Dec. 17, 1968 E. A. BROWN ET AL 3,416,442

SELECTIVE HAMMER ACTUATING MEANS IN CHAIN PRINTERS

Filed June 20, 1967 4 Sheets-Sheet 1

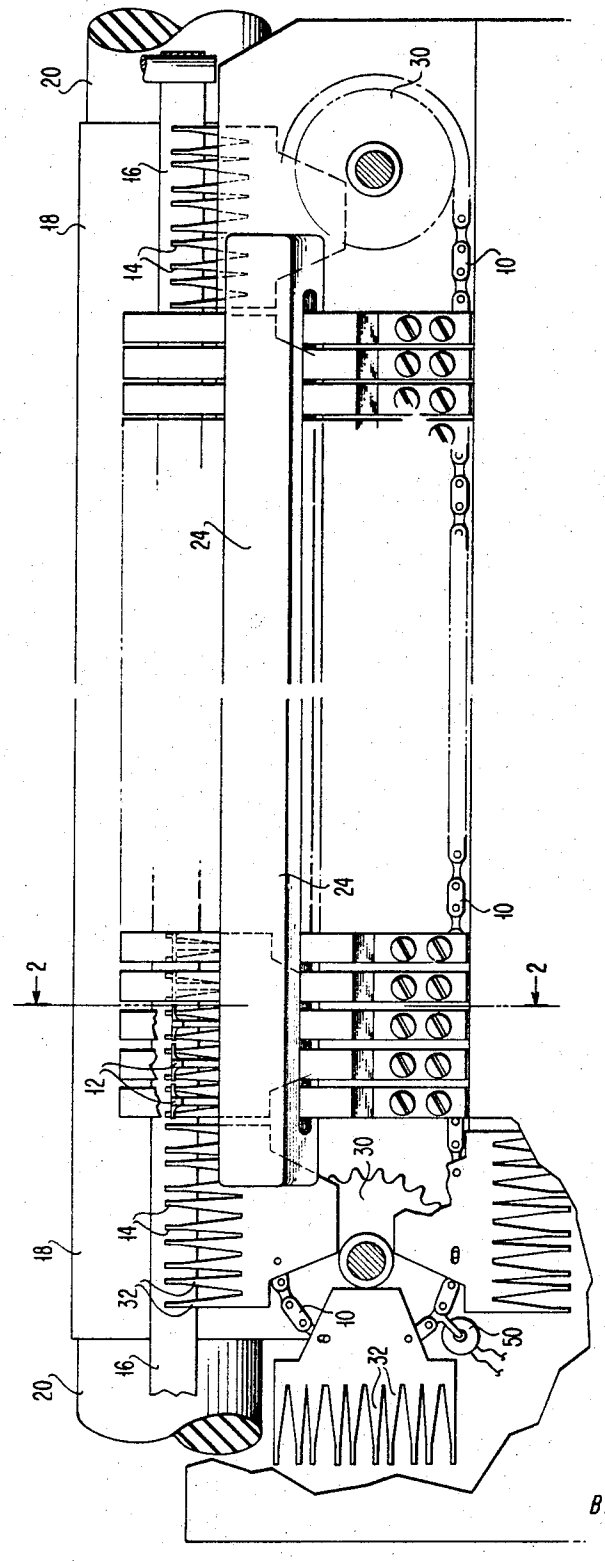

FIG. 1

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ATTORNEY

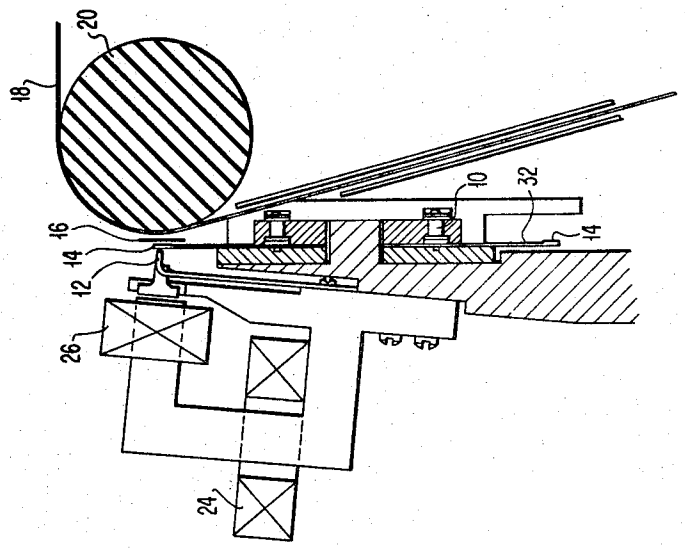
20
18
10
32
16
14
14
12
26
24

