

Oct. 22, 1968

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3,406,625

DRIVING MEANS FOR HIGH-SPEED PRINTING APPARATUS

Filed Aug. 25, 1967

3 Sheets-Sheet 1

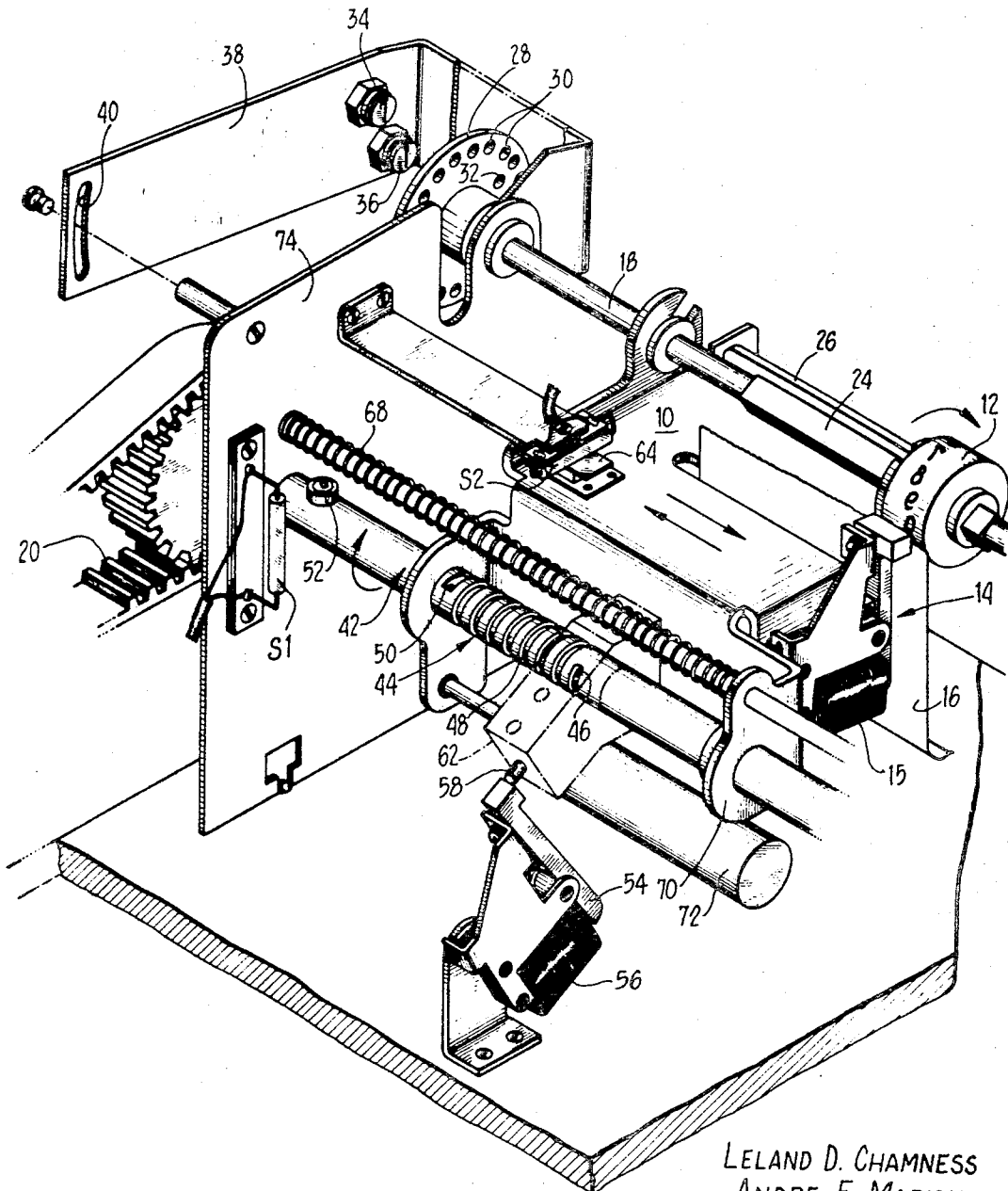


FIG. 1

