United States Patent

Foley et al.

[15] **3,677,176**

[45] **July 18, 1972**

[54] RIBBON CONTROL APPARATUS FOR HIGH SPEED PRINTERS

[72] Inventors: **John J. Foley**, West Acton; **Wallace J. Satas**, Hudson; **Joseph Konkel**, Lynnfield, all of Mass.

[73] Assignee: **Data Printer Corporation**, Cambridge, Mass.

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[21] Appl. No.: **71,154**

[52] **U.S. Cl.** **101/96**, 101/336, 197/160

[51] **Int. Cl.** **B41j 34/14**

[58] **Field of Search** ..... 101/96, 96 RC, 93 C, 336; 197/160, 161, 162, 165

[56] **References Cited**

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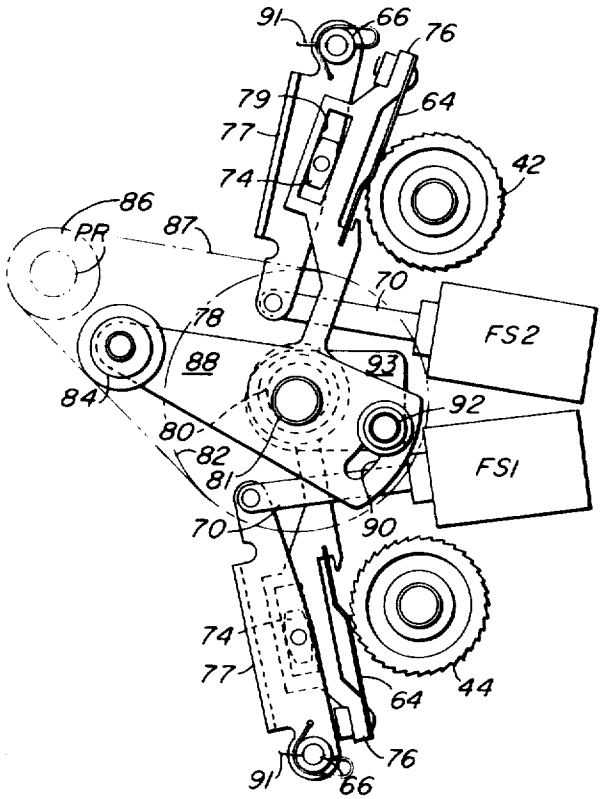
Primary Examiner—William B. Penn

Attorney—Rich & Ericson

[57] **ABSTRACT**

Ribbon control apparatus for a high speed printer in which the ribbon is intermittently and reversibly driven between a pair of reels while being steered from side to side to prevent a net uneven takeup on one reel or the other. The ribbon drive is synchronized with the type carrier and enabled by a print signal produced while printing is in progress. Counting means stepped by the counter when the print signal is absent delays disengagement of the ribbon drive to ensure movement of the ribbon at least one each print cycle.

