

United States Patent

[11] 3,572,601

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| [45] | Patented | Mar. 30, 1971 |
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- [54] WEB FEED SYSTEM SUITABLE FOR USE IN HIGH-SPEED PRINTERS**
7 Claims, 7 Drawing Figs.

- [52] **U.S. Cl.**..... **242/55,**
26/63, 226/193, 242/75.3, 242/156.2

- [51] **Int. Cl.**..... **B65h 75/00**

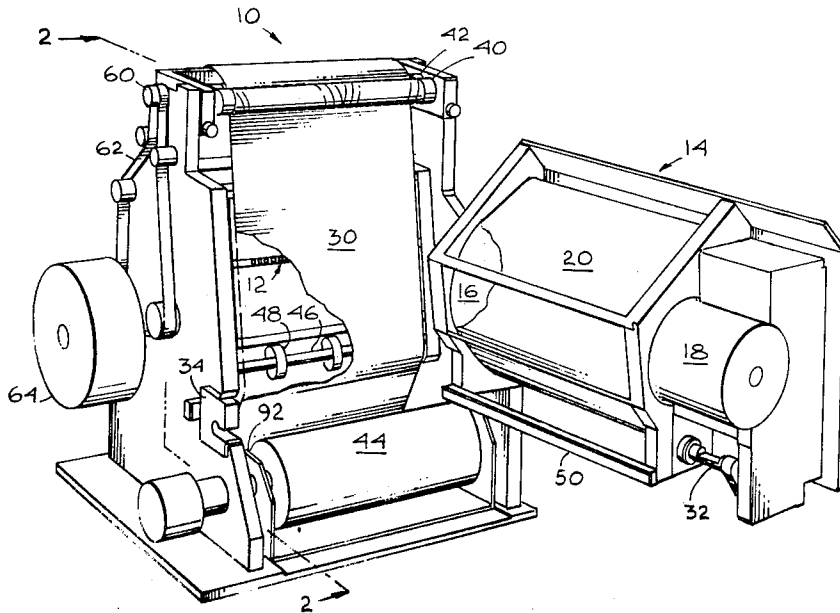
- [50] **Field of Search**..... 242/55, 56,
67.1, 67.2, 67.3, 75, 75.3, 75.4, 75.43, 156, 156.2;
226/188, 189, 193; 26/63

- [56]
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ABSTRACT: A web feed system suitable for feeding multipart paper in high-speed printers. The system utilizes a driving roller and a driven roller which together pull paper from a supply roll mounted in a paper supply buffer system. The ends of the driving and driven rollers are enlarged so that a driving force can be coupled directly therebetween rather than through the paper passing between the rollers. Reverse spiral grooves are formed in the roller surfaces to properly center and horizontally tension the paper as well as cause perfect tracking. The paper supply buffer system provides a means of supplying paper from a large roll without imposing the massive inertia of the roll into the paper-driving system.



