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PRINTING DEVICE FOR OFFICE MACHINES
AND DATA PROCESSING EQUIPMENTS

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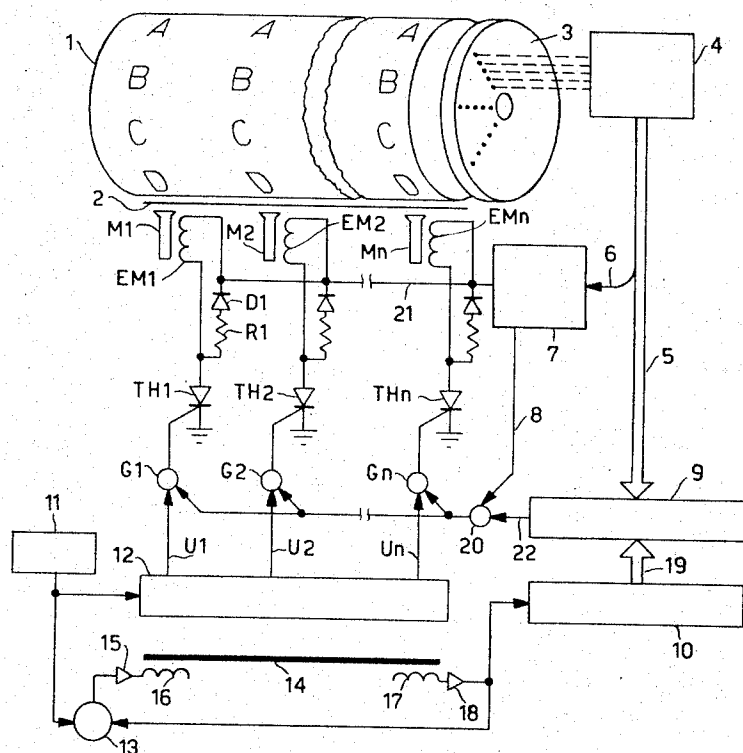


