Oct. 17, 1967 M. P. TUBINIS 3,348,212

PRINTER CONTROL SYSTEM

Filed Dec. 18, 1964 3 Sheets-Sheet 1

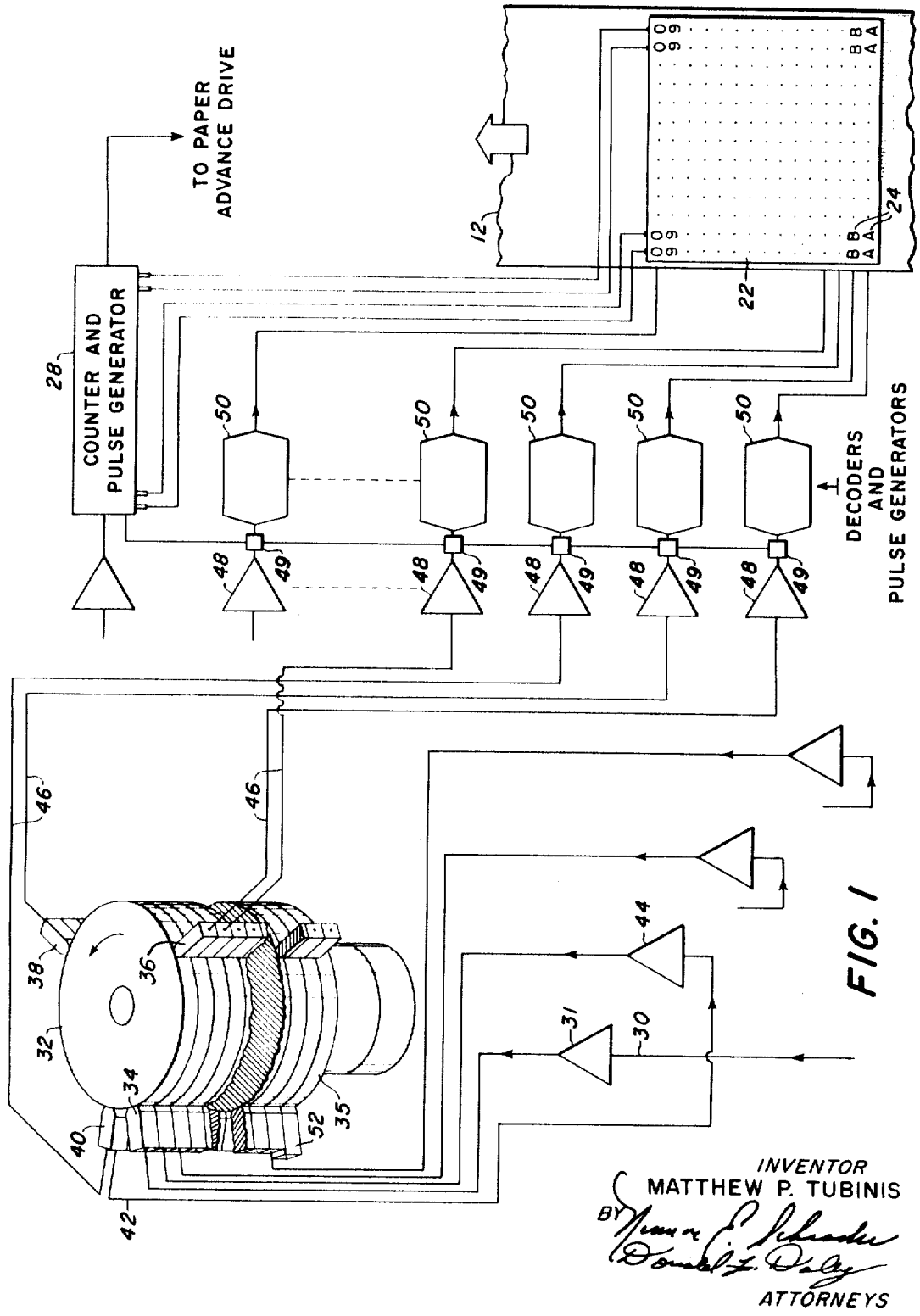


FIG. 1

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Oct. 17, 1967 M. P. TUBINIS 3,348,212