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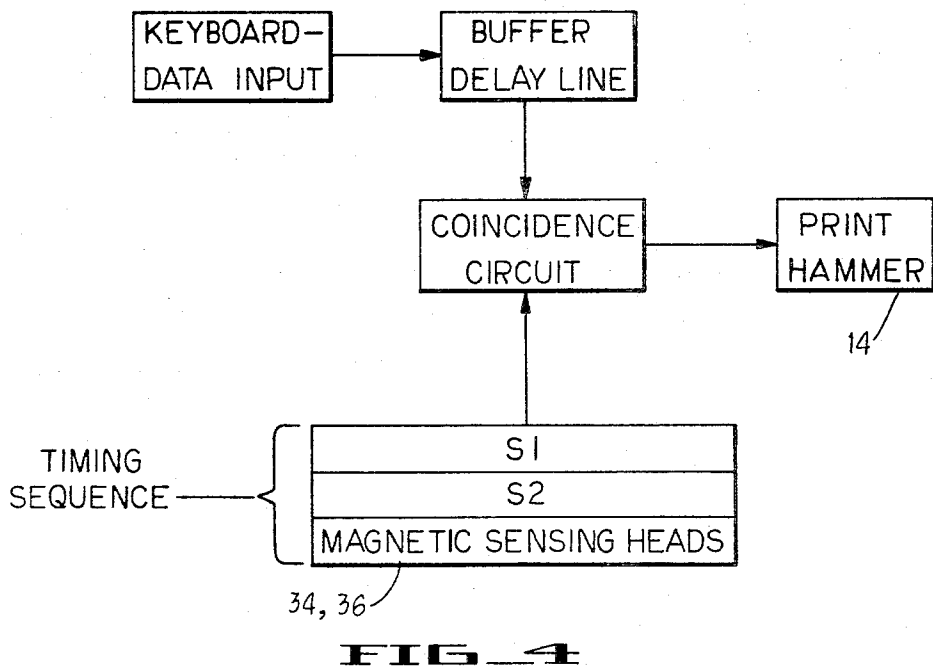
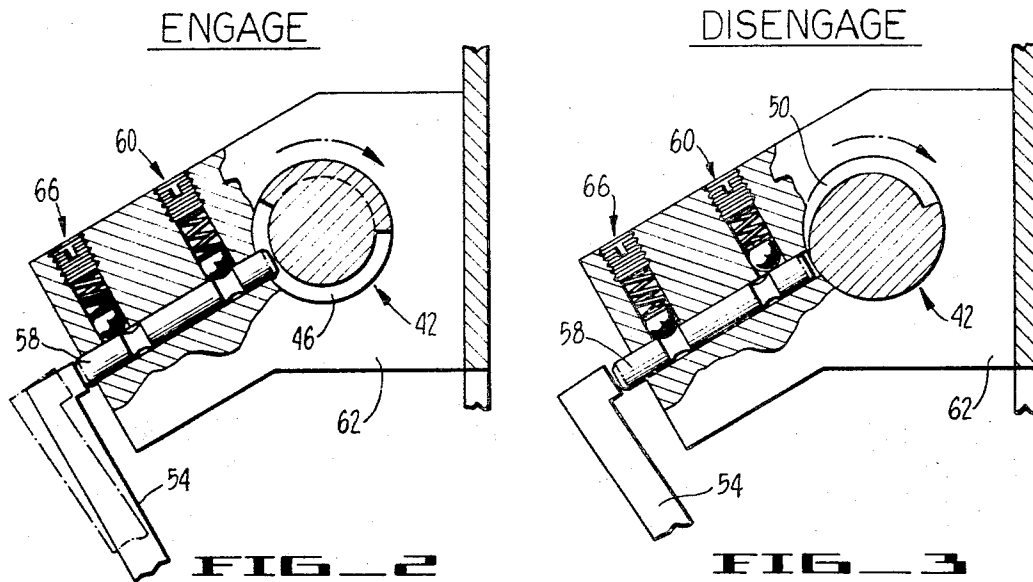
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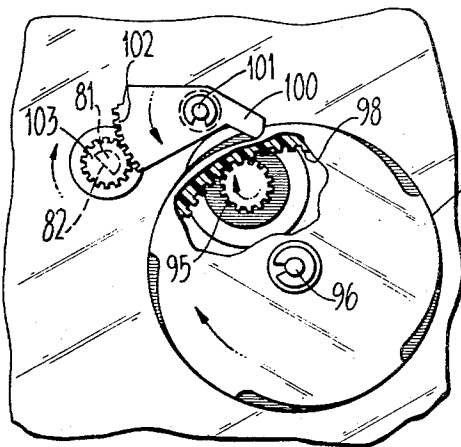