Fig. 1

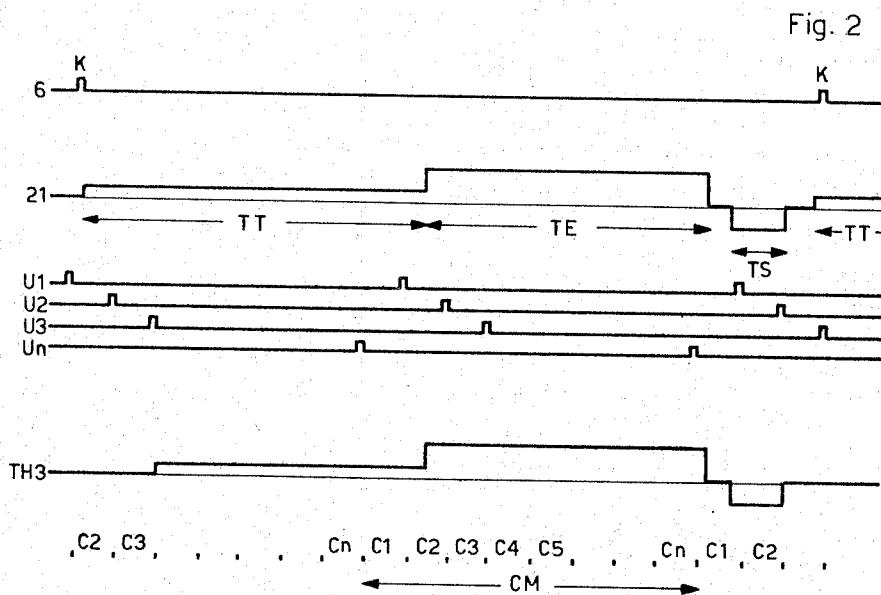


Fig. 2

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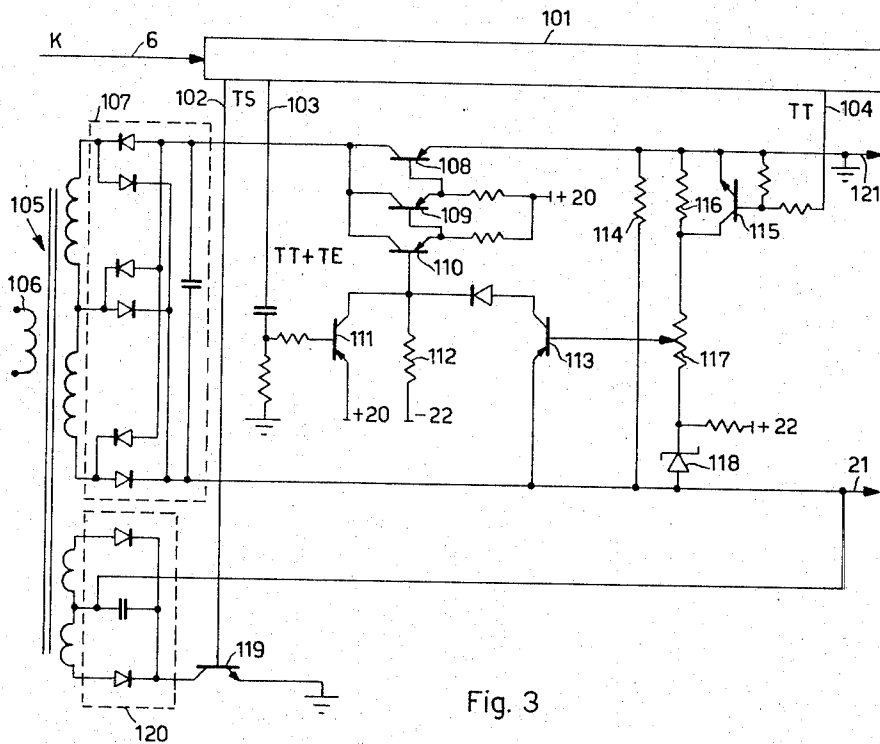


Fig. 3

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PRINTING DEVICE FOR OFFICE MACHINES AND DATA PROCESSING EQUIPMENTS

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1 Claim. (Cl. 101-93)

ABSTRACT OF THE DISCLOSURE

In a line-at-a-time printer having a rotary printing cylinder and fed by a cyclic serial memory, the print hammers are driven through thyristors which are selectively and sequentially fired upon reading out each character to be printed and are then powered at a same time when each row of characters comes in front of the hammers.

The present invention refers to a pluri-column printing device, provided with a hammer for each column. The hammer is operated by a proper electro-magnet. The device is further provided with a moving type carrying member comprising for each column a row of types disposed on lines of equal types each one pertaining to a different row. The device is fed by a cyclic memory whose cycle has a period shorter than the time interval comprised between the two instants when two successive rows of types come in front of the hammers.

The known devices of this type require complicate memory means to memorize the strike order of a hammer from the instant a character is read out of the memory to the instant the corresponding character of the type carrying member comes in front of the hammer. Furthermore in said known devices the reading out of the memory should be synchronous with the movement of said type carrying member, which imposes strong limits to the work flexibility of the same memory.

The above-mentioned disadvantages are obviated by the printing device according to the invention, which is characterized in that the winding of each electro-magnet is serially connected both with a thyristor selectively energized synchronously with the reading out of said memory according to the read information, and with a power pulse source common to all the electro-magnets.

This and other features of the invention will clearly appear from the following description of a preferred embodiment, made by way of example and not in a limiting sense, with reference to the annexed drawings, in which:

FIG. 1 shows a scheme of the printing device according to the invention;

FIG. 2 shows a time diagram illustrating the operation of the printing device of FIG. 1;

FIG. 3 shows a scheme of an electrical pulse generator employed in the printing device of FIG. 1.

The printing device comprises a continuously rotating type carrying drum 1, provided with n rows of types circumferentially arranged thereon and cooperating with as many hammers, $M1, M2, \dots, Mn$ respectively to write on as many columns or successive orders of a paper sheet 2.

