Nov. 9, 1965 K. F. OLDENBURG ETAL 3,216,348

HAMMER TIMING MEANS IN A HIGH SPEED BELT PRINTER

Filed Oct. 20, 1961 3 Sheets-Sheet 1

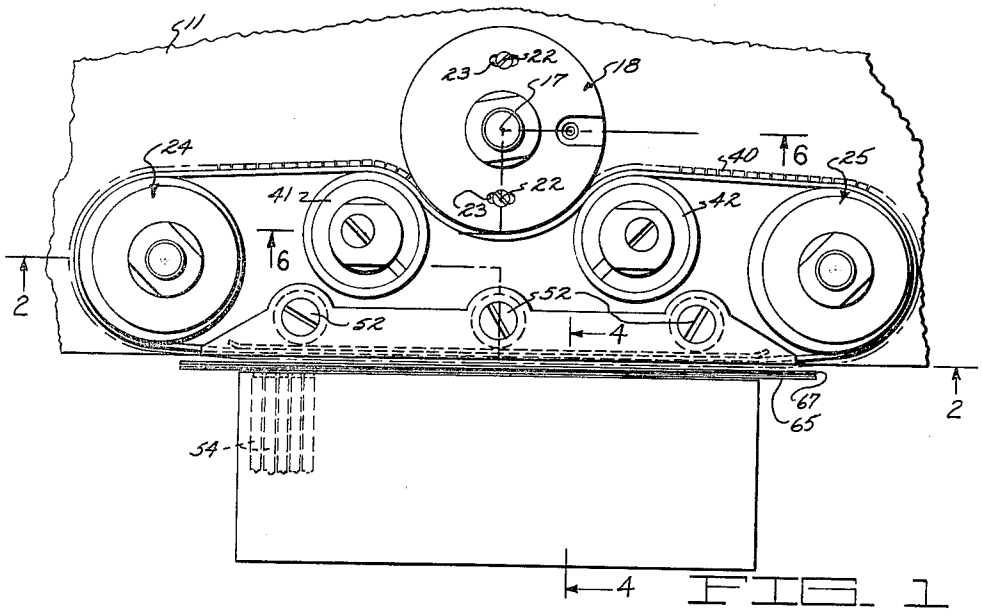

FIG. 1

