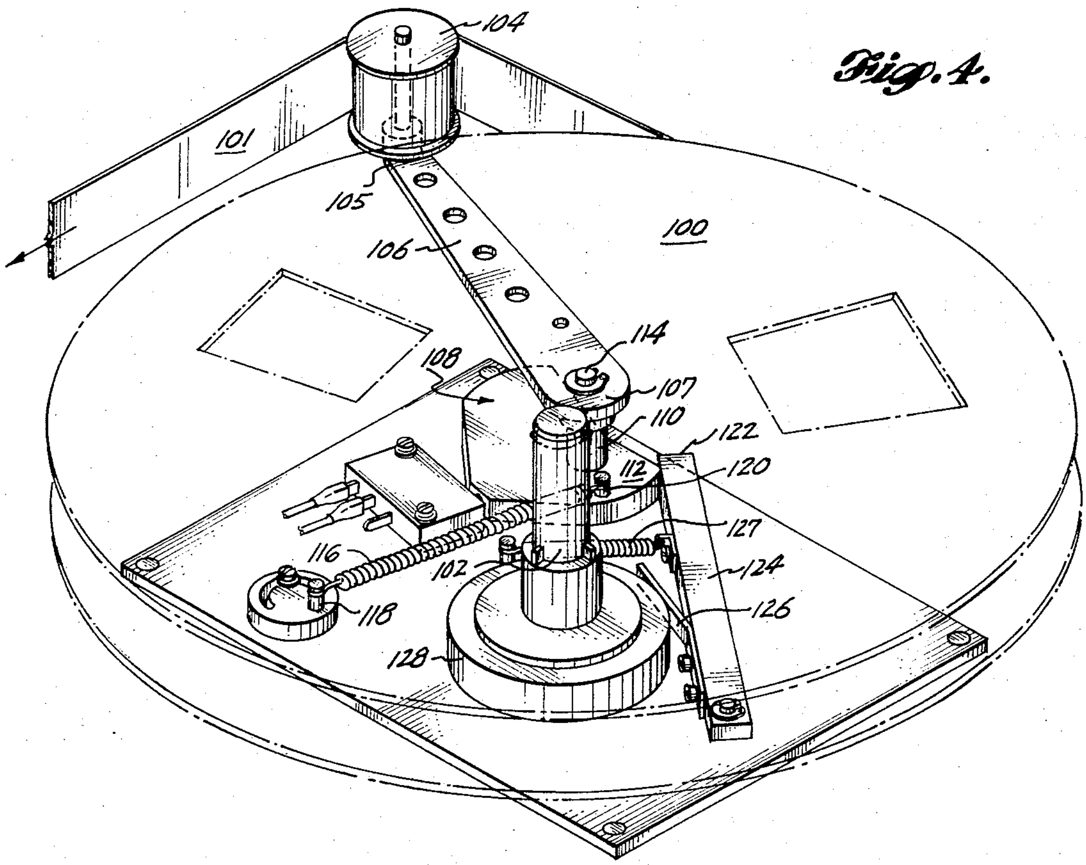


Fig. 4.

Fig. 5.

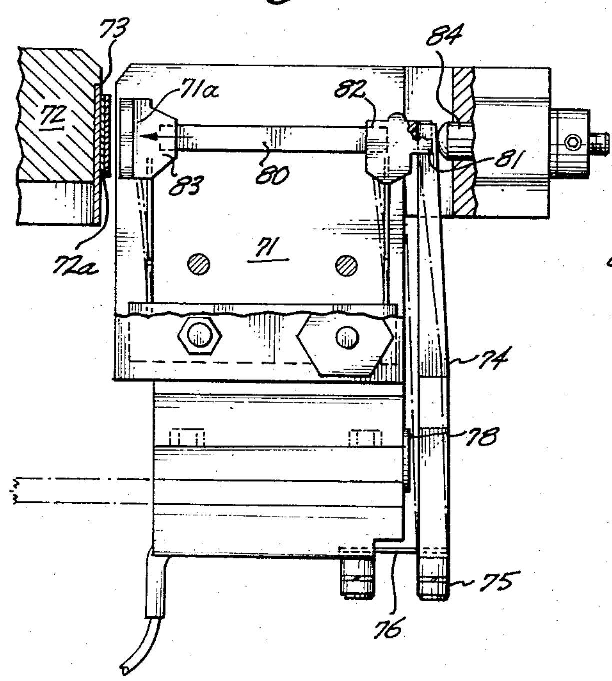
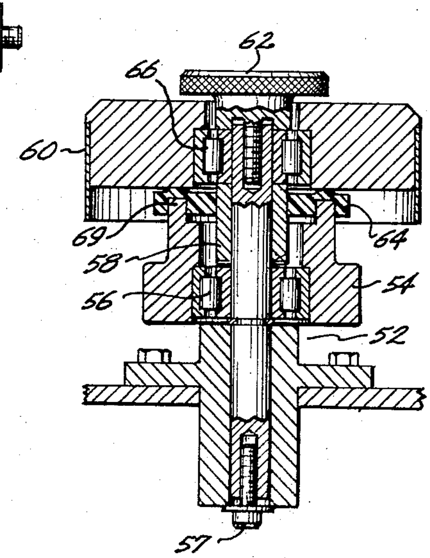