A code disc 3 rotating solidly with the drum 1 bears synchronizing marks, which can be scanned optically, magnetically or in another known way, to activate a code generator 4, apt to feed on one of its output lines 6 a pulse K right after the transit of each row of equal characters in front of the hammers. Further the code generator 4 is apt to feed, on a group of its output lines 5 during the whole time interval comprised between

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two contiguous pulses K , a group of binary signals representing in a suitable code that type of the drum 1 which comes in front of the hammers during said time interval.

Each of said hammers $M1, M2, \dots, Mn$ is operated by an electro-magnet $EM1, EM2, \dots, EMn$ respectively, which may be energized or not by a pulsing voltage source 7 according to whether a thyristor $TH1, TH2, \dots, THn$ respectively, has been energized or not by a pulse coming out of a gate $G1, G2, \dots, Gn$ respectively. In order to suppress undue electrical oscillations serially connected diode and resistor are disposed in parallel to the winding of each electro-magnet.

A magnetostrictive delay line memory 14 may contain at least all the n characters to be written in a whole printing line. The n characters are read out of the delay line 14, through a reading transducer 17 and a reading amplifier 18, serially bit by bit and character by character, during n digit periods from $C1$ to Cn respectively. Due to the cyclic structure of the memory 14, the digit periods from $C1$ to Cn repeat themselves cyclically. The memory cycle CM has a period shorter than the time interval comprised between two pulses K produced by the code generator 4, which is equal to the time interval occurring between the two instants when two successive types of the drum 1 come in front of the relevant hammer.

Each bit read out of the delay line 14 is immediately rewritten in the same line, through a gate 13, a writing amplifier 15 and a writing transducer 16. The frequency wherewith the bits are written in the delay line is controlled by an oscillator 11, which produces at each bit period a pulse apt to open the gate 13 and to operate the counting of a counter 12. The counter 12 operates as a pulse distributor in order to indicate that character of the memory which is at present read out through the amplifier 18. More particularly, the distributor 12 energizes the output $U1, U2, \dots, Un$ right after the reading out of the last bit of the first, second $\dots$ n th memory character respectively, i.e. at the end of the first, second $\dots$ n th digit period $C1, C2, \dots, Cn$ respectively. Therefore it is clear that the output lines $U1, U2, \dots, Un$ of the distributor 12 are cyclically energized synchronously with the reading out of the n characters memorized in the delay line.

According to a feature of the invention the reading cycle of the memory 14 is asynchronous with respect to the cycle of the type carrying drum 1.

Each character, read out of the delay line 14 serially bit by bit, is staticized into a serial-to-parallel converter 10, whose output 19 feeds a comparator 9 fed also by the output 5 of the code generator 4, so that the output 22 of the comparator 9 is energized when the character at present read out of delay line 14 coincides with the type of the drum 1 which is coming in front of the printing hammers.

During the time interval comprised between two successive pulses K (FIG. 2), the binary signals, which are present on the outputs 5, remain unchanged in order to represent the type of the drum which comes in front of the hammer, while the group of binary signals, which are present on the outputs 19, can change at every digit period $C1, C2, \dots, Cn$ in order to represent the successive n characters read out of the delay line 14 during each cycle CM . Therefore at the end of a general digit period Cm , i.e. when the output Um of the distributor 12 is energized, the output 22 of the comparator is significant only for the m th printing column and it indicates whether the m th character of the memory is equal or not to the one the printing device is now able to print. If it occurs, the electro-magnet through the gate Gm and the thyristor THm

is energized to operate the printing of said character on the m th column.

As the signals coming out of the gates $G1, G2, \dots Gn$, which control the operating of the hammers $M1, M2, \dots Mn$ respectively, appear at the end of the successive digit period $C1, C2, \dots Cn$ respectively, while the effective operation of the hammers should occur at a single instant, i.e. when the type line of the drum at present considered comes into a position fit for the stroke, it is necessary to provide for each column a binary memory element apt to memorize the signal coming out of said gates till the instant of the stroke.

According to the invention, the above-mentioned memory function is accomplished by the same thyristors $TH1, TH2, \dots THn$.

