COLUMN SELECTING AND TABULATING CIRCUIT FOR A PRINTING MACHINE

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ABSTRACT OF THE DISCLOSURE

The valving electrodes for controlling the ink flow in an electrostatic page printer having a plurality of ink-transfer nozzles mounted in side-by-side relationship are sequentially turned on and off by the output of a binary counter normally advanced one count for each character to be printed. To tabulate, advance pulses are applied to the counter at a rate which is considerably faster than the normal rate at which printing takes place, simulating rapid spacing of the printer, or the binary counter is set directly to a count corresponding to the desired column position on the page.

BACKGROUND OF THE INVENTION

Pat. No. 3,060,429, granted to C. R. Winston on Oct. 25, 1962, discloses a device for printing by transferring ink to paper in substantially the same way that a cathode-ray tube transfers electrons to a phosphorescent screen. As disclosed in the copending application to C. R. Winston, Ser. No. 449,732, filed on Apr. 21, 1965, now Pat. No. 3,432,844, it is possible to mount many of these ink-transfer devices side-by-side across the width of a page printer in order to print in lines across the width of a page. At any given time that one or more of the devices are used to print alphanumeric characters at predetermined locations (columns) on the page of paper, the rest of the ink-transfer devices are prevented from transferring ink to the paper. After a character is printed in one column on the paper, the next character is printed in the next column to the right of that one column until a complete line has been printed. When the end of a line is reached, the paper is advanced by a suitable line-feed mechanism; and printing of the next line is resumed at the left margin of the page. In such a printer, as in any printer, it is desirable to provide means for tabulating to predetermined columns quickly in response to a tabulation command.

SUMMARY OF THE INVENTION

According to the preferred embodiment of the present invention, as applied to an automatic-telegraph, character-by-character page printer using a plurality of ink-transfer devices, a binary counter normally receives from a pulse source one advance pulse each time that a character is printed in response to the completion of printing of that character. The output from the counter activates selected ones of the ink-transfer devices; and as the counter is advanced, ink-transfer devices that have printed a character are turned off and other ink-transfer devices located to their right are turned on, in order to print in successive columns from left to right on the page copy. To tabulate, advance pulses are applied to the counter at a rate which is faster than the normal rate at which characters are printed, simulating rapid spacing of the page printer. Alternatively, one or more telegraph character signals can be received to set the counter directly to a desired column position on the page—to the right or left of the character last printed.

BRIEF DESCRIPTION OF THE DRAWING

A more complete understanding of the invention may be obtained by those skilled in the art from the following detailed description considered in conjunction with the accompanying drawing, the single figure of which is a schematic diagram of a circuit for controlling spacing and tabulation across a page printer.

In the preferred embodiment of the present invention forty printing positions and printing devices are indicated. However, in the accompanying drawing only nine of these printing devices are actually shown. A dash-dot line is used to indicate that thirty-one printing devices have not been shown in the drawing, for clarity, since to show and describe them would simply be repetitious.

The several printing devices contain similar parts, and these similar parts are referred to with the same reference numbers. However, to designate the part of each individual printing device, a dash-number is used after the reference number. For example, the amplifier that is used in each device is referred to by the reference number "19." However, the amplifier that is used with the leftmost or first printing device is referred to by the reference number "19–1" to indicate that it is an amplifier 19 but associated with the first printing device. Similarly the amplifier associated with the second printing device is also given the reference number "19" but is given a dash-number "2." Similarly, the amplifier associated with the sixth printing device is referred to by the reference number "19–6." A similar technique is used in referring to each of those parts in the drawing which are repeated for each printing device.

When referring generally to the construction of the circuit for any printing device, without specific reference to any particular one of the several devices, the reference number only is used without the dash number, thereby to indicate that part in any of the forty printing devices; and it is understood that similar parts are contained in each printing device.

In a like manner a nozzle 10 is shown in association with the valving electrode 11–1 of the first printing device; however, it is to be understood that there is a nozzle 10 associated with each valving electrode 11–1, 11–2, 11–3, etc. Each valving electrode 11 also has associated deflection electrodes 12–to-15, inclusive.

