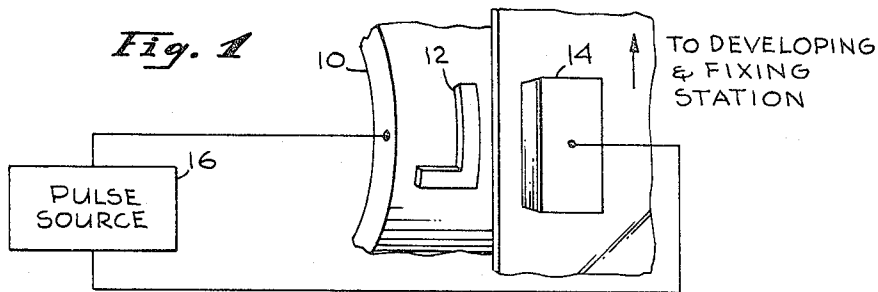
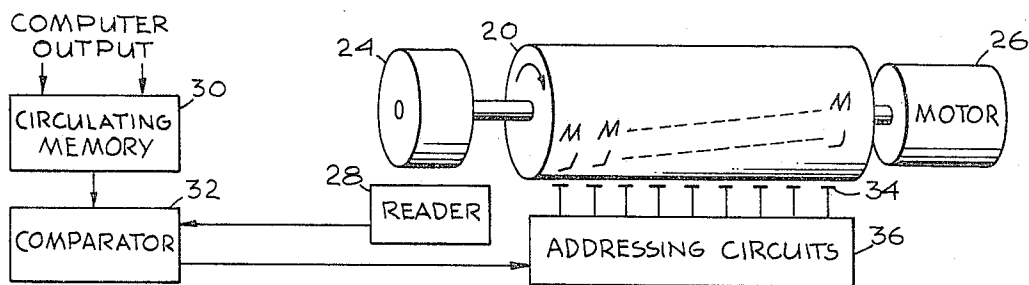
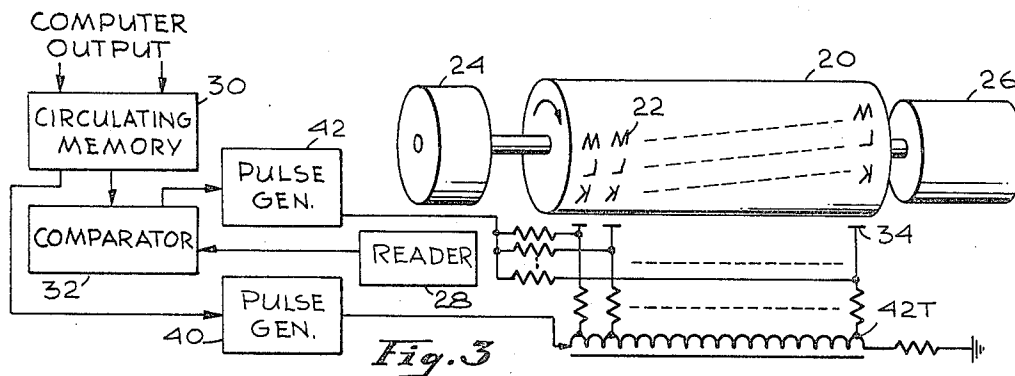
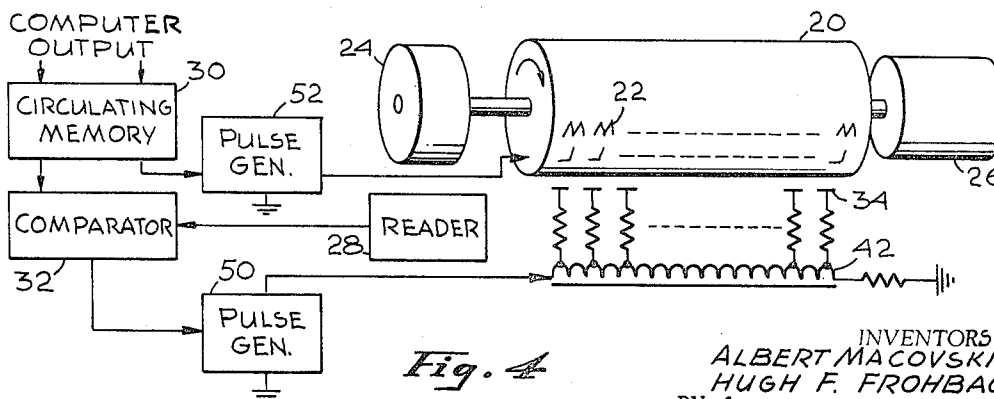