FIG. 2

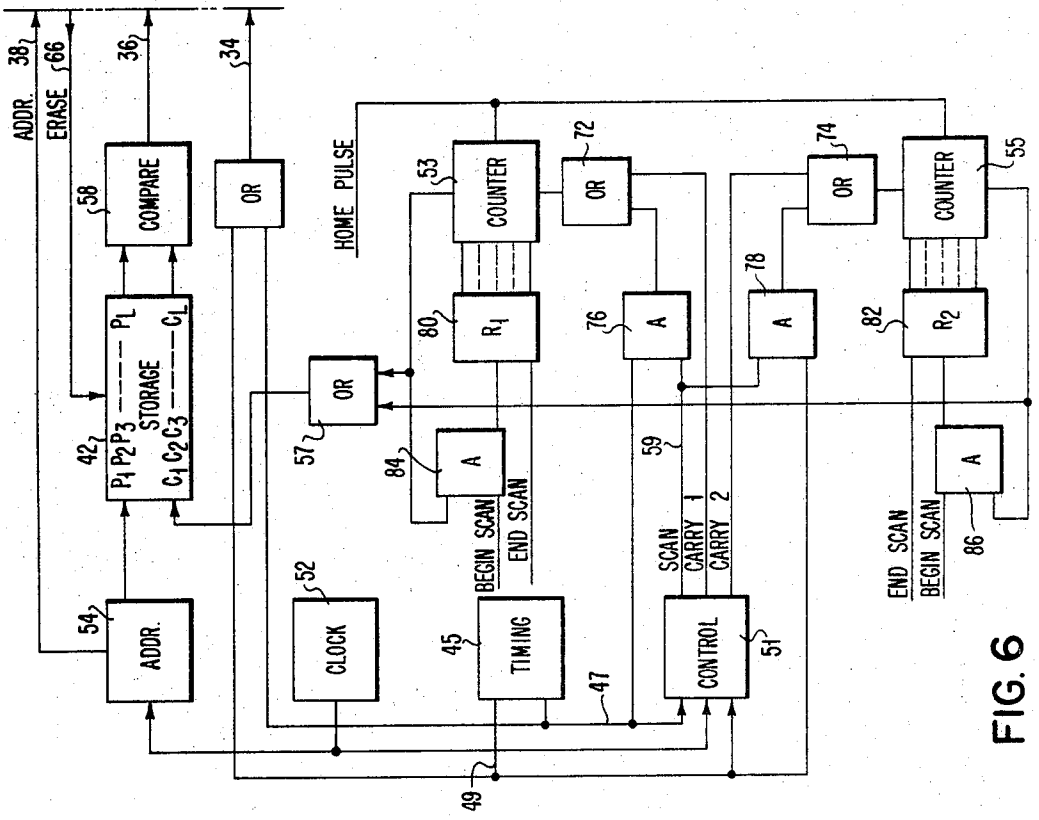
ADDR.
38
ERASE
66
36
34
58
COMPARE
OR
HOME PULSE
53
COUNTER
72
OR
74
OR
COUNTER
55
78
80
R1
76
A
A
82
R2
42
P1 P2 P3
STORAGE
C1 C2 C3
P1
C1
OR
57
84
A
59
A
86
BEGIN SCAN
END SCAN
SCAN
CARRY 1
CARRY 2
END SCAN
BEGIN SCAN
54
ADDR.
52
CLOCK
45
TIMING
47
CONTROL
51
49