For this purpose the voltage source 7 produces on the output line 21, for each type line of the drum coming in front of the hammers, a voltage having a wave form like the one indicated by 21 in FIG. 2. More particularly, starting from each pulse K and during a first time interval TT with a length of at least a cycle of the delay line, the output 21 feeds to the anode of the thyristors a keeping voltage, having a value of e.g. $+5$ v., which is sufficient both to activate the conduction in a thyristor if it receives a current pulse, having a value of e.g. 10 ma., on the control electrode from the output of the corresponding gate $G1, G2, \dots Gn$, and then to maintain energized said thyristor, but which voltage is per se inadequate to energize the thyristors. Successively the output 21 feeds on the anode of the thyristors a voltage having a value of e.g. $+30$ v., which is sufficient to make strongly conductive only the thyristors previously energized, in order to energize the printing electro-magnet during a time interval TE , but which voltage is per se inadequate to make conductive the remaining thyristors. Finally the output 21 feeds a negative voltage having a value of e.g. -30 v. during a time interval TS to deenergize all the thyristors and to predispose them for the striking of the successive alphabetical character. After having received the successive pulse K , the cycle of the voltage source 7 repeats itself for said successive character.

With reference to the time diagram of FIG. 2 the operation of the printing device of FIG. 1 will now be described.

At the start of a revolution of the drum 1 the code generator 4 produces a first pulse K , which starts a cycle of the voltage source 7. As the first type of the drum is A , from said pulse K to the next pulse K the code generator 4 produces on the outputs 5 the code of the character A .

Said start of the revolution can occur at any instant of the cycle of the delay line 14; e.g. in FIG. 2 it occurs during the first half of the second digit period $C2$ of the same delay line. At the end of this digit period $C2$ the second character of the line to be printed is available in the staticizer 10. If now we suppose that said character is B , then the output 22 of the comparator B is not energized because the coincidence between its two inputs is not realized, and therefore, the output of the gate $G2$ being deenergized, the thyristor $TH2$ cannot be energized and consequently the hammer $M2$ will not be operated.

At the end of the third digit period $C3$ of the delay line the character to be printed on the third column is available in the staticizer 10. If we suppose that said character is A , then the output 22 of the comparator 9 is energized because the coincidence between its two inputs is realized and therefore, the output of the gate $G3$ being energized, the thyristor $TH3$ is energized at the end of the third digit period $C3$, and then it is maintained conductive by the keeping voltage fed by the source 7.

Analogously the other thyristors $TH4, TH5, \dots THn$, $TH1$ are energized or not, at the end of the digit period $C4, C5, \dots Cn, C1$ respectively, according to whether the fourth, fifth, $\dots$ n th, first character respectively contained in the delay line is equal to A or not. Therefore at the end of the time interval TT the thyristors

energized are only the ones of the columns wherein the character A is to be printed. During the time interval TE , through these energized thyristors, the electro-magnets of said columns are energized to operate the corresponding hammers.

Not long after the printing of said characters A , the code generator 4 produces a second signal K , and then the signals on the outputs 5 change to represent the character B . Meanwhile a new time interval TT starts, wherein the thyristors are selectively energized to control the stroke of all the characters B of the printing line. Analogously all the characters C of the printing line are successively printed and so on.

The pulse source 7 comprises a timing pulse generator 101 of a type known per se which is apt to feed on the output 102, 103 and 104 a pulse whose period identifies respectively the time interval TS , during which the thyristors are deenergized, both the time intervals TT and TE , during which the delay line is scanned and the hammers are operated, and the single time interval TE .

From the alternate current network feeding the primary winding 106 of a transformer 105, by means of a network of rectifiers 107, a continuous current is obtained which is applied between the ground terminal 121 and the output terminal 21 through a power transistor 108, which in its turn is fed by two amplifying transistors 109 and 110.

When no output of the generator 101 is energized, the transistor 111 is conductive and therefore it keeps the base of the transistor 110 to a voltage sufficient to cut off the same transistor 110 and therefore also the transistors 109 and 108. In this condition no valuable current is fed on the terminal 21 and a resistor 114 having a very low resistance provides to keep the terminal 21 at the ground voltage.