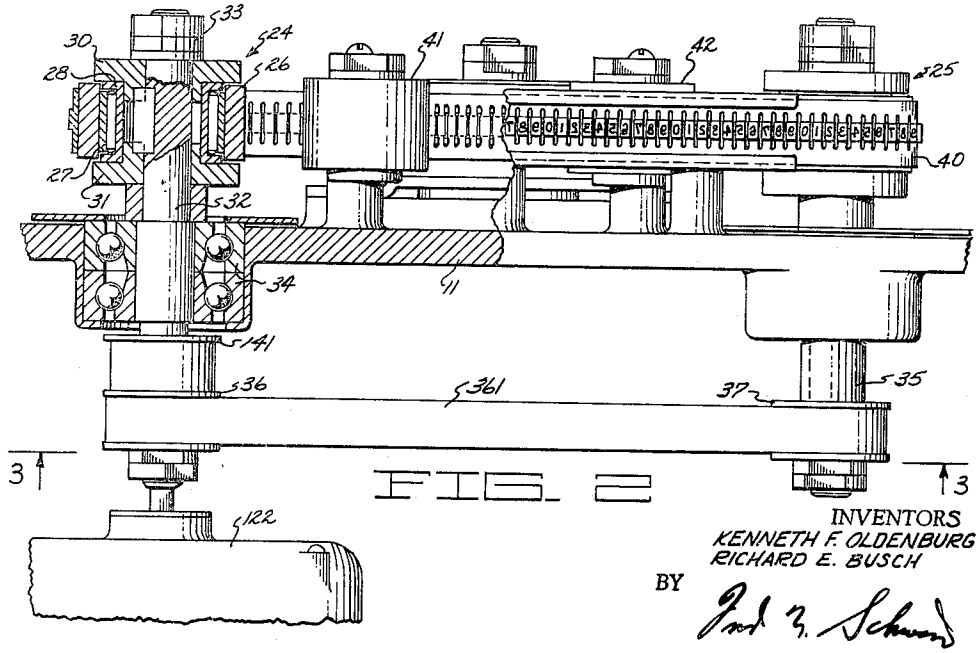

FIG. 2

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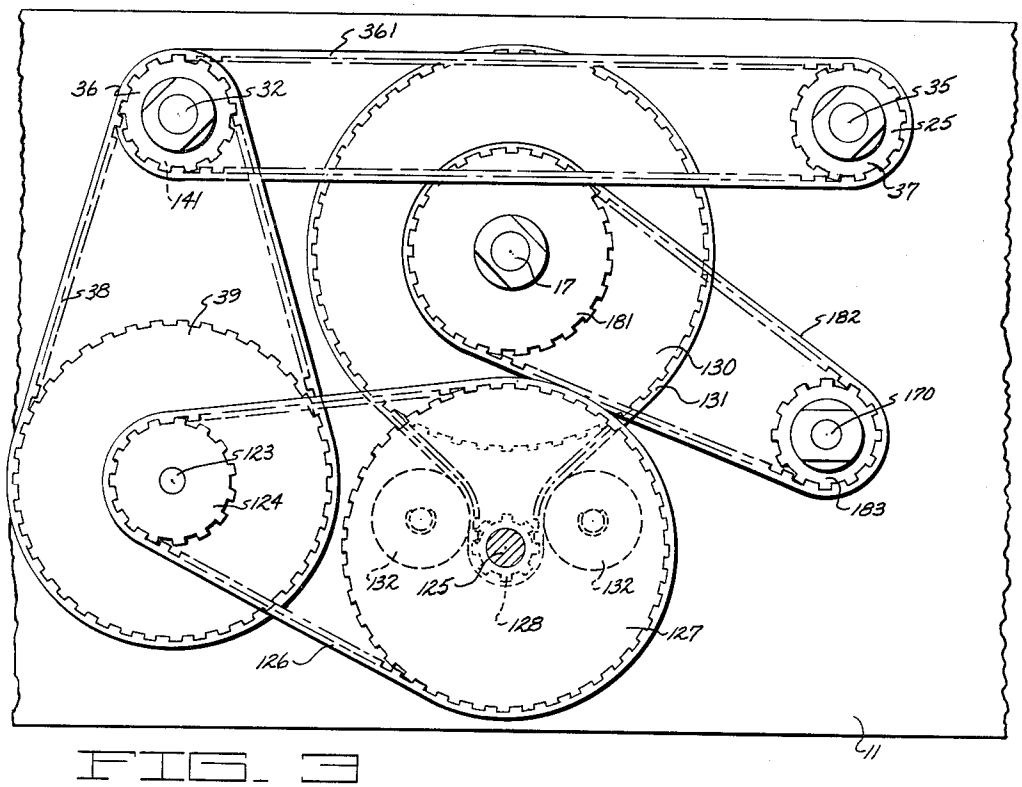
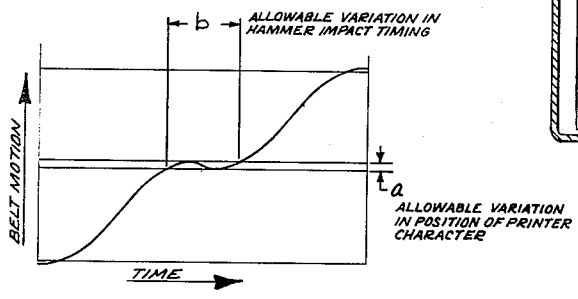