FIG. 6

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SELECTIVE HAMMER ACTUATING MEANS IN CHAIN PRINTERS

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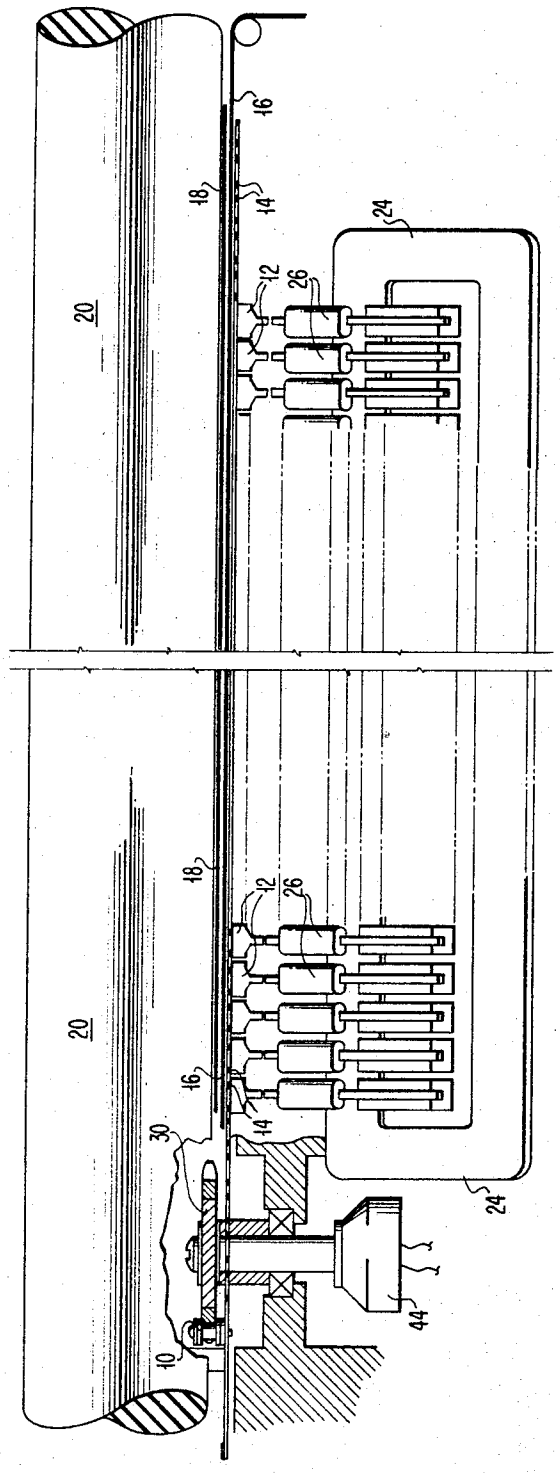