Fig. 6.



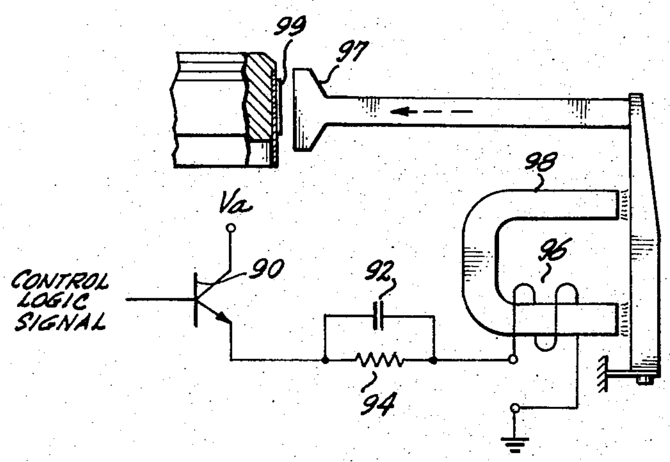


Fig. 7.

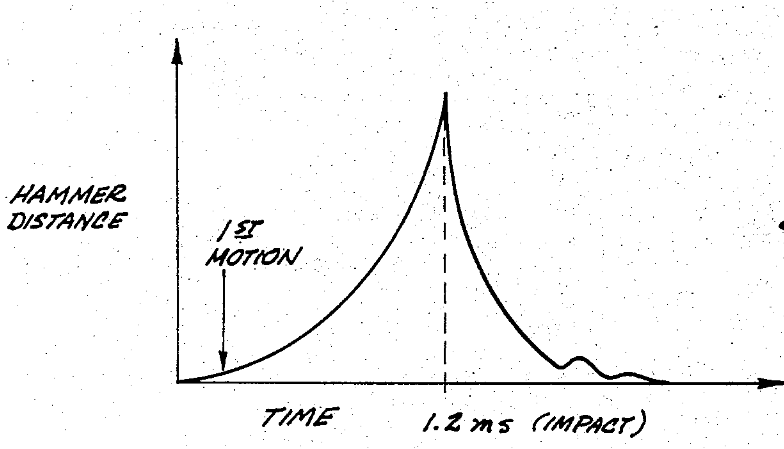


Fig. 8.

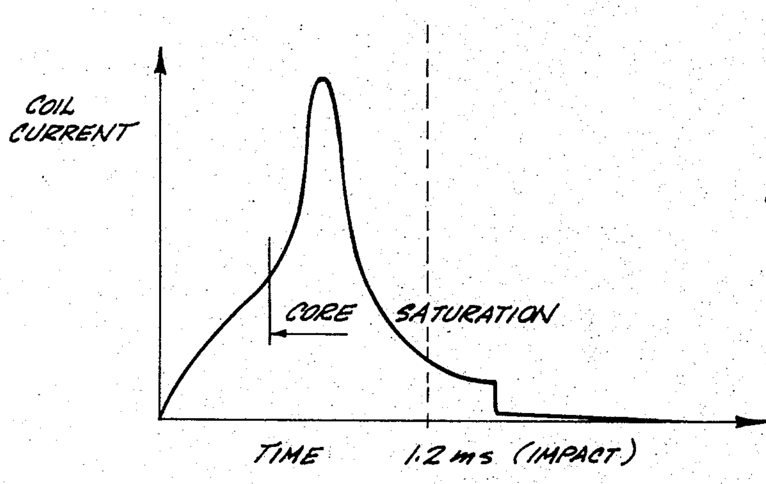


Fig. 9.

