July 29, 1969 E. FALCHERO 3,457,855

HIGH SPEED BELT OR CHAIN PRINTER WITH COORDINATED PAPER FEED MEANS

Filed July 28, 1967 3 Sheets-Sheet 1

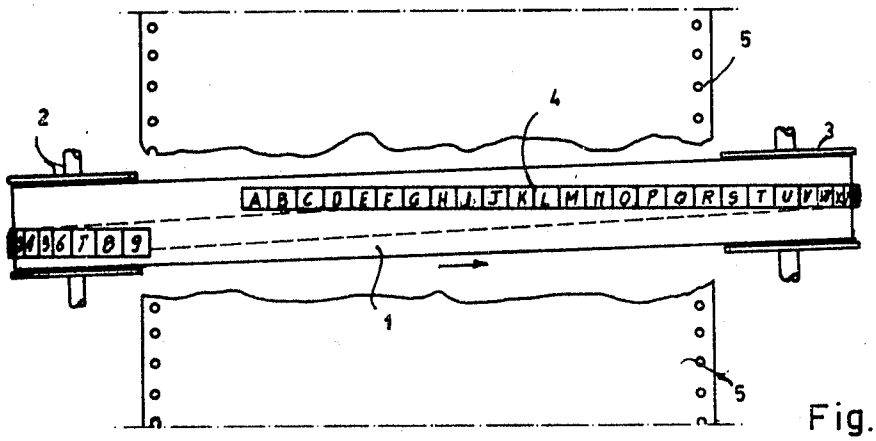

Fig. 1

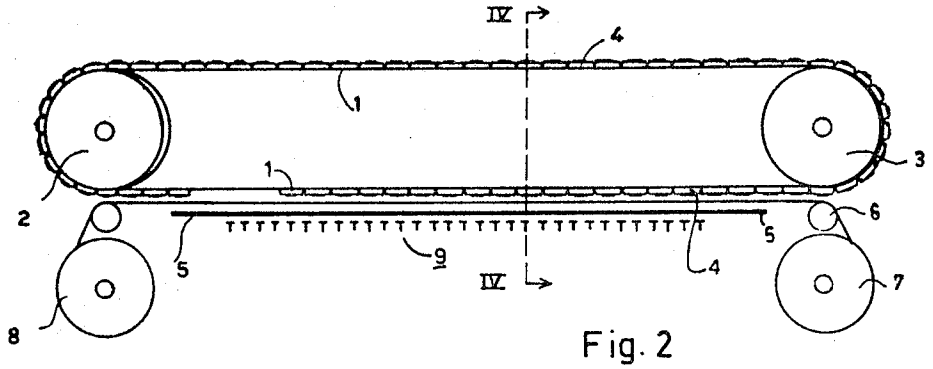

Fig. 2

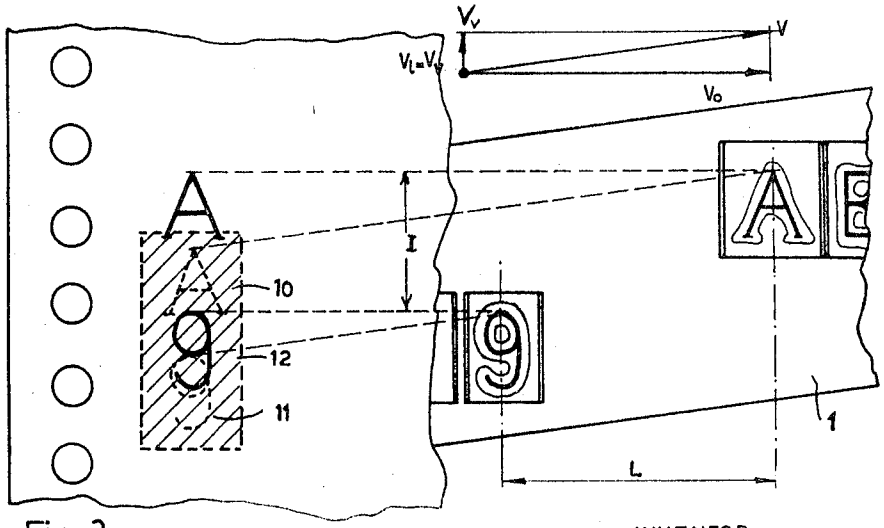

Fig. 3

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HIGH SPEED BELT OR CHAIN PRINTER WITH COORDINATED PAPER FEED MEANS

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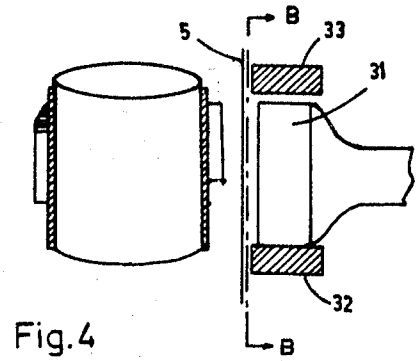