PRINTER CONTROL SYSTEM

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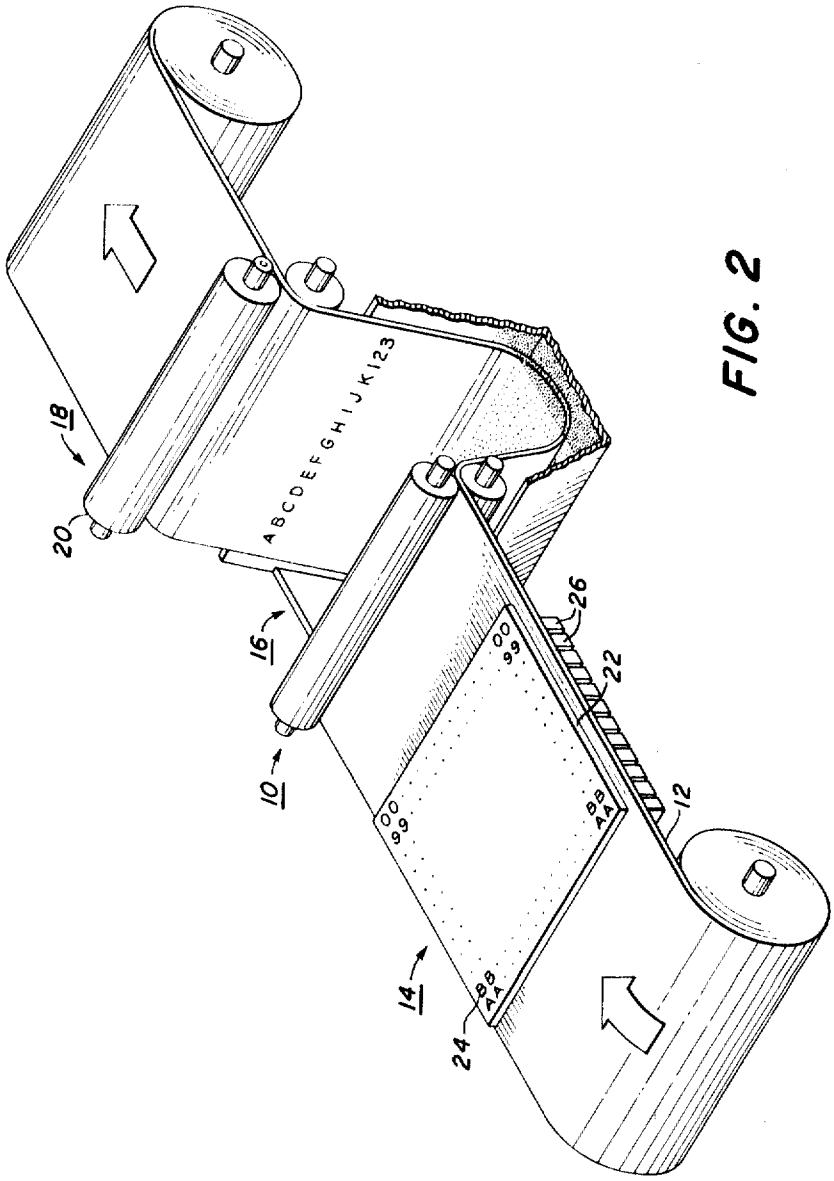


FIG. 2

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Oct. 17, 1967 M. P. TUBINIS 3,348,212