5 Claims, 11 Drawing Figures



Patented July 18, 1972 3,677,176

5 Sheets-Sheet 1

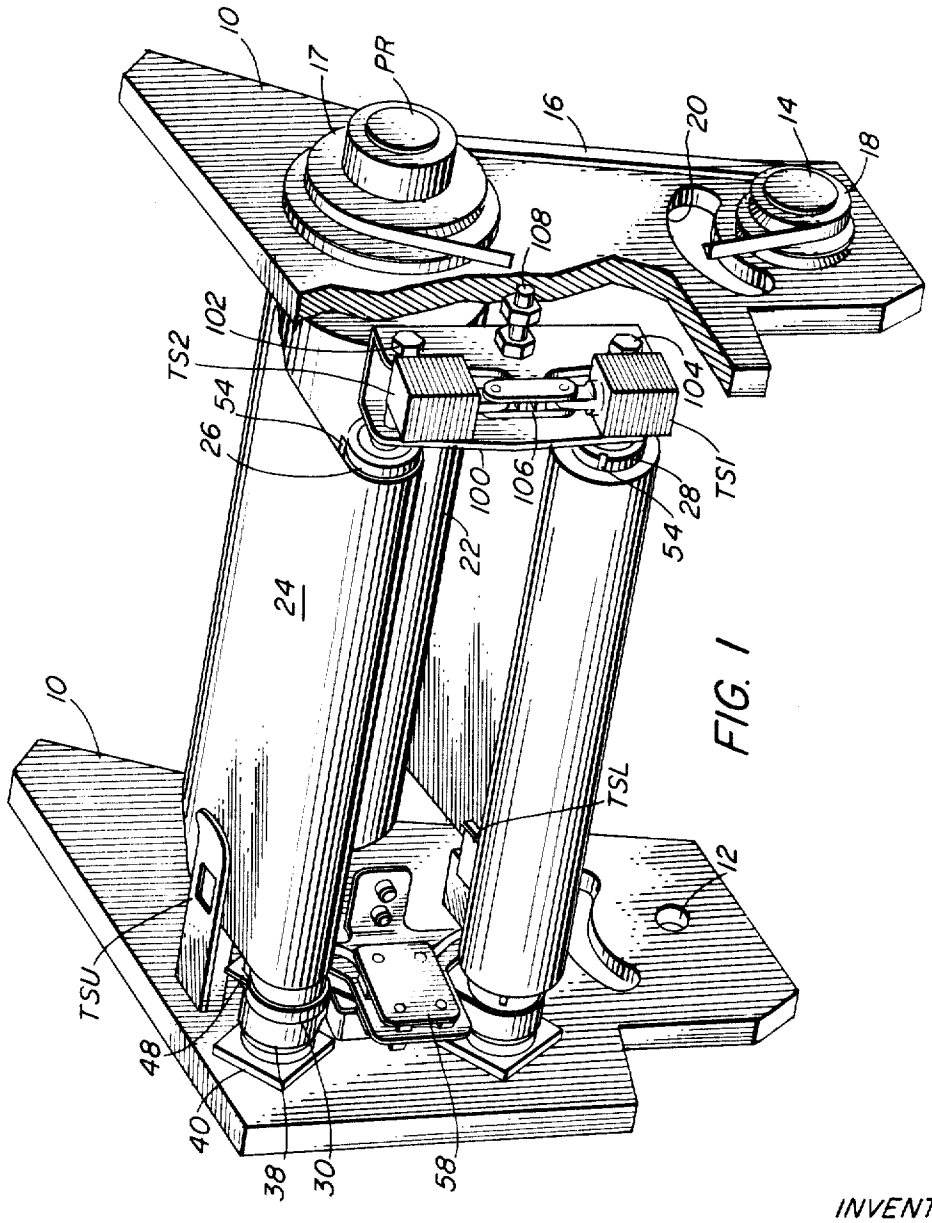


FIG. 1

INVENTORS
JOHN J. FOLEY
WALLACE J. SATAS
JOSEPH KONKEL
BY Richard Ericson
ATTORNEYS

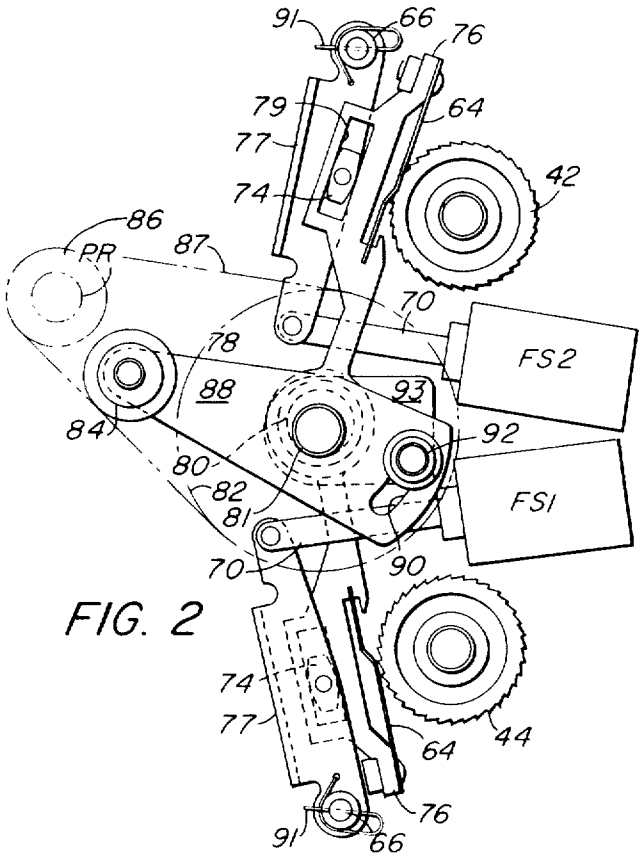


FIG. 2

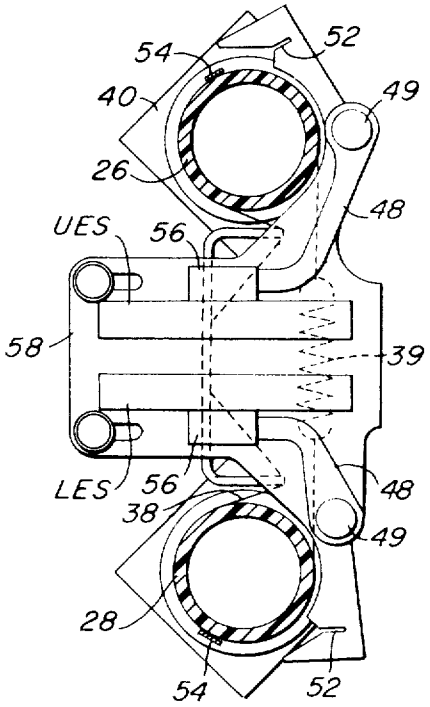


FIG. 3

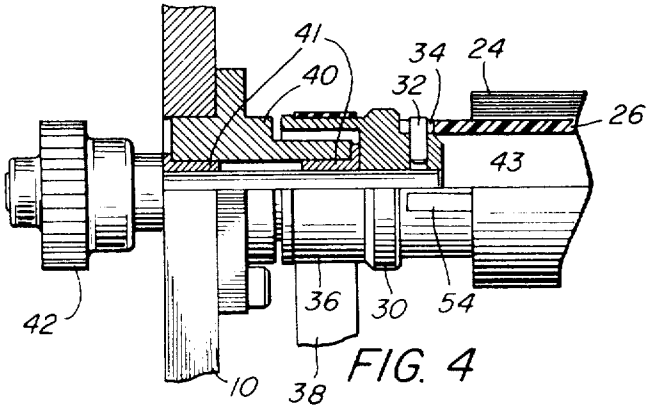