Fig.4

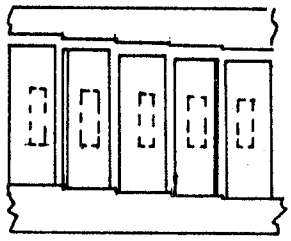

Fig.5

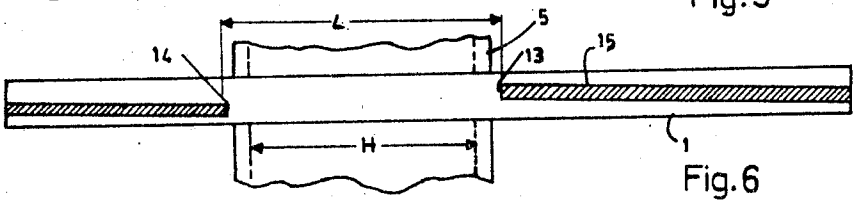

Fig.6

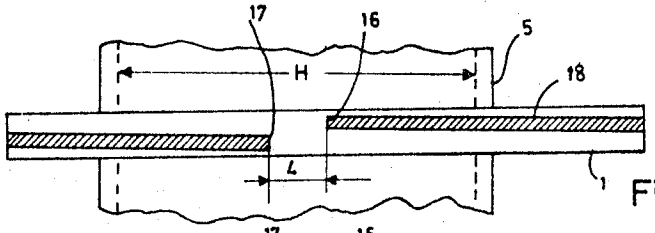

Fig.7

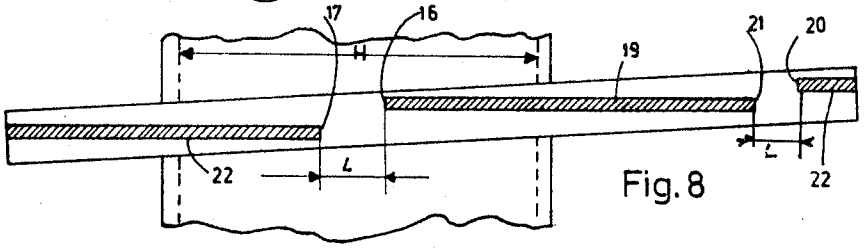

Fig.8

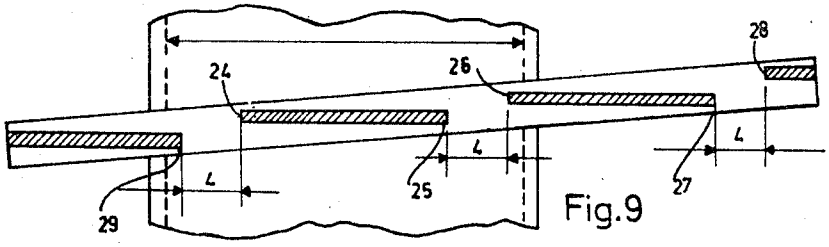

Fig.9

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HIGH SPEED BELT OR CHAIN PRINTER WITH COORDINATED PAPER FEED MEANS

Filed July 28, 1967 3 Sheets-Sheet 3

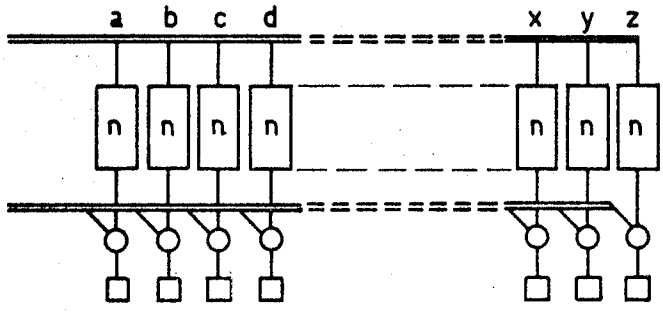

Fig.10

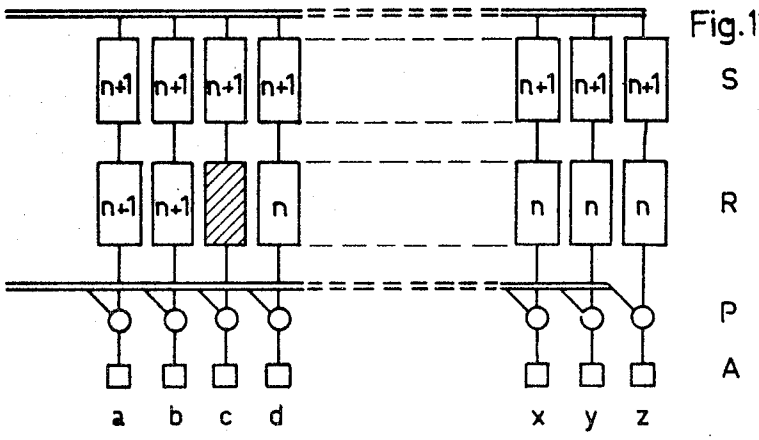

Fig.11

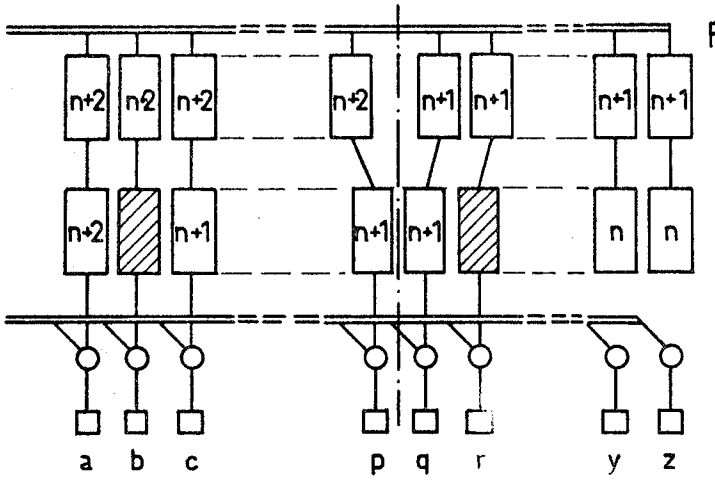

Fig.12

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HIGH SPEED BELT OR CHAIN PRINTER WITH COORDINATED PAPER FEED MEANS

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Claims priority, application Italy, July 29, 1966, 17,680/66
Int. Cl. B41j 1/20
U.S. Cl. 101—93 9 Claims

ABSTRACT OF THE DISCLOSURE

A high speed endless chain or ribbon printer wherein the characters are disposed at an angle with respect to a print line including continuous print support moving structure to provide effective printing in a straight line.

The present invention relates to high speed printers, of the model wherein the type members are carried by an endless chain or ribbon, moving in a direction parallel to the print line and known as chain or belt printers.

High speed printers in which the type members are horizontally aligned on a continuously moving endless ribbon or chain member and carried in a direction parallel to the print line, with the type members cooperating with a multiplicity of actuators and with proper inking means to print selected characters on the paper or other printing medium are known. In the case of mechanical printers the actuators are hammers which, when impelled by electromagnets, push the paper and the inking means (ink ribbon or carbon paper) against the type carried by the ribbon or the chain. A hammer is located, at every printing position and a logical control device operates each electromagnet so that each hammer is actuated by the electromagnet when the type corresponding to the character to be printed passes in front of the hammer. The printing is made "on the fly," that is, without stopping the type-carrying member, thereby obtaining high printing speed.