FIG. 3

FIG. 5



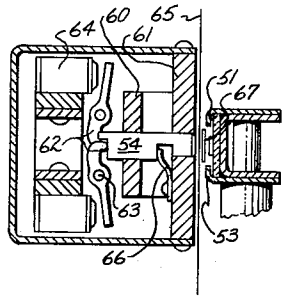


FIG. 4

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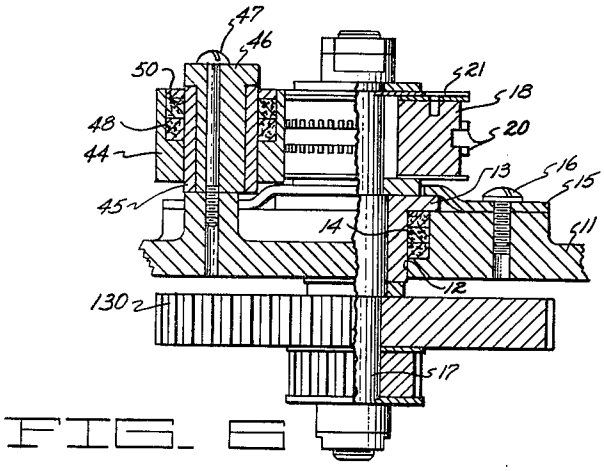

FIG. 6

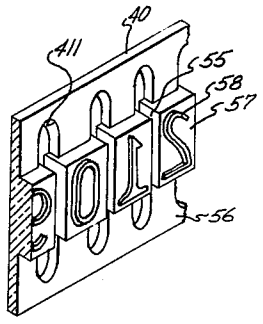

FIG. 7

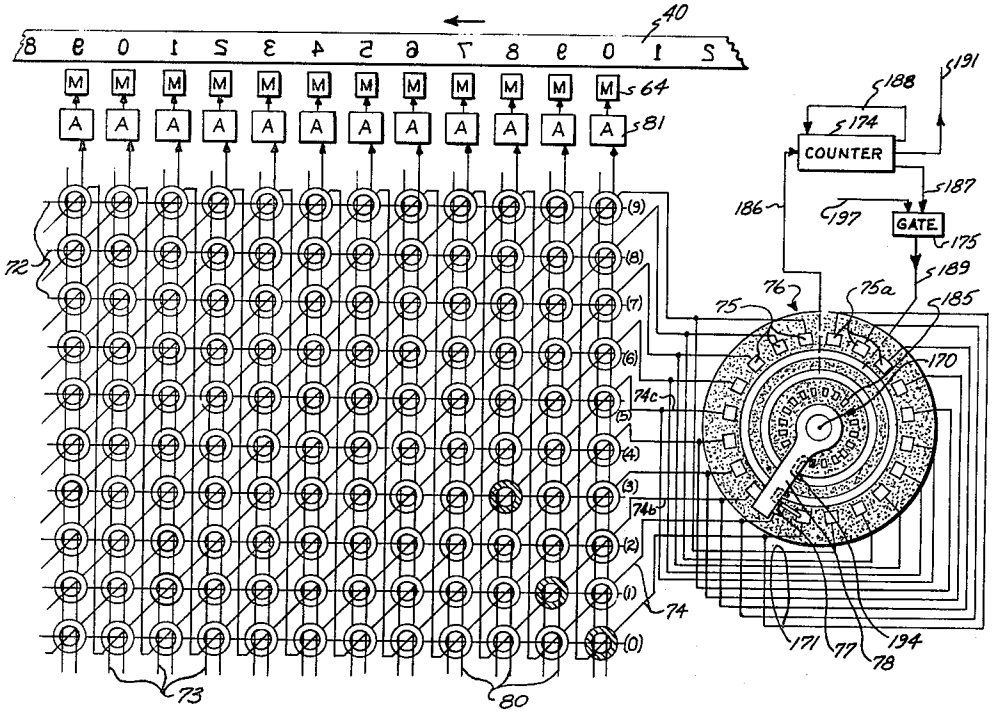

FIG. 8

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United States Patent Office 3,216,348
Patented Nov. 9, 1965

3,216,348

HAMMER TIMING MEANS IN A HIGH SPEED BELT PRINTER

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Filed Oct. 20, 1961, Ser. No. 146,465
7 Claims. (Cl. 101—93)

This invention relates to printers for line printing selected characters and has particular reference to a high speed printer of this type.

One form of high speed printer in successful commercial use is the so-called "belt type" printer in which an endless belt or band, having type characters spaced therealong, is constantly moved at a relatively high speed past a record medium. The belt is moved endwise in a direction parallel to a line of print.