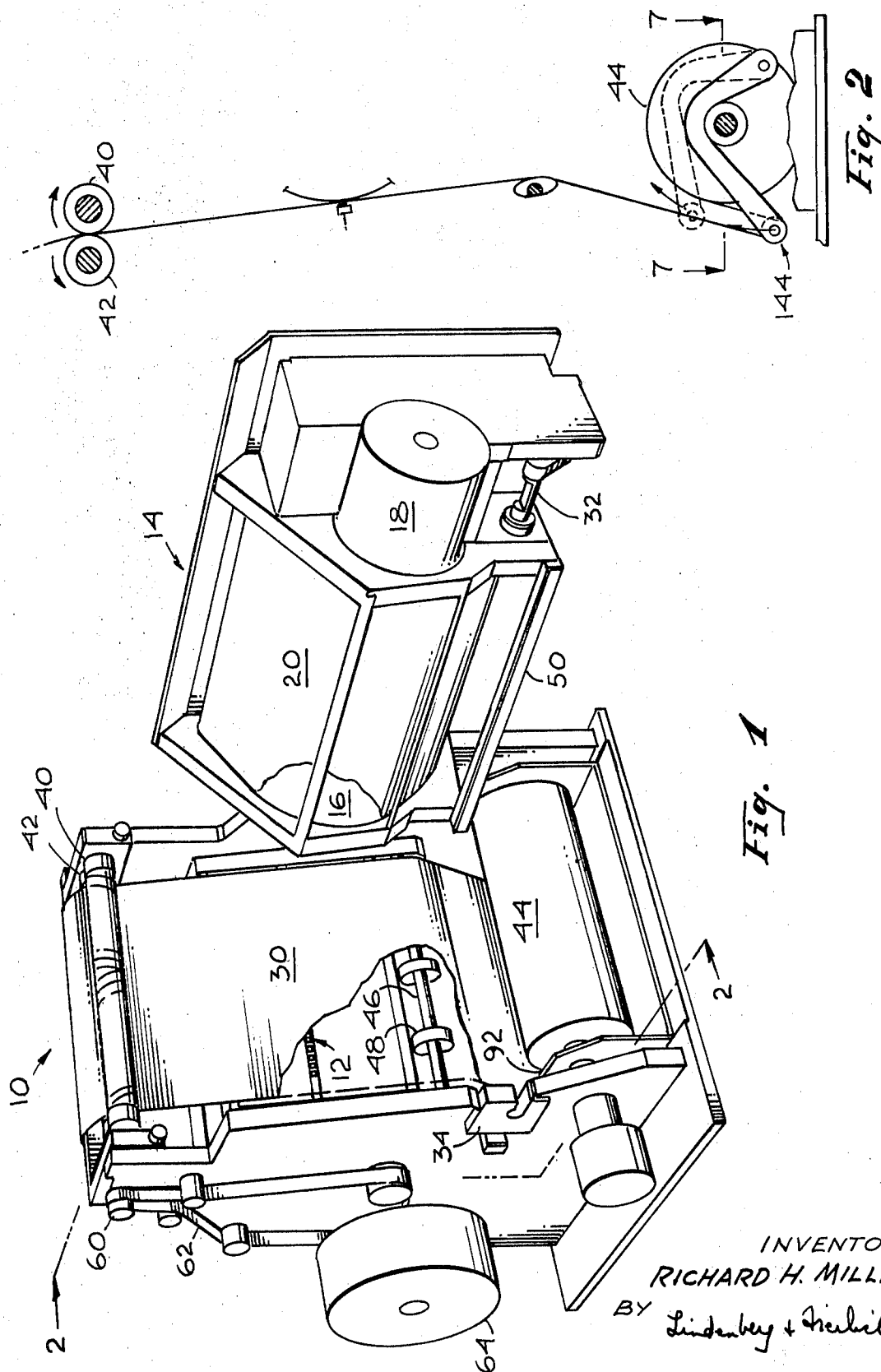


Fig. 1

Fig. 2

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Fig. 4

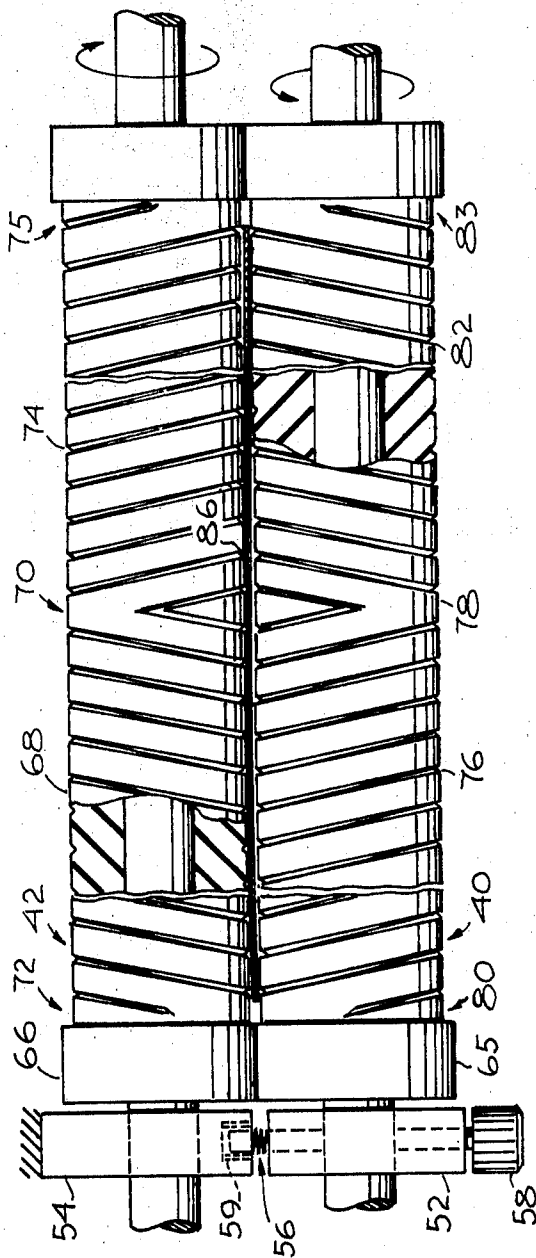


Fig. 5

