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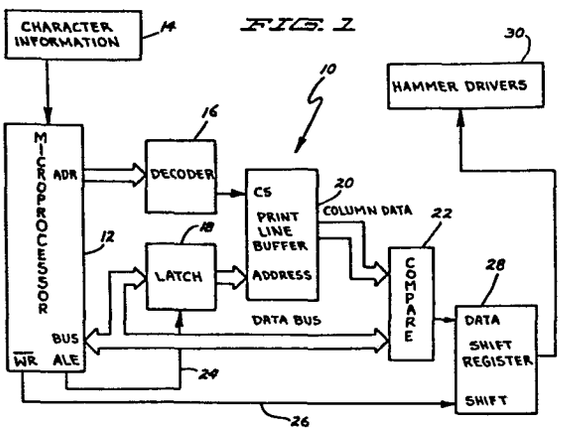
(54) A hammer control device for a band printer.

(57) A hammer control system for a band printer has a micro-processor (12) receiving character information and having an address (ADR) and a data bus (BUS) output together with a timing output. The microprocessor controls an optioning scheme used in the printer. A decoder (16) is connected with the address output of the microprocessor and a print line buffer (20) provides a stored print data output for subsequent comparison and printing connected with said decoder. A compare circuit (22) receives the output of the print line buffer and receives data from the microprocessor. A shift register (28) receives a compare signal from the compare circuit and a shift control signal from the microprocessor. A hammer driver device (30) causes printing to occur in response to the output of the shift register.

FIG. 1



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"A HAMMER CONTROL DEVICE FOR A BAND PRINTER"

This invention relates to hammer control devices for band printers.

Band printers, according to the prior art, use discrete components and circuits to provide hammer driver control in response to input print character controls. A typical prior art hammer control device has a print control circuit which receives input character pulses. The print control circuit drives a column counter increment network and a band code generator increment network. The column counter increment network provides an address to a print line buffer memory which supplies output data. A band code generator network provides information relative to the placement of characters on the band. Compare circuits receive the output of the print line buffer memory and of the band code generator. When the compare is made in the compare circuitry an output is provided to a shift register which is used to control the hammer drivers in response to input timing signals provided to the shift control of the shift register.

As is known, a band printer has a continuously moving, endless, print band having the appropriate characters thereon which may be selectively printed by a print hammer mechanism. The hammer mechanism drives against the moving print band to imprint the character on the printing medium. The hammer mechanism remains stationary while the hammers are fired but, the hammer mechanism may move in some machines between print positions. The protocol by which the characters are located on the print band and the print hammers are operated against the print band to generate printed material on the print medium is referred to as optioning. In the typical optioning scheme, the print line buffer memory is addressed by a column counter. The data that comes out of the memory is the character that is to be printed in

that column. The column counter sequentially addresses the memory locations 0 to N-1, (where N is the number of columns the printer is capable of printing) to select the print character stored in the print buffer memory at that column position. The band code generator provides the character code for the character, on the band, that is in front of the column that the column counter is addressing. The character code generated by the band code generator is compared to the data in the print line buffer addressed by the column counter. If the character in the print line buffer is the same as that in the band code generator character, a compare is shifted into the shift register. If there is no compare, no compare signal is shifted into the shift register. If a compare signal is shifted into the shift register, a print hammer is fired at the proper time and the character is printed on the print medium. If there is no compare, no print hammer is fired. By changing the sequence of column counting and band code generation, different optioning systems can be implemented. In the present invention, the sequence of column counting and band code generation is controlled by a microprocessor. By changing the program, while leaving the hardware unchanged, any optioning scheme can be implemented.

Referring first to Figure 5A, by way of background information, the relationship between the column counter and the band code generator is shown for a two position band printer. The column counter starts at column zero. The band code generator starts with the code for the character that is in front of column zero and in the example shown that character is "A". After the first column is optioned, the column counter is incremented by two and the band code generator is incremented by two. Now the column counter is set at two and the band code generator contains the code for the character "C". After this character is optioned, the column counter is incremented by two,

but the band code generator is incremented by only one. This pattern repeats across the width of the bank of print hammers so that the column counter is incremented by two and the band code generator is incremented first by two, then one, then two, then one, etc. Figure 5B shows the same relationship where the hammer positions are shown for the second position in the two position band printer.