FIG. 4

INVENTORS
JOHN J. FOLEY
WALLACE J. SATAS
JOSEPH KONKEL
BY Rich and Ericson
ATTORNEYS

FIG. 5

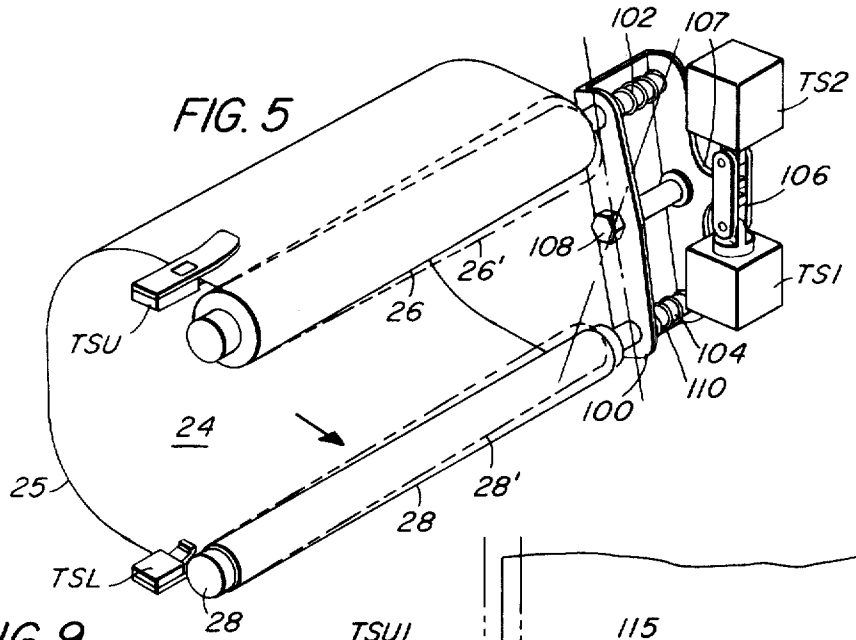


FIG. 9

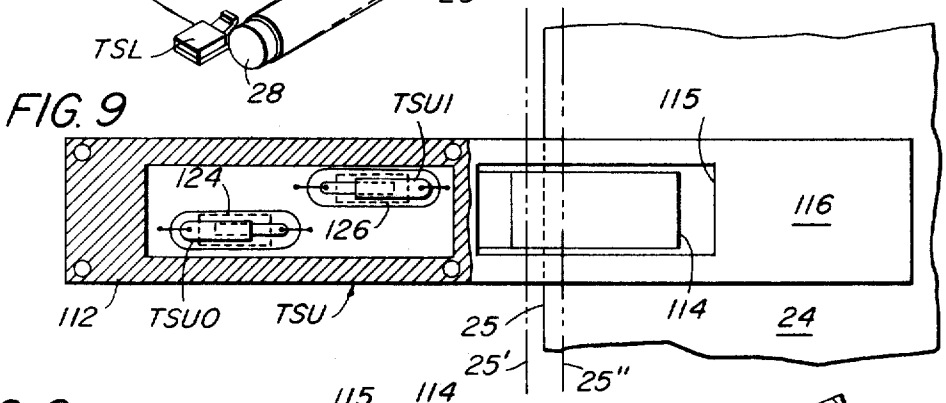


FIG. 6

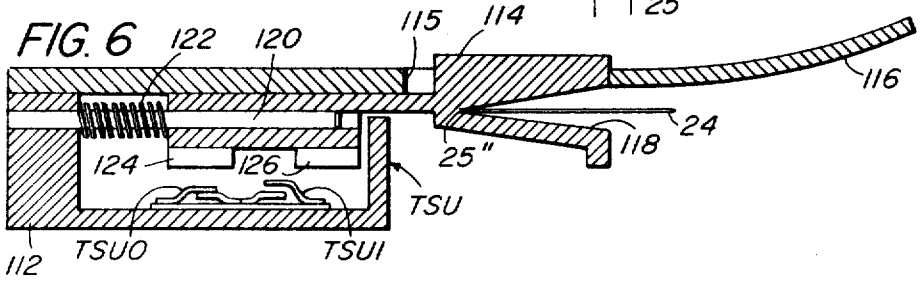


FIG. 7

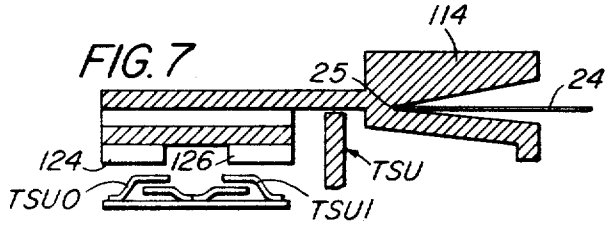
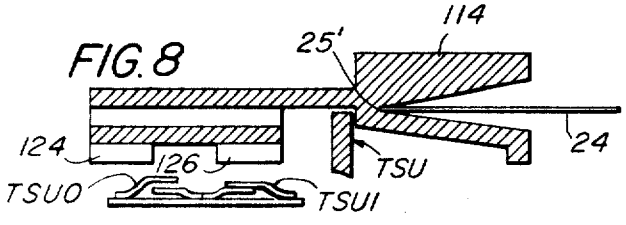