One or more printing hammers are provided to effect an impression from selected type characters onto the record medium as such type characters pass in front of the hammers.

Although such belt printers are generally satisfactory, it is obvious that the timing of the hammers must be extremely accurate in order to effect printing in proper columnar positions. Any minute differences in timing will result in uneven spacing of the printed characters in a line of print. Also, due to the relatively high and constant speed of movement of the belt past the printing hammers, the impact of the hammers must be substantially instantaneous in order to prevent blurring or smudging.

The problem of maintaining proper critical timing of the printing hammers increases with increased speed of movement of the printing belt and this, in addition to the smudging tendency, becomes a limiting factor as higher printing speeds are attempted.

It therefore becomes a principal object of the present invention to overcome the difficulties encountered in high speed printers of the above type.

Another object is to provide a relatively simple and economically manufactured high speed printer.

Another object is to provide a high speed printer of the belt type wherein the speed of traverse of each type character is materially reduced as it passes the printing point.

A further object is to provide a high speed printer of the belt type wherein minor variations in timing of the printing impression means may be tolerated without resulting in unequal spacing of the printed type characters on the record medium.

The manner in which the above and other objects of the invention are accomplished will be readily understood on reference to the following specification when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a front view of a printer embodying a preferred form of the present invention.

FIG. 2 is a sectional view through the printer and is taken substantially along the line 2—2 of FIG. 1.

FIG. 3 is a rear view taken in the direction of the arrow 3 of FIG. 2.

FIG. 4 is a transverse sectional view through the hammer actuating mechanism and is taken substantially along the line 4—4 of FIG. 1.

FIG. 5 is a graph showing the relation between the belt movement and allowable variation in hammer impact timing.

FIG. 6 is a sectional view taken substantially along the line 6—6 of FIG. 1.

FIG. 7 is an enlarged perspective view of a portion of the printer belt.

FIG. 8 is a diagram of a circuit for serially controlling the appropriate hammers of the printer.

The printer comprises a base 11 on which the operating components of the printer are mounted. The base has a counterbore 12 (FIG. 6) therein to receive a sintered metal bushing 13 and lubricant impregnated annular discs 14 of felt or the like. The bushing is held in place by an annular retainer 15 secured against the base by clamp screws 16.

A shaft 17 is rotatably mounted in the bushing 13 and has rotatably mounted thereon a belt sprocket 18 having two rows of regularly spaced drive teeth 20. A drive disc 21 is keyed on the shaft and is secured in driving relation with the sprocket 18 by screws 22 which pass through elongated slots 23 in the plate. This construction permits a limited angular adjustment of the sprocket relative to the shaft.

The sprocket 18 is continuously driven at a constant rate of speed by a motor 122 (FIG. 2) whose shaft 123 (FIG. 3) carries a sprocket 124 entrained with an intermediate shaft 125 through an endless cog belt 126 and a sprocket 127. Shaft 125 carries a small sprocket 128 which drives a sprocket 130 fastened on the shaft 17 through a second cog belt 131. Idlers 132 engage the cog belt 131 to maintain adequate engagement with the sprocket 128.

Two eccentric belt guiding rollers or spools 24 and 25 are located on opposite sides of the belt sprocket 18. Such rollers are of similar construction and, therefore, the details of one only will be described. As shown in FIG. 2, the roller 24 comprises an outer sleeve 26 carried by the outer race 27 of a roller bearing, the inner race 28 of which is fitted over eccentric shoulders of two end plates 30 and 31. The latter are keyed on a shaft 32 and are clamped against the bearing race 28 by a nut 33 threaded on the shaft 32.

The shaft 32 is rotatably mounted in a ball bearing 34 supported by the base 11. The shaft 32 is entrained with a similar shaft 35 carrying the sprocket 25 by a cog belt 361 which is wrapped around sprockets 36 and 37 attached to the respective shafts.

The idler rollers 24 and 25 are driven in orbits in time with each other and with the sprocket 18 through a cog belt 38 which is wrapped around a large sprocket 39 fastened to the motor shaft 123 and a smaller sprocket 141 fastened to the idler roller shaft 32.