The same principle may be applied to non-impact printing devices, wherein the printing is obtained by xerographic, photoelectric, thermoplastic or similar processes. In printing of the foregoing types, the type-carrying member is, for example, made of a flexible ribbon on which proper masks or patterns, related to the shape of the different characters to be printed are fixed, and the actuator is a device which modifies a limited portion of a printing medium by means of a chemical, electrical, or any other non-mechanical action, the modifications causing, either immediate or subsequent, appearance of the shape of the character, either on the same medium or, after a transfer operation, on a final print support. Due to the absence of mechanical action, such printing means may attain a very high speed.

One of the outstanding problems, connected with the designing and fabrication of printers of the described type, is to insure correct paper feeding, that is, to cause the printing medium to advance in a direction perpendicular to the printed line at the proper time and for the required distance.

The operation, known as "line feed," takes place, in the known printers, abruptly, or as soon as the printing of one line is completed and before initiating the printing of the next line. The time needed for the line feed, which cannot be used for the printing operation, is a considerable fraction of the time assigned to the whole line-printing cycle. This unused fraction of the cycle tends to become even more important as the printing speed is increased, thus in order to maintain the feed time within acceptable limits, it is necessary to impart to the printing medium

and to the means operating the feeding device, very rapid accelerations and decelerations, with unfavorable results as to wear, cost, reliability and noise. In the case of non-impact printers, wherein the abrupt feeding may be the only operation requiring an important mechanical stress of the organs involved, it may represent the limiting factor in the performance of the printer.

It is an object of a device made according to the invention to obviate the foregoing inconveniences, by an uninterrupted feeding operation of the printing medium. This is obtained by moving the printing medium at a constant velocity perpendicular to the printed line and disposing the type carrying member, that is the endless ribbon or chain, in oblique relation to the printed line direction such, that each type member is provided with a vertical constant speed component equal to the constant vertical feeding speed of the printing medium.

The foregoing arrangement provides a device of great simplicity and reliability, permits the device to reach the maximum printing speed allowed by the printing process, and may be applied as well to mechanical printers as to non-impact printers, thereby, the speed limitation inherent to abrupt feeding of the printing support may be disregarded, thus offering big functional, constructive and economical advantages.

These and other features and advantages of the invention will appear more clearly from the detailed description of an illustrative embodiment thereof, taken in conjunction with the accompanying drawings, in which:

FIG. 1 represents a schematic elevation view of the device;

FIG. 2 is a plan view of the same;

FIG. 3 represents in detail a part of the device;

FIG. 4 is a view of a section along plane IV—IV of FIG. 2 and FIG. 5 a partial view of a section along path B—B of FIG. 4;

FIGS. 6 to 9 show possible variants in the arrangement of the set of characters;

FIGS. 10 to 12 show the block diagram of corresponding register arrangements for controlling the actuators.

Referring to FIG. 1, an endless type-carrying ribbon **1** is supported upon two rollers **2** and **3**, which, under the action of motor means, not shown maintain the ribbon in steady motion in the direction indicated by the arrow. The ribbon, endless in the form of a ring, carries a row of type members **4** which are in the form of small blocks fixed to the ribbon; each one of the blocks carrying, on the external face, the relief of a shape corresponding to a symbol. The row **4** comprises the set of letters, numerals and marks used with the printer.

According to a known arrangement, the type members during their motion, are in motion at a short distance from the rear face of the paper **5**, which in FIG. 1 is cut out to show the types.

An inking means, such as an ink ribbon or a carbon paper ribbon **6**, which winds on and off spools **7** and **8** (FIG. 2), is interposed between the row of type members **4** and the paper **5**. A set of hammers **9**, not shown in FIG. 1, is disposed in front of the paper, as shown in FIG. 2; each of said hammers when actuated by the appropriate electromagnet, will push the ink-ribbon **6** and the paper **5** against the type member in front, thereof, thereby causing the print of the desired character.

The actuation of the electromagnets is selectively operated under the control of a logic device.

As shown in FIG. 1, according to the invention, the axis of the rollers **2** and **3** are slightly oblique relative to the edges of the paper. As a consequence, the ribbon **1** is obliquely located in respect to the print line. The type row **4** is arranged relative to the ribbon **1**, with the same obliquity angle, in the opposed sense, so that as to the part of the ribbon which is in the immediate proximity of

the paper, the row of type is substantially parallel to the print line.