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HIGH SPEED PRINTER ADDRESSING APPARATUS UTILIZING
MULTI-TAPPED DELAY LINE
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HIGH SPEED PRINTER ADDRESSING APPARATUS UTILIZING MULTI-TAPPED DELAY LINE

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ABSTRACT OF THE DISCLOSURE

An arrangement for electrostatically printing at a high speed uses a drum having type characters arranged in rows around the periphery thereof. At a printing position spaced from the type characters are a plurality of aligned electrodes. Paper to be printed on is passed between the electrodes and surface of the drum. The electrodes are connected to a means for successively applying a voltage pulse thereto having an amplitude less than that required to exceed the threshold voltage required for causing a discharge between the electrodes and a type character on the drum. A second pulse, which, combined with the previously applied pulse exceeds the electrostatic discharge threshold, is applied to the electrodes selectively, as required, to cause a print out of the characters in accordance with data provided from a convenient source.

This invention relates to systems for addressing high speed drum type printing systems and more particularly to improvements therein.

One of the high speed printing systems which is presently employed with data processing machines comprises a rotatable drum or cylinder having rows of characters dispersed around the periphery. At a writing station, there are placed a plurality of individually movable hammers. Between the hammers and the drum periphery carbon paper and paper are passed. When it is desired to print on the paper, the hammers are selectively actuated to press the paper and carbon paper against the drum periphery. This causes an imprint of the letter or character opposite the actuated hammer or hammers to be left on the paper.

The rotating printing drum usually has some associated arrangement for identifying which row of letters or characters is coming into the printing station. This identifying information is usually compared with the information from a computer consisting of a line of letters to be printed at a time. The line of letters to be printed is circulated once for comparison with each character in the printing station. In response to an identity, the hammers located at corresponding positions in the line are actuated. It usually requires one cycle of the drum for printing an entire line.

In an application by Rice and Frohbach Ser. No. 334,365, for a Nonimpact Drum Printer, there is described a system which uses the circulating drum but, instead of having a plurality of selectively movable hammers, there are provided a plurality of conductive segments. In accordance with that application, when a voltage pulse is applied between a conductive segment and the drum surface, there is deposited on the surface of the paper an electrostatic charge pattern which has the shape of the type font which is opposite the conductive segment at the time of the application of the voltage pulse. The paper is then moved to a location at which the electrostatic image thereon is developed and fixed in accordance with well known xerographic techniques.

Any addressing scheme for a printing drum must involve a storage means for holding information corre-

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sponding to one line of characters. If the printing drum is assumed to have a repertoire of 64 characters, with 120 characters per line and if six binary bits are required for identifying each character, then the storage device must be capable of holding $6 \times 120 = 720$ bits. Six 120-stage shift registers can be satisfactory as a storage device. During an interval when the paper is advanced to a new line the computer or other input device loads the 720 bits into the storage registers, and after that the data is circulated continuously at a rate equal to or faster than one complete cycle per character row of drum rotation. This must be done, since during the time that one row of characters, say an A, is present before the paper, the conductive segments corresponding to the positions on the line where the "A" is to be printed must be pulsed. The pulses required are on the order of 600 to 1100 volts in amplitude (depending on pulse duration and DC bias employed) so that the brute force solution of using a separate high voltage pulse amplifier and computer for each character position is not too appealing.

An object of this invention is to provide a novel and unique addressing system for a noncontact drum printer of the general type described.

Yet another object of the present invention is to provide an addressing system for a noncontact drum printer of the type described wherein the number of pulse generators, comparators and amplifiers are considerably reduced.

Still another object of the present invention is the provision of a simple addressing system for a noncontact printer of the type described.

These and other objects of this invention are achieved in a noncontact drum printer by connecting the conductive bar segments which are employed in applying voltage pulses, to successive taps along the delay line. The delay between taps is that required for adjacent characters in a row of type which row is skewed, to arrive at the printing position. In other words, in view of the skewing of the type font in a row, the entire row of type will not be present in the printing position simultaneously, but rather will appear therein successively one at a time. Skewing of type font on a drum type of printer is known and taught, for example, in a patent to Hartley, No. 2,776,618.