Fig. 1

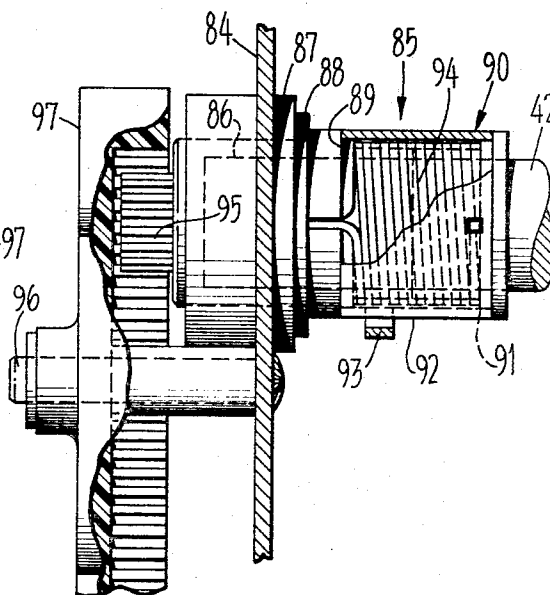


Fig. 2

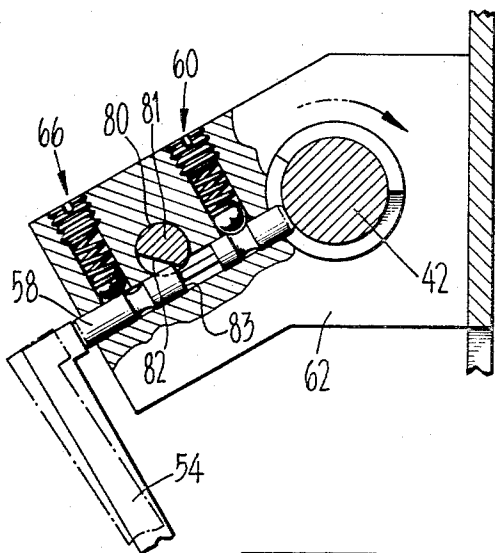


Fig. 3

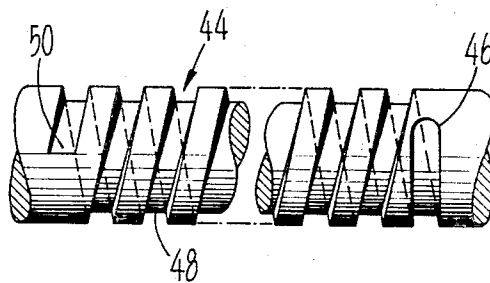


Fig. 4

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DRIVING MEANS FOR HIGH-SPEED PRINTING APPARATUS

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Continuation-in-part of application Ser. No. 528,501,
Feb. 18, 1966. This application Aug. 25, 1967, Ser.
No. 663,292

14 Claims. (Cl. 101—93)

ABSTRACT OF THE DISCLOSURE

A printing carriage is cyclically driven by means of a rotatable shaft having a helical-like shaped groove therein. One end of the groove has a variable pitch portion which is less than the pitch of the remainder of the groove and a ramp is located at the other end of the groove. A detent pin mounted to the carriage engages the variable pitch portion of the groove which enables the carriage to be coupled to the groove shaft, while the shaft is rotating, and smoothly brought up to a constant velocity, from a start position, with printing enabled to take place during the constant velocity travel of the carriage. To effect "zero" suppression and to decrease line-to-line printing time, the detent pin may be withdrawn from the groove anywhere along the length thereof. However, if a full line of printing is to take place, the ramp disengages the pin from the rotating shaft, when the detent pin reaches the end of the groove, thereby disengaging the carriage from the shaft. When disengaged from the rotating shaft, the carriage is automatically returned to its start position.

RELATED APPLICATION

This application is a continuation-in-part of our earlier filed application entitled, "High Speed Printing Apparatus," Ser. No. 528,501, filed Feb. 18, 1966, now abandoned.

FIELD OF THE INVENTION

This invention relates to a novel drive means, and in particular to a drive mechanism that is useful for transporting carriages or supports, such as utilized in high-speed automatic printing apparatus.

Although this invention is applicable to driven devices generally, the following description will be directed to high-speed printers for the purpose of explanation.