FIG. 8



INVENTORS
JOHN J. FOLEY
WALLACE J. SATAS
JOSEPH KONKEL
BY Rich and Ericson
ATTORNEYS

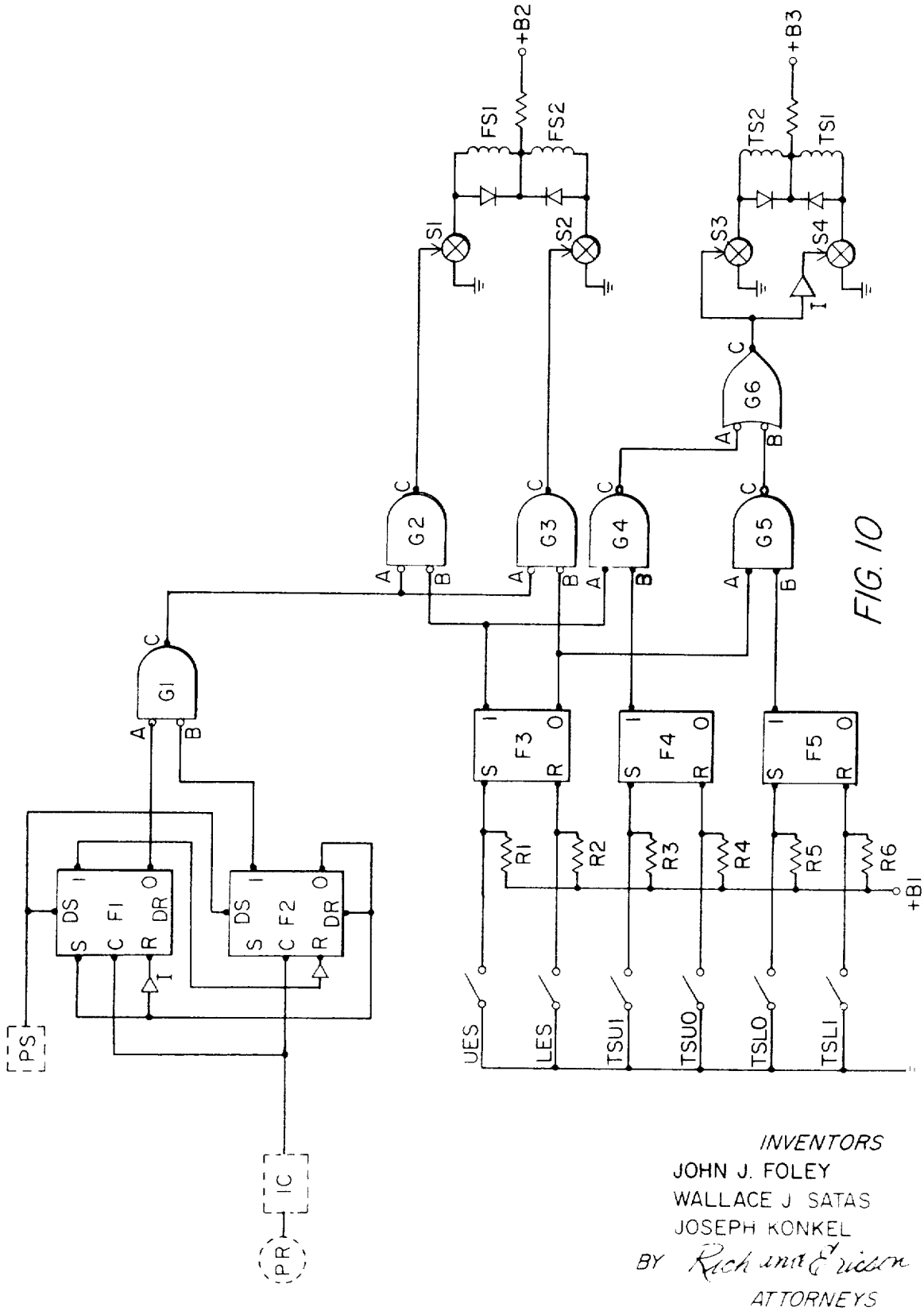


FIG. 10

INVENTORS
JOHN J. FOLEY
WALLACE J SATAS
JOSEPH KONKEL
BY Rich and Erickson
ATTORNEYS

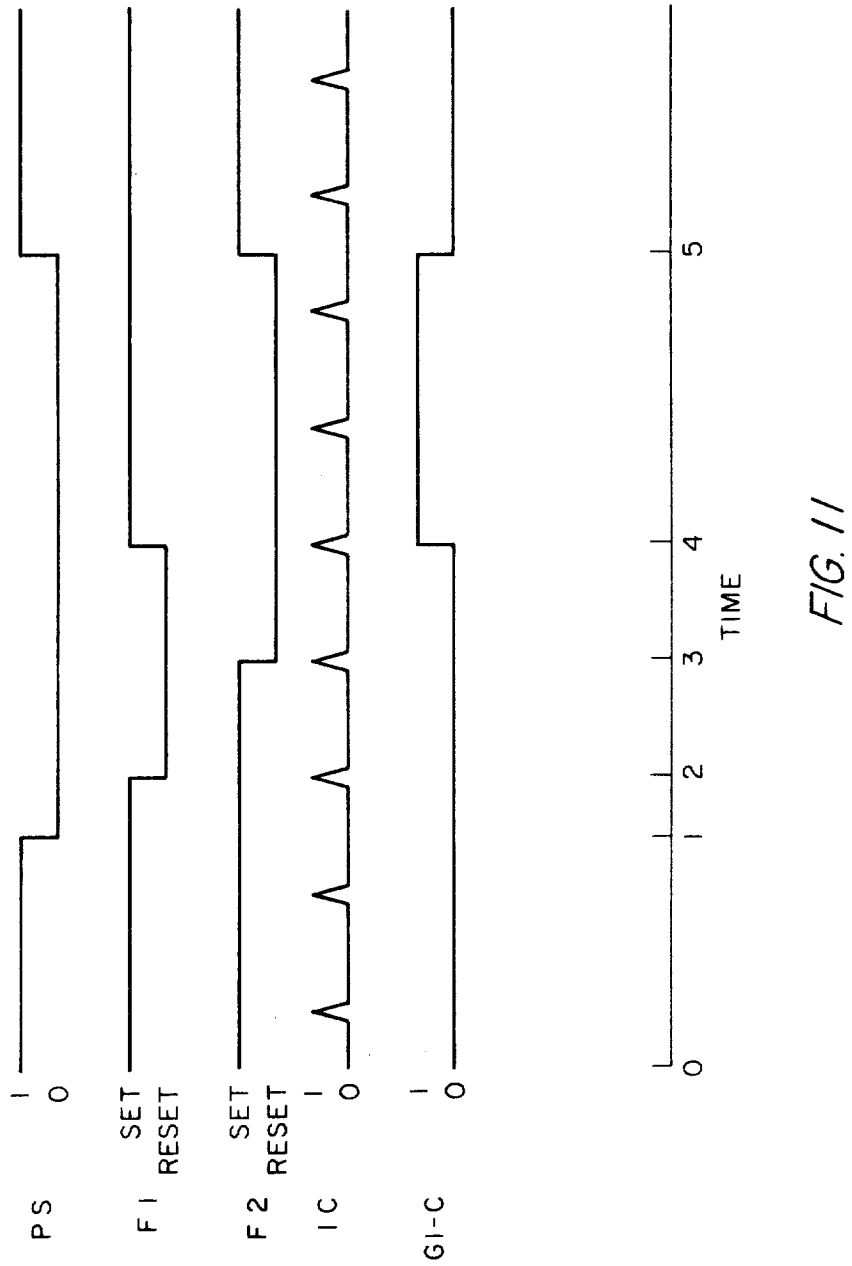


FIG. 11

INVENTORS
JOHN J. FOLEY
WALLACE J. SATAS
JOSEPH KONKEL
BY Richmond & Edison
ATTORNEYS

RIBBON CONTROL APPARATUS FOR HIGH SPEED PRINTERS

BACKGROUND AND BRIEF DESCRIPTION OF THE INVENTION

The present invention relates to apparatus for reversibly winding an inked printing ribbon for use in printers, and especially in printers of the high speed impact drum type. Conventionally, such a printer has a print drum on which are engraved a set of the characters that can be printed for each column. The drum is rotated at a constant speed in tangential relation to the printing paper and an inked ribbon, which are backed by a row of hammers arranged in a straight line parallel to the rotational axis of the drum. One hammer is provided for each vertical column to be printed, and cooperates with a corresponding column of different characters around the surface of the drum. Precisely timed actuation of a hammer in a given column imprints by striking the paper and ribbon against a selected character on the drum.

Typically, printers of this type may produce 600 lines or more per minute, so that each line is printed in a matter of only one-tenth of a second. In order to produce a uniform weight and quality of print, it is necessary to advance the printing ribbon regularly, to avoid overstriking the same area repeatedly.

The ribbon is conveniently reversibly wound by attaching its ends to a pair of reels. It may be reused a number of times by winding it back and forth between the reels as printing continues. It is, however, necessary to provide some means for guiding the ribbon accurately so that it will wind properly onto the reels, and to prevent it from wandering from side to side. The printing operations are often carried out in an intermittent fashion, with idle intervals during which no data is supplied to the printer. During these idle intervals it is preferred not to advance the printing ribbon. It is therefore desired to interrupt the ribbon-feeding whenever printing operations are not in progress.

It is the general object of the present invention to provide an improved apparatus for rewinding inked printing ribbon in a reversible manner, for guiding the ribbon in a predetermined path as it is wound and rewound, and for continuing the feeding of the ribbon only during periods of printing by an associated printing machine. It is another object to provide a compact and highly reliable apparatus for rewinding printing ribbon. Further objects and advantages of the invention will appear as the following description proceeds.

Briefly stated, according to a preferred embodiment of our invention, we attach the ends of a length of inked printing ribbon to a pair of reels, and mount these reels on adjustable supporting means which normally hold the reels in parallel relation, so that the ribbon may be threaded through the related printing mechanism from one reel to the other. The reels are driven by reciprocating pawl means cooperating with ratchet means to advance the ribbon in intermittent steps. The direction of winding is selected by sensing means which detect the completion of unwinding of the ribbon from either reel, and serve to reverse the feeding direction of the pawl and ratchet means.

The reel-supporting means are movable in a manner to cant the reels relative to the length of the ribbon for purposes of guiding it in a predetermined track. The guiding function is controlled by a pair of ribbon edge-sensing means, one of which is located adjacent to each reel. The end sensing means are arranged to enable either of the two edge-sensing means alternatively, selecting that one of these means which is associated with the reel onto which the ribbon is being wound at any given time. In this manner the winding reel is used to guide the ribbon to form an accurate roll, while the supply reel is allowed to unwind in any fashion dictated by the requirements of guiding onto the winding reel.

The continuance of these winding and guiding operations is subject to the presence of a signal indicating the continuance of printing operations. Interruption of this signal affects a control circuit in a manner to discontinue feeding of the ribbon. According to a feature of the invention, the interruption of feeding is delayed pending the completion of a full stroke of the pawl and ratchet-feeding mechanism, so that these means may be disengaged freely only after the completion of a full stroke advancing the ribbon through one complete line space. This is achieved by improved control circuit means which are responsive to signals generated by the printing mechanism, and also by the rotation of the print drum, which is coordinated with the cycling of the pawl and ratchet mechanism.

DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out the subject matter which we regard as our invention, it is believed that a clearer understanding may be gained from the following detailed description of preferred embodiments thereof, referring to the accompanying drawings, in which:

FIG. **1** is a fragmentary view in perspective showing a preferred embodiment of the improved ribbon rewinding apparatus;

FIG. **2** is a fragmentary view in elevation showing a feeding mechanism;

FIG. **3** is a sectional end view showing end sensing means which form a portion of the apparatus;

FIG. **4** is a fragmentary view partially in section showing a portion of the reel mounting and feeding mechanism;

FIG. **5** is a schematic perspective view illustrating the guiding action of the apparatus;

FIG. **6** is a sectional view in elevation showing an edge-sensing means with the parts in a position corresponding to a misaligned position of the ribbon;

FIG. **7** is a fragmentary view of the means of FIG. **6**, showing positions of the parts assumed when the ribbon is in the proper track;

FIG. **8** is a view similar to FIG. **7**, but showing the parts in positions assumed when the ribbon is misaligned in an opposite sense to FIG. **6**;

FIG. **9** is a fragmentary plan view of the means of FIGS. **6–8**;

FIG. **10** is a diagram of a control circuit for the apparatus; and

FIG. **11** is a timing diagram of the control of FIG. **10**.

Referring first to FIGS. **1–5**, a preferred embodiment of the improved rewinding apparatus is organized about a yoke frame which includes end plates **10** which are joined by ribbon guide castings **22**. The yoke frame is intended to be pivotally mounted on a printer frame, and is provided with bores **12** for this purpose, as well as arcuate slots **20** which permit the frame to be swung into operative relation to the main frame of the printer (not shown), or swung outwardly for replacement of the ribbon. The guides **22** partially enclose a conventional print drum PR, which is rotatably mounted in the yoke frame and is arranged to be driven at a predetermined rate by means which include sheaves **17** and **18**, the latter being mounted on a stub shaft **14**, a belt **16** and a suitable motor (not shown). The print roll PR has rows of characters engraved on its surface in a conventional manner for cooperation with the hammers of the printing machine. The ribbon passes tangentially over the surface of the print roll together with the printing paper, so that impact by the printing hammers produces desired images on the paper. As the present invention is not concerned with the printing machine itself, and is useful in conjunction with a variety of conventional printers, no further description of the printing mechanism is believed necessary. One such printer is shown by U.S. Pat. No. 2,940,385 to House.

The inked printing ribbon **24** is partially wound on reels **26** and **28**, and extends between them about the ribbon guides **22**. The reels **26** and **28** are supported at their right ends as seen in FIG. **1** by means of capped shafts **102** and **104**, which are resiliently biased by coil springs **110** into engagement with the ends of the reels, for purposes of convenient removal and

replacement of the reels when the ribbon is to be replaced. The shafts **102** and **104** are supported in a skew bracket **100**, which is pivotable about a bolt **108** that is mounted on the plate **10** at the right side of the yoke frame. The skew bracket **100** may be angularly positioned about the shaft **108** by means of solenoids TS1 or TS2, which are connected to a link **106** that is slideably engaged with a tongue **107** extending from the skew bracket. By actuating either of the solenoids TS1 or TS2 the skew bracket **100** may be canted in a manner to tilt the reels **26** and **28** in opposite angular directions with respect to the longitudinal dimension of the ribbon **24**. For example, the reels are shown in FIG. **5** in a tilted position at **26** and **28**, while the normal position perpendicular to the length dimension of the ribbon is shown in dashed lines at **26'** and **28'**. The tilted positions are in this case produced by energizing the solenoid TS2, which tilts the bracket **100** counter-clockwise as seen in FIG. **5**, shifting the right end of the roll **26** rearwardly and the corresponding end of the reel **28** forwardly. It is a well-established principle that a sheet may be guided by tilting the reels in this fashion, since any longitudinal element or edge of the sheet tends to wind itself in a plane radial to the longitudinal axis of rotation of the reel. Thus, tilting of the reels in the sense shown in FIG. **5**, assuming that the ribbon is winding onto the lower reel **28** as shown by the arrow, tends to shift the ribbon toward the left as viewed in FIG. **5**. Similarly, if the ribbon is being rewound in the opposite direction onto the upper reel **26**, the illustrated angle of tilting will tend to shift the ribbon toward the right side of this reel. Conversely, actuation of the solenoid TS1 would tilt the bracket **100** in the opposite sense, and guide the ribbon in the opposite directions, according to the direction of winding.

We provide edge sensing means comprising a pair of sensing switches TSU and TSL, which are respectively positioned adjacent to the upper reel **26** and the lower reel **28**. We utilize only one of these switches at a time, depending upon the winding direction, as it is desired to guide the ribbon correctly onto the winding reel, while the supply reel may be allowed to unwind without guidance of the ribbon at that location.

One of the edge sensing switches TSU, which is identical with the switch TSL, is shown in detail in FIGS. **6–9**. The casing **112** of the switch TSU slideably supports a ribbon sensor **114**, having a V-notch **118** in which the edge **25** of the ribbon **24** is slideably received. The sensor is movable within the limits of a slot **115** formed in an upper ribbon guide **116** which extends partially over the edge of the ribbon to prevent it accidentally becoming disengaged from the sensor. A pin **120** guides the sensor, which is biased by a compression spring **122** into light contact with the edge **25** of the ribbon. The sensor carries two spaced magnets **124** and **126**, which cooperate with pairs of ferromagnetic reed switch contacts TSUO and TSUI, which serve respectively to determine inner and outer tolerance limits of displacement of the edge **25**. Assuming that this edge is in a predetermined correct track shown in solid line at **25**, the sensor **114** assumes the position shown in FIG. **7**, in which the magnets **124** and **126** attract the upper one of each pair of contacts TSUO and TSUI more strongly than the lower one, so that both sets of contacts are held open. In the event that the edge of the ribbon shifts toward the right to a limiting position shown at **25''** in FIG. **6**, the magnet **124** sufficiently attracts the lower one of the contact pair TSUO to close this pair, but the magnet **126** holds its contact set TSUI in an open condition. Conversely, a leftward shift of the ribbon edge to a position **25'** illustrated in FIG. **8**, causes the magnet **126** to attract the lower one of the contact pair TSUI enough to close this pair, while the contacts TSUO are held open by the magnet **124**. These switches form a portion of a control circuit which will be described hereinafter.