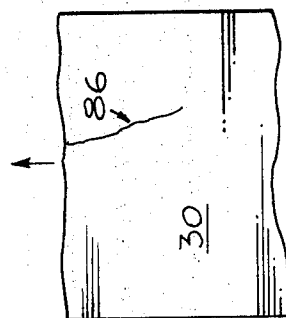
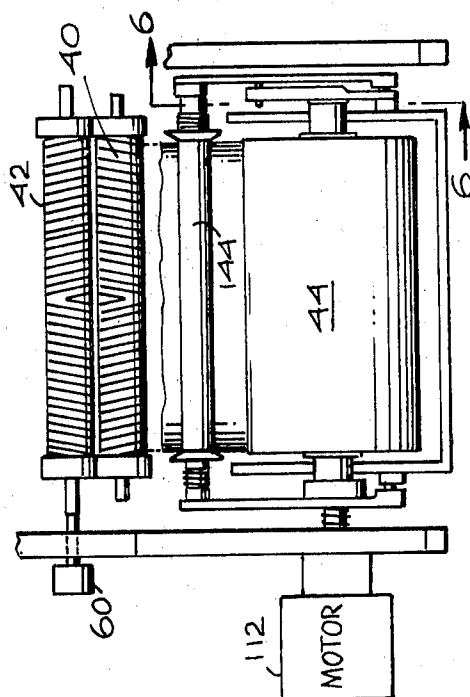


Fig. 3



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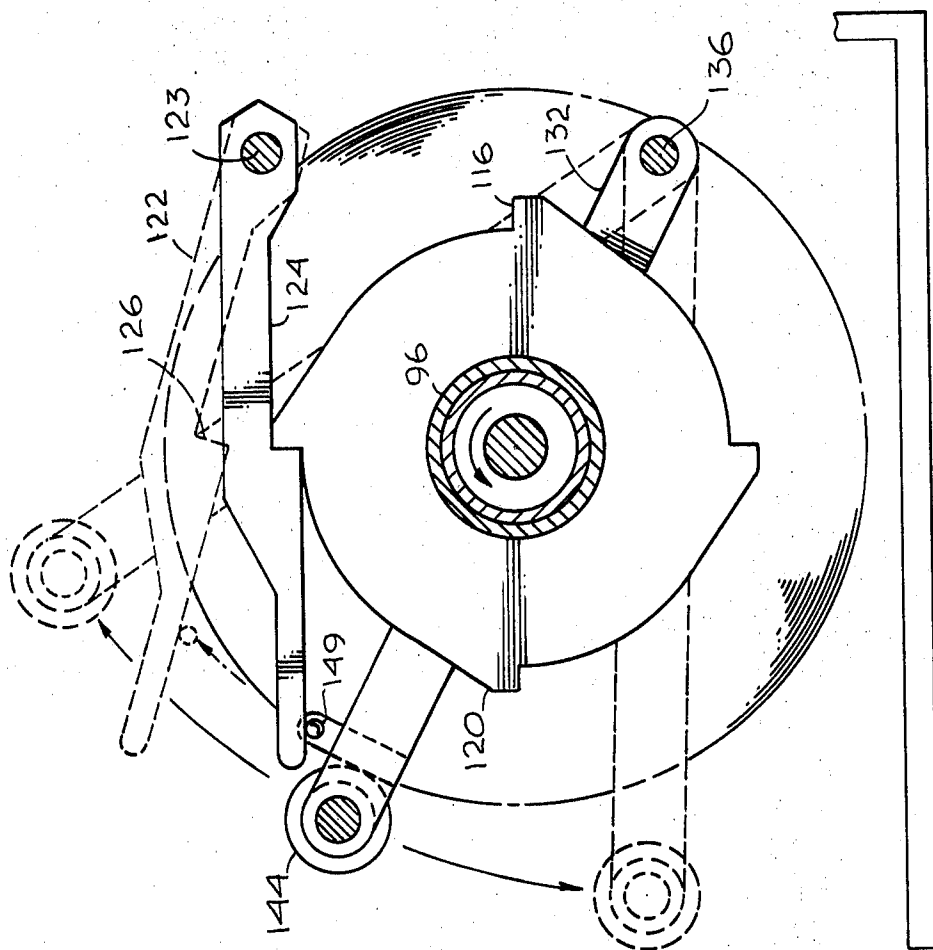


