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A. MACOVSKI

3,417,404

ELECTROSTATIC DRUM PRINTER

Filed Nov. 22, 1965

2 Sheets-Sheet 1

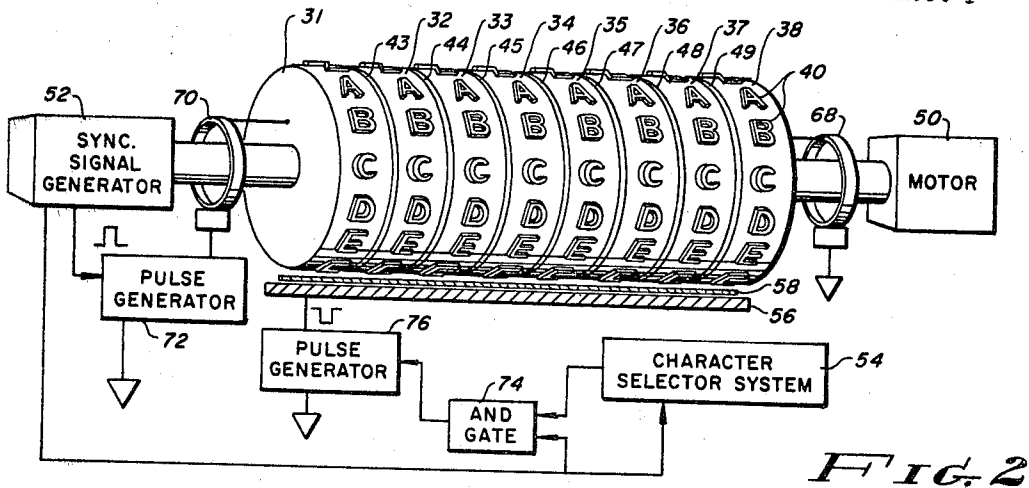


FIG. 2

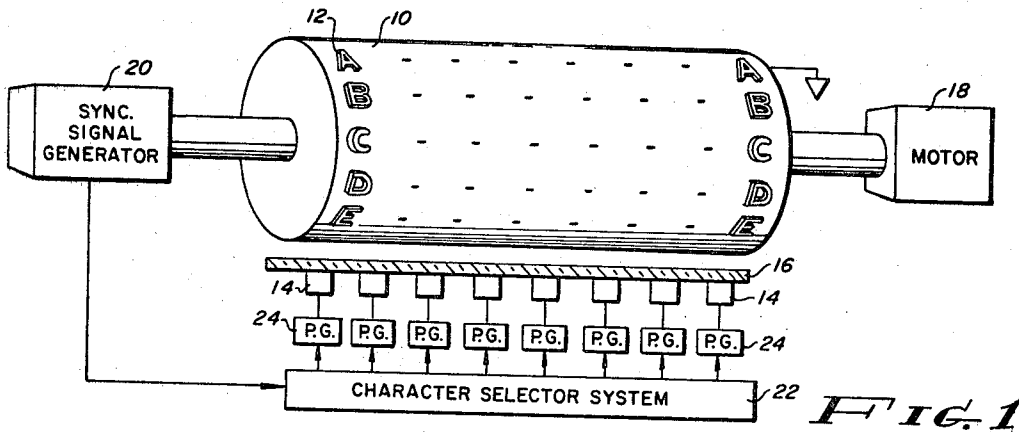


FIG. 1

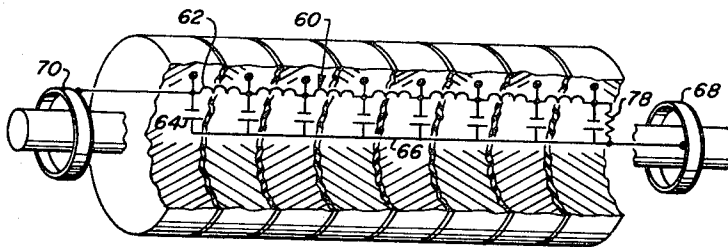


FIG. 3

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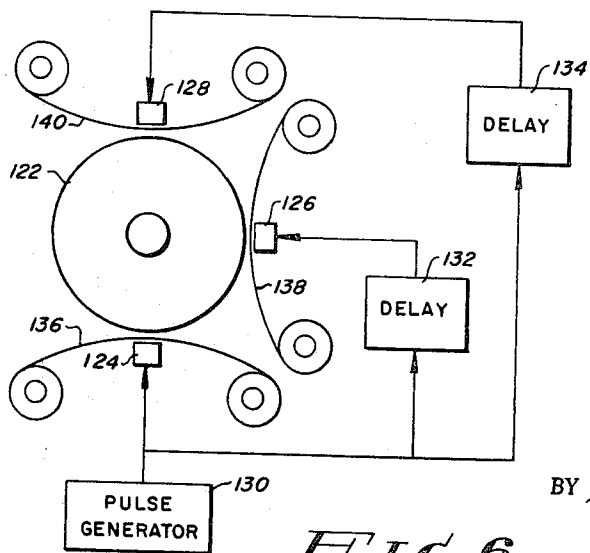
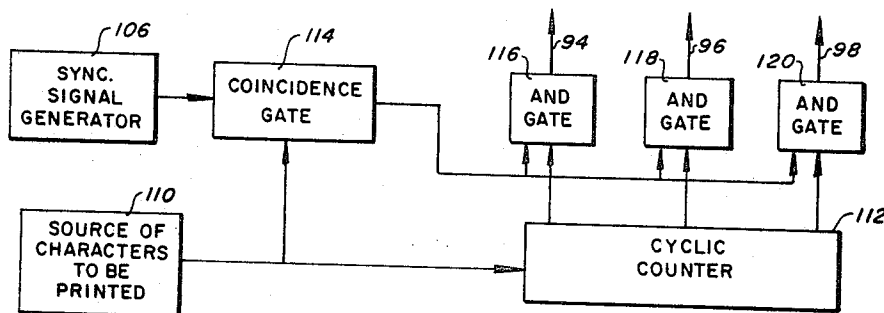
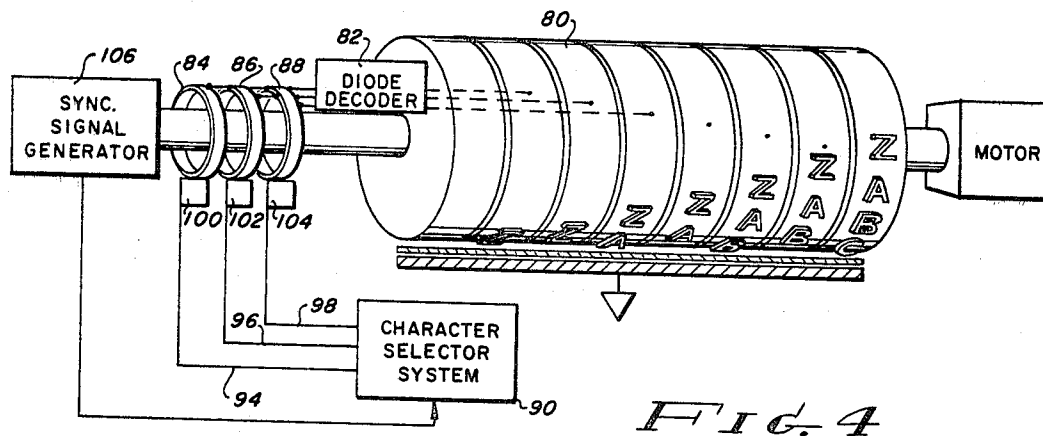
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ELECTROSTATIC DRUM PRINTER

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3 Claims. (Cl. 346—74)

ABSTRACT OF THE DISCLOSURE

A printing drum for electrostatic printing is constructed of a plurality of adjacent cylindrical segments, which are insulated from one another, each segment carrying on the periphery a plurality of spaced conductive type characters. A conductive back bar is positioned adjacent to the drum and substantially parallel to the axis of the drum. A web on which printing is desired is moved between the back bar and drum periphery. An electrostatic image of a character is provided by applying a pulse between each disc segment carrying a desired character and a back bar, when the segment is opposite the back bar.