Referring now to FIGS. **1** and **4**, the left ends of the reels **26** and **28** are slidably received by drive caps **30**, which are rotatably supported by bearings **41** mounted by housings **40** in the plate **10** at the left side of the assembly. Because of the necessity to allow the reels to cant, the left end of each reel is formed with a notch **34** in which a drive pin **32** affixed to the corresponding cap **30** is slideably received. Thus the reels are drivingly connected with the caps, but are nevertheless free to cant with respect to the rotational axes of the caps. Each cap is secured on a shaft **43**, and a pair of ratchet wheels **42** and **44** are secured to these shafts outboard of the plate **10**. As best shown in FIG. **2**, the mechanism for driving the reels alternatively through their ratchets **42** and **44**, includes a drive sheave **86** which is secured to a protruding end portion of the print roll PR. A belt **87** is threaded about the sheave **86**, an idler sheave **84**, and a driven sheave **82**, the latter being rotatably supported on an eccentric drive shaft **81**. This shaft is provided with an eccentric portion **80** and with a concentric portion mounting a bracket **88** which movably supports the sheave **84** to provide for adjustment of the tension in the belt **87**. An adjusting screw **92** is threaded into a stationary support member **93**, and extends through an arcuate slide **90** formed in the bracket **88**, so that the belt tension may be adjusted by loosening the screw **92** and turning the bracket **88** about the shaft **81**.

The eccentric portion **80** of the shaft **81** is engaged rotatably in a hub portion **78** of each of two actuator arms **76**. Each of these arms bears a slotted pawl **64** for driving cooperation with the ratchet wheels **42** and **44**, respectively. The actuator arms **76** are movable to engage or disengage the pawls **64** with the ratchet wheels **42** and **44** by means of feed solenoids FS1 and FS2, whose actuating rods **70** are respectively pivotally connected with links **77**, which are in turn pivotally supported on the plate **10** by pivotal connections **66**. Each of the links **77** rotatably mounts a cam **74**, which is in turn slideably received in a slot **79** formed in each of the actuators **76**. The actuators are continuously reciprocated in a direction lengthwise of the pawls **64**, by the rotation of the eccentric portion **80**, and are guided in this sliding motion by the cams **74**. Energization of either of the solenoids FS1 or FS2 swings the corresponding link **77** toward the related ratchet wheel **42** or **44**, and brings the pawl **64** into position to drivingly engage the teeth of that ratchet wheel. In FIG. **2**, the solenoid FS2 is assumed to be energized, so that the upper pawl **64** is drivingly engaged with the ratchet **42**. A pair of springs **91** attached to the plate **10** bias the links **77** and actuators **76** away from the ratchet wheels **42** and **44**, so that de-energization of either solenoid permits the pawl **64** to be drawn away from engagement with the corresponding ratchet wheel. It is assumed in FIG. **2** that the solenoid FS1 is de-energized, and the lower pawl **64** is shown disengaged from its ratchet wheel **44**.

The pawls **64** reciprocate once on each complete revolution of the eccentric portion **80** and the sheave **82**, and advance the driven ribbon reel through an arc corresponding to one ratchet tooth during this revolution. The rate of advance of the ribbon is correlated with the rate of rotation of the print drum by proper selection of the speed ratio between the sheaves **86** and **82**. In the illustrated embodiment, this ratio is selected at 3:1, so that the pawls **64** reciprocate through one full stroke in the course of three revolutions of the print roll. The control circuit, which will be described thereinafter, is so arranged that upon a cessation of printing operations, the feeding of the winding reel is continued through one full stroke of the actuators **76**.

As shown in FIGS. **1**, **3** and **4**, back tension is maintained in the ribbon by means of belts **38** trained about cylindrical surfaces **36** of the caps **30**. One end of each belt is affixed to a stationary mounting block **58**, and the opposite ends are connected by a tension spring **39**. These belts apply braking friction to either of the reels **26** or **28** which is serving as the supply reel at any given time.

Means are provided for detecting the completion of unwinding of the ribbon from either of the reels **26** and **28**, and these are illustrated in FIGS. **1** and **3**. A pair of metal strips **54** are secured near each end of the ribbon, and are sufficiently long to extend slightly out from the edges. These strips cooperate with jaws **52** formed in a pair of reversing levers **48**, which are pivotally supported at pivot points **49** on the mount-

ing block **58**. This block is supported near the left end of the assembly, and positions the jaws **52** closely adjacent to the reels and their caps **30**, each in a position to be engaged by a corresponding one of the strips **54** as the ribbon becomes fully unwound from the adjacent reel. This engagement pivots the corresponding lever **48** in a direction to withdraw a magnet **46** mounted thereon away from an associated end-sensing switch UES or LES. These switches are normally closed by internal magnets (not shown), but in the juxtapositions shown, the magnets **56** hold these switches in open condition. As either holding magnet **56** is raised by its lever **48**, the corresponding switch UES or LES is permitted to close under the influence of its internal magnet. These switches serve to reverse the direction of ribbon feeding, and are incorporated in a control circuit which is now to be described.

THE CONTROL CIRCUIT

The functions of the control circuit are: first, to cause the ribbon to feed between the upper and lower reels, and to reverse the feeding when the ribbon is fully wound on either reel; secondly, to guide one edge of the ribbon in a predetermined track in order to cause it to wind properly on the reels, in either winding direction; and thirdly, to interrupt the feeding of the ribbon when printing operations stop, after an interval long enough to complete a full stroke of the ribbon drive pawls.

The circuit shown in FIG. **10** includes five conventional integrated flip-flop circuits **F1** through **F5** inclusive, each of which has a set terminal S, a reset terminal R, and output terminals **1** and **0**. The flip-flops **F1** and **F2** are also provided with direct set terminals DS, direct reset terminals DR, and trigger terminals C. Both flip-flops **F1** and **F2** are so arranged that they can be set, i.e., so that their output terminals **1** will deliver a logic 1 signal, either by applying a logic **1** signal to a terminal DS, or by applying a triggering pulse to terminal C while a logic **1** signal is applied to terminal S. These flip-flops can be reset, i.e., so that their output terminals **0** will deliver a logic 1 signal, by applying a logic **1** signal to terminal DR, or by applying a triggering pulse to terminal C while a logic 1 signal is applied to terminal R. As will be understood by those skilled in the art, the logic 1 signal must be present at the terminal S or R for a short time prior to the trigger pulse in order to be effective. Both terminals C are connected to a conventional index pulse generator **IC**, which is energized momentarily at the completion of each revolution of the print roll PR to apply a triggering pulse transition to the terminals C of the flip-flops **F1** and **F2**. Inverters **I** apply logic 1 signals to the reset terminals R when activated by logic 0 signals.

The terminal **0** of the flip-flop **F1** and the terminal **1** of flip-flop **F2** are respectively connected to the terminals A and B of a NOR gate **G1**, whose output terminal C serves to inhibit ribbon feeding after printing operations are interrupted. The flip-flops **F1** and **F2** have their direct set terminals DS connected in common to a conventional print signal generator PS. The signal generator PS produces a signal PS so that while printing operations continue, both flip-flops **F1** and **F2** remain set, as shown during the interval 0–1 in the time diagram of FIG. **11**.