PRINTER CONTROL SYSTEM

Filed Dec. 18, 1964 3 Sheets-Sheet 3

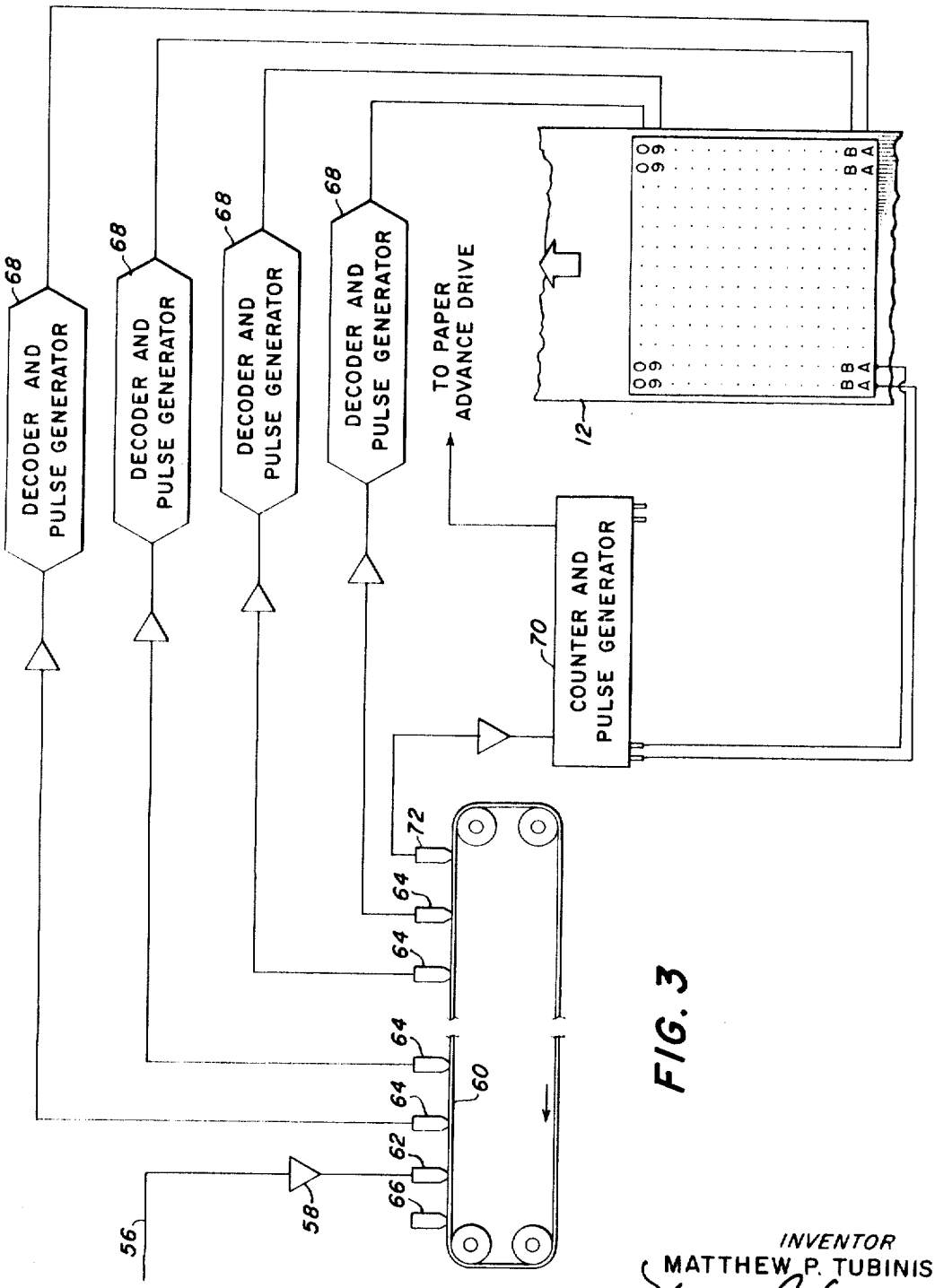


FIG. 3

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United States Patent Office 3,348,212 Patented Oct. 17, 1967

3,348,212

PRINTER CONTROL SYSTEM

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7 Claims. (Cl. 340—172.5)

ABSTRACT OF THE DISCLOSURE

Apparatus for controlling a printer having printing elements arranged in columns and rows, in response to electrical signals corresponding to characters to be printed. The signals are temporarily stored in line-by-line sequence such that signals of a plurality of lines can be read simultaneously. As a result appropriate printing elements in each row are actuated in timed relation to the input of electrical signals.

This invention relates to high speed printing apparatus and, in particular, to a control system for high speed printers of the type used to print information from electrical signals received from a computer or other external source.

A type of printer suitable for use with the control system described herein consists of an array of columns and rows of printing elements or characters arranged in a position to act upon the surface of an image receiving member. The columns extend in the direction of movement of the image receiving member and contain a printing element of each of the characters to be printed. The rows of printing elements extend transversely to the direction of movement of the image receiving member and contain printing elements of only one character to be printed. There are as many rows as there are characters to be printed and there are as many columns as there are printing spaces in a printed line on the image receiving member.