A pulse is applied to one end of the delay line at the time that the signals representative of the first character to be printed are applied to the comparator. This pulse travels down the delay line raising the voltage at each successive tap simultaneously with the arrival thereunder of the type font in the skewed row of type on the surface of the drum. The amplitude of this voltage, however, is below the threshold required to cause a charge pattern corresponding to the shape of the type font to be deposited on the paper. The comparator compares the incoming signals representative of the characters in the line of type being scanned with signals from the reader for the type drum indicative of the particular character which is in the printing position. When the comparator indicates an identity, a second pulse generator is energized to apply a pulse to all of the conductive segments. This pulse, is also below the threshold value required for depositing an electrostatic charge pattern on the paper. However, this pulse added to the voltage pulse on one of the taps corresponding to the position along the line of type desired for printing, exceeds the threshold value and therefore, there will be deposited at the location indicated an electrostatic charge pattern corresponding to the type font in the printing position at the time of the pulse discharge.

In the second embodiment of the invention, the rows of type font need not be skewed on the drum surface.

Here, the comparator energizes a pulse generator each time an identity is provided. The output of this pulse generator is applied to the tapped delay line. Accordingly, a pulse pattern will exist in the delay line by the time the row of type reaches the printing position, which corresponds to the desired ones of the type font it is desired to print. At this time, which is timed to occur at the end of a memory cycle of character representative signals received from the circulating memory, a pulse is applied to all of the conductive segments such that the voltage thereon will exceed the threshold required for electrostatic deposition of charge on the paper. Alternatively, an opposite polarity pulse may be applied to the drum at this time. As a result, there is a simultaneous charge deposition along a line corresponding to those taps having a voltage thereon which exceeds the threshold required for the electrostatic charge deposition.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a schematic diagram exemplifying the type of pressureless printing with which the addressing system of the present invention is most suitable;

FIGURE 2 is a schematic drawing of a pressureless printing system in more detail, with which the present invention finds its greatest use;

FIGURE 3 is a schematic drawing of one embodiment of this invention; and

FIGURE 4 is a schematic drawing of a second embodiment of this invention.

Referring now to FIGURE 1, there is shown a simple schematic drawing of the principles of non-contact printing, in order to afford a better understanding of this invention. A conductive drum surface 10, shown fragmentarily in FIGURE 1, contains thereon an embossed raised type font 12. Positioned opposite said type font 12 is a conductive segment 14. Paper on which it is desired to print is interposed between the type font 12 and the conductive segment 14. The better the dielectric properties of the paper, the longer the electrostatic charge pattern deposited thereon will remain undissipated.

A pulse source 16 is connected between the conductive segment 14 and the conductive drum surface 10. At the time that the drum surface positions the character 12 opposite the conductive segment 14, the pulse source is actuated by means, not shown, to apply a voltage between the drum and the conductive segment. The type font 12 shapes the electric field which is established therebetween so that a charge pattern is deposited on the surface of the paper 14 having the shape of the type font. It should be noted that in order to obtain a charge deposition, a certain threshold voltage must be exceeded. It has been found that voltage pulses between 600 and 1100 volts in amplitude, depending on pulse duration, and DC bias employed, must be applied in order to achieve electrostatic charge deposition. Thus, a threshold of voltage above approximately 550 volts, may be said to exist. The paper on which the electrostatic charge image has been deposited is next moved to a developing and fixing station. The electrostatic charge image is developed and fixed in accordance with well known xerographic techniques.

FIGURE 2 is a schematic drawing of a general arrangement for pressureless printing with which the present invention may be employed. A conductive drum 20, has the rows of type 22 disposed over the surface thereof. The rows of type are shown as skewed, so that only one type font in a row is within a printing position at any one instant, as the drum rotates.

Usually, some form of identifying mechanism is employed to indicate the character in a row of type font

which reaches the printing position. This may be accomplished by an auxiliary drum 24 or disc which is rotated with the drum 20. A motor 26 may be employed for rotating the drum and the disc 24. The disc contains the character code either by way of embossing, engraving or magnetic deposition, which can be scanned by a reader 28 as the drum 24 is rotated, for producing signals representative of the character which is reaching the printing position.