This invention relates to electrostatic printing and, more particularly, to improvements in electrostatic drum printers.

An electrostatic drum printer of the presently known type is substantially identical with a mechanical drum printer except that instead of printing occurring by selectively moving a hammer in a column of hammers to press paper against a character which is mounted on the surface of a drum, a segmented backbar is provided having a segment for each one of the characters in a row of characters on the drum. A voltage pulse is applied between the drum and a selected one of these segments in order to apply a charge pattern corresponding to a character to the paper. The charge pattern is thereafter developed using well known xerographic techniques.

In presently known electrostatic drum printer construction, the drum is made conductive and the selection of a character for printing is made by applying the voltage pulse to a bar opposite that character which exceeds a threshold value, required to be exceeded in order for an electrostatic discharge to take place. The paper upon which the writing is to occur usually is in the gap between the selecting backbars and the printing drum but moves over and is in contact with the selecting bar, but is spaced from the drum. The paper usually consists of a coating of insulation or a dielectric coating on the paper base, which is more conductive than the coating so that electrostatic charges deposited on the coating are retained for at least a long enough interval to permit fixing of the charge image. In order to obtain high speed printing, narrow pulses are used. This also requires that the resistivity of the paper base must be low enough to provide a relatively short charging time constant. This low resistivity paper, however, provides a low impedance across the selecting bars which the paper bridges. This requires relatively high drive power from the pulse generators connected to the selecting bars.

Another problem which arises with presently known electrostatic printing drums is that of fringing fields which extend between adjacent letters in a row causing the printing of these unwanted letters. The obvious expedient to avoid the deleterious effects of fringing fields on the resulting copy is to spread adjacent letters apart. Unfortunately, because the spacing of adjacent letters in printed copy is usually fixed, the spacing of the adjacent type letters is fixed and so nothing can be done to cure this defect.

An object of this invention is the provision of an ar-

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range for an electrostatic printing drum whereby the selecting bar structure is eliminated.

Another object of this invention is to minimize the drive power required for an electrostatic drum printer, while not reducing its printing speed.

Yet another object of the present invention is the provision of a novel arrangement for an electrostatic drum printer.

Another object of the present invention is to provide a construction for an electrostatic drum printer which eliminates fringing effects.

Still another object of the present invention is the provision of a construction for an electrostatic drum printer which enables the use of a wider range of papers for electrostatic printing.

These and other objects of the invention are achieved in a system whereby the drum of the electrostatic drum printer is made up of a plurality of small cylindrical segments which are axially aligned on a common shaft and are insulated from one another. These cylinders carry the type characters desired to be printed. The printing position is defined by a common backbar spaced from the drum which extends the axial length of the drum. The paper on which printing is to occur passes between the backbar and the drum periphery. When it is desired to deposit an electrostatic charge image of a character in the printing space, a voltage pulse is applied between the cylindrical segment bearing the desired character and the backbar. By this technique, since the selecting backbar segments are eliminated, the paper on which the electrostatic coating is deposited may be as conductive as desired since no problem of shorting is presented. Thus, the required driving power is minimized. Furthermore, since the discharge occurs between the character on the drum surface which is a portion of an insulated cylinder, rather than between the selecting backbar and a character which is a portion of an entire cylinder, there is no fringing effect obtained between adjacent characters in a row on the drum. Any fringing effect which can occur between adjacent characters on the periphery of a cylindrical segment may be compensated for by increasing the spacing between characters by increasing the cylinder diameter. This type of increase in size is permitted since it does not increase the spacing between adjacent characters which are printed.