It will be noted that the cog belts 126 and 131 and their respective sprockets for transmitting a drive between the motor shaft 123 and the belt sprocket 18 effect a reduction in speed, whereas the cog belt 38 and its sprockets for transmitting a drive between the motor shaft and the idler rollers effect an increase in speed. This relation is such that the idler shafts 32 and 35 are rotated one revolution during advancement of the sprocket 18 through an angle equal to the pitch between two adjacent teeth 20.

An endless printing belt 40 is wrapped around the spools 26 of the idlers 24 and 25 to form a loop and is held in driving engagement with the sprocket 18 by adjustable idler rollers 41 and 42. As shown in particular in FIG. 7, the belt is provided with two parallel rows of sprocket tooth perforations 411 engageable with the teeth 20 of sprocket 18 to ensure positive driving relation therebetween.

Each of the rollers 41 and 42 comprises an outer sleeve 44 (as seen in FIG. 6) suitably secured over a bearing sleeve 45 of sintered bearing material which is rotatably mounted on an eccentric bearing member 46. The latter is clamped in any rotatably adjusted position against the base 11 by a clamp screw 47. The sleeve 44 is counterbored at 48 to receive annular lubricant impregnated discs

50 of felt or the like to supply lubricant to the bearing sleeve 45.

The strand of the belt opposite that strand engaging the spcocket 18 is guided along a channel-shaped guideway 51 (see also FIG. 4) suitably supported by bolts 52 from the base 11. Flanges 53 overlap the edges of the belt so as to maintain the latter in contact with the guideway as it is intermittently advanced at high speeds past a series of printing hammers 54 located opposite the guideway.

As shown in FIGS. 2 and 7, the printer belt is formed of a flexible homogeneous material, preferably plastic, which is slit at 55 across each pair of tooth perforations 411, leaving flexible belt sections 56 adjacent opposite edges whereby the belt may flex as it moves around the various idlers and sprocket 18. The portions between the slits 55 are raised at 57 and each raised portion is formed into a different type character 58.

The various printing hammers 54 are slideably mounted in side-by-side relation in bearings formed in guideblocks 60 and 61 (FIG. 4). Levers 62 are pivoted at 63 behind respective ones of the hammers and each forms the armature of a respective electromagnet 64. Upon energization of a magnet 64, its hammer 54 will be impelled toward whichever type character on the belt is aligned therewith, thereby effecting a printing impression on a paper strip 65 suitably guided over the bearing block 61. Thereafter, the hammer is returned to its position shown in FIG. 4 by a light leaf spring 66 suitably attached to the rear of bearing block 61.

Suitable inking means such as an inked ribbon 67 extending along the guideway 51 is provided to transfer an inked impression to the paper from the aligned type characters.

Describing now the operation of the printer, it will be noted that the idlers 24 and 25 are moved through identical orbits once during advancement of the printer belt from one type character position to the next relative to each of the printing hammers. The shafts, i.e., 32, of the idler rollers 24 and 25 are properly oriented relative to each other so that at any one instant the centers of the spools 26 of the two idler rollers are located at the same direction from the center of rotation of the respective shafts. Thus, as the sprocket 18 advances the adjacent or inner strand of the belt 40, the idlers 24 and 25 cause an intermittent advancement of the opposite or outer strand which lies in the guide way 51.

It will be noted that because of the eccentric motion derived from the idlers 24 and 25, the outer strand of the printing belt 40 is gradually accelerated and decelerated as shown in the graph of FIG. 5, permitting relatively high rates of speed of the belt with a minimum of vibration due to inertia and momentum forces.

By virtue of the eccentric motion of the rollers 24 and 25, the outer strand of the belt 40 is actually at rest for only an infinite point in time. However, the amount of eccentricity is preferably such that the belt is reversed in direction for a short period of time while a type character is opposite a printing hammer. Accordingly, considering a relatively small allowable variation *a* (FIG. 5) in position of a printed character on the sheet 65, a relatively large variation *b* in time may be tolerated. Thus, allowances may be made for variations in temperature of the electromagnets 64, operation of the driving circuits therefor, and other factors which might vary the exact moment at which the hammers strike the paper without appreciably changing the position of the printed type characters relative to each other.