Referring now to Figure 5C, the optioning scheme is shown for a one print position band printer. The column address is incremented by one and the band code generator is incremented by one every optioning cycle except for every fourth optioning cycle. Every fourth optioning cycle, the band code generator is not incremented. In Figures 5A, 5B and 5C the optioning shown is for a band moving in a "forward" direction (from right to left). If the band direction is reversed (left to right), the optioning of the hammers may change, but the configuration will be unaffected.

It should be noted that the present invention may be used with a machine with any number of positions with the result being a unique incrementing pattern for the column counter and the band code generator in each configuration. Also, the present invention may be used equally well for either direction of band movement.

With microprocessor systems readily available, it might be believed that all of the functions of a print hammer control device could be implemented solely within a microprocessor. It is true that all of the control functions necessary, as described above, can be implemented in a microprocessor, however, a band printer also must operate at a comparatively high speed in order to be commercially desirable. It has been found that the implementation of all required control functions in a single microprocessor produces a limitation on speed which is not consistent with the necessary speed at which the band printer must print material on a printing medium. Therefore, the

implementation of all control functions on a microprocessor has not been found to be as desirable as originally forecast because of the time limitation and cost consideration with respect to the microprocessor.

Therefore, it would be desirable to have a band printer hammer control device which makes use of some of the advantages which can be obtained using a microprocessor but which will also maintain the various advantages and desirable characteristics of a high-speed printing rate.

According to the present invention, there is provided a hammer control device for a band printer having character information means for providing character information, and characterised by a microprocessor adapted to receive information from said character information means, said microprocessor having an address (ADR) and a data bus (BUS) output together with at least one output timing signal means, said microprocessor being arranged to control an optioning scheme used in said printer; decode means connected with the address (ADR) output of said microprocessor; print line buffer means for providing a stored print data output for subsequent comparison and printing connected with said decode means and having means for receiving signals from the data bus of said microprocessor; compare means for receiving the output of said print line buffer means and for receiving a data input from said microprocessor; shift register means for receiving a compare signal as a data input from said compare means and for receiving shift control signal means from said microprocessor; and a hammer driver means for causing printing to occur in response to the output of said shift register.

The hammer control device may include a latch connected to the output of said microprocessor to provide an input to said print line buffer means for de-multiplexing the input to said print line buffer means according to address latch enable (ALE)

signals received from said microprocessor.

Preferably said microprocessor is arranged to generate a band code generator signal to be compared in said compare means, said band code generator signal being incremented in a predetermined sequence according to the optioning scheme used.

The optioning technique does not only apply to a one or two position band printer. By changing the program in the microprocessor, a three or four or five, etc. position band printer could be implemented according to the present invention.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a schematic block diagram of a hammer control device according to the present invention for a band printer;

Figure 2 is a timing diagram for the hammer control device of Figure 1;

Figure 3 is a flowchart of a microprocessor program for a microprocessor of the hammer control device of Figure 1 according to a first optioning scheme;

Figure 4 is a software flowchart of a microprocessor program of a microprocessor of the hammer control device of Figure 1 according to a second optioning scheme; and

Figures 5A, 5B and 5C are figures showing the background information on the definition of hammer positions in various optioning schemes.

A hammer control device 10 according to the present invention for a band printer is shown in Figure 1. A microprocessor 12 receives character information from a source 14 of character information. The microprocessor 12 has an Address channel (ADR) which is connected with a decoder 16. The decoder 16 can be a read only memory or a standard decode device. The microprocessor 12 has a data bus channel (BUS) which is connected with a latch 18. The latch 18 contemplates operation with a microprocessor which

uses a multiplexed data address bus, and which is de-multiplexed by use of an ALE (Address Latch Enable) line. A microprocessor with separate address lines would not use such a latch. The decoder 16 has an output to a print line buffer 20. The print line buffer has a data output provided to a compare circuit 22. The latch 18 provides an address input to the print line buffer 20. Also, the channel BUS of the microprocessor 12 has a data bus connection to input to the compare circuit 22. The microprocessor has an address latch enable (ALE) timing signal output line 24 connected with the latch 18. The microprocessor 12 also has a write signal output line 26 connected to the shift input of a shift register 28. The data input to the shift register 28 is provided from the output of the compare circuit 22. The output of the shift register 28 is provided to a hammer driver unit 30.