HIGH SPEED IMPACT PRINTER

BACKGROUND OF THE INVENTION

This invention relates generally to printing devices, and more specifically, to the art of high speed mechanical impact printers.

Mechanical impact printers are generally well-known in the art, although frequently such printers must be specially adapted for particular applications. The printing of bar codes, such as that disclosed in U.S. Pat. No. 3,700,858 to Murthy, for purposes of high speed item identification, requires high resolution, accurately spaced, printing. The individual characters must be clear and precise, and the separation between characters accurate and uniform. If such high resolution, uniform printing is not maintained, errors in reading the bar code will increase, to the detriment of the identification system using the code.

Furthermore, in the printing of label stock, the operator of prior art printers must peel off the individual labels manually from the stock backing after they are printed in order to affix them to the commercial item; e.g., carton, which is to be identified. This manual stripping of the labels from the stock backing is often impractical as it can only be accomplished some distance away from the rotating printing element.

Thus, there is a current need in particular printing applications for an impact printer, otherwise utilizing conventional impact printing principles, which is capable of printing high resolution, accurately spaced, characters for particular code printing applications, and in the case of label stock, for a means which presents the labels to the operator after printing in a condition such that they may be readily stripped and affixed to the item to be identified. In accordance with the above, it is a general object of the present invention to provide a mechanical impact printer which overcomes the disadvantages of the prior art.

It is another object of the present invention to provide an impact printer wherein the printing stock supply reel has a tensioning means in conjunction therewith for maintaining a substantially constant tension on the printing stock.

It is a further object of the present invention to provide an impact printer in which the time for actuation of the print hammer is substantially decreased.

It is yet another object of the present invention to provide a mechanical impact printer having a print wheel which is rotated by means of a compressible ring connection between the driving means and the print wheel.

It is a still further object of the present invention to provide a mechanical impact printer wherein labels may be individually stripped immediately after printing is accomplished.

SUMMARY OF THE INVENTION

According, a tensioning apparatus is provided which includes a rotatable spindle for positioning a supply reel on which printing stock is conventionally wound. A reel arm assembly is rotatably secured at one end in the vicinity of the spindle, and a guide is provided at the other end of the reel arm assembly, with the printing stock being passed around the guide and to the printing station from the supply reel. A braking means acts on the spindle of the supply reel and is controlled by the relative position of the reel arm assembly, which reel

arm assembly tends to remain in a given position because of the action of a spring means. The pressure of the print stock against the guide will increase and decrease according to the tension exerted on the print stock. This pressure will result in rotation of the reel arm assembly, which in turn acts on the braking means, increasing or decreasing the pressure on the spindle.

DESCRIPTION OF THE DRAWINGS

A more thorough understanding of the invention may be obtained by a study of the following description of the preferred emboidment taken in connection with the accompanying drawings in which:

FIG. **1** is a simpified isometric view of the impact printer.

FIG. **2** is an elevation of the label stripper mechanism of the present invention.

FIG. **3** is a plan view of the label stripper mechanism of the present invention.

FIG. **4** is an isometric view of the tensioning means associated with the stock supply reel of the present invention.

FIG. **5** is a partial section elevation view of the print hammer actuator mechanism of the present invention.

FIG. **6** is a section view of the print wheel of the present invention.

FIG. **7** is a simplified representation of the print hammer actuator mechanism of the present invention.

FIG. **8** is a graph of the motion of the print hammer against time during actuation.

FIG.**9** is a graph of the current through the coil of the print hammer actuator mechanism of FIG. **7** against time during actuator.

FIG. **10** is a top plan view of the compressible pad of the present invention.