FIG. 3

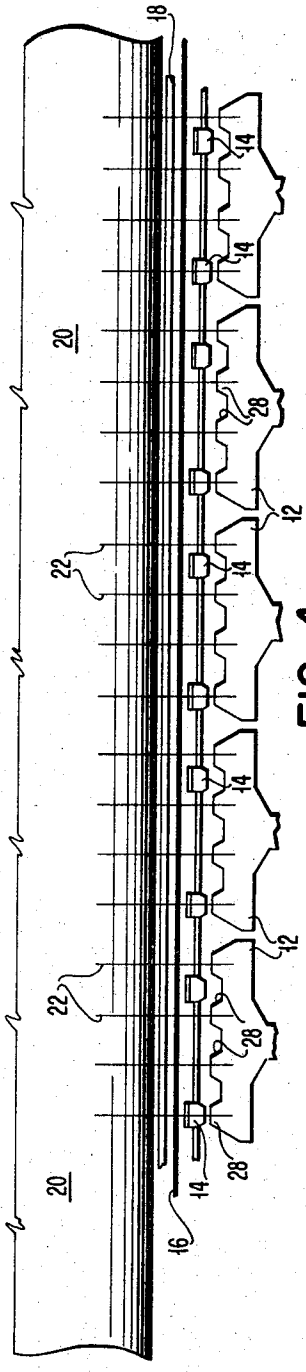

FIG. 4

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SELECTIVE HAMMER ACTUATING MEANS IN CHAIN PRINTERS

Filed June 20, 1967 4 Sheets-Sheet 4

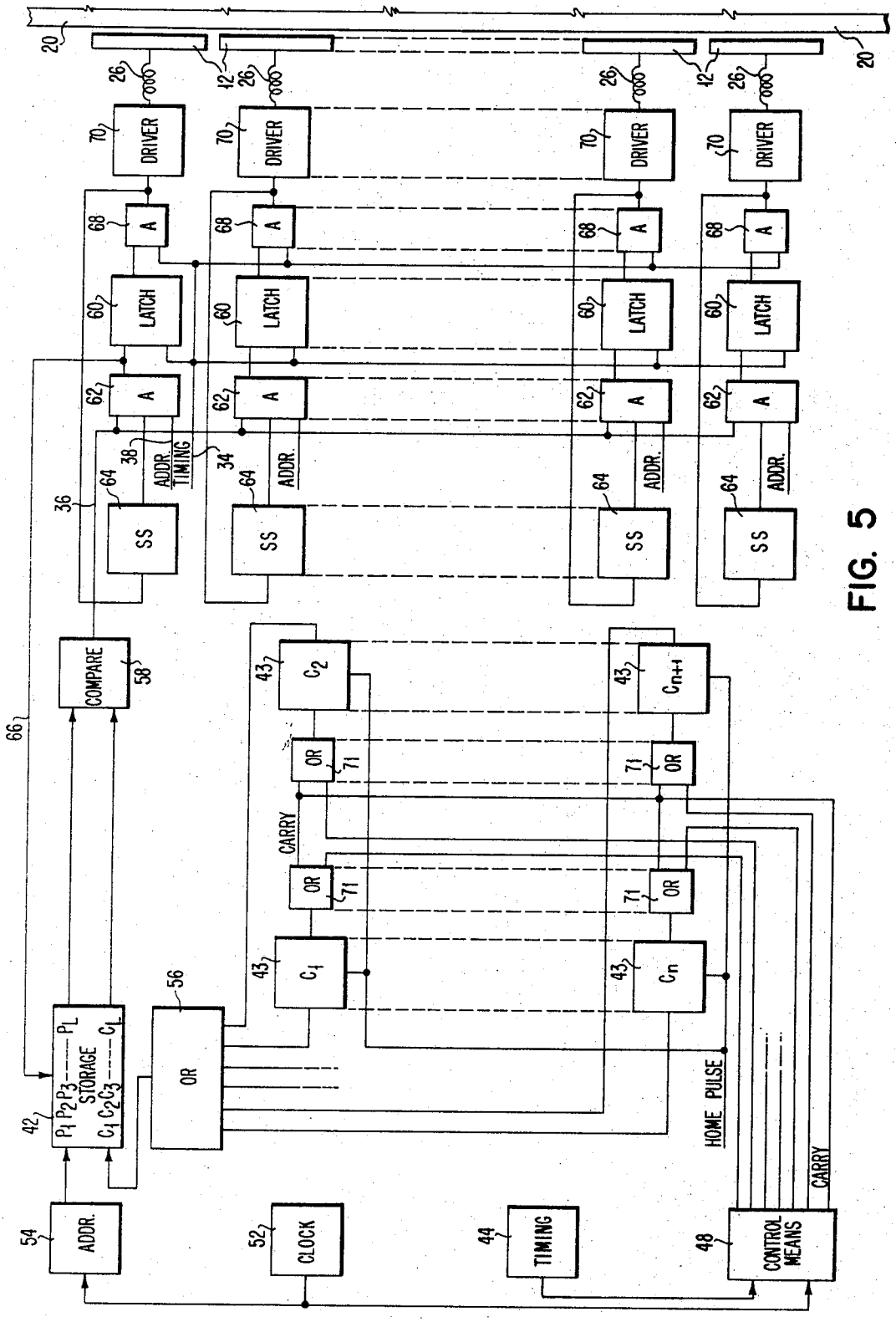

FIG. 5

United States Patent Office 3,416,442 Patented Dec. 17, 1968

3,416,442

SELECTIVE HAMMER ACTUATING MEANS IN CHAIN PRINTERS

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Filed June 20, 1967, Ser. No. 647,414
11 Claims. (Cl. 101—93)

ABSTRACT OF THE DISCLOSURE

A printing apparatus having a flexible carrier which moves print elements along a print line before a row of print hammers, each hammer covering a plurality of adjacent print positions and each having a plurality of preferred print portions. The print elements are spaced along the carrier so that a plurality of print elements are before each hammer at all times. Selective printing is accomplished by controlling the time at which the hammer is actuated coincident with the position of a print element to be engaged by one of the plurality of preferred printing portions.

BACKGROUND OF THE INVENTION

This invention relates to a chain printer and more particularly to a chain printer operating with print hammers covering a plurality of print positions.