In FIG. 3, for clearness, the obliquity of the ribbon **1** has been exaggerated. The ribbon moves with a constant speed represented by the vector V, which may be considered as resulting from two components, a horizontal speed V_o, parallel to the print line, and a vertical speed V_v, parallel to the paper feed direction.

If the paper is advanced toward the upper part of the drawing by a steady motion having a vertical speed V_1 equal to said vertical component V_v of the type members motion, the speed of the relative motion between type members and paper is limited to the horizontal component V_o. As a consequence, each type member horizontally scans the entire print line passing in front of all print positions and accompanying the paper in its steady motion of vertical feed.

As may be seen from FIG. 3, letter A, which is the leftmost type member of the row, presents itself to the first print position to the left, in the location indicated by the same letter drawn by dashed lines (shown by reference numeral **10**), whereas numeral **9**, which is the rightmost type member of the row, presents itself, in same first print position column, in the location indicated by the same numeral drawn by dashed lines (**11**).

At any moment, like the one represented by FIG. 3, the characters A and 9 printed in the first positions of two subsequent lines, appear, due to the steady vertical motion of the paper, in the locations, indicated by solid lines, and are vertically separated by a space equal to the interline distance I. The distance I is equal to the distance vertically separating the two type members A and **9**, on the type carrying member.

The remaining letters, figures and marks, will present itself, in front of the first print position, at intermediate distances between the indicated extremes.

As a result of the foregoing, the hammer must be in condition to operate effectively at both extreme vertical positions as shown, that is, the active surface of the printing hammer must extend approximately over the whole shaded area **12** of FIG. 3.

FIG. 4 represents a section of FIG. 2 along the line IV–VI, but on a different scale.

The paper **5** moves vertically at a constant speed. The active extremely of the hammer **31**, in its inactivated position, rests on a lower stop member **32** and is free to move upward a short distance, in order to follow the paper in its motion during the required time of contact. This upward motion is limited by an upper stop member **33**.

FIGS. 6, 7, 8 and 9 represent the ribbon **1** straightened out showing some different possible arrangements of the type rows on the ribbon in relation to the number of the characters comprised in each set, the length of the type members rows, and the length of the print line. In FIG. 6 there is only one row, and between its leftmost type member **13** and its rightmost type member **14** there is an interval L wider than the print line.

By this arrangement, when the leftmost type member **13**, moving toward the right, has abandoned the last print position on the right side, the corresponding line has been completely printed, and the printing of a new line is initiated only after the moment at which the rightmost type member **14**, moving toward the right, has arrived at the first printing position on the left side.

The control device of the printing hammers, in that case (FIG. 6), does not differ from the one of the chain printers of the presently known type, as the printing of a line is initiated only after terminating the printing of the preceding line as is briefly outlined hereinafter and shown in FIG. 10.

There is a time interval which cannot be used for printing, its ratio to the line printing cycle is, on the average, equal to the ratio between the length H (FIG. 6) and the entire length of the ribbon.

In the arrangement of FIG. 7, which is the one used in the preferred embodiment of the invention, as shown in FIGS. 1 and 2, the interval L between the leftmost limit **15** and the rightmost limit **17** of the type row **8** is considerably smaller than the length of the print line H. Through this arrangement, it is possible that the type members corresponding to some characters to be printed on a line, present themselves in printing position respective the appropriate hammers at a time when the printing of the preceding line has not yet terminated. As a consequence, the control device of the hammers must be different from the arrangement used in the known printer (shown in FIG. 10), as will hereafter be shown. With this disposition, the unused fraction of time needed for the printing of a line is negligible, because the interval L is very small with respect to the full length of the ribbon **1**.

If the length of the type member row is smaller than half of the full length of the ribbon, the arrangement shown in FIG. 8 may be used. Two rows, **19** and **22** of type members are disposed in successive position on the same ribbon. The vertical distance between the corresponding elements of two rows of type members for instance between the upper limiting line of the two rows, is equal to the space I, between printed lines, whereas the horizontal interval L is, in the preferred arrangement of FIG. 8, much smaller than the length H of the print line. If the length of every type member row is greater than the print line length H, the hammer control device in the arrangement of FIG. 8 does not differ from the one relating to the arrangement of FIG. 7.