Referring now to Figure 2, a timing diagram is shown of the output signals of microprocessor 12 shown in Figure 1 to show operation of the hammer control device 10. The microprocessor output on the channel ADR is shown in the top line of the Figure as the chip select signal paths. The outputs on the channel BUS of the microprocessor is shown as the column address and band code generator output signal (BCG). The third line of Figure 2 shows the output of the address latch enable signal which at the falling portion of an output pulse 50 provides a latch column address control signal. The output of the print line buffer 20 is shown as the fourth line of Figure 2. This output provides the column data for the hammer control device. Finally, the last line of Figure 2 shows the timing for the signal on the write signal output line 26. The rising portion at the trailing edge of a control pulse 52 is the control signal for shifting the result of the compare network 22 into the shift register 28.

The hammer control device shown in Figure 1 operates in

the following manner. The microprocessor 12 generates the column address and the band code generator output signal using a software routine internally. The column address and band code generator signal are sent to the print line buffer 20 and to the compare circuit 22 simultaneously. This is accomplished by doing a memory write-move operation from an accumulator (not shown) of the microprocessor. The de-multiplexing of the column address versus the band code generator output signal is accomplished by the latch 18 in conjunction with the ALE signal. The decoder 16 is addressed by the chip select address and generators a Chip Select (CS) signal to the print line buffer 20. The data at the specific column address appears at the output of the print line buffer 20 which is then compared to the contents of the data bus containing the band code generator output signal. The rising edge of the memory write signal is then used to shift the compare signal into the shift register 28.

The timing diagram shown in Figure 3 contemplates the use of an 8085A-2 microprocessor in which the address latch enable signal is used as described. The address latch enable signal is not necessarily required for all microprocessor configurations to implement the present invention. The 8085A-2 microprocessor is chosen because of the best cost-performance trade-off for the requirements of a proposed band printer. The latch 18 is necessary because of this particular microprocessor and would not be necessary with some other microprocessors. Other microprocessors would be connected directly to the print line buffer 20. Accordingly the latch 18 is not essential to all embodiments of the present invention.

Referring now to Figure 3, a flow diagram is shown which would be appropriate for the microprocessor 12 of Figure 1. This flowchart shows a routine which options the first character, then increments the band code generator output signal by two and

tests for a wraparound condition. The routine then options the second character, increments the band code generator output signal by one and tests for a wraparound condition. After these two options have been performed, the test for all hammers optioned is performed.

The timing of the software in this area was found to be very critical. The software was structured such that the incrementing of the band code generator output signal by one or two was built into the routine, thereby eliminating the requirement for a test to determine the proper increment. This technique provided a significant enhancement to the time required to perform one option, and can be further expanded to machines with position variations with the same resultant time enhancement.

Figure 4 is a flowchart depicting one of these variations for a one position optioning scheme.

The present invention uses the microprocessor as a hardware replacement for particular components of the known hammer control device of a band printer. The illustrated embodiment of the present invention shows an optimum trade-off of microprocessor usage with respect to retention of hardware circuits in order to perform optimum machine function at reasonable costs. This technique can be used with virtually any microprocessor, and can be applied to any variation in optioning schemes with only minor software modifications required.