DESCRIPTION OF THE PRIOR ART

One class of high-speed printers employs a print hammer, a rotary disk or drum supporting a plurality of characters on the periphery thereof, and a record medium or paper to receive imprinting by the action between the character support and the hammer. The print hammer and/or the character support are transported linearly relative to the paper so that line printing may be effectuated. For the print operational mode, uniform or constant speed drive is desirable. Heretofore in the prior art, the back and forth movement of the printing carriage has been achieved by means of a rotatable element, such as a shaft. This is accomplished by coupling the carriage to the shaft while it is not rotating and then rotating the shaft to move the carriage through the print mode. After printing takes place, the carriage is decoupled from the shaft, returned to its start position and the rotation of the drive shaft ceases to again enable coupling to the carriage. This arrangement has the disadvantage of the necessity of starting and stopping the rotation of the drive shaft for each print line and is not adapted to high speed line-to-line printing. Another arrangement is to have the printing carriage permanently coupled to the drive shaft which enables the

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drive shaft to be continuously rotated. This arrangement has the disadvantage that the print carriage traverses a complete print line for each cycle. For example, a print line may include thirty or more character spaces, however, a particular print line may require that information be printed in only one, or a few of the available spaces. Regardless of the number of character spaces printed, the carriage must traverse the entire print line. Also, since the motion of the carriage must be reversed at the beginning and end of each print line, the velocity of the coupled carriage prior to having its direction of motion reversed must be carefully controlled. A primary object of this invention is to overcome these and other disadvantages of the prior art.

SUMMARY OF THE INVENTION

According to this invention, a high-speed automatic printer apparatus comprises a rotary character wheel and print hammer means coupled to a common carriage, which is cyclically driven along successive print lines. The motion of the carriage is controlled by a continuously rotatable, channeled or contoured guide that enables, for each cycle or line of printing, acceleration from a start position during a first interval, then constant speed drive for line printing during a second period, and disengagement of the carriage from the guide at an end-of-print position thereby allowing return to the start position.

In a specific embodiment of this invention, the carriage is coupled to a rotating shaft by a detent pin that follows a groove formed in the shaft. The groove consists of distinct portions; the first portion being a short straight slot formed in a plane substantially orthogonal to the axis of the shaft; a second portion providing a transition by means of a progressive spiral from the straight slot to a helical third portion having a constant pitch; and a fourth portion constituting a ramp or incline which enables the pin, and therefore the carriage, to be automatically disengaged from the shaft. Each portion serves effectively to control the action and movement of the carriage. Also, in order to effect "zero" suppression and to decrease line-to-line printing time, disengagement of the carriage from the grooved, rotating shaft may take place anywhere along the length thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail with reference to the drawings in which:

FIG. 1 is a perspective view taken from the rear of the apparatus and shows the drive apparatus as used in a high-speed printer, in accordance with the invention;

FIG. 2 is a fragmentary sectional view of a portion of the drive apparatus shown at the beginning of a print line cycle;

FIG. 3 is another fragmentary sectional view of the same portion of the drive apparatus shown in FIG. 2 and shows the drive apparatus at the end of a print line cycle;

FIG. 4 is a simplified logic block diagram to aid in the explanation of the invention;

FIG. 5 illustrates a contoured drive shaft in accordance with the present invention;

FIG. 6 illustrates a modification of the apparatus shown in FIGS. 2 and 3 and which enables "zero" suppression; and

FIGS. 7 and 8 illustrate an end view and partial cross-section, respectively, of apparatus which activates the "zero" suppression apparatus of FIG. 6.

Similar reference numerals refer to the same or similar elements throughout the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, a high-speed automatic printer comprises a carriage 10 that is coupled to a rotary

character wheel 12 and a print hammer assembly 14 for conjunctive travel and disposed in opposition, i.e., printing relation. The character wheel 12, which may be made of hard steel, aluminum, or plastic, by way of example, carries a multiplicity of helically arranged raised characters or symbols to be printed on a record medium or paper 16 that is fed by a transport means (not shown) between the character wheel 12 and hammer assembly 14. The character wheel 12 is so constructed and arranged that the characters thereon are helical in form. The wheel is mounted to a rotary shaft 18 that is driven through a gear train (not shown) and a shaft 42 which is continuously rotatable by means of a drive motor (not shown) and a cog belt 20. The wheel 12 is positioned on a square-shaped portion 24 of the shaft 18. A yoke (not shown) that is supported by a bracket portion 26 of the carriage 10 drives the character wheel 12 along the axis of the shaft 18 as the carriage 10 is moved back and forth cyclically. In this manner, the wheel 12 is adapted to achieve simultaneous rotary and linear motion relative to the fixed frame 74 of the apparatus.