The printer preferably has a number of hammers 54 equal to the number of possible type characters in a printed line and the belt 40 may have any required number of complete sets of type characters successively following each other along the length of the belt. Accordingly, two or more characters may be printed at the same

time depending on the particular characters opposite respective hammers at any one time.

FIG. 8 shows an exemplary circuit for operating the printer. In such embodiment, a coincident current magnetic core system is employed wherein an array of magnetic cores is provided, each core having a substantially rectangular hysteresis loop characteristic. The cores are arranged in vertical columns, one for each hammer electromagnet 64. Also, the cores are arranged in ten horizontal rows representing the digits 0 to 9. Coordinate energizing windings, represented by lines passing through the cores, are provided for energizing the same. All energizing windings in each row are connected in series by horizontal lines 72, whereas all energizing windings in each column are connected in series by vertical lines 73.

In accordance with common practice, specific cores may be magnetically oriented to represent different digits only by concurrent energizing of the respective horizontal and vertical lines associated therewith, application of current in one winding only being insufficient to reverse the magnetic orientation of a core to represent a digit. Normally, the cores are magnetically oriented in one direction representing no digit.

The cores, further, have read windings represented by diagonally extending lines 74 passing therethrough. The windings 74 are connected in series diagonally and such series lines are connected to different contacts 75 of a commutator generally indicated at 76. When the read winding of a core which represents a digit is energized, the reversal of the magnetic flux orientation thereof will induce a control current in an output coil represented by a second vertical line, i.e., 80, passing through all coils in a respective column and connected through a respective amplifier 81 to the corresponding electromagnet 64.

A contact brush 77 is carried by a sweep arm 78 attached to a rotatable shaft 170 and is arranged to sweep across the various contacts 75 in time with movement of the belt past the hammers 54. The shaft 170 is driven by a sprocket 181 (FIG. 3) mounted on the sprocket shaft 17 through a belt 182 and a second sprocket 183 mounted on the shaft 170. The sprocket ratio is so arranged as to drive the shaft 170 at twice the speed of the sprocket, and therefore, a second set of contacts 75*a* are provided and are interconnected through lines 171 with respective diametrically opposite ones of the contacts 75.

To advance the paper while retaining the commutator in a timed relationship with the belt 40, there is provided a set of contacts 185 on the commutator 76 which cooperate with a second set of brushes 194 to pass a pulse to a clocking counter 174 over a line 186 each print time. As the counter counts from 1 through 10, an output line 187 from the counter to an "and" gate 175 will remain high to pass the current of a "read" potential input line 197 through the gate 175 and over a line 189 to the wipe ring for the brush 77. During the eleventh and twelfth counts, the counter will provide a low output to the "and" gate 175, thereby preventing passage of current to the commutator contacts 75 and 75*a*, but will make a line 191 high to initiate a suitable paper feed means (not shown).

At the end of the twelfth count, the counter will reset itself to zero through a reset line 188, thereby again raising input line 187 to open the gate 175.

For example, if the value 310 were registered in the three right-hand orders of the core matrix as indicated by the corresponding cross hatched cores in FIG. 8, and if the printer belt 40 and brush 77 move into their relative positions shown in this figure after the commencement of a read-out operation, the units order core, registering 0, would have its magnetic orientation reversed to accordingly energize the units order magnet 64 as one of the zero type characters on the belt 40 locates opposite the units order hammer whereby to print a zero in that order. Thereafter, upon movement of the belt 40 two steps to the left, a type character 1 will be located in the

tens order and the brush 77 will energize the read line 74*b* to reverse the magnetic flux orientation of the No. 1 core in the tens order so as to effect printing of the character 1 in that order. Upon movement of the belt 40 three steps further to the left, a type character 3 will be located in the hundreds order and the brush 77 will energize line 74*c*, thereby reversing the magnetic flux orientation in the No. 3 core located in hundreds order column. Accordingly, 3 will be printed in that order. Thus, the value 310 will have been printed.

Upon traverse of the brush 77 past all contacts 75, printing in all orders will have been effected whereupon the paper may be spaced by suitable means to a new printing line position during traverse of the brush onto its illustrated starting position.