FIG. **10*a*** is a section view of the compressible pad, taken along lines **10*a*—10*a*** in FIG. **10.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, an isometric view of the impact printer of the present invention is shown. As in prior art printers, input power is supplied via a standard **120** volt line (not shown) to a power supply module **12**, which in turn provides power for the printer, including the logic control circuit **14.** Signals from peripheral equipment can be connected into the printer through connector **16** to the motor drive circuit **18**, and the logic control circuit **14.** These two circuits **18** and **14** control, in conventional fashion, the operation of the printer. Printing stock **19** is typically stored on a supply reel **20**, and is directed around arm **22**, through stock sensor **24**, through a print station, comprised of print hammer assembly **26** and a cylindrical print wheel **28**, through a label stripper **30**, and then through a stock stepper assembly **32**, which typically contains a motor drive and a pair of rollers, for placing the printing stock under tension.

The ink ribbon **34** is typically stored on a supply reel **36**, first positioned partially around guide pin **38**, then directed between the printing stock **19** and the circumferential surface of the print wheel **28** before going through a powered ribbon drive assembly **40**, and finally wound up on a ribbon take-up reel **42** which is driven by motor **44.** The print wheel **28** is continuously rotated in operation by means of drive motor **46** acting through a drive wheel **54** and belt **48.**

In operation, print wheel **28**, having a set of raised print characters arranged around its circumferential surface, continuously rotates by means of drive motor **46**, and the ribbon **34** and printing stock **19** are pulled past the print station comprising print hammer assembly **26** and print wheel **28** by means of their respective take-up motors. The logic control board **14** issues signals commands to the print hammer assembly **26**, which signal commands actuate the print hammer to impact the printing stock **19** and the ribbon **34** sufficiently against the circumferential surface of the print wheel **28** that a single raised character is imprinted on the stock **19**. A system for synchronizing the operation of the rotating print wheel and the hammer assembly is disclosed in copending application Serial No. 110,517, filed January 28, 1971, entitled "High Speed Printer" and is assigned to the same assignee as the present invention. Briefly, such a synchronization system utilizes a cylindrical code wheel, attached to the print wheel and rotating therewith, which code wheel has a plurality of coded holes patterns, one for each print character, located therein. Photoelectric means is used to detect the hole patterns, which data is in turn applied to a circuit which compares the code data with signals representing the desired character selected at a keyboard or similar device. When there is a coincidence, the print hammer is actuated, resulting in the desired character being printed.

Referring now to FIG. **6**, a cross section view of the print wheel assembly of the present invention is shown. The print wheel assembly consists generally of: a housing **52**, which is attached to the deck of the printer; a drive assembly comprising drive wheel **54**, bearing **56** and drive shaft **58**; print wheel **60**; securing knob **62**; and a compressible plastic ring pad **64**. In operation, motor **46** (FIG. **1**) rotates drive wheel **54** by means of the belt **48** (FIG. **1**) connecting the motor **46** and the drive wheeel **54**. Shaft **58** does not rotate with the drive wheel **54**, but is anchored into the housing **54** by end bolt **57**.

The print wheel **60** is secured to the rotating drive wheel **54** by means of the compressible ring pad **64**, which is positioned between the drive wheel **54** and print wheel **60**. The print wheel **60** is forced toward the drive wheel, compressing ring pad **64**, by means of screw-adjusted securing knob **62**, which is turned into the drive shaft **58**. Thus, the only contact between drive wheel **54** and the print wheel **60** is through the compressible polyurethane ring pad **64**, shown in position in FIG. **6**, and in more detail in FIGS. **10** and **10***a*. The compressible pad **64** is in the shape of a ring having outer and inner boundary surfaces **65** and **67**, respectively. A trough **68**, formed in the ring pad **64** enables the ring pad to be fitted snugly over a mating ring **69** in drive wheel **54**. Trough **68** substantially follows the shape of the outer and inner boundary surfaces **65** and **67**, resulting in a compressible ring pad having two concentric edge members **64***a* and **64***b* extending perpendicularly from a cross member **64***c* connecting edge member **64***a* and **64***b* and one end thereof. Extending away from surface **64***d* of connecting member **64***c* are a plurality of integral compressible hemispheres **70—70**, which are of the same compressible polyurethane material as the remainder of the compressible ring pad.