A computer, not shown, supplies a line of character representative signals, which are to be printed, to a circulating memory 30. The circulating memory circulates this line of character representative signals and exposes signals representative of one character at a time in the line sequence to a comparator 32. The comparator compares these signals with those received from the reader 28. Each time an identity is established, the identity signal is applied to the addressing circuits. It will be appreciated that it is necessary for the circulating memory to circulate the line of character representative signals one complete cycle for each row of type which passes under the printing position. The printing position is defined by a plurality of individual conductive segments 34, one for each type font in a row of type. Each one of these segments 34 are identical to the segment 14 shown in FIGURE 1. The printing position is defined by the region between the plurality of conductive segments 34 and the space opposite to them extending to the surface of the drum. Each time the comparator 32 provides an output signal indicative of an identity between the signal received by the reader 28 and the line of character signals being circulated by the memory 30, addressing circuits 36 apply a voltage pulse between the drum and the one of the segments 34 opposite the location in line corresponding to the location in the line of character signals which is desired to be printed. In response to this voltage pulse, there is a deposition of electric charges on paper, not shown, which passes through the printing position between the conductive segment array and the surface of the drum. While only nine conductive segments are shown corresponding to nine characters in a row of type, the usual drum printer will have 120 characters or, for that matter, any desired number since other than for reasons of practicality there is really no limitation on the number which can be provided. Thus, if a pulse amplifier and/or pulse generator is required for driving each one of the conductive line segments 34, it will be appreciated that this can increase the expense of the apparatus considerably.

In accordance with this invention, as shown in FIGURE 3, only two pulse generators need be employed for properly addressing the conductive segments for printing. In FIGURE 3, those structures which function identically to the structures in FIGURE 2 are given the same reference numerals as are employed in FIGURE 2. When the circulating memory 30 commences to circulate the signals representing a line of data desired to be printed, the first character signal in said line of signals is employed for exciting a pulse generator 40. The output of this pulse generator is applied to one end of a tapped delay line 42. There are as many taps on this delay line as there are conductive segments 34 which it is desired to be driven. Each one of the conductive segments 34 is connected to a separate one of the taps 42T on the delay line 42. The delay interval between the taps provided by the delay line 42 corresponds to the time required to elapse between a type font which is passing through the printing position and the adjacent and succeeding type font in the skewed row to come into said printing position. The amplitude of the voltage applied by the pulse generator 40 to one end of the delay line 42 is below the threshold necessary for deposition of an electrostatic charge pattern on the paper in the printing position, said paper not being shown. Accordingly, as the drum 20 is rotated, a voltage pulse is applied to the plurality of conductive segments 34 successively as each type font in a row of type is opposite

each conductive segment. The amplitude of this voltage pulse is below the threshold required for electrostatic charge depositions.

Each time the comparator 32 determines that there is an identity between the reader signal output and the circulating memory output, it applies an identity signal to a second pulse generator 42. The output of pulse generator 42 is applied to every one of the conductor segments 34. The output of pulse generator 42 alone is below the threshold of voltage required for electrostatic charge deposition. However, the output of pulse generator 42 together with the pulse received from pulse generator 40 is sufficient to exceed the voltage threshold.

Only the conductive segments 34 having the combination of a voltage pulse from the pulse generator 42 and a voltage pulse received from the tap on the delay line have a sufficient voltage to exceed the required threshold for electrostatic charge deposition on paper in the printing position. By way of a specific illustration, assume that the circulating memory 30 is circulating a line of character signals such that the letter "A" appears on the second and last positions of the line. When the circulating memory first commences to circulate the line of character signals, the pulse generator 40 applies a pulse to the delay line 42. Assume now that a row of the letter "A" type has been recognized by the reader 28 as coming into the printing position. The pulse applied to the pulse generator will reach the second tap on the delay line 42 and therefore will bias the second segment 34B when the second A type font is in the printing position. By this time also, the circulating memory has applied a second set of character representative signals, those specifying an A to the comparator 32 whereupon the pulse generator 42 is excited to apply a pulse to all of the conductive segments 34. This results in the segment 34B having a voltage applied thereto which exceeds the threshold and therefore electrostatic charge deposition will occur on paper, not shown, which is in the printing position.

The circulating memory continues to circulate the line of data signals, the drum continues to rotate, and the pulse applied to the delay line 42 continues to travel down the delay line. When the drum positions the last type font A in the row of "A's" in the printing position, the pulse applied to the delay line 42 reaches the last tap and thus biases the last one of the conductive segments 34L in the array. At this time also, if properly timed, the last set of character representative signals in the line being circulated should be applied to the comparator 32. As a result, the pulse generator 42 is excited and applies a pulse to all of the conductive segments including the last one 34L. The resultant two voltages on this segment 34L exceed the voltage level required for causing electrostatic charge deposition on the paper.