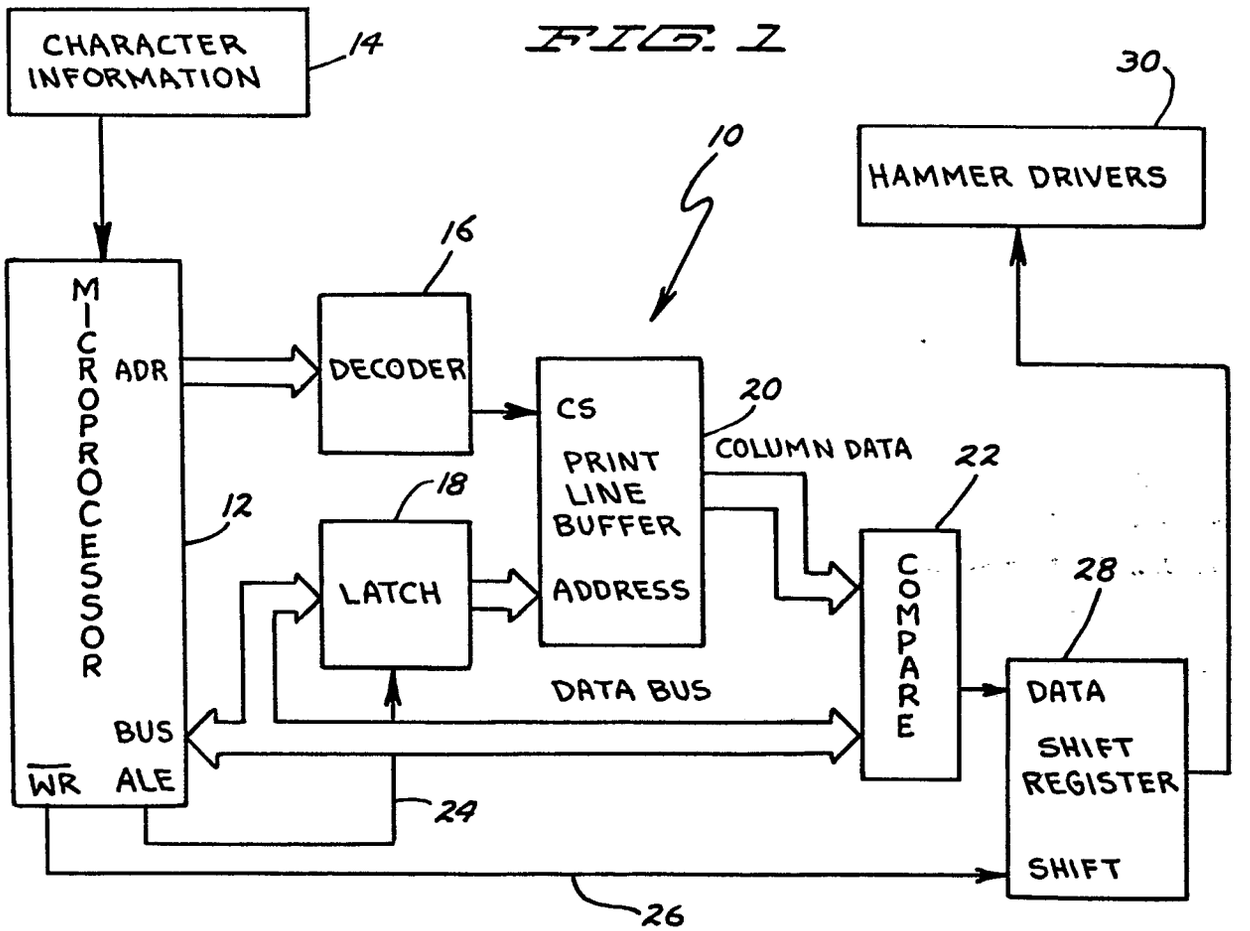
CLAIMS

1. A hammer control system for a band printer having: character information means (14) for providing character information, and characterised by a microprocessor (12) adapted to receive information from said character information means, said microprocessor having an address (ADR) and a data bus (BUS) output together with at least one output timing signal means, said microprocessor being arranged to control an optioning scheme used in said printer; decode means (16) connected with the address (ADR) output of said microprocessor; print line buffer means (20) for providing a stored print data output for subsequent comparison and printing connected with said decode means and having means for receiving signals from the data bus of said microprocessor; compare means (22) for receiving the output of said print line buffer means and for receiving a data input from said microprocessor; shift register means (28) for receiving a compare signal as a data input from said compare means and for receiving shift control signal means from said microprocessor; and a hammer driver means (30) for causing printing to occur in response to the output of said shift register.

2. A hammer control device as claimed in claim 1 characterised by including a latch (18) connected to the output of said microprocessor to provide an input to said print line buffer means (20) for demultiplexing the input to said print line buffer means according to address latch enable (ALE) signals received from said microprocessor.

3. A hammer control device as claimed in claim 1 or 2 characterised in that said microprocessor is arranged to generate a band code generator signal to be compared in said compare means (22) said band code generator signal being incremented in a predetermined sequence according to the optioning scheme used.