In this type of printer the input signals, representing characters to be printed, are fed to appropriate elements in the particular row and column by means of a control system. The control system provides a time delay for the signals of each character until the image receiving member is in position beneath the row corresponding to that character, and further positions the character in its proper location across the printed row.

Conventional line printers usually consist of a series of rotating discs, reciprocating bars, moving chains or other means containing the full range of characters to be printed. This type of printer presents all characters to be printed to a single print position for actuation in response to the electrical signal input. Whereas line printers print each line sequentially as signals are received from the computer; the printing in the type of matrix printer shown herein is performed on a plurality of lines at the same time.

The present invention is a control system useable with the matrix type printer. Prior control systems for this type printer involved complex electronic equipment. Applicant's invention is a relatively simple device which has the flexibility of being adaptable to various size printers. That is, it may be used with printers having a various number of characters or symbols to be printed, and it is useable for printing a copy that has various character positions per line.

It is the primary object of this invention to improve control systems for high speed printing apparatus of the type capable of being operated from electrical signal input.

It is a further object of this invention to improve control systems for matrix type printers to eliminate the use of electronic equipment.

Further objects of this invention are to provide a relatively small, inexpensive and reliable control system for use with high speed printers.

These and other objects of the invention are attained by means of a control system wherein electrical signals, corresponding to characters to be printed, are temporarily stored in line-by-line sequence so that the signals of a number of lines may be read simultaneously in timed relation to the position of each signal in the printed line and to thereby actuate appropriate elements in each row in timed relation to the electrical signal input.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic representation of a printer control system embodying the invention and utilizing a magnetic drum storage device;

FIG. 2 is an isometric representation of a xerographic printer suitable for use with the control system shown in FIG. 1; and,

FIG. 3 is a schematic representation of an alternative embodiment of a control system utilizing a magnetic tape storage device.

A xerographic printer containing an array of printing elements suitable for use with the control system disclosed herein is shown in FIG. 2. The printer is of the type wherein electrostatic images are formed on the surface of a dielectric image receiving member **12**. The image receiving member **12** is in the form of a web of material such as Mylar, paper or any other dielectric substance having a sufficiently high resistance to hold an electrostatic image for a period which permits subsequent utilizing of the image by a transfer to another surface, or by development thereof. The formation of the electrostatic latent image on the image receiving member is performed at a printing station **14**, and the image receiving member is advanced in the direction indicated by the arrows in FIGURE 2 to a developng station **16** wherein the electrostatic images are developed with a liquid or powdered toner material to produce visible images of the characters being printed. The developed images are fused or bonded to the surface of the image receiving member at fusing station **18** by means of any suitable type of fusing apparatus such as the heated pressure roller **20**, shown herein.

At the print station **14** there is an arrangement of printing elements or electrodes **24** mounted on a template **22**. The printing elements **24** consist of raised metal characters resembling type faces of characters to be printed. The character faces are positioned closely adjacent to the image receiving member **12** but spaced therefrom. Each of the characters of the printing elements constitute a printing electrode and are electrically connected to each of the other printing elements in the same column and are electrically insulated from each of the elements in the same row. The arrangement of the printing elements over the surface of the image receiving member **12** is such that rows containing printing elements of one character extend transversely to the direction of movement of the web **12** and colums containing printing elements representative of each character to be printed extend in the direction of movement of the web. Beneath the template **22** on the opposite side of, and in contact with, the web **12** there is a second series of electrodes **26** in the form of bars extending across the web **12**. When the electrodes **24** and **26** are subjected to a voltage differential of sufficient intensity and electrostatic discharge from the printing electrodes **24**

will impart an electrostatic charge in character configuration upon the surface of the image receiving member. For purposes of illustration, assuming that the threshold voltage with the printing elements used herein is in excess of 1,000 volts but less than 2,000 volts so that when 1,000 volts is impressed across the electrodes an electrostatic discharge does not take place; but when the same elements are pulsed with a second 1,000 volts to produce 2,000 volt differential, the electrostatic discharge will take place and an image will be formed on the web **12**.

In the schematic representation in FIGS. 1 and 2, the printing elements **24** are shown as characters on the top of the template **22**. This representation is used only for the purpose of indicating which characters are being printed at a given position. The actual character formed on the printing element is on the underneath side of the template **22** adjacent to the web **12**.