Fig. 6

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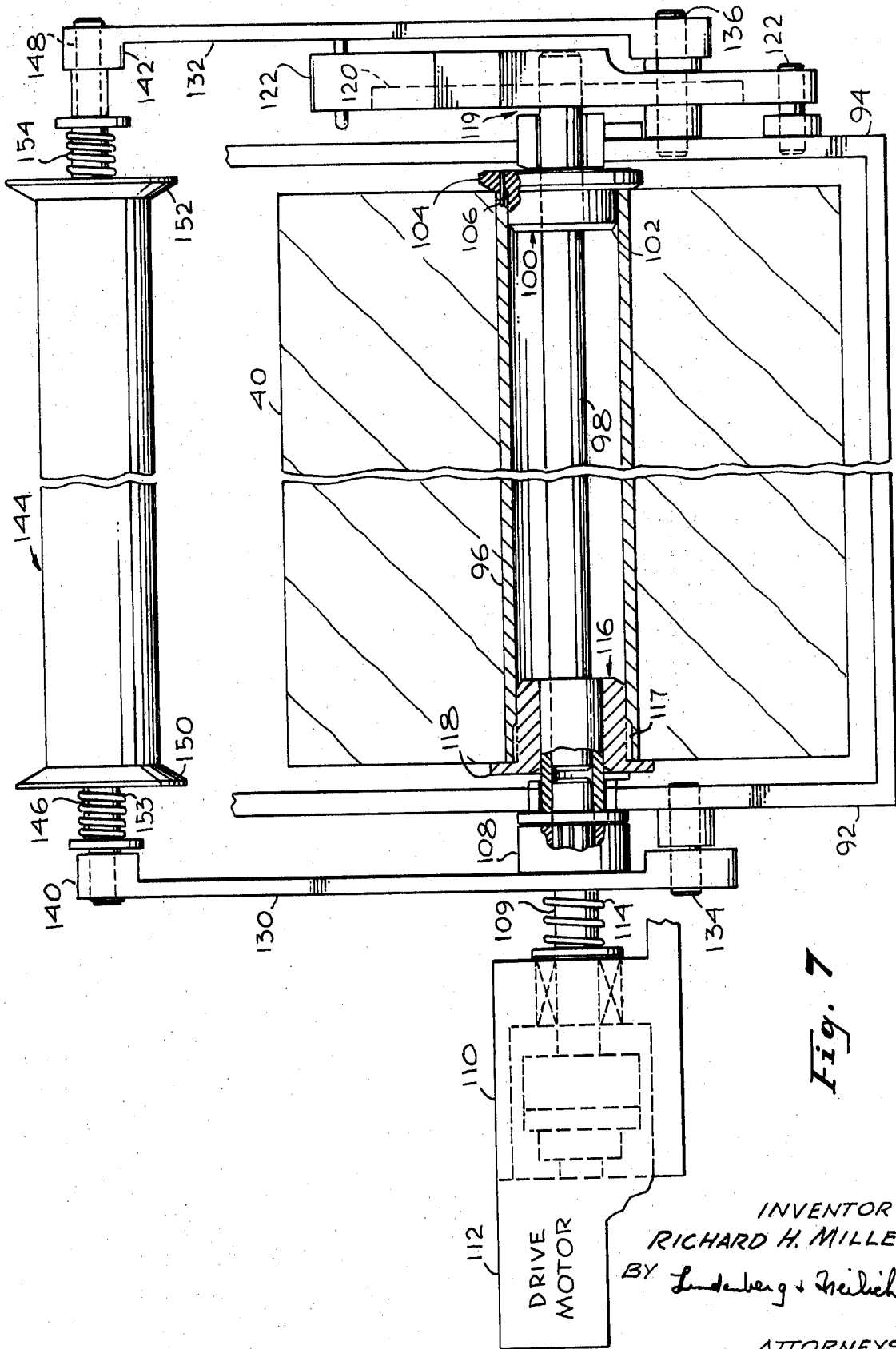


Fig. 7

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WEB FEED SYSTEM SUITABLE FOR USE IN HIGH-SPEED PRINTERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to a web feed system and more particularly to such a system suitable for use in a high-speed printer for friction feeding multipart paper past a printing station.

2. Description of the Prior Art

Many high-speed printers used in data-processing systems employ a hammer bank positioned opposite to a rotating character drum or chain. The hammer bank is comprised of a plurality of individually actuatable impact hammers and the character drum or chain has raised characters formed on the peripheral surface thereof. Paper or printing ribbon webs pass between the hammer bank and the drum.

The paper is moved one line at a time past the printing station, i.e. the hammers, and selected characters are printed in selected positions on the paper by propelling the hammers against the drum when the selected characters move into alignment therewith. The hammers strike the paper against the ribbon and drum to thus print the struck character on the paper.

Prior-art high-speed, multicopy printers generally use paper having apertures running along both longitudinal edges thereof. The paper is normally moved by upper and lower drive chain pairs. Each drive chain normally carries a plurality of projections, each adapted to engage an edge aperture of the paper. The upper and lower drive chain pairs are respectively disposed above and below the printing station. The drive chain pairs are driven in synchronism and thus tend to properly tension and evenly move the paper. In order for this type of paper drive system to operate satisfactorily at very high speeds with multipart paper, it is imperative that it be extremely accurate and that the paper be located accurately relative to the drive chains by the operator.