The print hammers and the associated drivers represent an appreciable part of the cost of an on-the-fly printer. A printer has been previously proposed which uses a hammer having a width sufficient to cover a plurality of print positions. This printer has type spaced on the chain by the width of the hammers so that only one type character is in front of the hammer at one time. This printer achieves the desired low cost due to the decreased number of print hammers and drivers required. However, the printing rate of this printer is not as great as prior chain printers. Previous attempts to increase the printing rate of chain printers have involved the approach of increasing the speed of the chain or decreasing the actuation time of the print hammer, or both. It is not possible to increase the speed of the above-described printer using these techniques, since an increase in the speed of the chain when used with the presently available print hammer (as opposed to a firing pin type of hammer) produces unwanted interference with the type due to the fact that the relatively massive print hammer is near the print surface for a much greater time. In addition, the cost of the chain increases by an exponential factor with increased speed. A small increase in the speed of the chain results in a lower printing speed due to the fact that some characters are passed on a print cycle and a significant increase in speed is required to equal the present print rate. It is, therefore, an object of this invention to provide an improved chain printer which utilizes a hammer covering a plurality of printing positions.

It is another object of this invention to provide a chain printer utilizing a hammer covering a plurality of print positions which produces a greatly improved printing rate.

It is another object of this invention to provide a chain printer having a hammer which covers a plurality of print positions wherein type is positioned on the chain so that a plurality of characters are before the hammer at any time and selection of one of the characters is provided by control of the time of actuation of the print hammer.

Summary of the invention

According to the invention, there is provided a chain printer having a type carrier which moves print elements

sequentially along a print line in front of a row of print hammers wherein each of the print hammers covers a plurality of print positions. Each of the print hammers has a plurality of preferred printing positions and one of a plurality of the print elements before the print hammer is selected responsive to control means which is operable to compare the print elements in a particular position with the data to be printed and to actuate the proper print hammer for printing of the data in the proper position in the print line.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings.

Brief description of the drawings

FIGURE 1 is a front view having some parts cut away, of a chain printer embodying the invention.

FIGURE 2 is a section view along line 2—2 of FIGURE 1.

FIGURE 3 is a top view of the chain printer embodying the invention.

FIGURE 4 is an enlarged view showing greater detail of the arrangement of print characters in front of a print hammer.

FIGURE 5 is a schematic block diagram of the electronic control circuit for the printer embodying the invention.

FIGURE 6 is a schematic block diagram of the electronic control circuit for the specific embodiment of the printer illustrated in FIGURE 4.

Referring to the drawings, there is shown a front printing chain printer wherein a type carrier **10** travels in a substantially vertical plane in front of the print hammers **12**. The type element **14** is mounted on the type carrier on flexible fingers which produce the selected character when struck by the print hammer. The type character is pressed into engagement with a ribbon **16** and a record member **18** which is backed by a suitable platen member **20**. The hammers have faces which traverse the span of a plurality of print positions **22** and the normal spacing of the type elements on the type carrier results in a plurality of type elements being positioned before the hammer at all times. Control of printing is accomplished by a hold coil **24** which holds all hammers in the inoperative position and individual bucking coils **26** which are selectively actuated to cause the associated hammer to go through a cycle of operation. The character of the type element **14** which is aligned before one of a plurality of protrusions **28** on the face of print hammers **12** is printed while the other type elements are spaced so that they are at one of the relieved portions of the hammer face between protrusions **28** and are consequently not printed. When the hammer strikes the type onto the platen member, the hammer rebounds and the hold coil flux reattracts the hammer to the inoperative position so that the hammer is then in position to be selected for another printing operation. The signal to energize the bucking coil is generated by the control means which is described in greater detail below. Briefly, the control means provides stored coded data of the text to be printed for a complete line and this data is compared with the coded data representing the print element in position for printing at each print position. An equal compare produces a signal which is coupled to actuate the proper print hammer to print the designated character at the designated print position. A similar operation is conducted at each time characters on the chain reach a print position until the complete line is printed.

According to the embodiment of the invention shown

in the drawings, the printer comprises a chain member **10** which is mounted to be driven by sprocket wheels **30** which are, in turn, driven from a suitable drive motor (not shown). Mounted upon chain **10** is a plurality of type elements **14**. Type elements **14** are mounted on flexible type fingers **32**. A plurality of type fingers are joined at the base to form a type segment which is removably attached to chain **10** so that the composition of the character set of the printer can be easily changed by changing the type segments. The type members **14** are positioned to be driven by the chain along a print line adjacent to platen **20**. A plurality of print hammers **12** are selectively actuable to print a character at one of a plurality of print positions before each hammer. Printing is accomplished by an electrical signal which is coupled to actuate print hammer **12** which impacts the type character **14** then before the hammer in print position, thereby causing the type character to be moved into ribbon **16** so that the selected character is printed at the selected position on record form **18**.