It can be seen from FIG. 1 that when a complete group of electrical signals representing a single printed line has been received by the printer all the characters of one type in that line may be printed by the first row of characters **24**, and if the other characters are delayed a length of time sufficient for the web to travel to a position corresponding to that character in the matrix then each character may be printed in the same line at different times. That is, all the A's in the first line are printed sequentially during time one; and as the web advances one space, the B's in that line could be printed in time two; and upon subsequent movement of the web, each of the characters could be printed in that line in timed relation to its character position in the colums. Also at time two when the B's are being printed in line one all the A's from a set of signals corresponding to the second printed line could be printed in line two. Following this pattern, it would be possible to simultaneously print, at time three, all the C's in line one, B's in line two, and A's in line three. Thus, when the first line has been completely printed and emerges from beneath the template **22**, the printer would be printing all the rows of charactrs in different lines at each time interval.

The selection of each printing element is accomplished by serially pulsing each column of elements **24** with a voltage less than the threshold voltage, for example, 1,000 volts. This voltage is impressed on the common lead to each of the printing elements in a column by means of a counter and pulse generator **28**. Any character in that column may be actuated by impressing a second 1,000 volt pulse of opposite polarity upon electrode **26** corresponding to the row to be printed. The differential voltage at the printing element common to the pulsed column and pulsed row exceeds the threshold voltage of the printing elements and thus impresses an electrostatic charge pattern on the web. By serially pulsing each column and selective pulsing the rows in response to control signals, selected printing elements will be actuated according to the electrical signal input.

In the embodiment shown in FIGURE 1 electrical signals are received from an external source such as a computer through line **30** and amplifier **31** to a temporary storage device such as magnetic drum **32**. The line **30** is connected to a write head **34** which magnetically stores the information in the first track of a set of tracks on the magnetic drum. As the drum rotates, the information in the first track is acted upon by subsequent read heads around the drum, then erased from track one and stored in track two. On each revolution of the drum all information is moved down one track and new signals are placed in track one. The drum is sized to store sets of signals corresponding to lines of printing at least equal in number to the number of different characters in the printer or equal to the number of rows of printing elements.

If for purposes of illustration it is assumed that the printer is composed of **51** different characters to be printed and thus has **51** rows of printing elements then

the magnetic drum is sized to store **51** lines of information. The drum shown in FIG. 1 is capable of storing three lines of information on each track around the drum surface and the drum has **17** such storage tracks and one timing track **35**. There are three groupings of read heads, indicated at **36, 38** and **40**, equally spaced around the drum with each group containing **17** read heads or one read head per track. The distance between the write heads **34** and the read heads **36** is exactly one line of information. For example, if the printed line contains **120** character positions and the information is received serially in a six bit code, then the spacing between the write head and the first read head would be 720 bits of information. Likewise, if the electrical signals are received in parallel, then the spacing would be equal to 120 bits of information with six read heads at each station. The read heads **38** are also spaced from the read heads **36** and **40** by one line of information.

When the information placed in the first track by the first write head **34** is read by the first read head **40**, it is erased and fed through line **42** to amplifier **40** where it is fed to the second write head **34** for storage in the second track. This process is repeated for each revolution of the drum and the information is fed down to the last track at which time it is merely erased by the last read head **40**.

As the information is read by the read heads **36, 38** and **40**, the information is transmitted through lines **46** to a series of amplifiers **48** then through a timing gate **49** to a series of decoders and pulse generators **50**. The decoders and pulse generators are well known in the art and do not require detailed description herein. However, it should be noted that each decoder and pulse generator is set to respond to one of the characters to be printed. For example, the decoder and pulse generator **50** which receives signals from the read head **36** on the first track is shown herein as set to generate a pulse only upon the receipt of signals corresponding to the character A; the decoder and pulse generator attached to the lead head **38** in the first track is set to generate a pulse upon receipt of information corresponding to the letter B; and the decoder and pulse generator receiving information from the read head **40** in the first track is set to generate a pulse upon the detection of information corresponding to the letter C. This series is continued for each read head, that is, the decoder and pulse generator receiving information from the read head **36** in the second track is set to generate a pulse upon receipt of information corresponding to the letter D and the decoder and pulse generator receiving information from the read head **40** in the last track on the magnetic drum is set to generate a pulse upon receipt of information corresponding to the numeral 0.