Also mounted to the shaft 18 is a timing disk 28 formed from a magnetic material and having a plurality of circularly aligned apertures 30 corresponding in number to the plurality of character positions on the wheel 12. In addition, an index or reference aperture 32 is located on the magnetic disk 28 for indicating each complete revolution of the disk and to provide a reference thereby. The apertures 30 and 32, which in essence form nonmagnetic gaps, are detected, as they traverse their respective rotary paths, by magnetic sensing devices or heads 34 and 36, respectively, by virtue of changes in magnetic reluctance. Each sensed change is converted to an electrical signal that is fed to a counter or logic circuit, in which the instantaneous position of the disk 28, and thus the related angular position of the wheel 12, is registered. The magnetic heads 34 and 36 are secured to an adjusting bracket 38 which may be rotated along a slot 40 whereby proper synchronization of the timing signals relative to the character wheel is achieved. Other sensing means, such as systems utilizing optical radiation and photosensitive cells, may be employed for determining the position or phase of the character wheel 12.

In accordance with this invention, a contoured, continuously rotating, cylindrical guide 42 (which is the main drive shaft) having a recessed configuration 44 is provided for controlling the forward motion of the carriage 10. As shown in FIG. 5, one end of the recess 44 is a slotted portion 46 having a circumferential path substantially perpendicular to the axis of the contoured cylindrical guide 42. The groove following the slot 46 varies angularly, increasing in pitch, and then assumes a helical form 48 of substantially constant pitch. The length of the variable pitch portion depends upon the mass of the carriage 10 and the speed of the rotating shaft 42. At the end of such helical portion, the groove becomes shallow to establish a ramp or cam 50 which is employed as a carriage disengaging means at the end of each printing cycle, as will be described hereinafter.

Referring again to FIG. 1, a small permanent magnet 52 is fixed to one end of the rotating cylindrical guide 42 relative to the slotted portion 46 of the helical groove 48 and provides an indication of the angular "Home" position or phase of the rotating guide cylinder 42, such indication being utilized at the start of each line print cycle. As the guide cylinder 42 rotates, the magnet 52 periodically passes adjacent to a reed switch S1. The switch S1 is closed by the proximity of the magnet and energizes a circuit, which establishes that the guide cylinder 42 is in its angular Home position. The angular Home position or phase represents a predetermined rotary position of the guide 42 at which time the detent pin 58 can readily engage the grooved start portion 46.

At the beginning of each line print cycle, when the guide 42 is sensed as being in the angular Home phase,

a striking hammer 54 is actuated by means of an electromagnet 56, that is energized by circuit means coupled to the reed switch S1. The hammer 54 depresses a detent pin 58, shown in detail in FIG. 2, so that the pin is locked in engagement with the slotted start portions 46 of the continuous recess 44 in the guide 42. The pin 58 remains seated in the slot 46 and in the following angular recessed portions of the guide by means of a common spring ball detent 60.

The pin 58 is secured by a support 62 that forms part of the movable carriage 10. Therefore, as the pin 58 is urged in the axial direction of the guide 42, then the support 62 and carriage 10 are also propelled axially. Similarly, the character wheel 12 which is coupled to the carriage 10 is moved along the axis of the shaft 18, that is, substantially parallel to the guide 42. Due to the configuration of the start portion 46 of the groove 44, the carriage 10 can engage the shaft 42, even though it is rapidly rotating, and be smoothly and evenly brought up to a constant velocity at which time line printing occurs.

When the carriage 10 is in the axial "Home" position, i.e., the position at which the printing mode is to begin, this condition is sensed by a permanent magnet 64 that is adjustably secured to a predetermined location on the carriage 10. The magnet 64 serves to energize a reed switch S2 to provide an electrical signal that marks the beginning of the print mode portion of the print line cycle. The position of the screw-mounted magnet 64 is adjustable, thus enabling the setting of the axial Home position which, in turn, establishes the margin on the paper 16 at which printing begins.

As the pin 58 is moved by the rotating grooved 44 shaft into the angular recessed or helical portion 48, the carriage 10 bearing the magnet 64 travels axially and is evenly accelerated during a start-up interval, in accordance with the increasing pitch of the recess immediately following the straight slot 46. When the pin 58 reaches the beginning of the uniform pitch helical portion 48, the print mode is initiated. As the carriage 10 moves away from the axial Home position, the magnet 64 leaves the reed switch S2, thereby de-energizing the switch and breaking the circuit. This action allows the print hammer 14 to be actuated for striking whenever the character wheel 12 is in proper phase and in coincidence with the character information from the data input circuit. As represented in the logic block diagram of FIG. 4, the data input signal is stored in a buffer, such as a delay line, and this signal, in conjunction with a counter signal developed by the magnetic sensing head 34 referenced to the signal from the head 36, triggers a coincidence circuit.