The type characters are arranged on chain **10** so that a plurality of characters are before a print hammer at all times. The face of print hammer **12** is provided with a plurality of preferred print regions comprising protrusions **28**, each spaced one print position apart. The area between protrusions **28** on the face of print hammer **12** is recessed below the surface of protrusions **28**. Print characters are spaced on chain **10** a distance equal to one and a fraction print positions. By this spacing, when one of the type characters before hammer **12** is in position to be engaged by one of the protrusions **28**, the other type characters are before one of the recesses between protrusions **28** so that only the type character opposite protrusion **28** is printed.

Each of the print hammers **12** is held in the print ready position by constantly energized hold coil **24**. To select a particular hammer for printing, an individual bucking coil **26** is energized by a suitable electrical signal. This signal produces a flux in opposition to the hold coil flux which releases the hammer for one cycle of operation. When the hammer rebounds from the platen, the current in bucking coil **26** has collapsed and the hammer is reattracted to the print ready position by hold coil **24**. A more detailed description of the operation of the print hammer may be obtained by referring to copending application Serial Number 606,308 filed Dec. 30, 1966, entitled "Print Hammer Actuator" by Edgar Alan Brown, Albert S. Chou and Richard H. Darling.

Control of the character to be printed is accomplished by providing an electrical signal denoting which character is in a particular print position and comparing this data with data to be printed at each of the print positions. An equal compare signal is coupled to actuate the corresponding print hammer and this operation continues until all characters in the line have been printed. As the paper is spaced, data for the next line to be printed is then stored in position to be compared with the print characters on the chain.

It is possible to provide type characters spaced in many different formats wherein more than one type character is before the print hammer at any prescribed time. In the general case which provides for equal spacing of the type on the chain relative to the print position, the spacing of the type is $s(n+1/n)$ where s is the spacing of adjacent print positions and n is the number of print positions spanned by the print hammer. In this general case, the characters to be printed in the line are stored in a storage device as an image of the line to be printed. This data is compared sequentially with the code for the characters in position to be printed at a particular print position. On an equal compare, a latch is set for that particular print position and at the proper time in the cycle the hammer is actuated to print the character at that print position. The code for the character in print position on the chain is provided by a plurality of $n+1$ counters, each counting in steps of $n+1$, and a control device which sequentially actuates the counters in $n+1$ steps and as the printer proceeds, at each end carry of the control device, each of the counters is advanced one step from the previous starting position. This operation continues until the complete line is printed. A means for generating a home pulse is provided and the output of the home pulse generator is coupled to reset each of the counters to the starting position.

In the general case wherein the print hammer spans n print positions, the control of the printer is accomplished by providing a storage device **42** which stores an image of the line in coded form. A timing device **44** is provided and the timing device generates a series of n equally spaced timing pulses. One suitable timing device is that claimed in application Ser. No. 422,302 filed December 30, 1964, entitled, "Timing Device" by Edgar Alan Brown. A ring circuit having $n+1$ stages is provided within control means **48** to control $n+1$ code control means. In the embodiment of the invention shown in the drawings the code control means comprise counters **43**. Each of the counters is designated to count in steps of $n+1$ so that, for example, counter **1** starts at count 1 and proceeds in steps of $n+1$; counter **2** starts at 2 and proceeds in steps of $n+1$ and counter n starts at n, likewise proceeds in steps of $n+1$. The counters designate the count for the character then in print position at a particular time. In the embodiment shown, the home pulse generator **50** comprises an insert of magnetic material coupled to the chain and a stationary sensing device. The home pulse generator produces one electric pulse output for each cycle of chain member **20** and this output is coupled to reset all the counters to the first position. This operation provides a continuous re-synchronizing of the physical position of the chain and the counters during operation of the printer.