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 shows an arrangement for an electrostatic drum printer which is provided to assist in an appreciation of this invention;

FIGURE 2 shows an electrostatic drum printing arrangement in accordance with this invention;

FIGURE 3 shows the electrostatic drum of FIGURE 2, a portion thereof removed for the purpose of illustrating connections to a delay line which extends within the drum;

FIGURE 4 shows an arrangement for the electrostatic drum printing system in accordance with this invention using another character selection system;

FIGURE 5 shows a schematic diagram of an arrangement for obtaining coded signals, required to be used in the structure of FIGURE 4; and

FIGURE 6 shows an arrangement in accordance with this invention for making multiple copy.

Reference is now made to FIGURE 1 which is an illustration of presently known electrostatic drum printers.

The drum 10 has rows of characters 12 thereacross. These characters are raised above the surface of the drum. Both the characters 12 and the drum are conductive and the drum 10 is connected to ground. The printing position of the drum is defined as the space between the drum and a plurality of selecting bars 14. Each one of these conductive bars spans the width of one of the characters 12. The paper 16 on which printing is to occur passes in the space between the drum 10 and the selecting backbars 14. The drum is rotated by a motor 18. A sync signal generator 20 is actuated from the shaft of the drum 10. Sync signals are required to indicate when a row of characters is in the printing space so that printing can occur in accordance with the information provided by a character selection system 22. Both the construction of the sync signal generator and the character selection system are well known in the art. An example of a suitable system is shown in the patent to Nelson, 2,850,566.

When the sync signal generator provides a signal which represents to the character selection that there is present in the printing location characters which are desired to be printed, the character selection system 22 energizes the proper one of the pulse generators 24 which applies a voltage to the selecting backbar connected thereto which is of sufficient amplitude to exceed the threshold required for providing an electrostatic discharge between the drum and the backbar. This discharge takes the form of the character within the printing space and therefore a charge image is deposited on the paper 16. If the paper has conductive properties, it serves to load the selecting backbars. It also can serve to broaden out the area of discharge between the paper and the drum, since the entire drum surface is conductive and further since more than one type character is presented simultaneously in the printing space. As a result, the printing which occurs may be spread out, false printing can occur, or printing may be prevented from occurring at all due to the conductivity of the paper.

Reference is now made to FIGURE 2 which illustrates an electrostatic drum printing system in accordance with this invention. The drum is made up of a plurality of cylindrical segments 31 through 38, eight of which are shown by way of illustration and not by way of limitation. The segments may be conductive and each has on its periphery conductive characters 40. The characters are the same on each one of the cylindrical segments.

The cylindrical segments are all mounted with their characters aligned on a common shaft 42. However, the cylinders are insulatingly spaced from one another by insulating spacers 43 through 49. Thus each cylindrical segment rotates in common with the others but is insulated therefrom. The segments form a printing cylinder and the cylinder is rotatably driven by means of a motor 50. On the opposite end of the shaft 42 is a sync signal generator 52 which provides the required sync signals whereby characters from a character selection system 54 may be selected. Instead of having a plurality of selecting backbars, a single backbar 56 is employed which is in the printing position and which extends substantially for the length of the printing drum. The paper 58 on which printing is to occur passes through the printing position and can contact the backbar 56.

While it is within the scope of this invention to apply pulses selectively to the cylinder segments whenever a character carried on a cylindrical segment is in the printing position, whereby the electronic equipment which can be employed is substantially identical with that shown in FIGURE 1, except that the pulse generators 24 actuate the cylinders selectively instead of the backbar selectively, the arrangement preferred is that which is shown in FIGURE 3. A tapped delay line 60 is placed within the drum and the taps on the delay line connect to each one of the cylinder segments. The tapped delay line effectively comprises a tapped inductance winding 62. The capacitor 64

connects each tap to a common bus bar 66. The common bus bar connects to a commutator ring 68 which is mounted outside of the cylinder to be rotatable with the shaft of the cylinder. The input end of the tapped delay line is connected to the commutator ring 70 which is mounted on the shaft of the drum.