FIGURE 4 shows an alternative arrangement which may be employed to FIGURE 3. Here, it is not necessary that the rows of type be skewed on the printing drum 20. Here, the comparator 32 applies an output pulse to a pulse generator 50 each time it senses an identity between the signals applied thereto by the circulating memory 30 and by the reader 28. The pulse generator 50 applies its output to the tapped delay line 42. It should be noted at this point that the drum 24 is positioned relative to the type rows on the drum 20 such that the reader 28 can indicate a row of type just before it reaches the printing position. As a result, a pulse pattern is established on the delay line 42 such that a voltage, which is less than the threshold voltage, is applied to each one of the conductive segments 34 in accordance with the ones of the characters desired to be printed. The circulating memory 30 also provides an output at the completion of the circulation of a line of data which is applied to a pulse generator 52. The output of this pulse generator is applied to all of the conductive segments on the drum. This output is also less than the threshold value for electrostatic charge deposition, but exceeds the threshold value when combined with the voltage applied from the segments driven by the delay

line taps. Thus, electrostatic charge deposition is made to occur simultaneously over the entire row of type but only at those locations where the particular character in the printing position is specified in the line of data signals being circulated.

It should be appreciated that it is possible with this addressing system to operate a plurality of printing stations simultaneously positioned around the periphery of the drum, if the type repertoire is repeated a number of times around the drum periphery. This can be done by repeating the conductive segments at the various locations around the drum to establish printing stations thereat and by connecting the conductive segments in parallel with one another. If, however, the drum only has a single set of rows of type spaced around the periphery then multiple printing can be effectuated by establishing a plurality of multiple printing stations around the drum with conductive segments. A separate read head, however, is necessary here for detecting when a row of type enters a specific printing position and a separate comparator for each printing position is required. However, these comparators can all be supplied by the output of the same circulating memory.

In the system shown in FIGURE 3, multiple stations are addressed by resistively connecting the conductive segments of every station to the same delay line. Thus, each set of segments is synchronously scanned by the same travelling pulse. The writing pulse is provided separately at each station through a separate comparator and pulse source. The writing pulse is resistively coupled to all of the segments of its own writing station. In the system shown in FIGURE 4, a separate delay line is required for each printing station. At the end of one cycle of the circulating memory, the proper pulse pattern exists on each delay line corresponding to the particular type row under each respective printing station. At this instant the writing pulse is applied to all the taps simultaneously, either by adding a pulse to all of the delay lines or by pulsing the drum itself.

There has accordingly been described and shown hereinabove a novel, useful system for addressing an electrostatic drum type printing system.

We claim:

1. The improvement in a high speed drum printer of the type wherein a plurality of aligned rows of type are dispersed about the periphery of a drum and an electrostatic printing location is established by a plurality of aligned conductive segments which are positioned adjacent the periphery of said drum to establish therewith said printing location, each one of said segments being positioned to be aligned with a different one of the type characters in each one of the rows of type, said improvement comprising means for applying first voltage pulses when a row of type is in said printing position between said drum and the ones of said conductive segments which are opposite type characters in said row which it is desired to print, each said first voltage pulse having an amplitude which is less than the amplitude required for electrostatic charge deposition and a duration substantially equivalent to the time that a type character is opposite a conductive segment, said means for applying first voltage pulses including a delay line having a plurality of taps therealong successively connected to successive ones of said conductive segments, means for applying first voltage pulses to one end of said delay line, and means for controlling the timing of the application of first pulses by said means for applying pulses to make each pulse arrive at a tap on said delay line connected to a conductive segment which is positioned opposite a type character desired to be printed when said type character is in said printing location, and means for applying at the time a first pulse is applied to the one of said conductive segments it is desired to print a second voltage pulse between said drum and all of said conductive segments having a duration substantially equivalent to the time that a type character is opposite

a conductive segment, and an amplitude which is less than the amplitude required for producing electrostatic charge deposition but which, when combined with the first voltage pulse, exceeds the minimum amplitude required for electrostatic charge deposition whereby an electrostatic charge deposition corresponding to all the characters in a row desired to be printed is made to occur during the interval required for a row of type to pass through said printing location.