The timing track **35** on the drum **32** has information recorded thereon to control the counter and pulse generator **28**. A clock read head **52** reads the information on the clock track and supplies the information to the counter and pulse generator **28** so that the columns in the printer are pulsed sequentially in timed relation to the movement of the drum **32**. The signal from the clock read head **52** is also used to control the drive system, not shown, of the web or image receiving member **12**. Thus the web **12** is moved past the printing elements **24** at a speed synchronized with the rotational speed of the drum **32**.

In operation, signals received from an external source are printed by the first write head **34** in the first track of the drum. When the first bit of information on the drum passes beneath the first read head **36** that information is transmitted to the decoder and pulse generator **50** corresponding to the character A. The decoder will trigger a pulse across the first row in the printer if the information received corresponds to the letter A. At the same time the counter and pulse generator **28** is pulsing the first column in the printer. Thus, if an A is the first

letter to be printed, then the counter and pulse generator would have pulsed the first column and the decoder and pulse generator would have pulsed the first row so that the letter A which is common to the first row and the first column would have been printed on the page. As the second letter is read by the first read head **36**, the counter and pulse generator pulses the second column and the decoder and pulse generator **50** would either pulse or not pulse the first row depending on whether or not an A was detected. This process continues until the first read head **36** has read each character in the first line and the counter and pulse generator **28** has sequentially pulsed each column across the printer. At this time the second line of information received from the computer had been written into the first track by the first write head **34** and the first read head in the group **38** is about to read the first character in the first line of information received and the first read head in the group of read heads indicated at **36** is about to read the first character in the second line of information. The first read head in group **38** passes its information to the decoder and pulse generator **50** corresponding to the second row or the letter B at the same time that the first read head **36** is transmitting its information to the decoder and pulse generator **50** corresponding to the first row or the letter A. Thus, during this reading cycle, B's are being printed in the first line and A's are being printed in the second printed line. At the end of this cycle the first read head **40** is in a position to read the letters C in the first line of information at the same time that the first read head in group **38** will be reading the B's in the second line of information and the first read head **36** is reading the A's in the third line of information. The read head **40**, as pointed out above, not only transmits the information to the decoder and pulse generator corresponding to the letter C but also transmits the information to the second write head **34** for storage in the second track on the drum **32**. The information is now erased from the first track of the drum so that it does not interfere with subsequent information being received by the first write head. This process is repeated as information is received until all read heads in the groups **36, 38** and **40** are reading information simultaneously and transmitting it to the decoder and pulse generators **50**. Thus, for any given pulse by the counter and pulse generator **28** any number of the characters in a column may be printed.

The web **12** may be stepped a line at a time corresponding to a complete cycle of the counter and pulse generator **28**, that is, in timed relation to each line of information received from the external source. However, the speed of printing with this type of apparatus is such that the web **12** can be operated continuously in timed relation to the movement of the magnetic drum. If, due to the continuous movement of the web, the information is not being printed exactly on line, then the printing elements **24** may be skewed slightly to compensate for the continuous movement of the web.

The second embodiment of the control system is shown in FIG. 3 and utilizes a magnetic tape as a temporary storage device rather than a magnetic drum. This system eliminates the need for additional write heads once the information is placed on the tape.

Information is received from an external source, such as a computer, through line **56** and amplifier **58**. The signals are impressed on a magnetic tape **60** in sets of signals corresponding to a printed line by means of a write head **62**. There are a set of read heads **64** corresponding in number to the different characters to be printed or the number of rows of printing elements. The read heads **64** are spaced along the tape **60** in a manner similar to the spacing of the read heads on the magnetic drum. That is, the distance between the write head **62** and the first read head **64** and between each of the read heads **64** is exactly the distance required to store one set of signals corresponding to a printed line.

The magnetic tape **60**, as shown herein, is in the form of a continuous loop wherein the tape after passing the last read head **64** continues around past an erasure station **66** to the write head **62**. The information stored on the tape is erased at the erasure station **66** so that new information may be placed on the tape by the write head **62**.