Referring now to FIGURE 2, the pulse generator 72 receives a signal from the same sync signal generator 52 each time a row of characters arrives in the printing position and applies this pulse to the input end of the delay line 60. This pulse is successively applied to each one of the segments 31 to 38 over the interval during which a row of characters is within the printing position. The pulse which is applied by the pulse generator 72 to the delay line does not exceed the threshold required for an electrostatic discharge. The additional voltage required to exceed the charge deposition threshold is applied to the backbar 56 each time the pulse applied to the delay line is applied to a segment at the location of a character in the printing position which it is desired to print.

The sync signal generator 52 also applies pulse to an And gate 74 each time a row of characters is in the printing position and holds it open during this interval. The character selection system 54, which is also synchronized by the output of the sync signal generator 52, applies a pulse to the And gate 74 in synchronism with the arrival of a pulse traveling down the delay line 60 at a segment having a character in the printing position desired to be printed. The And gate 74 applies a pulse to the pulse generator 76. The output of the pulse generator 76 is connected to the backbar 56 and it applies a pulse which taken together with the pulse applied to the segment by the delay line is sufficient to cause an electrostatic discharge between the excited cylinder segment and the paper. In this manner, for example, all of the "A's" in a line of type are deposited on the paper, followed by all of the "B's," etc., until after one revolution of the drum, a line of type is printed, or rather the electrostatic charge pattern for a line of type is deposited on the paper. It may be necessary to skew the type, that is offset the type in a row somewhat from a horizontal alignment to compensate for movement of the drum during the time required for a pulse to travel from the input to the end of the delay line 60.

From the foregoing description, it will be appreciated that since the insulating coating of the paper is on the drum side and the conductive part of the paper is placed adjacent the solid backbar, the conductivity of the paper can be increased to reduce the power required of the discharge voltage to charge up the paper capacitance. Since the cylindrical segments are insulated one from the other, there is no spreading out of the discharge and the electrostatic image pattern is sharper than was obtained with the previous system. Further, segment diameter can be increased to provide sufficient room between characters on a segment to prevent this type of adjacent character interference.

FIGURE 4 is a schematic drawing illustrating another arrangement for selective excitation of the cylindrical segments to effectuate charge deposition of a character. The drum 80 has the same construction as the drum shown in FIGURE 2 except that the cylindrical segments are not connected to a tapped delay line but rather each segment is separately connected to a diode decoder 82. The diode decoder rotates with the drum. The input to the diode decoder consists of three lines connected to three separate commutator rings 84, 86, 88.

The character selection circuit 90 applies a binary coded digital signal via three lines 94, 96, 98, to the three brushes 100, 102, 104. The commutator rings then apply these signals to the diode decoder which, in response thereto, energizes one of the segments with a voltage pulse so that the character of that segment in the printing position at the time is printed, or rather a charge pattern having the shape of the character is produced on the

paper. The sync signal generator 106 provides signals to the character selection system indicative of the character in the printing position. The character selection system then produces the coded signals which instruct the diode decoder as to which of the segments it should energize. Diode decoders capable of energizing a single selected line in response to a coded input are well known in the computer art.

The manner in which the character selection system instructs the decoder is shown in FIGURE 5. Signals representative of a line of characters to be printed are cycled by a source 110 at the input of a cyclic counter 112 and a coincidence gate 114. The cyclic counter advances its count once per character. A second input to the coincidence gate 114 is the sync signal generator input. This gate senses a coincidence of inputs to produce an output. This output is applied to enable And gates 116, 118, 120. These And gates are thereby enabled to apply the output of the cyclic counter 112 to the lines 94, 96, 98. The diode decoder converts the signal from the counter to the excitation of a single cylindrical segment.