Thus it is seen that the print mode corresponds in time with the passage of the pin 58 across the constant pitch portion 48 of the guiding helix during which time the carriage 10 is transported uniformly in a forward direction. Before actual printing commences, the following sequence of events occurs, as illustrated in FIG. 4:

- (1) The helically grooved shaft 42 is rotating.
- (2) The angular Home phase of the guide 42 is detected, the pin 58 engages the slot 46 and the carriage moves from its start position.
- (3) The axial Home position of the carriage 10 is sensed.
- (4) After a predetermined delay, the magnetic sensors determine that the character wheel 12 is in position to print the character corresponding to that received from the data input and stored in the buffer.

During operation, after the printer apparatus has been switched on, the first character or numeral is introduced to the data input system, for example, by depression of a key of a keyboard associated with the printer. The data signals representing characters may also be derived from a record tape or some other suitable storage medium.

During the printing period, an electromagnet 15 is energized by a pulse signal received from the coincidence circuit or gate, which is actuated when the character input conforms with the character position of the wheel 12.

The electromagnet 15 operates the hammer of the hammer assembly 14 which effectuates an imprint of the selected character on the paper 16 that is disposed in the interstice between the print wheel and hammer.

The length and the pitch of the uniform helical portion 48 is such that the time of travel of the carriage along the constant pitch portion corresponds in time to a line period of printing of data. At the end of such print mode, the pin 58 reaches the end of the helical groove or spiral recess 44, and is disengaged by ejection caused by the action of the incline or ramp 50 on the pin, as depicted in FIG. 3. The detent ball assembly 60 is released whereas a second spring ball detent assembly 66 becomes effective to retain the pin 58 in a retracted position, thereby precluding engagement of the pin with the helical groove 48 of the contoured guide 42 as the carriage is returned to its start position.

Upon disengagement of the pin from the guide, the carriage 10 is automatically urged to return to the start position by a resilient means or spring 68, which was compressed during the forward travel of the carriage. The spring 68 exerts decompression force against a carriage extension bracket 70 to achieve a relatively fast return of the carriage. A dashpot 72 damps the fast return motion of the carriage, in a well-known manner, as the carriage 10 approaches the start position. As the carriage reaches its start position, the magnet 64 closes the switch S2 so that no printing can take place until constant forward speed of the carriage is again realized and the magnet 64 has again passed the switch S2 to signify the start of the print mode. Thus, successive lines of data may be imprinted at high speeds under control of a sculptured or contoured guide coupled to a carriage that carries both the print hammer and print wheel in cooperative relation without the necessity of stopping and starting the rotation of the shaft 42 between print lines. However, it is to be understood that for those time intervals during which no printing occurs, the shaft 42 need not be rotating.

For ease of explanation, the circuitry and circuit connections have not been shown or described in detail. It is understood that it is well-known to those skilled in the art to provide the signals and pulses for firing the print hammer 14 and pin striking hammer 54 when necessary.

In the apparatus described above, the carriage 10 is driven the entire length of the groove 44 and is disengaged by the ramp 50. In order to effect "zero" suppression and to decrease line-to-line printing time, it is desirable to disengage the carriage 10 from the grooved 44 shaft 42 as soon as the last character in each print line has been printed. This can be accomplished, as shown in FIG. 6, by a rotatable shaft 81 which passes through an opening 80 in the support 62. The detent pin 58 has a reduced cross-sectional area intermediate its detents such that it presents a flattened surface 83 adjacent a flattened surface 82 of the shaft 81 as shown in FIG. 6. Once the last character of a print line has been printed, and if this occurs prior to the carriage 10 reaching the end of the groove 44 adjacent the ramp 50, clockwise rotation of the shaft 81 will cause the detent pin, and therefore the carriage 10, to be disengaged from the grooved 44 shaft 42 to automatically return the carriage 10 to its start position, from which it can again be coupled to the start portion 46 of the groove 44 in the rotating shaft 42.

Mechanism for so actuating the shaft 81 is illustrated in FIGS. 7 and 8 which show a spring clutch 85 located adjacent the end of the grooved shaft 42 remote from the switch S1 (FIG. 1). The clutch 85 enables the shaft 42 to rotate a cam 97 which in turn actuates a cam follower 100 which in turn rotates the shaft 81 in a clockwise direction by means of a gear 103. The clutch 85 can be actuated by means of an electromagnet (not shown) which in turn is actuated by an electrical signal that indicates the last character of the print line has occurred. This electrical signal may be generated by any number of well-known means that provide "zero" suppression for printers.