Each of the read heads **64** is connected to a decoder and pulse generator **68** which in turn are attached to the common leads of the rows of printing elements as described for the embodiment shown in FIG. 1. Each decoder and pulse generator is set to be actuated upon detection of a different character so that the row of printing elements of that character are pulsed in response to electrical signals.

A counter and pulse generator **70** is operatively connected to a read head **72** which continuously senses a timing track on the tape **60**. The counter and pulse generator **70** is connected to the common leads of each of the columns of printing elements and sequentially pulses each of the columns in response to the signals received from the timing track on the tape **60**. The counter and pulse generator also controls the drive mechanism for moving the image receiving member past the printing elements, so that the image receiving member is advanced at a rate consistent with the detection of signals stored on the magnetic tape **60**.

As the counter and pulse generator **70** pulse the first column of printing elements each of the read heads **64** senses the first character in the particular line that it is reading from the magnetic tape. If appropriate signals are received by the decoders and pulse generators **68** the electrodes corresponding to those decoders and pulse generators are also pulsed and various printing elements in the first column are actuated. The counter and pulse generator then pulse the second column and the read heads **64** read the second signal in the line and pulse the appropriate rows. This process is continued until each column has been pulsed and sets of signals corresponding to printed lines have passed beneath each read head **64** at which time the counter and pulse generator again pulses the first column and the read heads **64** read the first signals in the next set of signals. Between each pulsing of the first column the image receiving member **12** is advanced a distance equal to one line.

It is also within the scope of this invention, to feed the incoming signals into electrical delay lines which are read at various points along the line to provide the control necessary to the operation of this type of printer. The delay lines would be used in place of the magnetic drum or magnetic tape.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth, and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

What is claimed is:

1. Apparatus for controlling a printer in response to electrical signals, the printer being of the type wherein an image receiving member is moved past an array of printing elements, the elements being arranged in columns and rows with each column extending in the direction of movement of the image receiving member and having elements representing each of the characters to be printed and each row extending transversely to the direction of movement of the image receiving member and having elements representing one of the characters to be printed, including:

storage means to store signals received according to their column position in a printed line, the storage means being arranged in tracks and being of a size sufficient to store signals representing a number of printed lines equal to the number of rows of printing elements,

means operatively associated with said storage means for transposing the signals received in each track to the next adjacent track,

signal detecting means operatively associated with the storage means to simultaneously detect all signals in the same column position in the storage means and to detect each column sequentially,

and means operatively associated with the detecting means to determine the presence of pre-determined signals in the storage means and to actuate the elements in the proper columns and rows of the printer according to the column being detected and the rows represented by the signals detected.

2. Apparatus for controlling a printer in response to electrical signals, the printer being of the type wherein an image receiving member is moved past an array of printing elements, the elements being arranged in columns and rows with each column extending in the direction of movement of the image receiving member and having elements representing each of the characters to be printed and each row extending transversely to the direction of movement of the image receiving member and having elements representing one of the characters to be printed, including:

means to store sets of signals representing characters to be printed in a line with each signal stored in a predetermined relationship to the position of the character in the printed line,

said storage means having an array of tracks of a capacity sufficient to store a number of sets of signals equal to the number of rows of printing elements,

means operatively associated with the storage means for transposing the signals received in each track to the next adjacent track,

signal detecting and decoding means operatively associated with the storage means to sequentially read and decode each signal in the sets of signals stored, there being as many detecting and decoding means as there are rows of printing elements,

means to actuate printing elements in each row in response to signals from the detecting and decoding means in timed relation to the line position of the signal detected,

and means to control the movement of the image receiving member relative to the rate of detection of signals in the storage means.

3. Apparatus for controlling a printer in response to electrical signals, the printer being of the type wherein an image receiving member is moved past an array of printing elements, the elements being arranged in columns and rows with each column extending in the direction of movement of the image receiving member and having elements representing each of the characters to be printed and each row extending transversely to the direction of movement of the image receiving member and having elements representing one of the characters to be printed, including:

a rotatable magnetic drum adapted to store electrical signals serially received from an external source,

means to place the electrical signals on the surface of the magnetic drum in timed sequence according to the column position of the character represented by the electrical signal,

the drum having tracks arranged therein and being of sufficient size to store electrical signals corresponding to the characters to be printed in a number of lines equal to the number of rows of printing elements,

signal reading means associated with the magnetic drum to simultaneously read all the signals of a column position in each line of stored signals,

means operatively associated with the drum for transposing the signals received in each track to the next adjacent track,

decoding and pulse generating means connected to each row of elements to pulse the row of elements upon detection of a character corresponding to that row by the signal reading means,

means synchronized with the movement of the magnetic drum to pulse each column of elements as the reading means reads the electrical signals corresponding to that column position,

the pulse imposed on the rows of elements and on the columns of elements being insufficient individually to actuate the elements and being sufficient jointly to actuate the elements whereby elements common to a pulsed column and a pulsed row are actuated,

and means to control the movement of the image receiving member in timed relation to the rotation of the magnetic drum.