If the length of the type member row is substantially smaller than the length H of the print line, the disposition indicated in FIG. 9 may be adopted. In this case three or more rows of type members are so arranged so that type pertaining to three or more consecutive print lines may be printed at the same time. Correspondingly, the printing control device must be arranged in conformity to that disposition.

FIGS. 10 to 12 represent the storage registers for controlling the printing respectively in the event that the printing of a line is initiated only after the completing of the preceding line (FIG. 10, corresponding to the disposition of FIG. 6): or in the event that characters may be printed on a line before the end of the printing on the preceding line (FIG. 11, corresponding to the arrangements of FIGS. 7 and 8) or, finally, in the event that characters corresponding to three lines of print are typed during the same cycle (FIG. 12 corresponding to the arrangement of FIG. 9).

In the condition of FIG. 10, that is, if the printing of a line does not commence until the printing of the preceding line is terminated, there is, for example, a set R of registers, one for each printing hammer. Each register stores the code combination which corresponds to the character which is to be printed in correspondence of said hammer.

By means of known devices, the character which, from time to time, is in the correct printing position respective the face of each hammer, is checked for coincidence with the code combination stored in each register corresponding to each print position. When such coincidence takes place, the corresponding print hammer is energized, and the character is printed. In FIG. 10, the set of registers is indicated by R, and each register, corresponding to a single hammer, is indicated by the lower-case letters *a, b, c, . . . w, x, y, z*; said lower case letter corresponds therefore to the different print positions. Each register is connected to a coincidence-checking device P, which activates the actuator A, that is, in the case under consideration, the electromagnet operating the hammer when the coincidence takes place.

In the disposition of FIG. 10, there is a single set of registers R, which store the data relating to said line while the *n*th line is printed. This is indicated by the letter *n* in FIG. 10. When the *n*th line has been printed, in the time interval between the instant at which the left-

most end **13** of the type row leaves the last print position at the right (FIG. 6) and the instant at which the rightmost end **14** reaches the first position of print at the left, the registers R are loaded with the data related to the line $n+1$.

FIG. 11 corresponds to the arrangement of FIGS. 7 and 8. As has been explained, with this arrangement it may happen that some characters pertaining to line $n+1$ are printed before the printing of the nth line is terminated.

Therefore, as indicated in FIG. 11, two sets of registers, S and R, are provided. The registers of the set S are loaded with the data of the line $n+1$ while the registers of the set R, which, at the start of the printing of the line, contained the data relating to line n, are modified in succession, substituting gradually from the left of the right, such data with data relating to line $n+1$. To carry this out, a terminating command signal is associated with the leftmost end **16** (FIG. 7) of the type member set, in a manner such that, when said end has abandoned a printing position (for instance the one indicated by the index c in FIG. 11), in the corresponding register, the data relating to line n is deleted, and the data related to line $+n+1$ is loaded therein. This register is shown shaded in the FIG. 11.

When the end **16** has passed the rightmost end of the printing positions, all registers of the set R contain the data of line $n+1$. Before the end **16** (or, in the case of FIG. 8, the corresponding end **20** of the type member set **19**) passes in front of the first left print position, the register set S is loaded with the data referring to line $n+2$ in place of the data referring to line $n+1$; the process is subsequently repeated in the same way.

In case of FIG. 9, whereby it may happen that characters pertaining to line $n+2$ and to line $n+1$ are being printed before terminating the printing of line n, the storage register disposition is shown on FIG. 12.