The operation of the apparatus shown in FIGS. 6, 7 and 8 is described in detail hereinbelow.

Following the engagement of the carriage drive pin 58 with the helical groove 44 of the rotating shaft 42, energization of the electromagnet 15 operates the print hammer 14 for the printing of a desired character with each revolution of the type wheel 12. As the printing of each digit type character is effected, a zero suppression circuit of a conventional type comes into play to sense all higher orders of the factor to be printed. If the highest significant digit has been printed, the zero suppression circuit effects engagement of the clutch 85 (FIG. 8) by any suitable means, such as an electromagnet (not shown). Upon engagement of the clutch 85, one revolution of a pinion gear 95 at a 72° angular rotation of the cam disk 97 causes the cam follower 100 to rock the shaft 81 clockwise (FIGS. 6 and 7) against the urgency of a spring (not shown), thereby withdrawing carriage drive pin 58 and releasing the carriage 10 to the influence of the spring 68 which causes the carriage 10 to automatically return to its start position.

Accordingly, upon completion of less than a full line of printed characters, whether it be one character or a plurality of characters, the carriage drive pin 58 is withdrawn from its engagement with the groove 44 of the continuously rotating shaft 42 to enable the automatic return of the carriage 10 and type-wheel 12 to the start position. More specifically, a capstan spring clutch 85 (FIGS. 7 and 8) is provided. At its left end, as viewed in FIG. 8, the grooved 44 shaft 42 is supported for rotation within a cup-shaped bushing 86 which, in turn, is journaled in a bearing bushing 87 secured in a side-frame member 84. Intermediate its ends, the bushing 86 is provided with an integrally formed annular stepped flange 89 and disposed between the flange 89 and the bearing bushing 87 is a spacing ring, or washer, 88. The internal diameter of the cup-shaped bushing 86 is sufficiently greater than the diameter of the shaft 42 to provide a close running fit between the shaft and the bushing. The end surface of the open-end portion of the bushing 86 abuts the end surface of the hub of a stepped collar 90 secured on shaft 42 for rotation therewith. The outside diameter of the hub of the collar 90 and that of the abutting open-end portion of the bushing 86 is identical. Encircling the open-end portion of the bushing 86, as well as the hub of the collar 90, is a tightly coiled spring 94 having an inside diameter slightly less than the outside diameter of the two mating members. The diameter of the reduced portion or shoulder of each of the flanges 89 and 91 is identical and provides a bearing surface for the respective ends of a sleeve 92, the inside diameter of which is sufficiently greater than the outside diameter of the spring 94 to permit expansion of the spring within the sleeve. One end of the spring 94 is anchored in a suitable notch in the flange 89 of the bushing 86, while the other end projects radially outwardly and is engaged in a suitable aperture in the sleeve 92, so that if the sleeve 92 is held against rotation and shaft 42 is rotating in a clockwise direction, as viewed from the left in FIG. 8, the spring 94 is expanded to provide a free running fit between the spring and the shaft 42. However, when the sleeve 92 is released, spring 94 is permitted to assume its normal form, thereby providing a drive connection between shaft 42 and the bushing 86.

Normally, the sleeve 92 is latched in the position shown in FIG. 8 to disable the driving function of the coil spring 94. At the completion of each cycle of clockwise rotation of the clutch 85, i.e., after one revolution of the sleeve 92, the upturned end portion of latch lever 93 engages in an aperture (not shown) in the sleeve 92. Latch lever 93 is preferably rockably mounted intermediate its ends. Secured on the closed end surface of the bushing 86 is a fourteen tooth pinion 95 concentric with shaft 42, and enmeshed with the teeth of a seventy tooth internal

gear 98 (FIGS. 7 and 8) of cam disk 97 rotatably mounted on pin 96 secured on side frame member 84.