The output of the timing device is coupled to step the ring one step responsive to the timing signals. A clock means **52** produces a series of accurate equally spaced timing pulses which are coupled to addressing means **54** and to control means **48**. The clock pulses are gated through control means **48** to step the active counter. The outputs of control means **48** are coupled to actuate the corresponding numbered counter for generating a series of signals which are coupled through OR circuit **56** to sequentially read out from memory the code for the characters then in position to be printed. The addressing means provide a similar series of signals to sequentially read out the code for the character to be printed to form the next line of print. The data is stored in the same code as used to store the chain image and the character codes are coupled to compare circuit **58** and an equal compare produces an output signal on line **36** which is coupled to set a latch **60** for that particular address provided the corresponding AND circuit **62** is conditioned. Two of the inputs to AND circuit **62** are provided by the compare signal and the address signal on line **38**, while the third input is the OFF output of single shot multivibrator **64**. The single shot multivibrator functions to prevent the use of a hammer for a predetermined period determined by the design of the single shot after use of a hammer to provide sufficient time for the hammer to return to the print ready position.

The conditioning of AND circuit **62** denotes that a character will be printed at that address and this fact is communicated over line **66** to the memory **42** and this signal functions to erase the character from memory. Thus, by sensing the characters in area P of the memory, it can be determined when the complete print line has been printed. The leading edge of the next output pulse on line **34** from the timing means conditions AND circuit **68** and driver **70** to energize the hammer and print the character at the designated position. The trailing edge of the output pulse is used to reset latch **60**. This operation continues through the series of $n+1$ counters and the

next timing pulse causes the ring to end carry and start the count again. The end carry of the ring is sensed and the carry signal is coupled to each of the counters through OR circuit **71** to step each counter one step so that the counters next start from the $n+1$ point in the counter. This operation permits the circuits to compensate for the type characters which have already moved past the first print position at the start of that scan so that these characters are then added to the end of the count for possible printing in later positions. The hammer required for actuating a printer of this type must have flight time which is reasonably reproducible. In addition, the time the hammer is at or near the type finger is important to prevent interference between the raised portions of the hammer and the unselected character. Thus, it will be recognized by those skilled in the art that a wide variety of arrangements is possible, depending upon the speed of the chain, the arrangement of type characters on the chair and the characteristics of the print hammer.

A specific embodiment of the invention is shown in the drawings (see FIGURE 4) wherein two type characters are provided before a hammer spanning four print positions. In this case the type characters are not symmetrically placed on the type chain. For example, if the type chain is in a position so that one type character aligns with the leftmost print position serviced by each print hammer, an additional type character is before the hammer at a position 2½ print positions to the right. Thus, it is seen that the density of type characters on the chain is doubled and assuming the same velocity of the type chain, all the characters of a set are presented to the print hammers in half the time, thereby effectively doubling the speed of the printer.

In the embodiment of the printing apparatus shown in FIGURE 4, control of the printer is accomplished by the control circuits shown in FIGURE 6. The control circuits shown in FIGURE 6 operate in the same manner as the circuit shown in FIGURE 5 after the compare signal has been generated. The major difference in the circuits comprises the circuits for control of the readout of the chain image code from the storage device which is compared with the print line data. The data for he line to be printed is stored in a storage device **42** and control of the timing of a print scan is under control of a clock **52** which controls addressing means **54**. A timing means **45** provides a first timing pulse T1 on line **47** and a second timing pulse T2 on line **49**. The timing pulses and the clock pulses are coupled to control means **51**. Control means **51** provides the control of counters **53** and **55** to provide outputs through OR circuit **57** to read out the character code for the type element in print position to compare circuit **58**. Control means **51** comprises an eight-stage ring circuit which is stepped by timing puses on lines **47** and **49**. The ring circuit is designed to generate a first carry signal between the third and fourth stages of the ring which is coupled as one input to OR circuit **72**. A second carry signal is generated when the ring end carries from stage **8** to stage **1** and this carry signal is coupled as one input of OR circuit **74**. The timing pulses on lines **47** and **49** also are operative to gate the timing pulses from clock **52** to a scan line **59** which is coupled as one of the inputs to AND circuits **76** and **78**. The other input to AND circuits **76** and **78** comes from timing pulses T1 and T2 respectively so that AND circuit **76** is conditioned at T1 time to actuate counter **53** and AND circuit **78** is actuated at T2 time to actuate counter **55**. A register **80, 82** is provided in conjunction with each of the counters **53, 55** so that the first character signal from the counter is stored in the register through AND circuit **84** or **86** by the signal BEGIN SCAN which is generated by control means **51** and has the duration of one pulse period of the scan cycle. The END SCAN signal is coupled to the register to reset the value in the register back into the corresponding counter. This operation thus provides a setting in the counter which is ready for the next scan cycle. In the event that a carry signal is generated on the next timing signal, the counter is stepped one count responsive to this carry signal before the scan signal is actuated so that the counter produces the proper code synchronized with the character then in print position.