DETAILED DESCRIPTION

Referring now to the drawing, there is shown in a diagrammatic form an ink transfer device of the type shown in the above-mentioned patent to C. R. Winston. In that device ink is supplied at a negligible hydrostatic pressure to a nozzle 10. This nozzle 10 is constructed of a conductive material and is maintained at a negative electrostatic potential. A valving electrode 11, having a central hole 9, is positioned with this hole 9 directly in front of the nozzle 10. When the valving electrode 11 is maintained at a zero electrostatic potential, no ink flows from nozzle 10 and the ink transfer device is turned off. When the valving electrode 11 is maintained at a substantial positive electrostatic potential, ink which carries an electrostatic charge acquired from the metallic nozzle 10 is drawn from the nozzle 10 by electrostatic attraction and passes through the hole 9 in the valving electrode 11. The ink then passes between the vertical deflection electrodes 12 and 13, and differences in voltage between the two deflection electrodes 12 and 13 cause the electrostatically charged ink to be deflected in the vertical direction. Next, the ink passes between two horizontal deflection electrodes 14 and 15 placed at right angles to the vertical deflection electrodes 12 and 13; and the electrodes 14 and 15 are supplied with electrostatic potentials
of different magnitudes in order to deflect the ink droplets in the horizontal direction.

Analog signals are applied to the deflection electrodes 12, 13, 14 and 15 to cause the ink to trace an alphanumeric character on a piece of paper upon which it impinges. A circuit for supplying the analog deflection signals associated with any printing position is shown. In response to six-bit permutation-coded data signals received over a telegraph line, is disclosed in the above-mentioned copending Winston application.

A plurality of these ink transfer devices as shown in the above-mentioned Winston patent are arranged in a row transversely of the paper on which characters are to be printed in lines. Any one of these many devices may be turned on or off by controlling the voltage applied to its valving electrode 11, and in the drawing, representative ones of the valving electrodes 11 are shown schematically.

Each valving electrode 11 is connected to a zero-volt electrostatic potential or ground through a resistor 16 having a resistance of several megohms. The ground potential on the valving electrodes 11, while it makes the potential of the electrodes 11 positive relative to the negative potential on the nozzles 10, is well below the potential difference that exist between the nozzles 10 and the electrodes 11 in order to draw ink at atmospheric pressure from the nozzles 10 associated with valving electrodes held at ground potential.

Each valving electrode 11 also is connected through a normally-open contact pair 17 to the positive side of a D.C. source. When the contact pair 17 is closed, a relatively high potential is applied directly to the associated valving electrode 11, providing sufficient electrostatic potential between the nozzle 10 and the associated valving electrode 11 to extract a stream of ink droplets from the nozzle 10. Each normally-open contact pair 17 is energized when current flows through an associated relay coil 18, operated by the output of an associated amplifier 19 whenever the corresponding printing position is to be activated.

A space generator 25 is shown in the drawing as a functional block and performs the same function as a complex circuit disclosed in the above-mentioned copending application of C. R. Winston. The space generator 25 generates a spacing signal after each character has been printed in response to the completion of printing of the character. The presence of a spacing signal at the output of the space generator 25 indicates that a character symbol has been printed and that the next character symbol should be printed in the next printing position or column to the right. Each spacing pulse from the space generator 25 passes through an OR-gate 26 to advance a six-stage binary counter 27, and each stage of the binary counter 27 provides two binary outputs that constitute a conjugate pair.

The initial condition of the binary counter 27 selects the left-most nozzle 10 in the page printer for printing by providing all of the inputs necessary to select and AND-gate 28–1. When the AND-gate 28–1 is selected, it delivers a signal through an OR-gate 29–1 to energize an amplifier 19–1 which causes current to flow in the relay coil 18–1. When sufficient current flows in the relay coil 18–1, contact pair 17–1 closes, applying a high positive potential directly to the valving electrode 11–1, causing ink to flow from its associated nozzle 10.

Due to transient conditions in the ink transfer device when the activating voltage is first applied to a valving electrode 11, there is a slight lag in establishment of full emission from the nozzle 10. To preclude this lag from restricting the printing speed, the output of the AND-gate 28 associated with any printing position is used to turn on the ink transfer device located immediately to the right of the position. Thus, the output of the AND-gate 28–1 also passes through an OR-gate 29–2 and causes an amplifier 19–2 to pass current through a relay coil 18–2. When current flows in the relay coil 18–2, the contact pair 17–2 is closed, applying a high positive potential to the valving electrode 11–2. At the time of such turning-on of an ink transfer device to the right of the printing position, the ink stream issuing from the nozzle 10 is associated with that device is deflected vertically downward to impinge upon a baffle or mask (not shown), as is described more thoroughly in the above-mentioned application; so that the ink is not deposited upon the paper by the preparatorily turned-on device. Therefore, while the left-most ink transfer device is printing the first character in a line of characters, the second ink transfer device is "warming up."

As soon as the left-most printing device has completed the printing of the first character of the line, the space generator 25 issues a spacing pulse which passes through the OR-gate 26 and advances the binary counter 27 by one increment. In this next condition of the binary counter 27, five of the stages of the binary counter 27 remain unchanged but the first stage (connected to the OR-gate 26) of the binary counter 27 changes state. The resulting second condition of the binary counter removes one input from the AND-gate 28–1 and applies it to the AND-gate 28–2, producing an output from the AND-gate 28–2.

When the AND-gate 28–2 is energized, it supplies a signal through the OR-gates 29–2 and 29–3, taking over from the AND-gate 28–1 control of the contact pair 17–2 and causing the contact pair 17–3 to close, thereby maintaining the high positive potential on the valving electrode 11–1 and applying the same voltage to the valving electrode 11–3, causing the device associated with the valving electrode 11–3 to "warm up." Therefore, ink is extracted simultaneously from the nozzles 10 associated with all three of these valving electrodes 11–1, 11–2, and 11–3.

At this time the electrostatic field of the electrodes 12 and 13 associated with the devices represented by the valving electrodes 11–1 and 11–3 are maintained at suitable voltages to deflect their associated streams of ink droplets downwardly out of impinging relationship with the paper, while the stream of ink droplets issuing from the nozzle 10 associated with valving electrode 11–2 is deflected to impinge upon the paper. The extraction of ink from the nozzle 10 associated with the valving electrode 11–1 after a character has been recorded by ink issuing from that nozzle 10 (of the leftmost or No. 1 printing position) is not, in itself, beneficial. However, it is beneficial, as previously stated, to preparatorily extract ink from the next nozzle 10 (the No. 3 printing position, third from the left) to be used. There may be some possibility of interaction between the electrostatic fields of adjacent ink transferring devices, and compensation for such interaction is obtained by producing identical electrostatic fields in the devices on either side of the one that is recording a character. These fields then oppose and cancel one another in the region of the device which is recording the character.

Analog signals are applied to the vertical and horizontal deflection electrodes 12, 13, 14 and 15 associated with the valving electrode 11–2, as disclosed in the above-mentioned Winston application, to deflect the stream of ink droplets passing through the hole 9–2 in the center of the electrode 11–2 to trace an alphanumeric character on the paper in front of the valving electrode 11–2. After this character has been printed, another spacing pulse is generated by the spacing generator 25. This next spacing pulse passes through the OR-gate 26 and causes the binary counter 27 to advance one more increment, causing the first stage (connected directly to the OR-gate 26) of the binary counter 27 to revert to its initial con-
dition causing the second stage (connected directly to the first stage and positioned immediately below it on the accompanying drawing) of the binary counter 27 to change state. In this condition of the binary counter 27, only the AND-gate 28–3 is energized and supplies a signal through the OR-gates 29–2, 29–3, and 29–4 to the amplifiers 19–2, 19–3, and 19–4. These three amplifiers 19–2, 19–3, and 19–4 cause contact pairs 17–2, 17–3, and 17–4 to apply high positive potential to the valving electrodes 11–2, 11–3, and 11–4; thereby extracting ink from the nozzles 10 associated therewith.

In this way, three nozzles 10 normally issue ink simultaneously providing a signal to the spacing generator. Generator 25 causes the left-most nozzle 10 of any group of three nozzles to cease issuing ink and turns on the nozzle 10 to the right of the three nozzles 10 that previously issued ink. As successive characters are printed, printing advances from left to right across the page copy, until the page is full. During the time that control of the control operation is transferred from one amplifier 19 to another. The leftmost contact pair 17 of the three contact pairs 17 previously closed, however, does open and remains open. Thus, in normal operation, once a given contact pair 17 closes, it remains closed for three character intervals, and the nozzle 10 associated with the contact pair 17 is recording a character during the second or middle of these three intervals. After a contact pair 17 is opened in normal operation, it remains open until the next line is printed.

When printing is to begin again at the lefthand margin of the paper, the binary counter 27 is reset to its initial condition by a reset pulse from a carriage-return pulse generator 33. The generator 33 is shown in the drawing as a functional block but is similar to the carriage-return function circuit that is disclosed in the above-mentioned copending application of C. R. Winston. A reset pulse from the carriage-return pulse generator 33 passes through the OR-gates 34 to reset the several stages of the binary counter 27 to the initial condition.

If a feature known in the telegraph art as automatic carriage-return is desired, the binary counter 27 can be arranged, according to known prior art techniques, to assume its initial condition after printing an alphabet character with the stream of ink droplets that passes through the hole 9–40 in valving electrode 11–40. This can be accomplished, for example, by gating the output of the space generator 25 with the output of the AND-gate 28–40 to generate a reset pulse for the binary counter 27. To facilitate immediate printing from the left-most nozzle 10 in the event of an automatic carriage return, the output of the AND-gate 28–40 can be connected to one of the inputs of the OR-gate 29–1 in order to "warm up" the ink stream associated with the electrode 11–1.

In telegraph page printers and in typewriters, it is often desirable to have the same printing position on the page to another printing position on the same line which is more than one space to the right of the first printing position. This is accomplished by a machine function called tabulation. In the circuit shown in the accompanying drawing, a tabulator pulse generator 35 constantly emits pulses at a rate significantly faster than the one-pulse-per-character rate of the spacing generator 25. A tabulator start circuit 36, shown as a functional block in the drawing, is similar to either the line feed or bell-ringing function decoding circuits 55 or 58 disclosed in the above-mentioned application of C. R. Winston. This tabular start circuit 36 issues a signal output to an AND-gate 37 when ever a code combination representative of a tabulator command signal has been received by the telegraph receiver of which this invention forms a part. An inverter 38 normally delivers an enabling input signal to the AND-gate 37. Therefore, rapid pulses from the tabulator pulse generator 35 pass through the AND-gate 37 whenever the tabulator start circuit 36 issues a signal. The signal issued by the tabulator start circuit 36 persists for an entire character duration until the next code combination is received over the telegraph line. When a tabulation command is received, tabulator pulses are sent from the generator 35 through the AND-gate 37 and the OR-gate 26 rapidly to advance the binary counter 27. Tabulation pulses issue from the generator 35 at a rate high enough to advance the binary counter 27 from its initial condition, wherein the AND-gate 28–1 is selected to a condition wherein the AND-gate 28–40 is selected in the time normally required to print one character.

Each AND-gate 28 has a tabulator stop output 40 which can be manually connected (programmed) to one of the inputs of a tabulator stop OR-gate 41 in order to select any one of the AND-gates 28 to represent a possible tabulator stop position. Any electrical connection between the tabulator stop lead 40 of an AND-gate 28 and the tabulator stop OR-gate 41 is purely arbitrary (as on a type writer). No such connections have been shown herein, but it is understood that any desired tabulator stop connection can be made by an operator by simply connecting a wire between the desired AND-gate 28 and the OR-gate 41. When a signal is received by the tabulator stop OR-gate 41 over the lead 40 that is connected to the output of a selected AND-gate 28, this signal is amplified by an amplifier 42 and is delivered to the inverter 38. When the inverter 38 receives a signal from the amplifier 42, the inverter 38 removes the enabling signal input to the AND-gate 37 and blocks the passage of further tabulator pulses to the OR-gate 26. For example, assume the binary counter 27 is in a condition to select the AND-gate 28–3 and a tabulation command signal is received by the printer, the tabulator start circuit 36 issues a signal to the AND-gate 37 which permits tabulator pulse signals to pass from the tabulator pulse generator 35 through the OR-gate 26 to the binary counter 37. Assuming that the printing machine has been programmed to produce a blank space from the AND-gate 28–6 has been connected by means of tabulator stop output 40–6 to the tabulator stop OR-gate 41, the binary counter 27 rapidly advances until the AND-gate 28–6 is selected. When the AND-gate 28–6 is selected, a signal is issued from the tabulator stop output 40–6 to the tabulator stop OR-gate 41. This signal passes through the OR-gate 41 and causes the inverter 38 to remove the enabling input signal from the AND-gate 37, preventing further tabulator pulses from reaching the binary counter 27. The binary counter 27 remains at a count which selects the AND-gate 28–6, and tabulation has been accomplished. The next code combination received over the telegraph line is not normally another tabulator command signal; consequently, this next code combination causes the tabulator start circuit 36 to remove another one of the inputs to AND-gate 37. At the same time, the character represented by this next code combination is printed in a valid position associated with the valving electrode 11–6 under control of the output of the AND-gate 28–6.

In the event that it is necessary to tabulate the page printer without the use of a manually-programmed or pre-set tabulator stop, a one-or-two-character automatic tabulator signal may be sent to the printer over the telegraph line and used directly to set the state of the
several stages of binary counter 27. An automatic tabulator function circuit 45 is shown in the drawing as a function block and is similar to the function decoding circuits 50, 55, and 58 that are disclosed in the above-mentioned, copending Winston application. The automatic tabulator command circuit 45 issues a command signal each time that a code combination representing an automatic tabulation function command is received over the telegraph line. This signal enables a set of automatic tabulator AND-gates 46 for a duration that is slightly longer than the period during which a single code combination is normally received. Each code combination that is received over the telegraph line is supplied to a set of automatic tabulator inputs 47, but these code combinations normally are blocked by the disabled AND-gates 46. When these AND-gates 46 are enabled by the circuit 45 in response to receipt of a coded automatic tabulator command signal, the code combination received next is passed through the AND-gates 46 directly to one set of inputs to the several stages of the binary counter 27. A plurality of tabulator inverters 48 generate signals that are the binary inverse of the code combination that passes through the AND-gates 46 and deliver these inverted signals through OR-gates 34 to another set of inputs to the several stages of the counter 27. The counter 27 then assumes a condition dictated by the code combination that followed the automatic tabulator command. Since any possible permutation code combination can be set into the counter 27 through the AND-gates 46, the counter 27 can be set to energize any one of the AND-gates 28 to cause ink to be drawn from its associated nozzle 10. Therefore, the page printer can be tabulated on command to a column position that is either to the left or to the right of the previous column position of the printer.

I claim:

1. A printer for selecting at least one of a plurality of column positions in which a symbol is to be printed including:
   a plurality of printing means, each printing means individual to at least one of a plurality of column positions for causing the printing of any one of a plurality of symbols at its associated column positions;
   a binary counter having a plurality of outputs;
   means for normally advancing the counter a predetermined amount in response to the printing of a symbol by the printing means;
   means responsive to the output of the counter for causing different printing means to be rendered operative for different counter outputs;
   means for supplying a tabulation signal to the printer;
   means responsive to the tabulation signal for advancing the counter at a rate which is substantially faster than the rate at which symbols are received;
   a coincidence gate individual to a predetermined column position and having an output and a plurality of inputs, each of the inputs of the coincidence gate being connected to different ones of the outputs of the binary counter; and
   means responsive to the output of the coincidence gate for disabling the fast counter advancing means.

2. A printer having a circuit for selecting at least one of a plurality of column positions in which a symbol is to be printed in response to a permutation-coded input signal, including:
   a plurality of printing devices, each printing device corresponding to at least one of a plurality of column positions for printing symbols at its associated column positions;
   means for controlling the operation of each printing device;
   a counter;
   means for normally advancing the counter a predetermined amount in response to printing of a symbol by the printing device;
   means controlled by different output counts from the counter for selectively causing the controlling means to render the printing device for at least one column position operative;
   means responsive to a first tabulation input signal for enabling the setting of the counter; and
   means for setting the counter to a predetermined count in response to a second permutation-coded input signal corresponding to the predetermined count.

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