Upon energization of the clutch 70, a 72° angular rotation is imparted to the cam disk 97. During this partial revolution of the cam disk 97, the cam follower 100 is rocked counter-clockwise about its pivot 101 on side frame member 84. The cam follower 100 is provided with a toothed sector 102, which is meshed with a pinion 103 secured on the end portion of the shaft 81 journaled in side frame member 84. In addition to being journaled, shaft 81 also passes through the aperture 80 in the print hammer carriage support 62 (FIG. 6) and is normally resiliently urged by a spring (not shown) to the counter-clockwise rocked position shown to maintain the follower 100 in engagement with the peripheral surface of cam disk 97. As the shaft 81 is rocked clockwise (FIGS. 6 and 7) by cam follower 100, the surface 82 of the flattened portion of the shaft 81 engages the shoulder 83 formed in the carriage drive pin 58, moving the pin to the left out of engagement with the groove 44 on the shaft 42. Upon retraction of the carriage drive pin 58 from its engagement with the groove 44, the print hammer carriage 10 is released to the influence of the relatively strong spring 68 (FIG. 1) that returns the carriage to its start position.

It should be understood that the invention is not limited to the particular configuration set forth above, but may employ alternative embodiments. For example, the recessed guide may have a raised configuration engaging a seating element. The configuration can be modified to afford variations in speed of movement of the carriage. Also, the paper may be moved axially, and different approaches to achieve relative motion between the printing elements may be utilized. Furthermore, a plurality of hammers, or a plurality of character wheels, or different forms of character supports may also be utilized within the scope of the present invention. In addition, the drive mechanism delineated herein is not necessarily limited to a high-speed printer, but may also find utility in various other apparatuses.

What is claimed is:

1. A drive apparatus comprising:
 - a movable carriage having at least a start position;
 - a rotatable, contoured element for controlling the motion of said carriage;
 - said contour having a start portion, an end portion, and a major portion therebetween being formed as a substantially helical groove along said rotatable element;
 - means for coupling said carriage to said start portion of said contoured element while said contoured element is rotating to impart motion to said carriage;
 - means different from said means for coupling for disengaging said carriage from said contoured element while said contoured element is rotating; and
 - means for automatically returning said carriage to said start position after disengaging said carriage from said contoured element, said start portion of said groove including a first portion which is a circumferential slot in a plane substantially perpendicular to the axis of said contoured element and a second portion providing a transition by means of a progressive spiral from said slot to said helical portion.
2. The apparatus of claim 1 wherein said start portion of said contour has a pitch less than that of said helical groove.
3. The apparatus of claim 1 wherein said start portion of said contour includes a variably pitched, helical-like groove.
4. The apparatus of claim 1 wherein said coupling means includes a detent pin adapted to be seated in said contour.
5. The apparatus of claim 1 wherein said disengaging means includes a ramp formed at the end portion of said contour.
6. The apparatus of claim 4 wherein said disengaging

means includes means for withdrawing said detent pin from said contour anywhere along the length thereof.

7. The apparatus of claim 1 wherein said automatic carriage returning means includes resilient means coupled to said carriage, said resilient means being tensed when said carriage is propelled from said start position so that upon disengagement of said carriage from said contoured element said resilient means urges said carriage back to said start position.

8. A high speed printer apparatus comprising:

- a rotary character wheel;
- a print hammer;
- a movable carriage, having a start position, for transporting said wheel and said print hammer along a predetermined path in print relation at a substantially constant velocity;
- a grooved, rotatable shaft disposed along such predetermined path;
- said groove having a start portion, an end portion, and a major portion therebetween being a substantially helical groove around said shaft;
- means for coupling said carriage to said start portion of said groove while said shaft is rotating whereby motion is imparted to said carriage along said predetermined path;
- said start portion of said groove adapted to evenly accelerate said carriage from said start position, said start portion of said groove including a first portion which is a circumferential slot in a plane substantially perpendicular to the axis of said contoured element and a second portion providing a transition by means of a progressive spiral from said slot to said helical portion;
- said major portion of said groove adapted to impart a substantially constant velocity to said carriage during which time printing may occur;
- means different from said means for coupling, for disengaging said carriage from said grooved shaft; and
- means for automatically returning said carriage to said start position after disengaging said carriage from said grooved shaft.

9. The apparatus of claim 8 wherein said grooved start portion has a pitch less than that of said grooved major portion.

10. The apparatus of claim 9 wherein said grooved start portion has a variable pitch.

11. The apparatus of claim 10 wherein said coupling means includes a detent pin adapted to engage said groove.

12. The apparatus of claim 11 wherein said disengaging means includes a ramp formed at the end portion of said groove.

13. The apparatus of claim 11 wherein said disengaging means is adapted to withdraw said detent pin from said groove anywhere along the length thereof.

14. The apparatus of claim 11 wherein said automatic returning means includes resilient means coupled to said movable carriage, said resilient means being tensed when said carriage is propelled along said predetermined path whereby said resilient means urges said carriage back to said start position upon disengagement of said carriage from said grooved shaft.

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