4. Apparatus for controlling a printer in response to electrical signals, the printer being of the type wherein an image receiving member is moved past an array of printing elements, the elements being arranged in columns and rows with each column extending in the direction of movement of the image receiving member and having elements representing each of the characters to be printed and each row extending transversely to the direction of movement of the image receiving member and having elements representing one of the characters to be printed, including:

a rotatable magnetic drum adapted to store electrical signals serially received from an external source in tracks around the drum surface,

means to impose electrical signals on the drum surface in a first track as they are received from an external source,

means to impose each of the signals in the tracks on the next succeeding track as the magnetic drum rotates,

means to remove the signals in the last track from the magnetic drum,

a plurality of read heads positioned around the tracks of the magnetic drum to simultaneously read all the electrical signals representing characters to be printed in a given column,

means responsive to the rotation of the magnetic drum to sequentially permit all the elements in each column to be actuated as the read heads detect the stored signals corresponding to the characters to be printed by that column,

and decoders and pulse generators associated with each of the read heads to actuate the elements in the column being detected by the read heads when the signals detected correspond to a predetermined signal for each of the decoders,

and means responsive to rotation of the magnetic drum to control the movement of the image receiving member past the printing elements.

5. Apparatus for controlling a printer in response to electrical signals, the printer being of the type wherein an image receiving member is moved past an array of printing elements, the elements being arranged in columns and rows with each column extending in the direction of movement of the image receiving member and having elements representing each of the characters to be printed and each row extending transversely to the direction of movement of the image receiving member and having elements representing one of the characters to be printed, including:

magnetic tape storing means adapted to receive and store signals from an external source in timed sequence to the receipt of such signals,

said tape being of sufficient size to store sets of electrical signals corresponding to lines to be printed of a number equal to the number of rows of printing elements,

a number of read heads equal to the number of rows of printing elements positioned relative to the magnetic tape to simultaneously detect all the signals of

a column position in each of the sets of signals stored,

means operable in timed relation to the detection of stored signals to sequentially energize each column of elements to a level whereby they will be actuated by a subsequent pulse,

a signal decoder and a pulse generator associated with each of the read heads and each of the rows of elements whereby upon detection of a predetermined signal by the read head a pulse will be generated to actuate the printing element in the associated row and in the column being energized,

and means to control the movement of the image receiving member past the printing elements in timed relation to the detection of signals on the magnetic tape.

6. Apparatus for controlling a plurality of printing elements arranged in columns and rows in a position to print upon an image receiving member wherein the columns contain printing elements of each of the characters to be printed and the different rows contain printing elements of one of the characters to be printed, including:

means to move the image receiving member past the printing elements in a predetermined time sequence,

a magnetic drum having a plurality of write heads adapted to place electrical signals in tracks on the magnetic drum as the drum is rotated whereby signals received in each track can be transposed to the next adjacent track in spiral-like fashion,

a plurality of read heads arranged relative to the drum to simultaneously read the signals of a number of

printed lines corresponding to the number of rows of printing elements,

and means to decode the signals read from the surface of the magnetic drum of each row and to energize the printing elements in the row corresponding to the character decoded and in the column indicated by the time position of the electrical signal in the line of information stored on the magnetic drum.

7. Apparatus for controlling a matrix printer from electrical signals representing characters to be printed including:

means including tracks arranged side by side adapted for movement to store all signals in a timed sequence for a plurality of lines to be printed, the signals received on each track being transposed to an adjacent track,

means to read simultaneously signals in print position,

means to detect and decode predetermined signals read by the reading means,

and means to actuate the printer in accordance with the signal detected and decoded and the timed occurence at the signal.

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