Although the invention has been described in detail and certain specific terms and languages have been used, it is to be understood that the present disclosure is illustrative rather than restrictive and that changes and modifications may be made without departing from the spirit or scope of the invention as set forth in the claims appended hereto.

Having thus described the invention, what is desired to be secured by United States Letters Patent is:

1. Printing apparatus comprising the combination of a pair of spaced spools, eccentric members rotatably supporting said spools, a flexible endless belt guided in two strands by said spools, a constantly rotating drive wheel engageable with one of said strands to advance said belt through its length, means for effecting a printing impression from a selected type character on the other of said strands, and means for rotating said eccentric members in time with each other and at a speed relative to the speed of said drive wheel such that said type characters are successively presented to said printing impression means, the eccentricity of said eccentric members being such as to intermittently move said other strand in both a forward and a retrograde direction while each of said type characters is presented to said printing impression means.

2. Printing apparatus comprising the combination of a flexible endless belt arranged in a loop with two strands connecting the ends of said loop, said belt having type characters therealong, means for continuously moving one of said strands through its length, printing means for effecting an impression of selected ones of said type characters in the other of said strands onto a record medium, means for guiding said other strand past said printing means in a fixed path whereby to successively present said type characters to said printing means, and means operatively connected to said moving means for bodily oscillating said ends of said loop in time with each other whereby to decelerate a said type character upon passage thereof adjacent said printing means.

3. Printing apparatus comprising the combination of a pair of spaced rotatable elements, a flexible endless belt extending in a loop around said rotatable elements, said belt having type characters therealong, said belt forming two strands extending between said rotatable elements, means for moving one of said strands through its length at a constant speed, a plurality of printing devices spaced along the other of said strands for effecting impression of selected ones of the type characters located on said other strand onto a record medium, means for constantly moving the centers of said rotary elements in circular paths whereby to cause said other strand to move said type characters thereon at varying speeds past said printing devices, and means for actuating at least certain of said printing devices when said first strand is moving at minimum speed.

4. Printing apparatus comprising the combination of a pair of spaced spools, a flexible endless belt extending

in a loop around said spools, said belt having type characters therealong, said belt forming two strands extending between said spools, means for moving one of said strands through its length at a constant speed, a plurality of printing devices spaced along the other of said strands for effecting impression of selected ones of the type characters located on said other strand onto a record medium, eccentric members rotatably supporting respective ones of said spools, means for rotating said eccentric members at a speed relative to the speed of said moving means such that the speed of said other strand is reduced to substantially zero when at least certain of said type characters on said other strand are located in printing relation with said printing devices, and means for actuating at least certain of said printing devices when said last mentioned type characters are located in printing relation with said printing devices.

5. Printing apparatus comprising the combination of a pair of spaced spools, a flexible endless belt extending in a loop around said spools, said belt having type characters therealong, said belt forming two strands extending between said spools, means for moving one of said strands through its length, a plurality of printing devices spaced along the other of said strands for effecting impression of selected ones of the type characters located on said other strand onto a record medium, eccentric members rotatably supporting respective ones of said spools, means for rotating said eccentric members in time with each other whereby to successively present certain of said type characters to said printing devices, the amount of eccentricity of said members being such as to move said other strand in both a forward and retrograde direction while certain of said type characters are presented to said printing devices, and means for actuating at least certain of said printing devices when said last mentioned type characters are located in printing relation with said printing devices.

6. Printing apparatus comprising the combination of a pair of spaced spools, eccentric members rotatably supporting said spools, a flexible endless belt guided in two strands by said spools, said belt having type characters therealong, means for constantly advancing one of said strands lengthwise, means for effecting a printing impression from a selected type character on the other of said strands, and means for rotating said eccentric members in time with each other at a speed relative to the speed of said advancing means such that said type characters are successively presented to said printing impression means, the eccentricity of said eccentric members being such as to intermittently move said other strand in both forward and retrograde directions while each of said type characters is presented to said printing impression means.

7. Printing apparatus according to claim 6 comprising means for actuating said printing impression means when a said type character is presented to said printing impression means.

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