Print wheel **60** rests on the plurality of compressible hemispheres **70—70**, and these hemispheres are compressed by the action of tightening securing knob **62** into shaft **58**. The friction fit between the print wheel **60**, the compressible ring pad **64** and the ring portion **69** of drive wheel **54** is sufficient to rotate print wheel **60** by rotating drive wheel **54** by means of motor **46** and belt **48**, without slippage between them. A bearing **66** is positioned between the print wheel **60** and shaft **58** to provide rotational freedom of movement. The friction drive of print wheel **60** accomplished by compressible ring pad **64** eliminates the need for high tolerance machining and keying to mate a print wheel with a drive wheel, as is done in the prior art. The friction drive also significantly reduces the potential for printing inaccuracies due to wear or poor machining of the print wheel **60** or the drive wheel **54**. Furthermore, such an arrangement allows for the print wheel to be easily removed for cleaning or exchange, as desired, without the necessity of time-consuming realignment of the printing wheel assembly.

The print station, as mentioned above, comprises print wheel assembly **28** and the print hammer assembly **26** (FIG. **1**) which is under the control of control logic circuit **14**. Referring to FIG. **5**, the print hammer assembly **71** is shown in a partial section view. When the hammer **71***a* is to be actuated toward print wheel **72**, a signal is applied from control logic **14** (not shown) to an electromagnet (not shown) within the assembly. When the electromagnet is energized by current flowing through its coil (not shown) lever arm **74** which is secured to the hammer assembly **71** by flexible member **76** at one end **75** thereof, is drawn into contact with a portion **78** of the assembly electromagnet (otherwise not shown). As lever arm **74** moves toward the magnet portion **78**, hammer arm **80** moves in the direction of the arrow toward the circumferential surface **73** of print wheel **72**. At the other end **83** of hammer arm **80** is connected hammer **71***a*. When lever arm **74** is actuated, hammer **71***a* moves in the direction of the arrow toward circumferential surface **73** of print wheel **72** to such an extent as to impact the printing stock (not shown) and ink ribbon (not shown) positioned between the print wheel **72** and the print hammer **71** against a particular character **72***a* on circumferential surface **73**.

When the current is discontinued through the electromagnet, lever arm **74** springs back away from engagement with magnet portion **78** by means of flexible member **76**. The force of this spring-back is absorbed by spring loaded stop **84**, and any oscillations of hammer arm **80** are quickly damped. Such a print hammer assembly is commonly referred to as a cantilever beam assembly.

A principal disadvantage to such print hammer assemblies has been the time heretofore required to actuate and retrieve the print hammer mechanism. The response time of the mechanism is dependent on the rate of increase of current of di/dt, in the electromagnet coil. The greater the rate of increase in current over time, the faster the hammer will actuate. Heretofore, however, coil di/dt has been limited because high di/dt values have been obtained only by using actuator circuits which produce a high value of coil current for much of the hammer travel time, which results in undesirable coil heating and drive transistor strain, ultimately resulting in failure of both elements.

To prevent high heat loss and coil failure, while significantly increasing coil di/dt so as to provide faster actuation of the print hammer, the actuator circuit of the present invention has been developed. Referring to FIG. 7, a significantly higher actuating voltage V_a than is provided by the prior art (**100** volts as opposed to approximately **25** volts) is connected through a transistor **90** and an RC circuit comprising capacitor **92** and resistor **94** to the electromagnet coil **96**. Transistor **90** is controlled by a signal from control logic circuit **14** (not shown). In operation, when transistor **90** is turned on by the logic control signal, current flows primarily through capacitor **92** and coil **96**. A diagram of coil current v. time is shown in FIG. **9**. As the charge on capacitor **92** approaches actuating voltage V_a, the current decreases to a value dependent on resistor **94**, thus limiting the energy dissipated in coil **96** to a tolerable level and easing the load on transistor **90**. Because of the high initial rate of current increase, however, the hammer **97** begins to move substantially sooner than previously, and actuation time is reduced. At **1.2** milliseconds from the start of current flow, hammer **97** impacts the paper stock and ribbon against the desired character **99**. A graph of distance v. time for the travel of the print hammer is shown in FIG. **8**.