FIG. 1


CHARACTER INFORMATION
14
30
HAMMER DRIVERS
10
16
MICROPROCESSOR
ADR
DECODER
CS
PRINT LINE BUFFER
ADDRESS
20
COLUMN DATA
22
18
12
LATCH
COMPARE
28
DATA BUS
DATA SHIFT REGISTER
BUS
WR
ALE
SHIFT
24
26

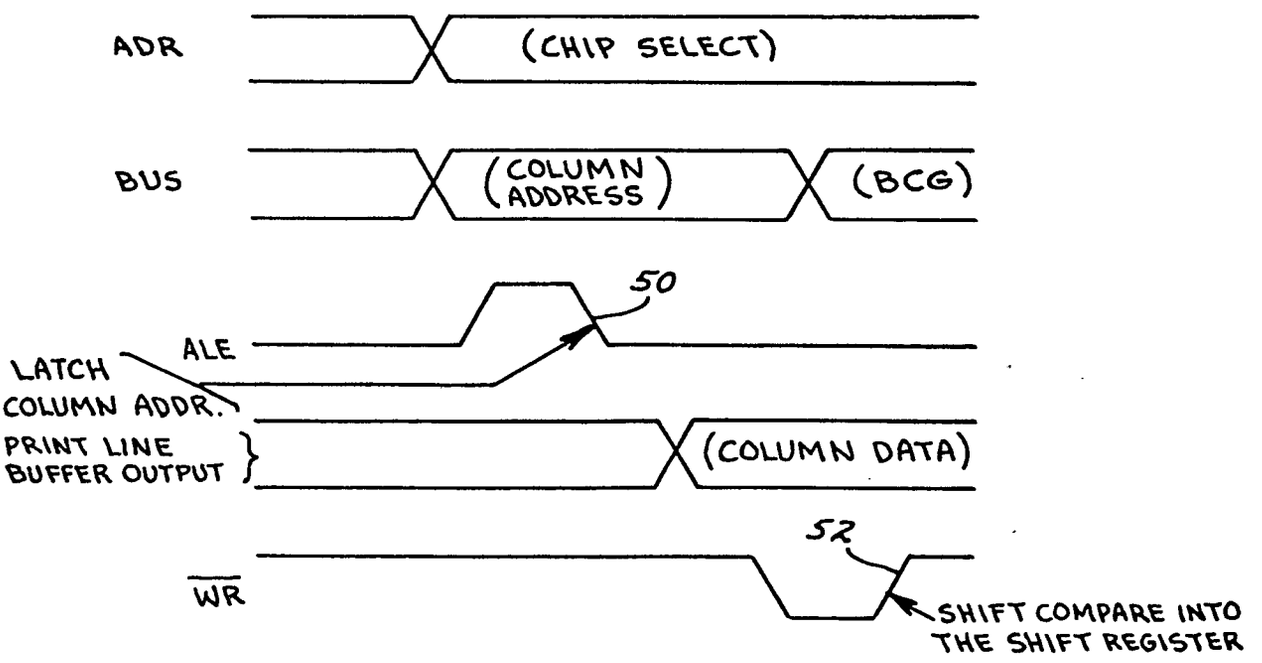

ADR
(CHIP SELECT)
BUS
(COLUMN ADDRESS)
(BCG)
50
ALE
LATCH COLUMN ADDR.
PRINT LINE BUFFER OUTPUT
(COLUMN DATA)
52
WR
SHIFT COMPARE INTO THE SHIFT REGISTER