Although the desirability of eliminating the requirement of using edge-apertured paper in high-speed printers has been recognized for some time, paper drive systems capable of moving nonapertured multipart paper at the speeds (e.g. 1,000+ lines per minute) and with the accuracy required have thus far not been available.

SUMMARY OF THE INVENTION

The present invention is directed to a friction feed web driving system particularly suited for moving paper in a high speed printer.

In one embodiment of the invention, a pair of substantially cylindrical rollers are mounted for rotation parallel to one another. The rollers are closely spaced to one another so that the surfaces thereof frictionally engage paper passing therebetween. Thus, as the rollers are driven, they are able to pull the paper web from a paper supply, e.g. a paper roll.

In accordance with one aspect of the preferred embodiment of the invention, the pair of rollers consists of a driving roller and a driven roller. In order to eliminate slippage between different layers of a multipart paper web, the ends of the rollers are enlarged so that a driving force is coupled directly between the rollers, rather than through the paper web therebetween.

In accordance with a different aspect of the invention, oppositely directed spiral grooves are formed in the surfaces of the rollers to produce forces on the web perpendicular to the direction of travel tending to properly center the web and cause perfect tracking thereof.

In accordance with a still different aspect of the invention, a paper supply buffer system is provided which enables the paper to be supplied from a large reservoir, e.g. a large diameter roll, without imposing the massive inertia of the roll into the paper-driving system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a high-speed printer showing the drum gate thereof open and an embodiment of the subject friction feed paper drive system in position;

FIG. 2 is a side sectional view of the subject friction feed paper drive system taken substantially along the plane 2-2 of FIG. 1;

FIG. 3 is a plan view of the paper drive system of FIG. 2;

FIG. 4 is an enlarged plan view illustrating in detail the roller surfaces;

FIG. 5 is a front view of a portion of a paper web tending to illustrate the centering action of the rollers on the web;

FIG. 6 is a sectional view taken substantially along the plane 6-6 of FIG. 3; and

FIG. 7 is a sectional view taken substantially along the plane 7-7 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is now called to FIG. 1 of the drawings which illustrates a high-speed printer incorporating a web feed system in accordance with the present invention. The printer of FIG. 1 is basically comprised of a first frame 10 supporting a bank of individually actuatable impact hammers 12, whose tips are disposed in horizontal alignment. The number of hammers normally provided is equal to the maximum number of characters it is desired to print in a single line. Thus, if it is desired to print lines having up to 120 character positions, then it is normally necessary to provide 120 hammers.

The printer of FIG. 1 also includes a hinged frame or gate 14 which is hinged relative to the first frame 10 for movement about a substantially vertical axis. The frame 14 supports a character drum 16 for rotation about its own axis. The drum is driven by a motor 18 and is supported behind a printing ribbon web 20. The circumferential surface of the drum is provided with a plurality (e.g. 120) of tracks, each track including a set of raised printing characters. Each track corresponds to a different character position in a line of print and the number of different characters in each track of course determines the number of different characters which can be printed in the corresponding character position.

In accordance with the present invention, a web feed system is provided for driving a paper web 30 past the print station; i.e. the line of hammer impact tips. Prior to considering the details of the web feed system in accordance with the invention, the operation of the printer will be briefly considered. In operation, the gate 14 is moved from the open position shown in FIG. 1 to a closed position in which the printing ribbon web 20 and character drum 16 is immediately opposed to the hammer tips 12. The paper web 30 is drawn through the passageway between the line of hammer tips and the printing ribbon 20. Printing is accomplished by incrementally moving the paper web 30, line by line, and by actuating each hammer when the appropriate character on the drum moves into alignment therewith to thus propel the hammer against the paper to urge the paper against the ribbon and drum.

From the foregoing brief description of the operation of the apparatus of FIG. 1, it will be readily recognized that in order to achieve high-quality printing, it is essential that the character drum be positioned precisely with respect to the hammer bank 12. On the assumption that the individual hammers can all be precisely positioned with respect to the frame 10 and that the axis of the character drum can be precisely located with respect to the gate 14, it is then merely necessary to precisely position the gate 14 with respect to the frame 10 when they are in closed operative relationship. In order to assure this, the printer of FIG. 1 includes a latch assembly comprised of a precisely mounted rotatable latch shaft 32 carried by gate 14 and a precisely mounted bracket member 34 having a receptacle for receiving the shaft 32, mounted on the frame 10.