Referring again to FIG. **1**, printing stock **19** is directed through a print station comprising hammer assembly **26** and print wheel **28** by means of a supply reel **20**, and a label stepper **32**, which exerts a pulling force on stock **19**. However, in certain applications, such as label printing, where the movement of the printing stock is not uniform, slack will tent to occur in the printing stock between the supply reel **20** and the print station. Any such slack is ordinarily unsatisfactory, as it results in either distortion of the printed characters or variations in the character separation or both. The printed code is thus more difficult to accurately read and subject to an increased number of reading errors.

To overcome this tendency, a tensioning means is provided by the present invention in conjunction with the supply reel **20**, as shown in FIG. **4**. A printing stock supply reel **100** is positioned conventionally on a reel spindle **102**. In operation, stepper **32** exerts a pulling force on stock **19**, and hence pressure on roller guide **104**, which roller guide is rotatably mounted on one end **105** of guide arm **106**. The other end **107** of guide arm **106** is fixedly connected to a rotating arm assembly **108**, which comprises a cylinder **110** fixedly mounted on plate **112**, which arm assembly rotates with the rotation of guide arm **106** about a fixed central shaft **114** against the tension of spring **116**, one end of which is secured to a fixed peg **118**, and the other end to a peg **120** on the rotating arm assembly **108**. As the force on stock **101** increases in the direction of the arrow, thus forcing guide arm **106** to move counterclockwise about central shaft **114**, the rotating arm assembly **108** also rotates counterclockwise, forcing the free end **122** of pivot arm **124** toward the periphery of supply reel **100** against the tension of spring **127**. This movement of pivot arm **124** reduces the braking force of tension arm **126**, which is secured to pivot arm **124**, against supply reel spindle ring **128**, allowing spindle **102** to rotate more freely, and thus feed printing stock **101** faster. Roller guide **104** and guide arm **106** will eventually reach an equilibrium angular position when a constant force is exerted on stock **101**. However, if the force on stock **101** varies, as in label printing, the angular position of guide **104** and guide arm **106**, and hence, the remainder of the system will attempt to track the force, "searching" for an equilibrium position.

For instance, if the force on roller guide **104** is suddenly reduced, as would occur with the return of the stripper to its original position, the tension exerted by spring **116** will tend to rotate the arm assembly **108** in the clockwise direction, and along with it guide arm **106** and roller guide **104** until a system equilibrium is reached. Equilibrium is eventually achieved because the clockwise rotation of arm assembly **108** will allow pivot arm **124** to move in the direction of the spindle **102**, under the tension of spring **127**. This will increase the braking force on spindle ring **128** exerted by tension arm **126**, and the supply reel will thus be increasingly braked. Such a responsive tensioning device tends to maintain that portion of printing stock **101** located between the supply reel and the print station in substantially constant tension, thus increasing printing resolution and accuracy, and hence, reducing code reading errors.

Following the print station is located a label stripper **30**, shown generally in FIG. **1** and in more detail in FIGS. **2** and **3**. In operation, the label stock (when used) is passed between guide elements **130** and **132**, connected by support member **133**. The entire stripper **30** is rotatable about axis **134—134** with respect to the deck of the printer, so that it may be conveniently taken out of operation. Guide elements **130** and **132**, as well as support element **133** are rotatable about axis **135—135**. By rotating the stripper about axis **135—135** in a clockwise manner from its original position by convenient means of rotation knob **142**, peg **130** guides the label stock through a substantially U-shaped path before it comes to the label stepper **32**. Although the stock backing follows such a path, the labels themselves do not, and separate from the backing when the backing begins to bend to follow the U-shaped path. By thus rotating label stripper knob **142** in such a fashion, the operator is able to strip a label in close proximity to the print mechanism, and then conveniently place them, if desired, on appropriate cartons or other commercial items. Located within rotation knob **142** is a spring **140**, which is secured at one end thereof such that the knob, and hence, guide pins **130**, 132 are rotated against the tension of the spring. When the knob **142** is released, the action of spring **138** returns the stripper elements to their rest position of FIG. **1**. Bendable stop **141** provided to lock the stripper in operating position, if desired. A spring **138** is positioned so as to place the stripper **30** and element **139** in tension along shaft **139***a*.

Thus, a mechanical high speed impact printer has been disclosed which utilizes a generally conventional configuration but which has several novel features to increase printing resolution, printing accuracy, and operational convenience in the printing of bar codes on labels or other printing stock.