Two register sets, S and R, are provided, set S being devided in two parts, the left one of which contains the data referring to the left half of line $n+1$, and the right one contains the data referring to the right half of line n. As, at any instant, two leftmost ends **24** and **26** of the type member rows may be present in the print line, two terminating command signals are associated with said ends to cause the changing of the data in the registers corresponding ot the print positions in front of which said ends have just passed. Therefore, in the register set R, there are two registers, shaded in FIG. 12, whose contents are being changed. In the rightmost one, the contents referring to line n are being changed to the data referring to line $n+1$: in the left one the contents referring to line $n+1$ are being changed to data relating to line $n+2$. When the leftmost end **24** has passed the print position corresponding to register q of FIG. 12, which is the first of the right half of the set S, the left half of the set R will contain the data referring to line $n+2$: and, as the leftmost end **28** has passed the last print position to the right of the line, the right half of the set R contains only the data referring to line $n+1$. Before the ends 28 and **24** pass in front of the first print position to the left, and the print position corresponding to register q, the right half of register S is loaded with the data referring to the right half of line $n+2$, and the left half is loaded with the data referring to the left half of line $n+3$.

The foregoing described arrangements of the register sets are only examples of a method to be employed for controlling the printing of the characters in different embodiments of the present invention. It should be understood that changes and modifications in the form, construction, arrangement and combination of parts may be made and substituted by those herein shown, and particularly that every known method of selectively controlling the printing of characters in high speed chain printers may be adapted to the same purpose in a way easily to be inferred from the above description, without departing from the principle and scope of the invention.

What is claimed is:

1. In a high speed printing device, the combination of feeding means for moving a print medium at uniform feed velocity in a first direction, a plurality of selectively operable actuators arranged in a plurality of print positions defining a print line substantially perpendicular to the feed direction of said print medium, an endless belt type carrying member including a plurality of type members supported and obliquely disposed thereon in a straight line and having an initial type member and an end type member, said type carrying member being disposed in proximity to and in an oblique direction with respect to the print line, so that a segment of said plurality of type members facing the print medium is substantially parallel to the print line, means for moving said type carrier member along said oblique direction, the speeds of said type carrier member and of said printing medium being so related the one to the other as to move said portion of type members facing the print medium with a speed component in the direction of the feed velocity of said print medium substantially equal to said feed velocity.

2. A high speed printing device as defined in claim **1** wherein said plurality of actuators, includes one actuator for each print position.

3. A high speed printing device as defined in claim **2** wherein said actuators consist of hammers impelled by electromagnets.

4. A high speed printing device as defined in claim **2**, including a plurality of storage means, one for each actuator, each of said storage means including means for receiving an electrical code combination representative of preselected type member to be printed on said printing medium in the print position defined by said actuator, and means for introducing an electrical code combination representative of a new preselected type member to each of said storage means as the end type member passes the print position defined by the actuator which said individual storage means is associated.

5. A high speed printing device as defined in claim **2** wherein the initial and end members are separated by a type free segment substantially longer than a print line.

6. A high speed printing device as defined in claim **5**, including a plurality of storage means, one for each actuator, each of said storage means including means for receiving an electrical code combination representative of a preselected type member to be printed on said printing medium in the print position, defined by said actuator, and means introducing an electrical code combination representative of a new preselected type member to each of said storage means as the end type member passes the end of the print line.

7. In a high speed printing device, the combination of feeding means for moving a print medium at a uniform feed velocity, a plurality of selectively operable actuators arranged in a plurality of print positions defining a print line substantially perpendicular to the feed direction of said print medium, an endless type carrying member including a plurality of type members supported and obliquely disposed thereon in a plurality of straight, parallel lines, each line containing the same repetitive group of type members, having an initial and an end type member, said type carrying member being disposed in proximity of and in an oblique direction with respect to the print line, so that a segment of said plurality of type members facing the print medium is substantially parallel to the print line, means for moving said type carrier member along said oblique direction, the speeds of said type carrier member and said printing medium being so related one to the other as to move said portion of type members, facing the print medium with a speed component in the direction of the feed velocity substantially equal to said feed velocity.

8. A high speed printing device as defined in claim 7 wherein said plurality of actuators includes one actuator for each print position.

9. A high speed printing device as defined in claim 8, including a plurality of storage means, one for each actuator, each including means for receiving an electrical code combination representative of a preselected type member to be printed on said printing medium in the print position defined by said actuator, and means for introducing an electrical code combination representative of a new preselected type member to each individual one of said storage means as any one of the end type members passes the print position defined by the actuator to which said individual storage means is associated.

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U.S. Cl. X.R.

101—111; 197—133