FIGURE 6 shows how a single drum 122, fabricated in accordance with this invention, may be used for producing multiple copy. Three backbars, for example, are spaced around the drum periphery. The pulse generator 130, corresponding for example to the pulse generator 72 in FIGURE 2, applies a voltage pulse to backbar 124 and to a first delay line 132 connected to backbar 126 and to a second delay line 134 connected to backbar 128. The delay interval of the first delay line is established as the interval required for a row of characters opposite backbar 124 to move opposite backbar 126. The delay interval of the second delay line is established as the time required for the row of characters opposite backbar 124 to move opposite backbar 128. Three separate webs of paper respectively 136, 138, 140 are pulled through the space between backbars 124, 126, 128 and the drum periphery to receive identical electrostatic charge image patterns thereon.

The remainder of the system required to effectuate multiple copy printing in FIGURE 6 is exactly as shown in FIGURE 2. Since the delay line inside the drum has a pulse applied thereto each time a character reaches a printing position, for example that opposite backbar 124, the segments will be properly energized if each of the backbars is placed so that it is opposite a row of characters when there is a row of characters opposite backbar 124. Thus, the selective energization of backbar 124 reaches backbar 126 and later backbar 128 when the characters to be printed reach the locations opposite these backbars. The arrangement shown does not require any holdup of printing at the location of backbar 124 until printing has occurred at the later printing stations. Printing can continue uninterruptedly and multiple copies are obtained uninterruptedly.

There has accordingly been described and shown herein a novel, useful and improved electrostatic drum printing system.

What is claimed is:

1. An electrostatic drum printing system comprising a

conductive type carrying rotatably driven drum made of a plurality of adjacent cylindrical segments, each segment carrying on the periphery a plurality of spaced conductive type characters, insulating material spacing said segments, a conductive backbar positioned adjacent to said drum and substantially parallel to the axis of said drum, said conductive backbar being substantially coextensive with the axial length of said drum, and means for applying a voltage pulse between a conductive type character on one of said segments and said backbar when it is desired to provide an electrostatic image of a character carried by said one of said segments on a web passing between said backbar and said drum periphery, said means for applying a pulse between one of said type characters on one of said segments and said backbar comprises a multiple tapped delay line, each tap of said delay line being connected to a different one of said segments, each of said segments being conductive, first means for applying a voltage pulse to one end of said multiple tapped delay line which does not exceed the threshold required for establishing an electrostatic discharge, and second means for applying a voltage pulse to said backbar having an amplitude which taken together with the amplitude of the voltage pulse applied by said delay line to one of the segments at the time said voltage pulse is applied to said backbar exceeds the threshold required for an electrostatic discharge.

2. An electrostatic drum printing system as recited in claim 1 wherein each segment on which said conductive type is mounted is conductive, and wherein said electrostatic drum printing system includes a plurality of conductive backbars which are spaced around the periphery of said drum, and delay line means is provided for each of said plurality of conductive backbars, each said delay line means is connected between each said backbar and said second means for applying a voltage pulse to said backbar, the delay provided by each said delay line means being determined by the time required for said rotatably driven drum to rotate from the location of the first backbar to receive a pulse from said second means for applying a voltage pulse to the location of the backbar to which said delay line means is connected.

3. An electrostatic drum printing system as recited in claim 1 wherein each segment on which said conductive type is mounted is conductive, said means for applying a voltage pulse between a conductive type character and said backbar includes means connected to each conductive segment for decoding an encoded signal and for applying a voltage pulse to one of said conductive segments responsive to the encoded signal, a source of encoded signals representative of characters desired to be printed, and means for connecting said source of encoded signals to said means for decoding said encoded signal.

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60 J. F. BREIMAYER, *Assistant Examiner*.