A wide variety of arrangements of type elements **14** upon chain **10** is possible. For example, the type may comprise one of the preferred character sets wherein more than one of each of the characters that are frequently used are included in the character set. Another arrangement which permits alphanumeric printing at a first rate and numeric only printing at a much higher rate comprises the placement of alternate alphabetic and numeric characters on the chain.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in the form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A printer comprising a plurality of type members movable along a print line having a plurality of spaced print positions,

selectively operable hammer means positioned along said print line for striking said type members at said print positions;

said hammer means spanning a plurality of print positions and having a plurality of print regions corresponding to said print positions connected by non-printing regions;

said type members having a spacing relative to the span of said hammer means so that a plurality of type members are before said hammer means along said print line at all times but only one of said type members is adjacent one of said print regions of said hammer means at any time;

means for advancing said type members along said print line;

means for storing coded data to be printed;

means for generating a coded signal denoting each of said plurality of said type members aligned for printing by each of said print regions of said hammer means;

means for comparing said stored coded data to be printed at a particular print position and said generated coded signal for the type member aligned at the particular print position; and

means for coupling an equal compare signal to actuate the hammer means to print the stored character at the selected print position.

2. The printing apparatus according to claim **1** wherein said type members are mounted on a flexible type carrier.

3. The printing apparatus according to claim **2** wherein said flexible type carrier is a chain member.

4. The printing apparatus according to claim **1** wherein said means for generating a coded signal denoting each of said plurality of type members aligned for printing comprises a plurality of counters.

5. The printing apparatus according to claim **4** wherein said plurality of counters is equal to one more than the number of print positions spanned by said hammer means.

6. The printing apparatus according to claim **1** wherein said print regions on said print hammers comprises a plurality of protrusions spaced an amount equal to the print position spacing, and wherein each of the protrusions is separated by a relieved portion.

7. A printer comprising a plurality of type members movable along a print line having a plurality of spaced print positions,

a plurality of selectively operable hammer means positioned along said print line for striking said type members at said print positions;

each of said hammer means spanning a plurality of

print positions and having a plurality of print regions corresponding to said print positions separated by nonprinting regions;

said type members having a spacing relative to the span of said hammer means so that a plurality of type members are before each of said hammer means along said print line at all times but only one of said type members is adjacent one of said print regions of each of said hammer means at any time;

means for advancing said type members along said print line;

means for storing coded data to be printed;

means for generating a coded signal denoting each of said plurality of said type members aligned for printing by each of said print regions of said hammer means;

means for comparing said stored coded data to be printed at a particular print position and said generated coded signal for the type member aligned at the particular print position; and

means for coupling an equal compare signal to actuate the proper hammer means to print the stored character at the selected print position.

8. The printing apparatus according to claim **7** wherein said type members are mounted on a flexible type carrier.

9. The printing apparatus according to claim **8** wherein said flexible type carrier is a chain member.

10. A printer comprising a plurality of type members mounted upon a flexible type carrier means, said type carrier means being movable along a print line having a plurality of spaced print positions,

a plurality of selectively operable hammer means positioned along said print line for striking said type members at said print positions;

each of said hammer means spanning a plurality of print positions and having a plurality of print regions corresponding to said print positions separated by non-printing regions;

said type members having a spacing relative to the span of said hammer means so that a first and a second type member are before each of said hammer means along said print line at all times, said type members being mounted on said type carrier means so that when said first type member is adjacent one of said print regions, said second type member is adjacent one of said non-printing regions;

means for advancing said type carrier means along said print line;

means for storing coded data to be printed;

means for generating a coded signal denoting each of said plurality of said type members aligned for printing by each of said print regions of said hammer means;

means for comparing said stored coded data to be printed at a particular print position and said generated coded signal for the type member aligned at the particular print position; and

means for coupling an equal compare signal to actuate the proper hammer means to print the stored character at the selected print position.

11. The printing apparatus according to claim **10** wherein said means for generating a coded signal denoting each of said plurality of type members aligned for printing comprises a plurality of counters.

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