FIG. 2

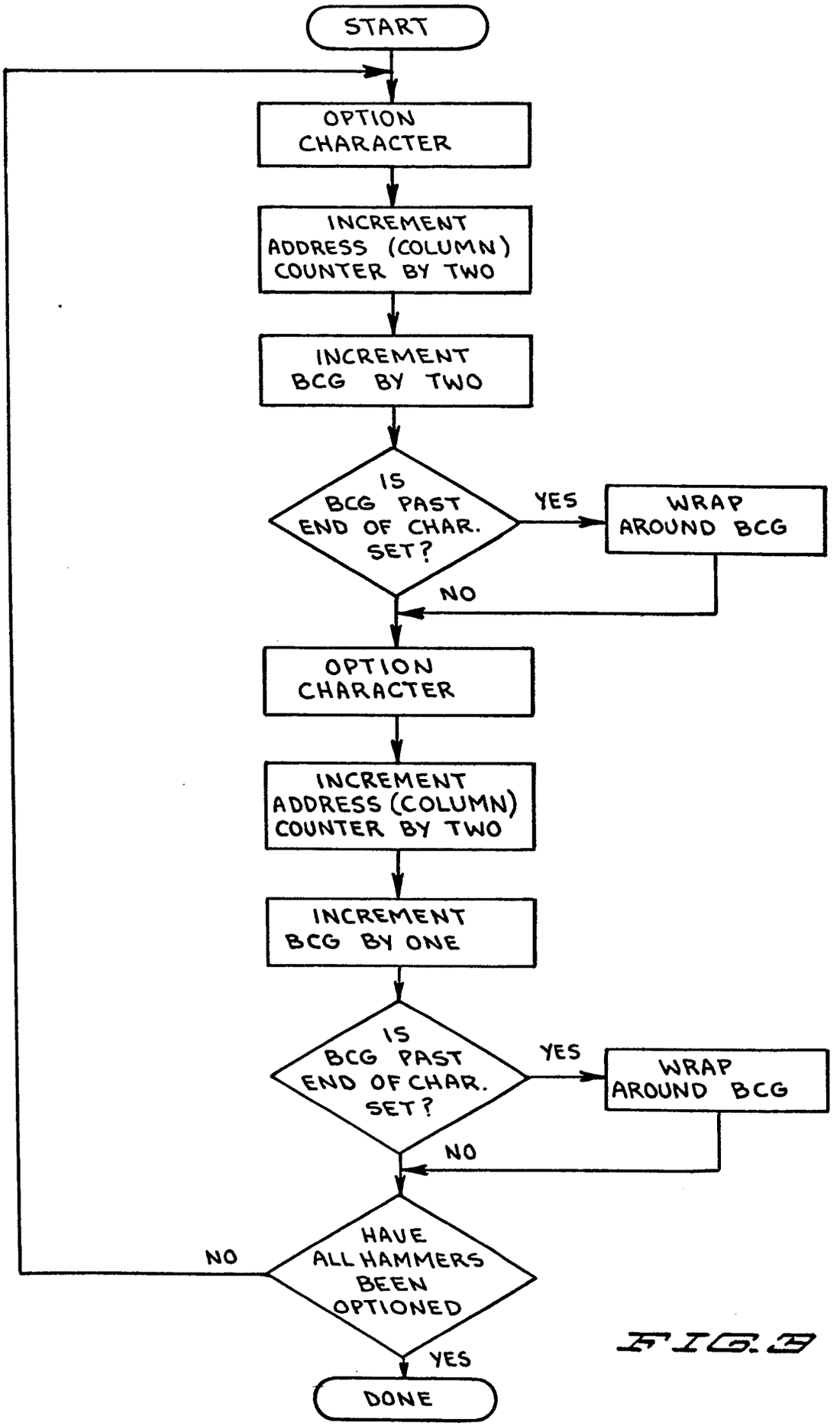

START
OPTION CHARACTER
INCREMENT ADDRESS (COLUMN) COUNTER BY TWO
INCREMENT BCG BY TWO
IS BCG PAST END OF CHAR. SET?
YES
WRAP AROUND BCG
NO
OPTION CHARACTER
INCREMENT ADDRESS (COLUMN) COUNTER BY TWO
INCREMENT BCG BY ONE
IS BCG PAST END OF CHAR. SET?
YES
WRAP AROUND BCG
NO
HAVE ALL HAMMERS BEEN OPTIONED
NO
YES
DONE