During this printing period, index pulses IC are generated at the completion of each revolution of the print roll PR, and are applied to the terminal C of the flip-flop **F1**, but do not change its set condition even though the reset terminal R continually receives a logic 1 signal from its inverter I and the terminal **0** of the flip-flop **F2**; the brief index pulse IC is ineffective to overcome the printing signal at the direct set terminal DS. Not until the printing signal PS ceases can an index signal succeed in resetting the flip-flop **F1**, as shown at time **2** in FIG. **11**.

During the printing period between times **0** and **1**, the terminal **0** of the flip-flop **F1** delivers a logic 0 signal, and the terminal **1** of the flip-flop **F2** delivers a logic 1 signal, to the NOR gate **G1**, whose output terminal C therefore delivers a logic 0 signal. This gate is connected to the terminals A of each of two NOR gates **G2** and **G3**, which control ribbon feeding. Either of these gates is therefore incipiently prepared to transmit logic 1 signals from its output terminal C at this time; provided that it also receives a logic 0 signal at its terminal B.

The direction of ribbon feeding is determined by the last previous momentary closing of one of the ribbon end switches UES or LES by the engagement of one of the strips **54**, previously described, with its cooperating switch lever **48**. A voltage source **B1** is normally applied to the terminals S and R of the flip-flop circuit **F3** through resistors **R1** and **R2** respectively, but either terminal can be grounded and supplied with a logic 0 signal by closing a corresponding one of the switches UES or LES. In the event that the upper ribbon end switch UES is closed by the exhaustion of ribbon from the upper ribbon reel **26**, for example, this momentarily grounds the terminal S to set the flip-flop **F3**. The flip-flops **F3**, **F4**, and **F5** are of a type which can be set or reset by logic **0** signals. The flip-flop **F3** remains in a set condition until such time as the lower ribbon end switch LES is closed by exhaustion of the ribbon from the lower reel **28**; this in turn momentarily grounds the reset terminal R and resets the flip-flop **F3**.

Assuming a set condition of the flip-flop **F3**, the ribbon having been exhausted from the upper reel **26**, a logic 1 signal is applied to the terminal B of the gate **G2**, inhibiting this gate and producing a logic 0 signal at its terminal C. The lower ribbon feed solenoid **FS1** is de-energized at this time, as a controlling electronic switch **S1** is in an open condition. However, the terminal **0** of the flip-flop **F3** delivers a logic 0 signal to the terminal B of the gate **G3**, resulting in the delivery of a logic 1 signal from the terminal C of this gate to an electronic switch **S2**. This in turn energizes the upper ribbon feed solenoid **FS2** from a power source **B2**. The solenoid **FS2** engages its feed pawl **64** with the upper ribbon reel ratchet **42**, and commences rewinding of the ribbon on the upper reel.

A reversal of the direction of feeding occurs when the supply of ribbon becomes exhausted from the lower reel **28** and its end strip **54** contacts the switch LES. This momentarily grounds the terminal R of the flip-flop **F3**, which is thereby reset, and applies a logic **1** signal to the terminal B of the gate **G3** to inhibit this gate. The switch **S2** then opens and de-energizes the upper ribbon feed solenoid **FS2**, discontinuing the feeding of ribbon onto the upper reel **26**. At the same time, terminal **1** of the flip-flop **F3** applies a logic 0 signal to terminal B of the gate **G2**, causing this gate to deliver a logic 1 signal and thereby energize the switch **S1** and the lower ribbon feed solenoid **FS1**. This engages the lower ribbon feed pawl **64** with the lower reel ratchet **44**, and the ribbon is subsequently re-wound from the upper reel onto the lower. Rectifiers **R** are provided to protect the electronic switches **S1** and **S2** from excessive voltages when either of the switches **S1** or **S2** is opened.

It will be seen that the logic circuit is so arranged that the switches UES and LES control the periodic reversal of the direction of ribbon feeding, while the print signal generator PS permits feeding to continue so long as printing operations are taking place. In the event that printing is stopped, feeding is continued through one full revolution of the pawl-driving shaft **81**, which corresponds to three revolutions of the print roll PR. This insures that the engaged feed pawl completes a full stroke before it is disengaged from the teeth of the corresponding ribbon reel ratchet **42** or **44**. Referring to the time diagram of FIG. **1**, in conjunction with FIG. **10**, it is assumed that the printing signal PS is discontinued at time **1**. Upon the occurrence of the next succeeding index pulse IC at time **2**, the flip-flop **F1**, no longer held by the printing signal, is reset by the simultaneous receipt of the index pulse and of a logic 1 signal at terminal R, the latter being delivered continuously by the inverter I from the terminal **0** of the still-set flip-flop **F2**.

The resetting of **F1** does not reset **F2** at this moment, because the logic 0 signal now delivered by the terminal **1** of **F1**, applying a resetting signal through an inverter I to the terminal R of **F2**, does not become effective until the trigger pulse is gone. However, upon the delivery of the next index pulse IC at time **3**, the logic 1 signals simultaneously applied to

the terminals R and C of the flip-flop F2 are effective to reset it.

When the third index pulse IC following the cessation of the print signal PS is delivered at time 4, it is effective to set the flip-flop F1, acting in conjunction with the logic 1 signal received at the terminal S of F1 from terminal 0 of the reset flip-flop F2.

Thus at time 4 F1 is set and F2 is reset, with the result that the terminal 0 of F1 applies a logic 0 signal to gate G1, while the terminal 1 of F2 also applies a logic 0 signal to this gate. Terminal C of the gate G1 then delivers a feed-inhibiting logic 1 signal to the terminals A of gates G2 and G3 for the first time. This results in the opening of either switches S1 or S2, (depending on the state of F2) disengaging the ribbon feed solenoid FS1 or FS2 and causing the ribbon feeding to stop. It is to be noted that the logic signals applied to terminals A and B of the gate G1 during the time interval 0–2 are 0,1; during the time interval 2–3 are 1,1; and during the interval 3–4 are 1,0. None of these combinations results in the delivery of an inhibiting logic 1 signal to the gates G2 and G3, so that only at time 4, when F2 is reset and F1 is set, does the ribbon feeding stop.

The purpose of continuing the ribbon feeding after the print signal ceases is to insure that the ribbon will not remain stationary when single lines are being printed at intervals. A print signal lasting through only one or two revolutions of the print roll is too brief for the completion of one revolution of the shaft 81 and a full cycle of reciprocation of the feed pawls, which might therefore not fully engage the ratchet wheels and advance the ribbon. Continuing the pawl engagement until three index pulses are generated guarantees that the pawls will complete a full cycle and advance the ribbon.

During the time interval 4–5, index pulses IC attempt to set the flip-flop F2, in concert with the logic 1 signal received at the terminal S of this flip-flop; but they are prevented from doing so by the logic 1 signal delivered by terminal 0 to the direct reset terminal DR.