In order to assure high-quality printing, it is essential that the paper be moved smoothly and evenly past the hammer

bank 12. That is, if the movement of the paper is somewhat skewed, then the resulting print will also be somewhat skewed. Accordingly, it is essential that the movement of the paper 30 be precisely perpendicular with respect to the row of aligned hammer tips. Moreover, in order to assure that successively printed lines are evenly spaced, and that each copy, simultaneously printed by utilizing multipart paper, is identical, it is important that all the layers of the multipart paper be moved in unison. In other words, it is essential that the layers of the multipart paper do not slip relative to one another. Another important criteria for high-quality printing is the stopping and tensioning of the paper web. If the paper web is not properly tensioned, the rotating character drum 16 could pull the web out of alignment.

The present invention is primarily directed to a system for supplying and feeding the paper web 30 past the print station.

The web feed system, in accordance with the present invention, is essentially comprised of a pair of rollers 40 and 42, mounted in closely spaced parallel relationship, such that they respectively frictionally engage opposite surfaces of a web passing therethrough. As will be seen in greater detail below, by rotating the rollers 40 and 42 in opposite directions, the paper web will be driven through the passageway between the rollers. Thus, the rollers 40 and 42 can pull the paper web 30 from a paper supply roll 44 which is mounted in a paper supply buffer system.

In order to assure proper tensioning of the paper, a web-tensioning apparatus, disclosed in greater detail in U.S. Pat. application Ser. No. 797,640, filed on Feb. 7, 1969 by Richard H. Miller and assigned to the same assignee as the present application, is provided. The web-tensioning apparatus includes a rotatably mounted adjuster rod 46 carrying a plurality of elliptical springs 48 which bear against the rear surface of the paper web 30. A backup bar 50 is mounted on the gate 14 in opposition to the springs 48. The surface characteristics of the backup bar 50 and springs 48 are selected to be essentially identical so that the drag forces created on the front and rear surfaces of the paper web 30 are essentially equal.

In accordance with the preferred embodiment of the present invention, the rollers 40 and 42 are journaled for rotation in the frame 10. More particularly, the ends of the central shaft of roller 40 are journaled in movable bearing blocks 52. The ends of the central shaft of roller 42 are journaled in fixed bearing blocks 54. Springs 56 are disposed between the fixed and movable bearing blocks to urge roller 40 away from roller 42 in order to facilitate paper loading. Clamping bolts 58 are held captive in blocks 52 and extend therethrough to fixed blocks 54. The blocks 54 are provided with threaded recesses 59 adapted to receive the threaded ends of clamping bolts 58. Thus, by threading the bolts 58 into the recesses 59, the force of springs 56 can be overcome to draw blocks 52 toward blocks 54 and thus roller 40 toward roller 42.

One end of the central shaft of roller 42 is coupled to a drive gear 60 driven by a belt 62 coupled to motor 64. The motor 64 rotates the roller 42 in a counterclockwise direction as shown in FIG. 2. The rotation of the roller 42 in turn drives the roller 40 in a clockwise direction. As previously pointed out, in order to avoid having to couple the driving force between the rollers 40 and 42 through the paper web, the ends 65 and 66 of the rollers 40 and 42 are enlarged as is best shown in FIGS. 3 and 4. In use, the circumferential surfaces of the enlarged ends of rollers 40 and 42 frictionally engage one another so that rotation of the roller 42 by the belt 62 in turn rotates roller 40. The enlarged ends of the rollers 40 and 42 space the major portion of the circumferential surfaces of the rollers from one another to define a narrow passageway just less than the thickness of the paper web being driven.

In order to cause the paper web 30 to track properly, spiral grooves are formed in the circumferential surfaces of the rollers 40 and 42. The material of the roller surfaces is, for example, rubber and is selected to be sufficiently hard to maintain accurate diameter as well as sufficiently soft to somewhat comply with paper thickness variations of 0.007 inches. The

spiral grooves formed in the roller surfaces are best shown in FIG. 4. Oppositely directed spiral grooves are formed in each roller from the center to the opposite ends thereof. The rollers are rotated in a direction to cause the grooves to spiral outwardly, that is from the roller centers to the roller ends. More particularly, in considering FIG. 4, it will be noted that a first groove 68 is spiralled in a first direction from the center portion 70 of the roller 42 toward the first end 72 thereof. A second groove 74 in the roller 42 is spiralled in an opposite direction from the center portion 70 to a second end 75 of the roller 42. Similarly, oppositely directed spiral grooves are formed in the surface of roller 40. Thus, groove 76 is spiralled in one direction from the center portion 78 of roller 40 to a first end 80. Groove 82 is spiralled in a direction opposite to groove 76 from the center 78 of roller 40 to the second end 83.