Although an exemplary embodiment of the invention has been disclosed herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the claims which follow.

What is claimed is:

1. A tensioning apparatus used in conjunction with a printing stock supply reel in a high speed impact printer, comprising in combination:

rotatable spindle means for receiving said printing stock supply reel;

a reel arm assembly rotatably mounted at one end thereof in the vicinity of said spindle means;

spring means connected to said reel arm assembly for biasing said reel arm assembly into a first angular position;

roller guide means mounted on said reel arm assembly and spaced away from said one end thereof, said printing stock, as it is unwound from said supply reel and passed partially around said roller guide means, pressing against said roller guide means and forcing said reel arm assembly to rotate about said one end against the bias of said spring means; and,

braking means mounted in the vicinity of said spindle means, said braking means engageable with said spindle means such that as said reel arm assembly rotates relatively away from said first angular position against the bias of said spring means, pressure of said braking means against said spindle means decreases, allowing said spindle means to turn more freely, said braking means including a brake arm, rotatably mounted in the vicinity of said spindle means, and operative to engage said reel arm assembly, said braking means further including a second spring means, and a spring lever mounted on said brake arm, said second spring means biasing said brake arm such that said spring lever engages said spindle means, the rotation of said reel arm forcing said brake arm to rotate against the bias of said second spring means, thereby decreasing the pressure of said spring lever spindle means.

2. An apparatus according to claim **1** wherein said roller guide is a cylindrical section, rotatably secured to said other end of said elongated reel arm assembly.

3. An apparatus according to claim **2** wherein said reel arm assembly includes a plate member located at said one end of said reel arm assembly and rotating therewith, said first spring member being secured to said plate member, said plate member further mating with said brake arm, and being shaped such that a rotation of said reel arm assembly under stock pressure forces said brake arm to rotate in response thereto through the rotation of said plate member.

4. An apparatus according to claim **3** wherein said plate member is shaped in the vicinity of its mating with said brake arm such that when said reel arm assembly is at said rest position pressure exerted on said spindle means by said spring lever is at a maximum, and when said reel arm assembly is gradually rotated against the action of said first spring member, the accompanying rotation of said plate member gradually forces said brake arm against the action of said second spring member, gradually reducing the pressure exerted on said spindle means by said spring lever.

5. A tensioning apparatus, useful in a machine which includes a tape supply means, wherein the tape supply means includes a reel for receiving tape or the like, the machine being operative to exert a force on the tape, tending to cause the reel to rotate and the tape to unwind therefrom, the tensioning apparatus comprising:

tape guide means engaging the tape as it is unwound from the reel, said tape guide means mounted to rotate about a first axis and yieldably biased into a first angular position about said first axis, said tape guide means being rotated against the bias thereon when the force is exerted on the tape by the machine;

braking means yieldably biased into a stopped position engaging said tape supply means in a manner substantially preventing rotation of the reel; and,

cam means rotatable with said tape guide means and engageable with said braking means and operative upon rotation of said tape guide means relatively away from said frist angular position to displace said braking means against the bias thereon relatively away from the stopped position, permitting rotation of said reel.

6. An apparatus of claim **5,** wherein said braking means is rotatable about a second axis spaced apart from said first axis.

7. An apparatus of claim **5,** wherein said cam means is engageable with said braking means substantially upon initial rotation of said type guide means, said cam means being so configured as to substantially uniformly increase the displacement of said braking means relatively away from its stopped position as said cam means is rotated, thereby gradually increasing the relative freedom of rotation of said reel.

8. An apparatus of claim **5,** wherein said braking means further includes means connected thereto and engaging said tape supply means in frictional engagement, the engagement of said resilient means and said tape supply means preventing rotation of the reel when said braking means is in said stopped position, the pressure of said resilient means against said tape supply means gradually decreasing as said tape guide means is rotated about said first axis under the external force, thereby permitting increasing freedom of rotation of said reel.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,866,851
DATED : February 18, 1975
INVENTOR(S) : Robert G. Brooks

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 33, add the words --against said-- after the word "lever".

Column 8, line 41, add the word --resilient-- after the word "includes".

Signed and Sealed this

Tenth Day of August 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks