United States Patent

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[54] PRINTER AND CONTROL CIRCUIT THEREFOR

3 Claims, 4 Drawing Figs.

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[51] Int. Cl. B41j 9/14, B41j 1/34, H01h 47/00
[50] Field of Search .... 101/93 C, 96 C; 317/137; 340/172.5; 178/23 R, 23 A

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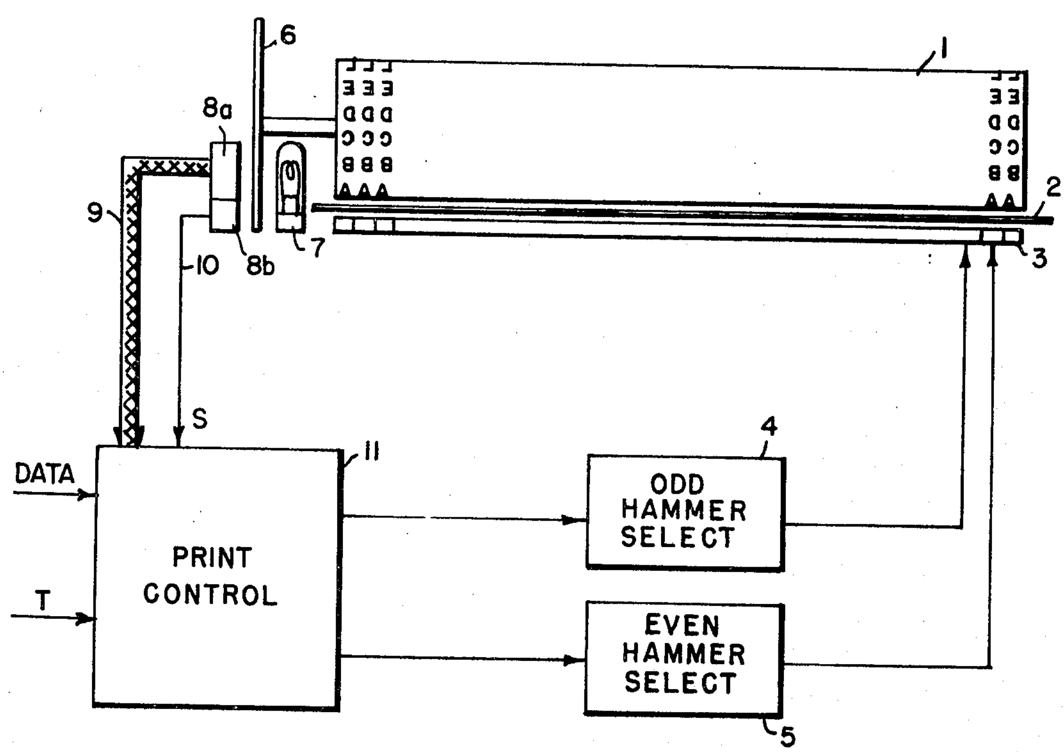
ABSTRACT: A printer having a bank of electromagnetically operated print hammer mechanisms which are sequentially energized by only two driving circuits. Those hammer mechanisms which print in the even columns of the line being printed are energized by one of the driving circuits while those which print in the odd columns are energized by the other driving circuit. The two driving circuits are alternately energized so that characters are alternately printed in the odd and even columns. Each driving circuit is connected to the hammer mechanisms which it energizes via a network formed by two sets of leads arranged as a matrix. A first group of relays is provided to selectively connect the leads in one set with the driving circuit while another group of relays is provided to selectively connect the leads in the other set with a reference potential. Each hammer mechanism has its coil connected between a different pair of leads, each lead of the pair being in different sets. When one relay in each group is closed, a conductive path is provided from a driving circuit, to a hammer mechanism, to the reference potential. Decoding means are provided to simultaneously operate a pair of relays, one in each group, in response to outputs from a binary counter. Advancement of the counter sequentially operates the decoding means to close one pair of relays at a time and cause the hammer mechanisms to be sequentially electrically connected between the driving circuit and the reference potential. In this manner, one driving circuit sequentially energizes those hammer mechanisms which print in either the odd or even columns.



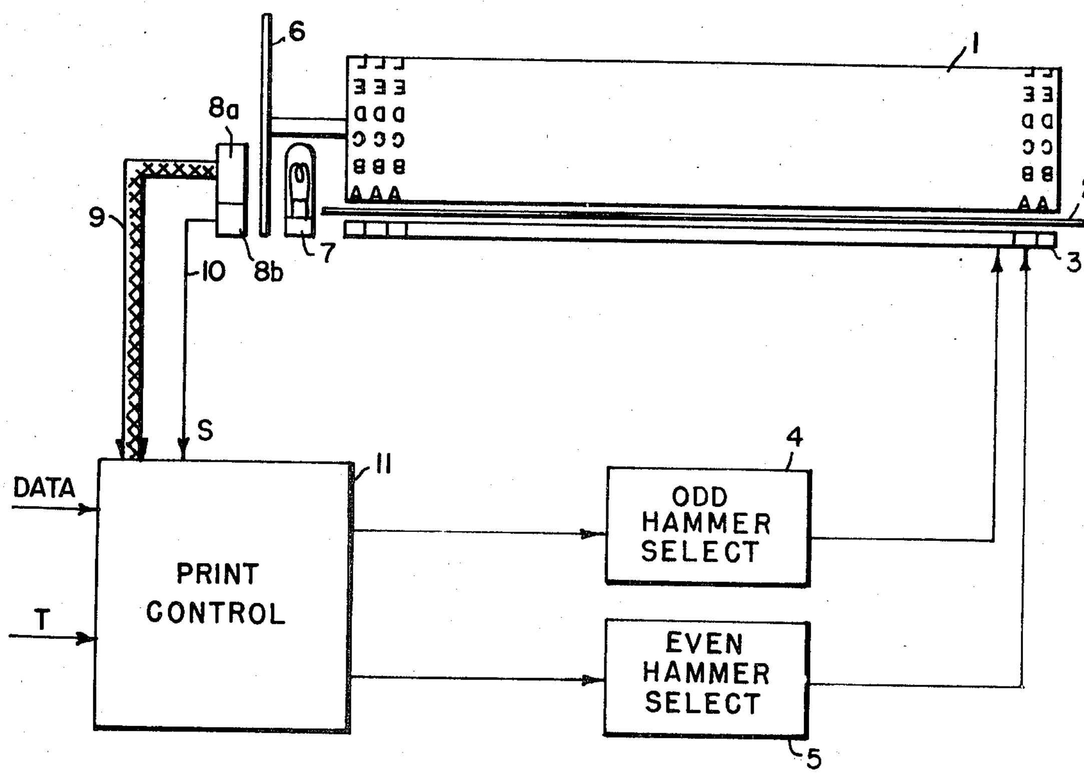


FIG. 1

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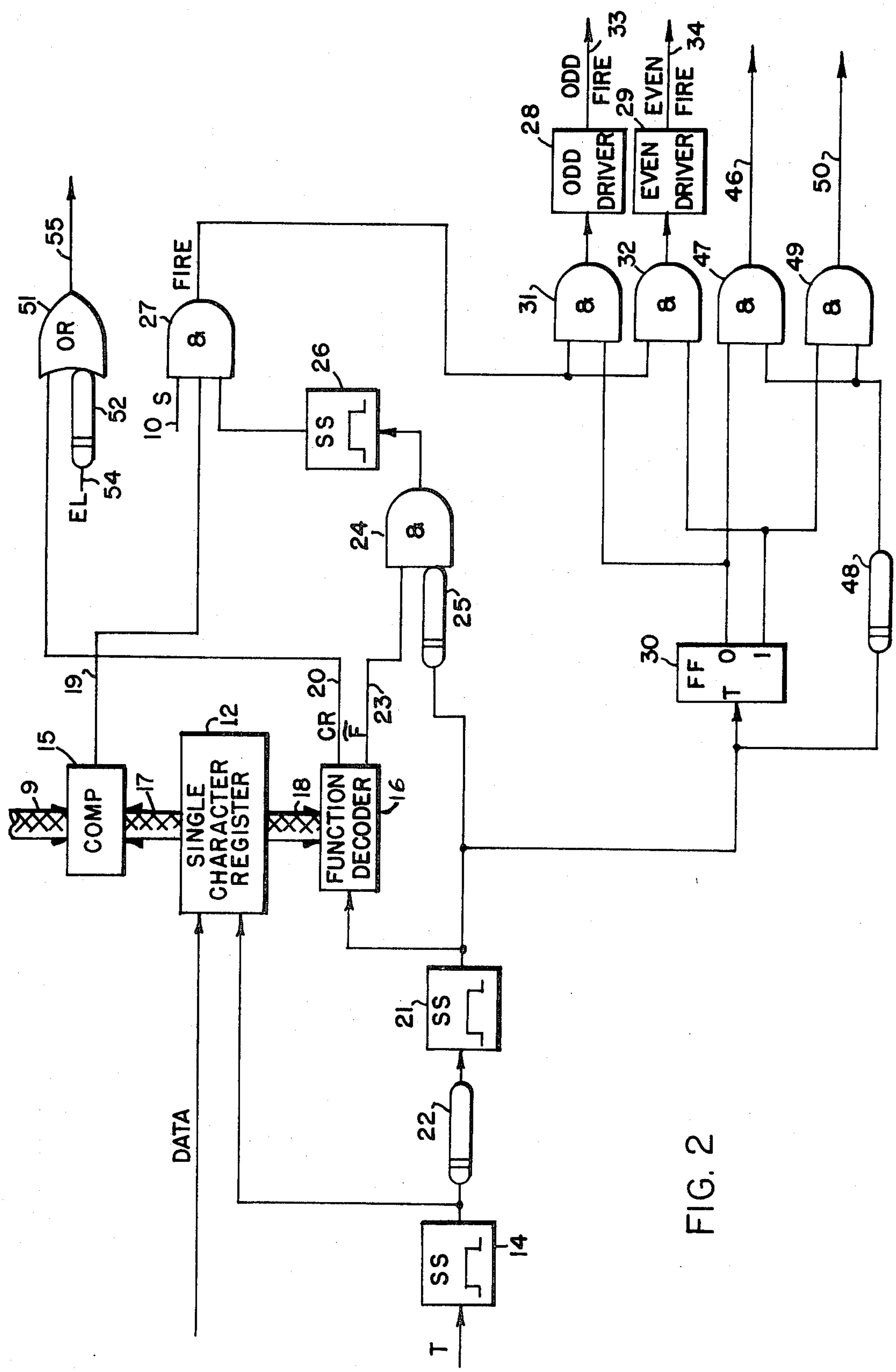

COMP
SINGLE CHARACTER REGISTER
FUNCTION DECODER
DATA
T
SS
OR
EL
FIRE
CR
ODD DRIVER
EVEN DRIVER
ODD FIRE
EVEN FIRE
FF

FIG. 2

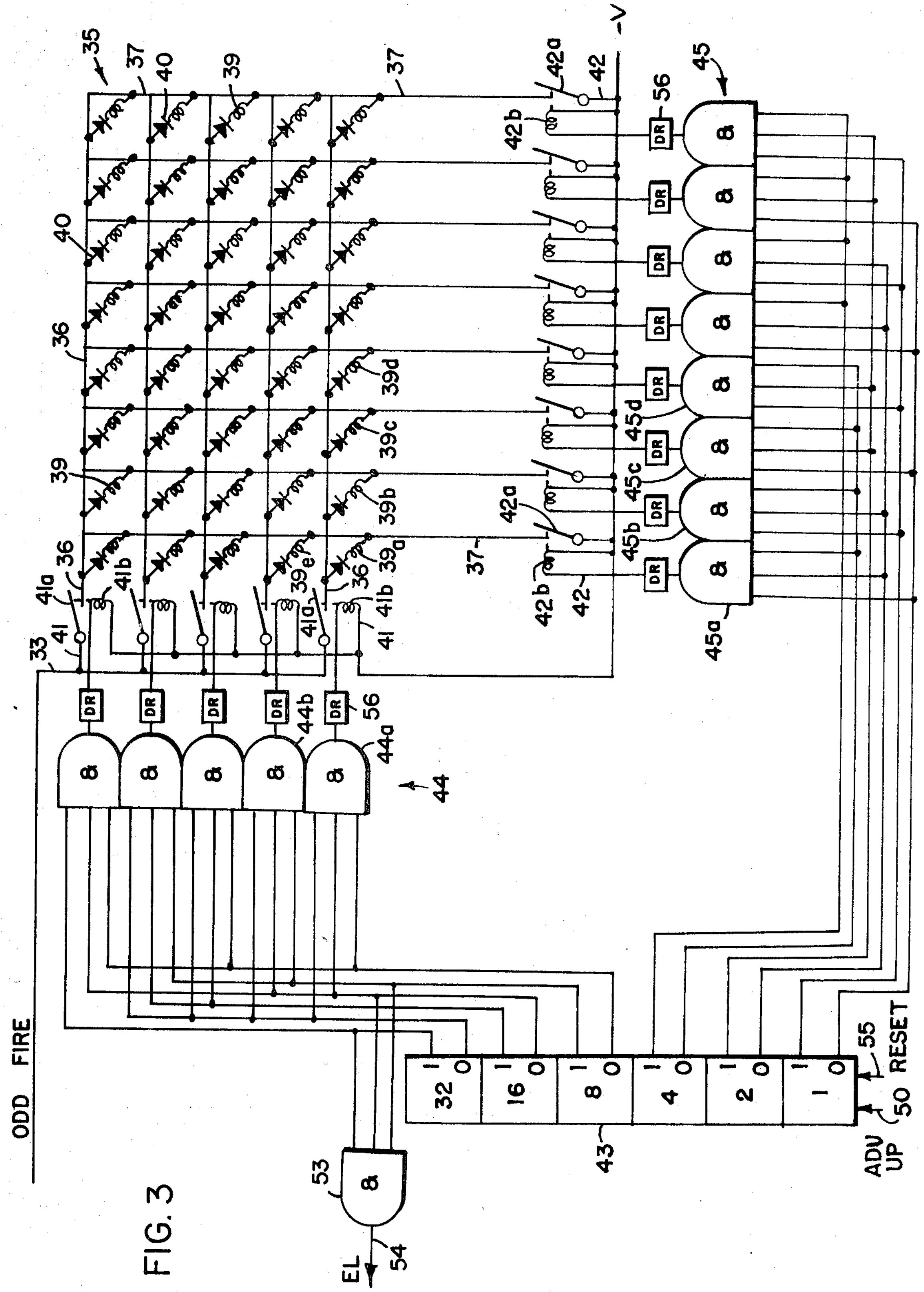
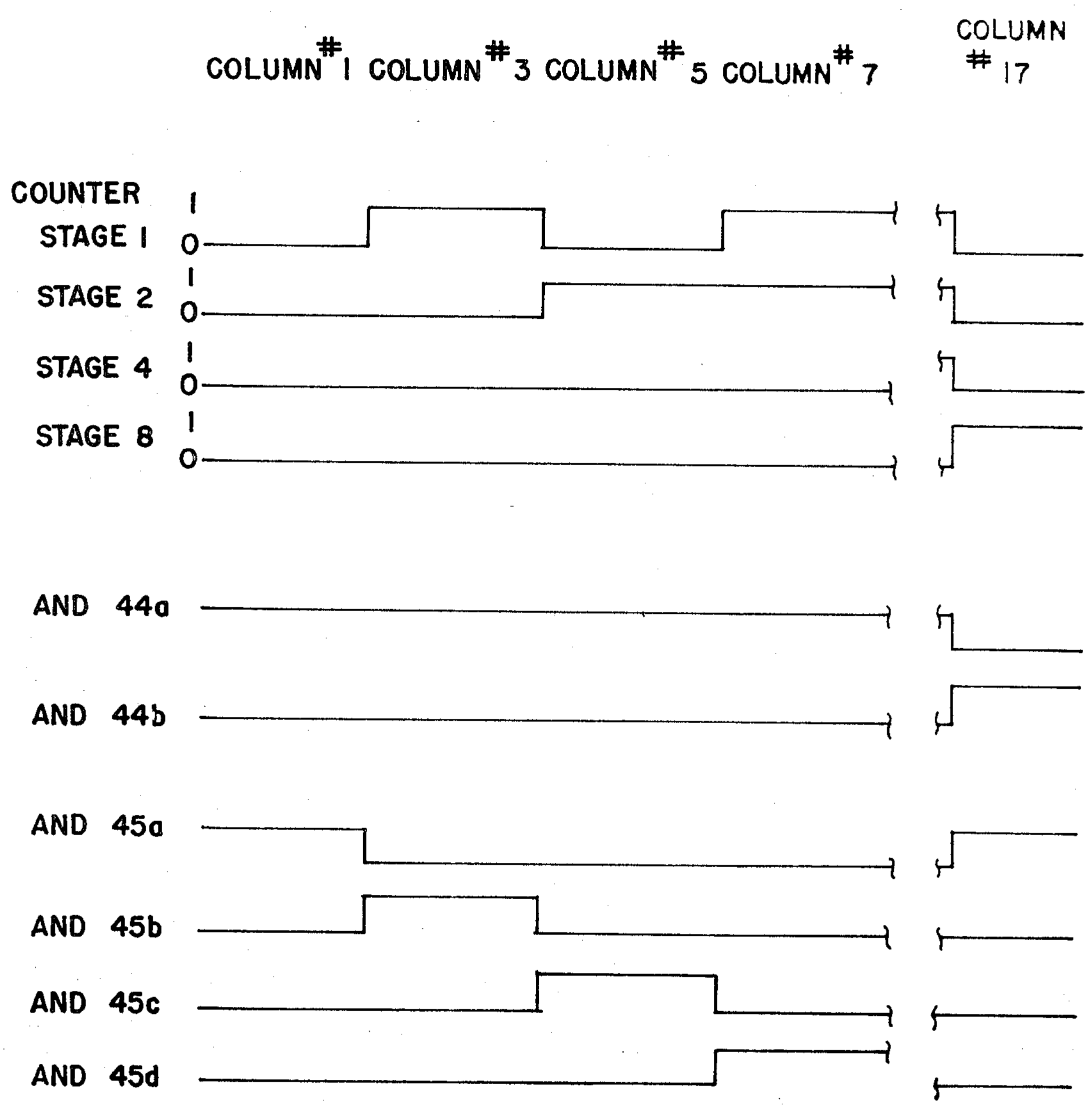


FIG. 3

FIG. 4


COLUMN # 1
COLUMN # 3
COLUMN # 5
COLUMN # 7
COLUMN # 17
COUNTER
STAGE 1
STAGE 2
STAGE 4
STAGE 8
1
0
AND 44a
AND 44b
AND 45a
AND 45b
AND 45c
AND 45d

PRINTER AND CONTROL CIRCUIT THEREFOR

BACKGROUND OF THE INVENTION

This invention relates to printers for printing data represented by coded electrical signals and, more particularly, to a control circuit for such a printer.

Numerous printers have been developed for printing the coded electrical output of data processing apparatus. Generally, in these printers, one or more print hammers strike a document and ribbon against type characters on a drum or chain revolving at high speed in back of the document. The mechanisms for activating the print hammers are usually electromagnetically operated and contain actuating coils. Energization of the hammer mechanisms is timed with respect to the moving drum or chain such that the desired type characters are impacted.

The control circuits for these printers contain logic circuit elements which conventionally operate on a binary voltage level basis wherein the inputs to the elements and the outputs therefrom always exist at either of two discreet voltage levels—the positive voltage level of the circuit or the negative voltage level of the circuit. Since these voltage levels are relatively low (typically, +4 volts and −2 volts) the outputs of the logic circuit elements are not sufficient to energize the coils in the electromagnetically operated print hammer mechanisms. Thus, a driving circuit arrangement is required to provide an output of sufficient magnitude to drive the hammer mechanisms in response to an output signal from one of the logic elements in the circuit.

In the prior art, a separate driving circuit was provided to energize each hammer mechanism. However, since driving circuits are relatively expensive, it is desirable to minimize their number.

SUMMARY OF THE INVENTION

According to the invention, a printer is provided having a control circuit for sequentially energizing a plurality of print hammer mechanisms with a single driving circuit. The energizing sequence is regulated by a network formed by two sets of leads arranged as a matrix. The driving circuit is adapted to be connected to each lead in one set, each lead in the other set is adapted to be connected to a reference potential, and each print hammer mechanism is connected between a different pair of leads with the leads in each pair being from different sets. Each set of leads has a different group of switching devices for connecting the leads to either the driving circuit or reference potential. When a switching device in each group is operated, a conductive path is provided from the driving circuit, along a lead in one set, to a hammer mechanism, along a lead in the other set, and to the reference potential.

The switching devices are selectively operated by a counter having its output leads connected to first and second decoding means. Each decoding means is connected to a different group of switching devices and adapted to selectively and individually operate the switching devices in the group to which it is connected. For each output of the counter, the decoding means operate a selected switching device in each group and successively advancing the counter sequentially operates the switching devices to sequentially energize the hammer mechanisms.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic diagram of a preferred embodiment of the printer with its control circuit.

FIG. 2 is a schematic logic diagram of the print control circuit shown as a block in FIG. 1.

FIG. 3 is a schematic logic diagram of the odd hammer selecting circuit shown as a block in FIG. 1.

FIG. 4 is a diagram illustrating the operation of the odd hammer selecting circuit shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 schematically illustrates a printer having a conventional print drum 1 with type characters on its periphery. The type characters are arranged in rows paralleling the drum's axis and in columns corresponding to the columns to be printed in a line on a document 2. Each column on the drum contains a complete font of type characters. The drum is rotated at a constant speed by a driving means not shown. The document 2 is stepped by tractor means (not shown), line by line, out of the plane of the drawing. A bank of hammer mechanisms 3 is positioned adjacent the drum and the paper passes between them and the drum. A hammer mechanism is provided for each column of type characters on the drum and all hammer mechanisms in the bank are electromagnetically operated. The hammer mechanisms may be of any conventional construction. For example, the bank 3 may be made up of a plurality of hammer modules as described in U.S. Pat. No. 2,940,385 issued to F. R. House on June 14, 1960. When energized, each hammer within a hammer mechanism forces a ribbon (not shown) and the document 2 against the type character on the drum which is to be printed. Of course, the hammer mechanisms may be of the type wherein an activating coil is attached to a movable print hammer and located in a magnetic field so that energization of the coil caused the hammer to move toward the document. The hammer mechanisms may also be of the type wherein a movable print hammer is mounted on one or more leaf springs which bias the hammer toward the document but are normally held stressed by magnetic holding forces; a bucking magnetic field is used to nullify the magnetic holding force on each hammer, release the stressed springs, and thereby allow the hammer to fly toward the document. A pair of hammer selecting circuits, 4 and 5, are provided for sequentially selecting the hammer mechanisms which are energized to print characters in the odd or the even columns respectively.

For ascertaining the row of type characters approaching the hammer mechanisms at each instant, a conventional circular code disk 6 is mounted on the shaft of the print drum to rotate therewith. The code disk is interposed between a light source 7 and a photosensing device 8. As is conventional, the code disk 6 contains radial rows of coded apertures. Each radial row corresponds to a different character on the drum and contains a sufficient number of apertures to represent that character according to a binary code. Light passes from the light source, through the coded apertures and onto a portion 8*a* of the photosensing device. In response, the photosensing device provides a unique binary coded signal representing the row of type characters. This output of the photosensing device is fed over a cable 9 which contains sufficient leads for transmitting binary-coded electrical signals representing the characters on the drum.

As is also conventional, the code disk 6 contains a series of radially spaced apertures, each corresponding to one row of characters on the drum. Light passing through these apertures on to a portion 8*b* of the photosensing device causes it to provide a series of sprocket pulses S. Each sprocket pulse is fed over a lead 10 and indicates when a row of type characters passes the hammer mechanisms.

Both the character-indicating outputs and sprocket pulses S from the photosensing device 8 are fed to a print control circuit 11. The data to be printed by the printer along with a series of timing signals T from the data source are also fed to the print control circuit 11. The circuit 11 provides outputs to both the circuit 4 for selecting the odd hammer mechanisms and the circuit 5 for selecting the even hammers mechanisms.

Before proceeding with a description of FIGS. 2 and 3, the meaning of the more extensively used logic element symbols is given. The logic elements in FIGS. 2 and 3 operate in a conventional manner on a binary voltage level basis wherein the inputs of the elements and outputs therefrom always exist at either of two discreet voltage levels, the positive voltage level or the negative voltage level of the system.

An AND circuit is represented by a D-shaped block containing an "&" symbol. The input lines are always connected to the straight part of the block and the output line is always connected to the curved side of the block. The function of this circuit is to provide a positive output voltage only when all input lines exist at the positive level.

An OR circuit is represented by an arrow-shaped block containing the symbol "OR." Input lines are always connected to the concave side of the block and the output line is always connected to the point. The function of this circuit is to provide a positive level output only when any one or more of the input lines is at the positive level.

A single-shot multivibrator is represented by a rectangular block containing the symbol "SS." The input line to the circuit is always connected to the left or bottom edge of the block and the output line is always connected to the right or top edge of the block. The function of this circuit is to generate a negative to positive to negative square-wave output pulse of fixed duration in response to a negative to positive transition at the input.

A delay circuit is represented by an elongated oval-shaped block with a pair of stripes nearest the input end. The function of this circuit is to generate an output level which follows the input level but which changes state at some fixed period of time after the input changes state.

FIG. 2 illustrates the print control circuit **11** shown as a block in FIG. **1**. The data to be printed is supplied serial by character, parallel by bit. Each character is initially stored in a single character register **12**. The timing signal T from the data source is fed to the print control circuit **11** as the input to a single shot **14** whose output conditions the register **12** to load the character. One timing signal T occurs for each character.

Once the character register **12** is loaded the input data is fed both to a comparator **15** and a function decoder **16** over cables **17** and **18** respectively. Each of these cables contain sufficient leads to transmit binary coded signals representing the character. A comparator is a well-known circuit element which provides a positive level signal at its output when the coded signals supplied to its inputs represent identical data. The comparator **15** receives coded signals over cable **19** from the portion *8a* of the photosensing device which provides an output signal indicative of the particular row of type characters on the rotating drum which is approaching the hammer mechanisms. When the coded signals from the register **12** and photosensing device **8** represent identical data, the drum is in a position such that the particular type character on the drum which corresponds to the character in the register **12** will be impacted by a hammer upon energization of a hammer mechanism at that time. The comparator **15** then provides a positive signal over its output lead **19**.

As noted above, the single character register **12** also feeds the input data to a function decoder **16**. In general, a function decoder is any type of circuit arrangement which, when enabled, provides positive signals on one or more outputs when the coded signals fed to it represent functions to be performed by the printer rather than characters to be printed, e.g., signals commanding the printer to begin a new line of print. The function decoder **16** illustrated has only one such function-indicating output and this provides a positive signal CR over a lead **20** when a new line is to be initiated. Of course, the function decoder **16** could also have other outputs which are activated to signal the printer to perform other functions.

The function decoder provides a CR signal on lead **20** when enabled by the output of a single-shot **21**. The single-shot **21** receives its input from the output of the single-shot **14** after it passes through a delay **22**. This arrangement of the single-shots **14** and **21** and the delay **22** allows the function decoder to provide an output only after sufficient time has elapsed for the data to be loaded into the character register **12** and subsequently transferred to the function decoder **16**.

In the event that the signals fed to the function decoder **16** do not indicate a function but rather a character to be printed, the function decoder **16** provides a signal $\bar{F}$ over its output lead **23** to condition an AND-gate **24**. As with the CR signal, the $\bar{F}$ signal only occurs after the function decoder is enabled by the output of the single-shot **21**. The AND-gate **24** receives its enabling input from the output of the single-shot **21** via a delay **25**. The delay **25** is provided to delay application of the output of the single-shot **21** to the AND-gate **24** until it may be applied concurrently with an $\bar{F}$ signal from the function decoder **16**.

When energized, the AND-gate **24** provides the trigger signal for another single-shot **26**. The output of the single-shot **26** is fed to an input of another AND-gate **27**. This AND gate also receives as conditioning inputs the output over lead **19** of the comparator **15** and the sprocket pulses S over lead **10** from the photosensing device **8** indicating each instant when a row of type characters is passing the bank of hammer mechanisms. Upon receiving inputs from these three sources, the AND-gate **27** provides a FIRE pulse at its output for activating a hammer mechanism. The FIRE pulse is provided since energization of a hammer mechanism at this instant will cause its hammer to strike the document against the type character on the rotating drum which is to be printed. The period of delay occurring between the time when the photosensing device **8** senses signals indicative of the character to be printed and the time when the hammer actually impacts the character is compensated for by having the disk **6** lead the characters on the drum by an appropriate distance.

The single-shot **26** provides an output pulse of a duration equal to the time required for one complete revolution of the drum. It thus defines the print cycle of the printer by only allowing printing during that revolution of the drum which occurs after the AND-gate **24** is activated. The AND-gate **24** is activated by an $\bar{F}$ signal and the output of the single-shot **21** which is triggered by the delayed output of the single-shot **21** which is triggered by the delayed output of the single-shot **14** which, in turn, occurs in response to a timing signal T from the data source. Thus, a print cycle occurs only after a timing signal T is fed to the printer: Since a timing signal occurs only once for each character fed from the data source, each character has only one print cycle in which it may be printed and unwanted duplication in printing the character cannot occur.

In accordance with the invention, only two driving circuits, **28** and **29**, are required. Those hammer mechanisms which are adapted to print characters in the odd-numbered columns are energized by the driving circuit **28** while those adapted to print characters in the even-numbered columns are energized by the driving circuit **29**. These driving circuits are alternately energized and, therefore, a line is printed by alternately printing characters in the odd and even columns.

This alternation is achieved by the use of a flip-flop **30**. A flip-flop circuit is a bistable arrangement wherein (assuming that the 0 output is initially positive) a positive level signal at the T input causes the 1 output to go positive and stay positive while the 0 output simultaneously goes negative and stays negative. A succeeding positive level signal at the T input causes the 0 output to go positive and stay positive while the 1 output simultaneously goes negative and stays negative. The flip-flop **30** receives its trigger input from the output of the single-shot **21** which, of course, is energized once for each timing signal T from the data source. A T signal occurs with each individual character to be printed and, therefore, the 0 and 1 outputs are alternately energized with successive characters.

The 0 output of the flip-flop **30** is fed to the driving circuit **28** via an AND-gate **31**. The 1 output of the flip-flop is fed to the driving circuit **29** via another AND-gate **32**. Both AND-gates **31** and **32** have the FIRE pulse from AND-gate **27** as their enabling inputs. The driving circuit **28** for energizing the odd hammer mechanisms is energized when AND-gate **27** provides a FIRE pulse concurrently with the 0 output of the flip-flop **30** being positive. The other driving circuit **29** which energizes the even hammer mechanisms is activated when AND-gates **27** provides a FIRE pulse concurrently with the 1 output of the flip-flop **30** being positive. With AND-gate **27** providing a FIRE pulse each time a character is to be printed and fliprflop 30 changing states at successive characters, the odd and even driving circuits are alternately energized to thereby alternately print in the odd and even columns. When energized, the driving circuit **28** provides an ODD FIRE pulse over lead **33** and the driving circuit **29** provides an EVEN FIRE pulse over lead **34** when energized.

Referring now to FIG. **3**, the circuit **4** shown as a block in FIG. **1** for selecting the hammer mechanisms which print in the odd-numbered columns is schematically illustrated. A similar circuit (shown as block **5** in FIG. **1**) is provided for those hammer mechanisms which print in the even-numbered columns and, therefore, only the odd hammer selecting circuit **4** will be described.

The odd hammer selection circuit comprises a network **35** having two sets of leads **36** and **37** which are arranged to intersect each other and form a matrix. The activating coils **39** in the electromagnetically operated hammer mechanisms **3** which print in the odd columns are each connected between a different pair of leads, each lead of such a pair being from different sets. Of course, the hammer mechanisms' coils **39** are physically parts of the hammer mechanisms **3** and are actually located along the length of the drum **1** as indicated in FIG. **1**. However, for ease of illustration, the coils **39** are shown as physically located within the matrix in FIG. **3**. Each coil **39** is connected to a lead in the matrix with an isolation diode **40**. The diodes **40** perform a conventional function of blocking current flow in unwanted directions within the matrix network **35**.

As illustrated, there are five leads in the set designated **36** and eight leads in the set designated **37**. There are 40 coils **39** connected to the matrix **35** and, with 40 similar coils for those hammers mechanisms which print in the even-numbered columns, the printer has 80 hammers mechanisms for 80 columns.

Two groups of relays, **41** and **42**, are provided. The relays in group **41** have their contacts **41***a* adapted to be connected to a lead in set **36**. The relays in group **42** have their contacts **42***a* adapted to be connected to a lead in set **37**. The relays may be of any suitable conventional construction and, preferably, consist of the well-known "reed contact" variety. The relays in the group **41** are commoned to the lead **33** over which the driving circuit **28** feeds its ODD FIRE pulse when actuated. When one of the relays in the group **41** is closed, any ODD FIRE pulse on lead **33** is applied to one of the leads in the set **36**. The relays in the group **42** are commoned to a negative voltage potential −V such that when one of the relays in this group is closed, the −V potential is applied to one of the leads in the set **37**.

When one relay from each of the groups **41** and **42** is closed, a conductive path is provided for any ODD FIRE pulse from the driving circuit **28** on lead **33**, along one of the leads in set **36**, across a particular isolation diode **40**, across a particular coil **39**, along one of the leads in set **37**, to the negative reference potential −V. Therefore, by closing a selected pair of relays, one in each group (**41** and **42**), a conductive path is provided from the driving circuit, through one particular hammer mechanism's coil **39**, to the negative reference potential. In this manner, selectively closing a pair of relays, operates a selected hammer mechanism.

The relays (and therefore the hammer coils **39**) are sequentially energized by a six-stage binary counter **43** and two groups of AND-gates **44** and **45**. The counter **43** is represented in FIG. **3** as a block subdivided into stages **1**, **2**, **4**, **8**, **16** and **32**. Since the counter is binary, each stage has two outputs (only one of which is energized at a time) and the outputs of each stage represent one bit of a binary number. The counter has two inputs: an ADV UP input and a RESET input. Each positive signal at the ADV UP input causes the binary number represented on the output lines of the stages to advance by a count of 1. A positive signal at the RESET input causes the binary number represented on the output lines to revert to 0, i.e., positive voltages on all six 0 output lines.

There are five AND gates in the group designated **44**. Each AND gate in this group has its output connected to one of the relays in group **41** such that actuation of a gate energizes a relay coil **41***b* to close the associated contacts **41***a*. The AND gates in group **44** each have three inputs. Each of the inputs is connected to one of the outputs from the high-order stages **8**, **16** and **32** of the binary counter. The connections between these AND gates and the counter **43** are such that each gate is actuated by a particular combination of the three high-order bits in the binary-coded number represented by the output of the counter. With different combinations of the three high-order bits, different AND gates are actuated. Advancement of the **8**, **16** and **32** stages of the counter sequentially actuates the AND gates in group **44**. Since each of the AND gates in this group closes a relay in the group designated **41**, sequential advancement of the counter sequentially closes the relays in group **41**.

The other group of AND-gates **45** is made up of eight gates. Each AND gate in this group has its output connected to one of the relays whereupon activation of an AND **45** energizes a coil and closes the associated contacts **42***a* to connect a lead **37** to the voltage source −V. As do the AND gates in group **44**, the AND gates in group **42** each have three inputs. Each of these is connected to one of the outputs from the low order stages **1**, **2** and **4** of the binary counter **43**. Similar to the connections between the AND gates in group **44** and the counter, the connections between the AND gates in group **45** and the counter are such that each gate is actuated by a particular combination of the three low order bits in the binary coded number represented by the output of the counter. Different combinations of the three low order bits actuate different AND gates. Advancement of the counter sequentially actuates the AND gates in group **45**. Sequential advancement of these AND gates sequentially operates the relays in group **42**.

Each setting of the counter actuates an AND gate in one of the groups **44** and **45**. Advancement of the counter by successive pulses at its ADV UP input sequentially actuates selected pairs of the AND gates, one of each pair being in a different group. Each of these pairs of AND gates closes one relay from each of the groups **41** and **42** and provides a current path from the driving circuit **28**, through a selected coil **39**, to the reference potential. In this manner, the AND-gates, **44** and **45**, act as a pair of decoding means utilizing the binary coded outputs of the counter **43** to electrically and sequentially connect the coils with the driving circuit **28**. As the counter advances, the coils are sequentially energized. With alternate energization of the driving circuits, **28** and **29**, (FIG. **2**) the characters in an entire line are sequentially printed since the even hammer selecting circuit **5** (FIG. **1**) is similar to the odd hammer selecting circuit **4** shown in FIG. **3**.

Each of the AND gates in group **44** and **45** has a small driving circuit **56** associated with it and connected to its output. These act in a conventional manner to connect the low output of the AND gates to a sufficiently high voltage to operate the relays.

Of course, other decoding means rather than a plurality of AND gates could be utilized. For example, two diode decoding matrices, each of which is connected to one group of relays, could be utilized in each hammer selecting circuit.

The counter **43** in the odd hammer selecting circuit **4** shown in FIG. **3** is advanced by successive pulses applied to its ADV UP input. These pulses are provided over a lead **50** connected to the output of an AND-gate **49** shown in FIG. **2**. The AND-gate **49** receives a conditioning input from the 1 output of the flip-flop **30**. The other input of the AND-gate **49** is connected to a delay **48** whose input is connected at the flip-flop's **30** T input. Thus, when the 1 output of the flip-flop **30** is actuated by a signal at the flip-flop's T input, AND-gate **49** is energized after a duration determined by the delay **48**. Such duration is only long enough for the flip-flop **30** to change state and provide a settled steady signal at its 1 output.

The counter, not shown, in the even hammer selecting circuit **5** is advanced in a similar manner as is its counterpart counter **43** shown in FIG. **3**. The output of an AND-gate **47** having inputs from the 0 output of the flip-flop **30** and from the delay **48** provides the ADV UP input for this counter over lead **46**. Since AND-gates **49** and **47** are enabled by alternate outputs of the flip-flop **30** over its 1 and 0 outputs, the counters in the odd and even hammer select circuits, **4** and **5**, are alternately advanced. As previously noted, the driving circuits **28** and **29** are alternately energized by the outputs of the flip-flop **30** in coincidence with the output from AND **27**.

The odd hammer driving circuit **28** provides an ODD FIRE pulse only when the 0 output of the flip-flop **30** is active and the counter (not shown) in the even hammer selecting circuit is advanced when the 0 output of the flip-flop **30** is active. Conversely, the even hammer driving circuit **29** provides an EVEN FIRE pulse only when the 1 output of the flip-flop **30** is active and the counter **43** in the odd hammer selecting circuit is advanced when the 1 output of the flip-flop is active. Thus, the counter in each hammer selecting circuit is advanced about the time when a FIRE pulse is fed to the other hammer selecting circuit. This manner of operation provides sufficient time for each counter to become settled after advancing and provide steady signals for effectively selecting the relays, **41** and **42**, before a FIRE pulse is fed to them.

Since the hammer selecting circuits are alternately energized, sufficient time is provided for the coils of the relays in these circuits to deenergize before being energized again. While a pair of relay coils are being energized in one of the hammer-selecting circuits, the previously energized relays in the other hammer selecting circuit have sufficient time to deenergize before the next selection cycle. Such operation enables the use of low-speed inexpensive relays. Further, since the system operates to open and close the relays only at times when the relay contacts are inactive (not conducting) the useful life of the relays is greatly extended.

The counter in either hammer selecting circuit is reset upon either of two conditions: the presentation of CR from the function decoder **16** commanding that the printer begin a new line, or the printing of a character in the last column associated with the particular hammer selecting circuit.

Resetting of only the counter **43** in the odd hammer selecting circuit **4** shown in FIG. **3** will be described since this function is similarly performed in the even hammer selecting circuit **5**.

The counter **43** is reset by a signal on lead **55** from an OR-gate **51** (FIG. **2**). The OR-gate **51** is activated by either a signal CR on lead **20** from the function decoder **16** indicating that a new line is to be initiated, or a signal EL, delayed by delay **52**, from an AND-gate **53** over lead **54** (FIG. **3**).

The AND-gate **53** has three inputs: one of which is connected to the 1 output of stage **32** of the counter, another of which is connected to the 0 output of stage **16** of the counter, and the third of which is connected to the 1 output of stage **8** of the counter. Thus, AND-gate **53** is energized when the counter **43** sufficiently advances to have as its output signals representing the binary number "101000" or "40." Therefore, the AND-gate **53** is energized to activate the OR-gate **51** and reset the counter **43** by a signal on lead **55** after the last hammer mechanism which prints in an odd column, i.e., 40th odd hammer mechanism has been actuated. Similarly with the even hammer selecting circuit, when the counter in that circuit has as its output binary signals representative of the number "40," the last hammer mechanism in the group of hammers mechanisms for printing in the even columns has been actuated and the counter is reset.

OPERATION

The operation of the printer will now be described assuming that a new line of print is being initiated. Binary-coded signals representing the character to be printed in the first column of the line are fed to the single-character register **12** shown in FIG. **2** and stored there when the register is conditioned by the output of single-shot **14** which is triggered by a timing signal T from the data source.

The photosensing device **8** shown in FIG. **1** continually provides both the periodic sprocket pulses S and signals identifying the rows of type characters as they approach the bank of hammer mechanisms **3**. The series of sprocket pulses is fed to the AND-gate **27** shown in FIG. **2** while the character-identifying signals are fed to the comparator **15**.