FIG.3

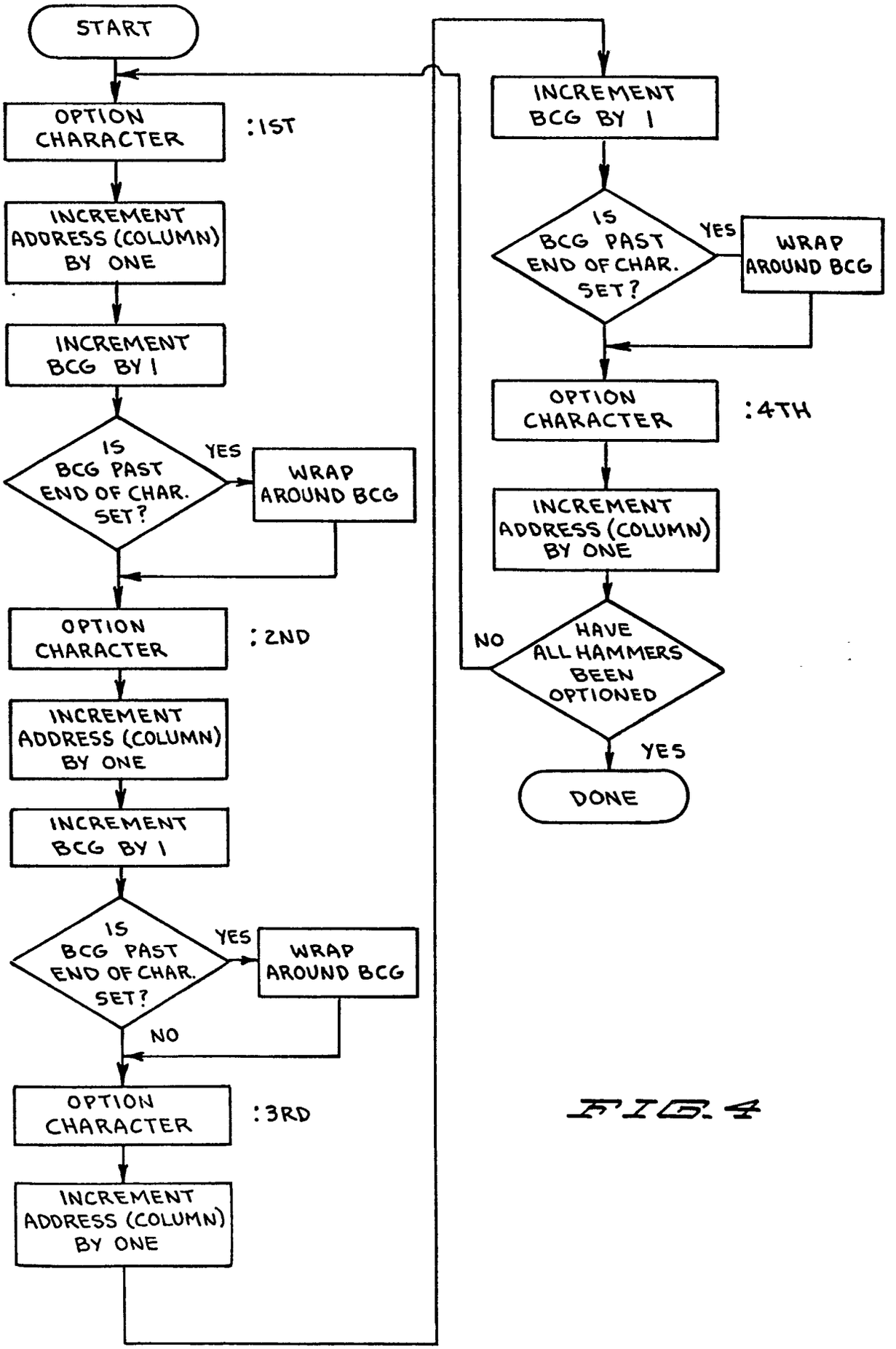

START
OPTION CHARACTER
:1ST
INCREMENT ADDRESS (COLUMN) BY ONE
INCREMENT BCG BY 1
IS BCG PAST END OF CHAR. SET?
YES
WRAP AROUND BCG
OPTION CHARACTER
:2ND
INCREMENT ADDRESS (COLUMN) BY ONE
INCREMENT BCG BY 1
IS BCG PAST END OF CHAR. SET?
YES
WRAP AROUND BCG
NO
OPTION CHARACTER
:3RD
INCREMENT ADDRESS (COLUMN) BY ONE
INCREMENT BCG BY 1
IS BCG PAST END OF CHAR. SET?
YES
WRAP AROUND BCG
OPTION CHARACTER
:4TH
INCREMENT ADDRESS (COLUMN) BY ONE
HAVE ALL HAMMERS BEEN OPTIONED
NO
YES
DONE