2. In a printing system of the type wherein a rotatable drum has rows of type spaced around the periphery thereof and a printing position is established with the surface of said drum by a plurality of aligned conductive segments spaced opposite said drum each conductive segment being associated with a different one of the type characters in a row of type and being positioned so that the associated type characters pass thereunder as said drum rotates, the improved means for addressing said conductive segments for producing electrostatic charge depositions on paper which is moved through said printing position comprising multitapped delay line means for successively applying over the interval required for a row of type characters to pass through said printing location, a first voltage pulse between said drum and each of said conductive segments within the interval that occurs as a type character in a row of type with which a conductive segment is associated passes through the printing position, said first pulse having an amplitude value which is below that required to produce electrostatic charge deposition, and means for applying only during the interval of a first voltage pulse a second voltage pulse between said drum and all of said conductive segments which together with said first pulse raises the voltage amplitude above that required for electrostatic charge deposition at a time when it is desired to secure such electrostatic charge deposition, whereby electrostatic charge deposition occurs for all of the characters in a row of type desired to be printed within the interval required for said row to pass through said printing location.

3. The improvement recited in claim 2 wherein there is a means connecting each successive tap along said multitapped delay line means to a successive one of said plurality of conductive segments, the delay provided between taps of said multitapped delay line means being determined as the transit time between type characters through said printing position, the connections between said conductive segments and the taps on said delay line being arranged in a succession to establish a voltage on a conductive segment connected to a tap on said delay line at the time that a type character is in said printing position opposite said conductive segment.

4. The improvement in a drum type printer wherein said drum has a plurality of rows of type characters dispersed around the periphery thereof and a plurality of conductive segments positioned adjacent said drum periphery established a printing station therebetween, each of said conductive segments being aligned with a different one of said type characters in each row of type characters, said improvement comprising means for circulating in their proper sequence character representative signals indicative of a line of characters desired to be printed, means responsive to said drum rotation for providing identifying signals representative of a type character at said printing location, means for comparing each of said character signals in said means for circulating with said identifying signals, multitapped delay line means responsive to the first of said character representative signals in said means for circulating for successively applying over the interval required for a row of type

characters to pass through said printing station a voltage pulse between said drum and all of said conductive segments which has an amplitude less than that required to produce electrostatic charge deposition and a duration determined by the interval that a type character is at said printing station, means responsive to said means for comparing indicating an identity for applying a voltage pulse simultaneously between said drum and all of said conductive segments which has a duration on the order of one of said successively applied voltage pulses and an amplitude less than that required for producing electrostatic charge deposition except when added to the voltage pulse being successively applied to said conductive segments, whereby electrostatic charge deposition occurs for all of the characters in a row of type desired to be printed within the interval required for said row to pass through said printing location.

5. The improvement in a drum type printer wherein said drum has a plurality of rows of type characters dispersed around the periphery thereof and a plurality of conductive segments positioned adjacent said drum periphery establish a printing station therebetween, each of said conductive segments being aligned with a different one of said type characters in each row of type characters, the improvement comprising means for circulating character signals representative of characters in a line of type desired to be printed, means for producing identifying signals representative of the type characters in a row on said drum periphery before it reaches said printing position, means for comparing each of said character representative signals to produce for each identity therebetween an identity output pulse having an amplitude less than that required for securing electrostatic charge deposition and a duration determined by the interval of alignment of a type character and a conductive segment, multitapped delay line means for applying within the interval that a row of type characters passes through said printing station said identity pulses to those of said plurality of conductive segments having a location from the first one thereof corresponding to the location of the character signal which produces an identity signal from the first of the character signals in the line of character signals, means for producing a second voltage pulse having an amplitude insufficient to produce electrostatic charge deposition except when it is added to the identity voltage pulse and a duration on the order of that of an identity output pulse, and means for applying said second voltage pulse to all of said conductive segments when the row of type characters, the identifying signal for which has been compared with the line of character signals, reaches said printing position, whereby electrostatic charge deposition occurs for all of the characters in a row of type desired to be printed within the interval required for said row to pass through said printing location.

References Cited

UNITED STATES PATENTS

60	3,131,256	4/1964	Frohbach	346—74
	3,188,649	6/1965	Preisinger	346—74
	3,196,451	7/1965	Jones	346—74
	2,919,967	6/1957	Schwartz	346—74
	3,184,749	2/1962	Groth	346—74
65	3,208,076	5/1960	Mott	346—74

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