It is assumed in FIG. 11 that printing is resumed at some later time 5. The receipt of a renewed print signal at the terminal DS sets the flip-flop F2, which now delivers a logic 1 signal to the gate G1. This gate then produces a logic 0 signal at its terminal C, removing the previous feed-inhibiting logic 1 signal from the terminals A of the gates G2 and G3. Feeding of the ribbon then resumes, under the directional control of the switches UES and LES.

Guiding of the ribbon is controlled by that one of the upper and lower edge-tracking sensors TSU and TSL which is associated with the ribbon reel onto which the ribbon is winding at any given time. The terminals S and R of both of the flip-flops F4 and F5 are connected through resistors R3–R6 to the voltage source B1. The upper edge-tracking switches TSUO and TSUI are respectively operable, when either of them is closed by lateral displacement of the edge of the ribbon to one of its tolerance limits, to ground a corresponding terminal S or R and thereby set or reset the flip-flop circuit F4. Similarly, the lower edge-tracking switches TSLO and TSLI are respectively operable, when either is closed, to ground a corresponding terminal S or R and thereby set or reset the flip-flop circuit F5.

The output terminals of the flip-flops F4 and F5 are connected respectively to the input terminals B of NAND gates G4 and G5, whose output terminals C exhibit a logic 1 signal under all conditions other than receipt of logic 1 signals at both input terminals. The state of terminal B of either gate G4 or G5 will depend upon the last previous actuation of the corresponding edge-tracking switch TSU or TSL, respectively, by displacements of the ribbon edge.

The input terminals A of gates G4 and G5 are connected respectively to the terminals 1 and 0 of the flip-flop circuit F3, and consequently only one of them receives a logic 0 signal at any given time; this will be at gate G4 while the ribbon is winding onto the lower reel 28 after actuating the lower end switch LES, and at gate G5 while the upper reel 26 is being rewound after actuation of the upper end switch UES. Therefore, terminal C of the NAND gate G4 must exhibit a logic 1 signal whenever the ribbon is winding onto the lower reel, regardless of the logic signal issued by the flip-flop F4 and the upper tracking switches TSUO and TSUI, and these switches are rendered ineffective to control the guiding function. Similarly, terminal C of the NAND gate G5 must exhibit a logic 1 signal whenever the ribbon is winding onto the upper reel, and the signals then produced by the lower tracking switches TSLO and TSLI become ineffective to control ribbon guiding. In this manner, the ribbon-end switches UES and LES select the upper or lower tracking switches in accordance with the winding direction, that set of tracking switches which is associated with the winding reel being chosen.

The terminals C of gates G4 and G5 are respectively connected to the input terminals A and B of a third NAND gate G6, whose output terminal C delivers a logic 1 signal under all conditions other than receipt of logic 1 signals at both input terminals. Assuming that the ribbon is winding onto the upper reel, terminal B of the gate G6 continually receives a logic 1 signal from the gate G5. Gate G4 and terminal A of the gate G6 will therefore determine the output of the latter gate, which will be a logic 0 signal if the upper tracking switch TSUO was last actuated, or a logic 1 signal if the upper tracking switch TSUI was most recently closed.

A logic 0 output from the gate G6 actuates an electronic switch S4 through an inverter I, to energize the lower tracking solenoid TS1 from a voltage source B3; this rocks the reel-supporting bracket 100 downwardly, tilting the rolls in a manner to guide the controlling ribbon edge laterally outwardly, opposite to the displacement that closed the switch TSUO. Conversely, a logic 1 output from the gate G6 actuates an electronic switch S3 to energize the upper tracking solenoid TS2, and rock the bracket 100 upwardly, thereby guiding the controlling ribbon edge laterally inwardly. This guiding action periodically reverses so long as the ribbon is winding onto the upper reel.

As the ribbon becomes fully wound on the upper reel and the feeding is reversed in favor of the lower reel 28, terminal A of the gate G6 begins to receive a continuous logic 1 signal from the gate G4, and the upper tracking switches give up control of the guiding function to the lower tracking switches TSLI and TSLO, which thereafter control the signals delivered to terminal B of the gate G6 through the gate G5. The output of gate G6 will then be a logic 0 signal if the tracking switch TSLI was last actuated, or a logic 1 signal if the tracking switch TSLO was most recently closed. A logic 0 output again actuates the lower tracking solenoid TS1, tilting the bracket downwardly and guiding the controlling ribbon edge laterally inwardly; while a logic 1 output raises the bracket by actuating the solenoid TS2, and guides the controlling ribbon edge laterally outwardly. The guiding action reverses at each successive actuation of one of the lower tracking switches, until the ribbon is fully wound on the lower reel and the cycle is reversed.

What I claim is:

1. For use in a high speed printer, apparatus for winding an inked ribbon comprising:

a pair of reels adapted for winding the ribbon from one to the other, and means for driving said reels intermittently in steps of predetermined arc;

signal generator means for generating print control signals;

means for generating index signals correlated with advancement of said reels;

control circuit means including means operatively connected to inhibit operation of said reel-driving means in response to discontinuance of said control signals;

said control circuit means further including means operatively connected to delay operation of said inhibiting means, subsequent to discontinuance of said control signals, until index signals are generated indicating subsequent completion of one full step of advancement of the reels.

2. Apparatus as recited in claim 1,

said index signal means being constructed and arranged to generate index signals at intervals corresponding to a predetermined fraction of one step of advancement of the reels;

said delay means comprising register means connected to delay operation of said inhibiting means, subsequent to discontinuance of said control signals, until the number of index signals is generated which corresponds to the denominator of said fraction.

3. In a ribbon control system for a high speed printer having a rotating print roll, a ribbon movably mounted adjacent said print roll;

reversable drive means responsive to a first or a second applied signal to drive said ribbon in a first or a second sense, respectively;

sensing means responsive to the position of said ribbon for alternately producing a first direction signal and a second direction signal to direct said ribbon to be driven in said first or said second sense, respectively;

means for producing a printing signal;

gate means settable to first and second states and controlled by said sensing means in the first state of said gate means for applying a first or a second signal to said drive means according as said first or said second direction signal is produced respectively;

means responsive to said printing signal for setting said gate means to its first state,

and delay means responsive to rotation of said print roll in the absence of said printing signal to set said gate means to its second state after a predetermined rotation of said print roll.

4. The apparatus of claim 3, in which said delay means comprises:

a pulse generator responsive to the rotation of said print roll to produce a pulse each time the print roll rotates through a predetermined angle,

circuit means settable to two alternative predetermined states and connected to be held in a first predetermined state by said printing signal,

circuit means controlled by said pulse generator and effective in the absence of said printing signal to reverse the state of said settable circuit means in response to said pulses, and;

means controlled by said settable circuit means in a second predetermined state thereof for setting said gate means to its second state.

5. The apparatus of claim 4, further comprising:

circuit means effective in the absence of said printing signal and controlled by said settable circuit means in said second predetermined state for holding said settable circuit means in said second predetermined state.

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