FIG. 4

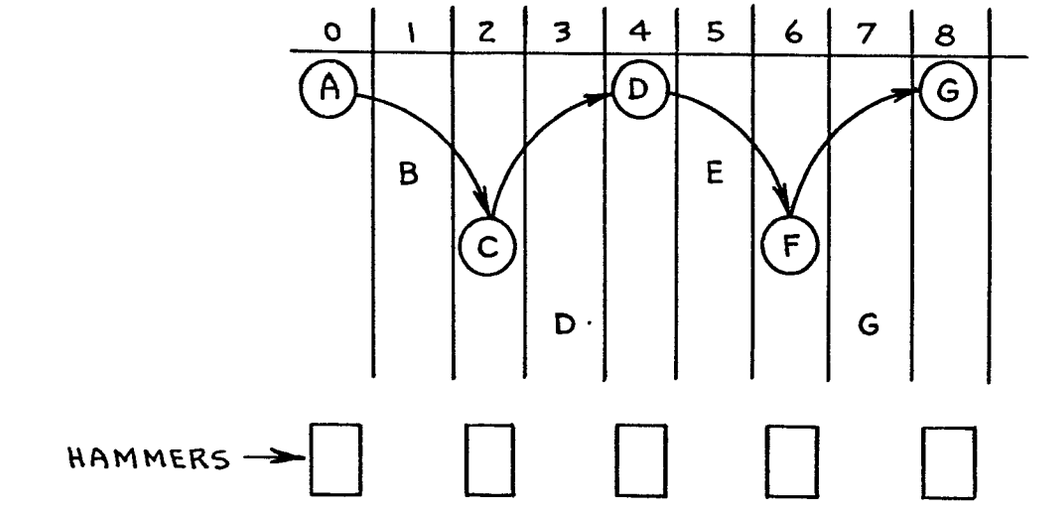


FIG. 5A

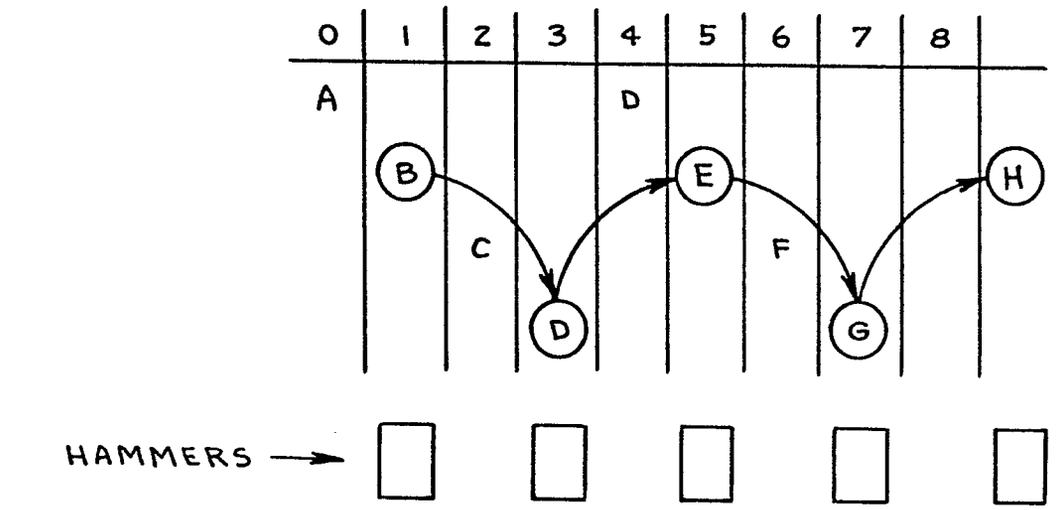


FIG. 5B

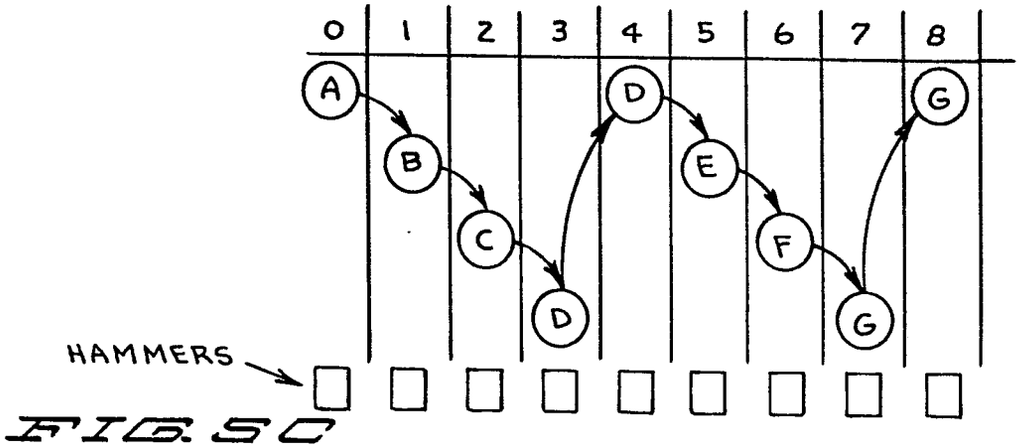


FIG. 5C