The optimum spiral groove parameters depend to a great extent upon the application in which the web feed system is being employed and more particularly upon the parameters of the web and such factors as web speed, etc. In the illustrated preferred embodiment, each groove previously referred to actually comprises a dual lead groove in which two spiral grooves are interleaved with another. The use of dual lead grooves provides a greater number of grooves over a given length for a given pitch. In designing the roller surfaces, consideration should be given to an optimization of the relationship between groove pitch, width, and depth and land width. As will be better understood hereinafter, the spiral grooves function to center the web and the land areas primarily function after centering to produce outwardly directed horizontal tension on the web to cause perfect tracking.

The rollers 40 and 42 are rotated in the directions illustrated in FIG. 4 to thus draw the paper web 30 out of the plane of the drawing toward the reader. In order to understand the centering action of the spiral grooves on the web, assume that the web is initially offset to the left as seen in FIG. 4. As the rollers rotate, the land areas associated with spiral groove portions 68 and 76 initially produce horizontal forces on the web tending to pull it toward the left. The land areas associated with groove portions 74 and 82 produce horizontal forces tending to pull the web toward the right. Since it has been assumed that the web is initially off center to the left, a greater number of left-pulling land areas will be acting on the web than right-pulling land areas. As a consequence, there will be a resultant force acting on the web toward the left. This resultant force pulls the portion of the web to the right of the roller centers toward the left and thus in a direction opposite to which the adjacent land areas are trying to drive the web. As a result, the frictional engagement between the web and land areas tends to deform or spread one of the groove turns in the compliant roller surfaces to the right of center. The web, in turn, due partially to the resiliency of the roller surface, somewhat deforms as at 86. The deformation of the web at 86 can be compared to the formation of a thread in the web which then is pulled toward the right ends 75 and 83 of the rollers as a nut would be threaded onto a bolt. The fragment of the paper web shown in FIG. 5 illustrates the crease or deformation 86 formed in the web 30 and illustrates how it travels from the center of the web toward the right edge as the web moves toward the right roller ends 75 and 83. Once the web 30 is centered with respect to the center portions 70 and 78, the oppositely directed spiral grooves of each roller will produce equal outwardly directed horizontal forces on the web to thereby cause the web to thereafter track along the center of the roller lengths. The outwardly directed tension on the web irons out the deformation 86.

In order to permit uninterrupted printing for a long duration, a large paper supply reservoir is provided in the form of a paper supply roll 44. In order to drive the paper web, line by line, at a high speed, it is important that the large inertia of the supply roll 44 be isolated from the paper driving means; that is, the rollers 40 and 42 and the drive train coupling the rollers to the drive motor 64. If the inertia of the supply roll is not iso-

lated from the paper drive system, then it will take considerably more time and power to step the paper one line and to permit the paper to settle in its new position after stepping. In order to isolate the inertia of the paper supply roll 44 from the paper drive means, a paper supply buffer system is provided which functions to release paper from the supply roll 44 in incremental lengths of several lines and to lock the supply roll to prevent rotation thereof in between these releasing operations.

As shown in FIG. 7, the paper supply roll 44 includes a central tube 96 around which the paper web is wound. The paper supply buffer system includes means for supporting the tube 96 for controlled stepped rotation. More particularly, the paper supply buffer system utilizes a support shaft 98 having a collar 100 fixed thereto. The collar 100 includes a reduced diameter portion 102 which extends into the bore of the supply roll tube 96 and a flange portion 104 which carries spikes 106 which project into the material of the tube 96 to prevent relative rotation between the tube 96 and shaft 98. The opposite end of the shaft 98 is splined in order to enable the shaft 98 to be driven by collar 108. Collar 108 is held captive by, but is slidable on, the splined output shaft 109 of slip clutch 110 driven by motor 112. Spring 114, disposed around shaft 109, urges collar 108 into driving engagement with the splined end of shaft 98. The shaft 98 is externally threaded inwardly from its splined end and is threadedly engaged with the internally threaded bore of a collar 116. Collar 116 has a reduced portion 117 which extends into the bore of tube 96 and a flange portion 118 which bears against the end of tube 96.

The shaft 98 extends through the collar 100 and at its end 119 carries a sprocket wheel 120. The periphery of the sprocket wheel 120 is stepped as is best shown in FIG. 6.