The comparator also receives signals from the single-character register **12** representing the stored first character of the line. When the comparator's inputs match, the drum **1** is in a position such that the desired type character will be printed in the first column by energizing the hammer mechanism associated with the first column. The comparator's output is fed to the AND-gate **27** as are the sprocket pulses S. The AND-gate **27** receives its third input from the single-shot **26** which provides one output for each timing signal T when the function decoder **16** provides an $\bar{F}$ signal. When enabled, the AND-gate provides a FIRE pulse which is fed to the AND-gates **31** and **32**.

The outputs of the flip-flop **30** are alternately energized upon successive signals from the single-shot **21** which provides an output for each timing signal T. Since the character is being printed in an odd column, the first, the 0 output of the flip-flop will be energized and its 1 output deenergized when the flip-flop receives its input signal. The signal from the active 0 output of the flip-flop is fed to the AND-gate **31** which, upon concurrently receiving a FIRE signal from AND-gate **27**, activates the driving circuit **28** for the hammer mechanisms which print in the odd columns.

The signal from the 0 output of the flip-flop **30** is also fed along with the delayed output of the single-shot **21** to AND-gate **47** whose output causes the counter (not shown) in the even hammer selecting circuit to advance at this time.

Referring to FIGS. **3** and **4**, since the first column is being printed, the counter **43** will have just been reset by a signal from the OR-gate **51** (FIG. **2**) on lead **55** indicating either the end of the previous line or a command to initiate a new line from the data source. Positive signals now appear on all six of the counter's 0 output lines. The AND gates designated **44*a*** and **45*a*** in groups **44** and **45** are enabled by these outputs and will be active to energize their associated relays. A conductive path is thereby provided across the hammer coil designated by **39*a***. The coil **39*a*** is in the hammer mechanism which prints in Column No. 1. Thus, an ODD FIRE pulse from the odd driving circuit **28** on lead **33** travels along this conductive path and energizes the coil **39*a*** to print in the first column.

As previously noted throughout the specification, the even hammer selecting circuit is identical to the odd hammer selecting circuit illustrated in FIG. **3**. The EVEN FIRE pulse is fed to the even hammer selecting circuit from the even driving circuit **29** whenever the AND-gate **27** provides a FIRE pulse concurrently with the 1 output of the flip-flop **30** being active. Since the alternate outputs of the flip-flop **30** are alternately energized in response to successive timing signals T and since one timing signal T occurs for each character, the EVEN and ODD FIRE pulses occur in alternating sequence to effect alternate printing in the odd and even columns.

FIG. **4** illustrates the time relationships between the bits represented on the output lines of the counter **43** and AND-gates **44**, **45** in FIG. **3**. Only some of the stages of the counter and some of the AND gates are indicated since they are illustrative.

As previously disclosed, the 0 outputs of the counter **43** are all positive, representing the binary number 000000(decimal 0), for printing in Column No. **1**. Thus, for Column No. **1**, FIG. **4** indicates that the outputs of all stages in the counter represent 0 bits. These outputs enable AND-gates **44*a*** and **45*a***.

For printing in the third column, the binary number 000001 (decimal 1) is represented by the outputs of the counter; the outputs of all stages except stage No. **1** represent 0 bits. This activates AND-gates **44*a*** and **45*b*** to thereby provide a conductive path across the hammer coil designated **39*b***. The hammer coil **39*b*** is in the hammer mechanism associated with Column No. **3**.

Printing in the fifth column occurs when the counter advances from representing 000001 to 000010(decimal 2).

As illustrated in FIG. **4**, the output of stage No. **1** represents a 0 bit, the output of Stage No. **2** represents a 1 bit, and the outputs of the other stages represent 0 bits. AND-gates **44***a* and **45***c* are energized to provide a conductive path for the ODD FIRE pulse across coil **39***c* which is within the hammer mechanism associated with Column No. **5**.

Similarly, for the seventh column, the binary number 000011(decimal 3) is represented on the counters' output lines and AND-gates **44***a* and **45***d* are energized to provide a path across coil **39***d* for the ODD FIRE pulse. The coil **39***d* is part of the hammer mechanism associated with the seventh column.

For the seventeenth column the counter will have advanced until it represents the binary number 001000(decimal 8). The outputs of all stages except Stage No. **8** represent 0 bits. This activates AND-gates **45***a* and **44***b* and, thereby, provides a conductive path across the hammer coil associated with the 17th column and designated **39***e*.

After printing occurs in each odd column an even column is printed. The hammer-selecting circuit for the even columns is operated in a manner similar to the above explanation relating to FIG. **3**.

I claim:

1. A printer comprising:

a. a plurality of printing mechanisms, each of which is adapted to be individually operated when electrically energized;

b. a single driving circuit for energizing the printing mechanisms;

c. means for energizing the driving circuit;

d. a network having two sets of leads arranged to form a matrix, each printing mechanism being connected between a different pair of the leads, the leads of each pair being from different sets;

e. a plurality of first switching devices, each of which is adapted to connect the driving circuit to a different lead in one set of leads;

f. a plurality of second switching devices, each of which is adapted to connect a different lead in the other set of leads to a reference potential; and

g. means for operating the first and second switching devices such that the printing mechanisms are individually and sequentially energized by the driving circuit.

2. The printer as recited in claim **1** wherein the operating means sequentially operates selected pairs of the switching devices, each pair comprising a first and a second switching device, whereby conductive paths are sequentially provided from the driving circuit, through selected printing mechanisms to the reference potential.

3. The printer as recited in claim **2** wherein the operating means comprises:

a. a counter having a plurality of successive stages whose outputs represent successively high order quantities;

b. means for advancing the counter through successive stages;

c. first decoding means which is responsive to the outputs of a first group of the counter's stages and adapted to sequentially generate a plurality of outputs, each output operating a different one of the first switching devices; and

d. second decoding means which is responsive to the outputs of a second group of the counter's stages and adapted to sequentially generate a plurality of outputs, each output operating a different one of the second switching devices,

whereby the print mechanisms are sequentially energized as the counter advances.

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