In operation, the drive motor 112 continuously rotates, and through slip clutch 110 and collar 108 tends to drive the supply roll 44 in a direction to supply paper to the drive means comprised of rollers 40 and 42. A pawl 122, however, cooperates with the sprocket wheel 120 to permit only intermittent rotation of the roll 44. More particularly, the pawl 122 is pivoted at 123 and has an undersurface relieved at 124 to thus define a step 126 which cooperates with the stepped periphery of the sprocket wheel 120 to lock the forward motion of the paper roll 44 when the pawl is in the full line position shown in FIG. 6. The position of the pawl is controlled by a sensing means constituting a buffer roller, which is responsive to the tension on the length of free web between the supply roll 44 and the paper drive means. More particularly, first and second arms 130 and 132 are hinged about pins 134 and 136 supported in plates 92 and 94. The arms 130 and 132 terminate in bearing portions 140 and 142. A buffer roller 144 is provided which includes reduced end portions 146 and 148 which are respectively journaled for rotation in bearing portions 140 and 142. The buffer roller 144 is provided with flanges 150 and 152 which, as will be seen, act to guide the paper web 30 as it leaves the paper supply roll 44. Springs 153 and 154 bear against the flanges 150 and 152 to tend to center the roller 144 but to additionally permit the roller to move laterally slightly in order to conform to the web and guide its path. The roller 144 is preferably suitably mechanically damped in order to minimize vibratory oscillations.

As can be clearly seen in FIG. 2, the web passes around and engages the circumferential surface of the buffer roller 144 as it leaves the supply roll 44. As the web is drawn upwardly (as seen in FIG. 2) by the rotating rollers 40 and 42, the length of the web portion between the rollers and the supply roll 44 is reduced as the web is pulled through rollers 40 and 42. It should be appreciated that as the web is pulled, it will pull the buffer roller 144 upwardly to in turn swing the arms 130 and 132 upwardly, as observed in FIG. 2. As the arm 132 swings upwardly, a projection 149 (FIG. 6) thereon engages and lifts the pawl 122 to thus disengage the step 126 formed in the undersurface thereof from the stepped surface of the sprocket wheel 120. As a consequence, the sprocket wheel is unlocked

thereby permitting the drive motor 112 to rotate the paper roll 44 through the slip clutch 110 to release a portion of the web material. It will be recognized that as soon as the supply roll begins to unroll to reduce the tautness in the web portion bearing against the buffer roller 144, the buffer roller will drop carrying with it the arms 130 and 132. This in turn, of course, will permit the pawl 122 to drop so that the step 126 defined therein will engage the succeeding step in the sprocket wheel. In this manner, the paper supply buffer system can continue to dispense paper from the supply roll 44 in increments of one-fourth revolutions, the increments of course being determined by the spacing between the steps of the sprocket wheel. Thus, the only inertia seen by the paper drive system comprised of the rollers 40 and 42 will be limited to a relatively short length of paper and will always be substantially uniform.

From the foregoing, it should be appreciated that a web feed system has been disclosed herein which is particularly suitable for use in high-speed printers for friction feeding nonapertured paper past a print station.

I claim:

1. A web feed system suitable for use in a high-speed printer, said system comprising:

a web supply roll;

means mounting said supply roll for rotation;

first and second substantially cylindrical rollers;

means mounting said rollers for rotation parallel to one another and spaced from one another by a distance no greater than the thickness of said web whereby the surfaces of said rollers will frictionally engage opposite surfaces of a web passing therebetween;

means for rotating said rollers in opposite directions to thus pull said web from said web supply roll in a direction substantially perpendicular to the longitudinal axes of said rollers;

roll drive means coupled to said supply roll tending to rotate said supply roll in a direction to unwind said web toward said rollers, said roll drive means including a motor and a slip clutch coupling said motor to said supply roll;

lock means coupled to said supply roll for preventing rotation thereof; and

sensing means responsive to the tension on said web between said supply roll and said rollers for releasing said lock means.

2. The system of claim 1 wherein the circumferential surface of said first roller has a first groove spiralled in one direction extending from the center of said roller to a first end thereof and a second groove spiralled in an opposite direction extending from the center of said roller to a second end thereof.

3. The system of claim 2 wherein the circumferential surface of said second roller has a first groove spiralled in one direction extending from the center of said roller to a first end thereof and a second groove spiralled in an opposite direction extending from the center of said roller to a second end thereof.

4. The system of claim 3 including means for rotating said first and second rollers in opposite directions for causing each of said grooves to spiral outwardly from said roller centers to said roller ends.

5. The system of claim 1 wherein a circumferential portion of said first roller surface is enlarged and in contact with a portion of said second roller surface.

6. The system of claim 1 wherein said lock means includes: a sprocket wheel coupled to said supply roll; and pawl means for engaging the sprockets of said sprocket wheel.

7. The system of claim 6 wherein said sensing means includes:

a buffer roller;

means mounting said buffer roller for movement by engagement with said web between said supply roll and said web drive means; and

means coupling said buffer roller to said pawl means.