On the contrary during the time intervals TT and TE , the output 103 being activated, the transistors 111 is cut off and therefore the base voltage of the transistor 110 can be controlled, through the transistor 113, by the output voltage present between the terminals 21 and 121, so that the power transistor 108 is controlled, according to a well known art of the stabilized feeder, by a feed-back signal provided by said output voltage.

More particularly, during the time interval TT , the signal present on the terminal 104 keeps the transistor conductive 115, so that the resistor 116 is short-circuited. In this condition the value of the current the transistor 113 feed to the base of the transistor 110, and consequently the value of the impedance between the collector and the emitter of the transistor 108 is defined by the output voltage between the terminals 121 and 21, reduced by the voltage on the Zener diode 118 and on a part of the resistor 117, so that said output voltage is stabilized near the value $+5$ v.

During the following time interval TE , the terminal 104 being deenergized, the transistor 115 is cut off, so that even the resistor 116 is now inserted in the feed-back circuit, and so the value of the output voltage between the terminals 21 and 121 is now stabilized to a higher value equal to $+30$ v.

During the time interval TS , the activation of the terminal 102 makes the transistor 119 conductive, so that a rectifying network 120 fed by the transformer 105 provides on the terminal 21 a negative voltage apt to cut off the thyristors.

It is intended that the thyristors, whose characteristics are described e.g. in the article of David D. Holmes, "Application of Transistors in Communications Equipments," Proceedings of the IRE, June 1958, p. 1255, can be replaced by any other equivalent circuit element having at least three electrodes and may be energized by an ignition pulse fed on the control electrode, and successively kept lowly conductive by a keeping voltage or current applied between the other two electrodes and de-energized being arranged to permit movement of said successively made strongly conductive by a higher voltage or

current applied between said electrodes and inadequate per se to switch on said element, and finally switched off by a deenergizing pulse fed on whatever one of said electrodes.

It is intended that the invention can be likely applied to a printing device of the type "without striking," e.g. of the type wherein a first electrode shaped as the type to be printed cooperates with an exciting electrode to modify chemically or electrically the state of the paper in the area corresponding to said first electrode. It is intended that in this case the winding of the electro-magnet is replaced by said exciting electrode.

What I claim is:

1. A line-at-a-time printing device comprising

- (a) a rotary type-carrying drum having on the face thereof a plurality of columns of spaced characters with each column extending circumferentially around said drum and with each character in each column being positioned on the periphery of said drum so that it lies in alignment with an equal character of each other column in a longitudinal row parallel to the axis of said drum;
- (b) a like plurality of printing hammers each one positioned in front of a different one of said columns, said hammers being aligned on a line parallel to the axis of said drum;
- (c) a like plurality of electromagnets each one having an exciting winding and being operatively connected to a different one of said hammers;
- (d) a source of power pulses having two terminals, one of said two terminals being connected in common to one terminal of all said exciting windings;
- (e) means for driving said source in synchronism with the rotation of said drum to produce a power pulse between the two terminals of said source each time a row of characters comes in front of said hammers;
- (f) a like plurality of thyristors each one having a first power electrode connected to the other terminal of a different one of said exciting windings, a second power electrode connected to the other terminal of said source and further having a firing electrode.
- (g) means connected to said drum and operable each time a row of characters comes in front of said

plurality of hammers for indicating the identity of the last mentioned characters;

- (h) a cyclic memory for storing a line of information characters to be printed, said memory having output means for reading out once during each memory cycle all the information characters of said line to be printed, said information characters being serially read out during said memory cycle, and said memory cycle being shorter than the time interval between the instants at which two successive rows come in front of said plurality of hammers;
- (i) means for comparing the character indicated by said indicating means with the character concurrently being read out of said memory, said comparing means having an output line energized upon coincidence of the compared characters;
- (j) a like plurality of gating means each one connecting said output line to the firing electrode of a different one of said thyristors;
- (k) a pulse distributor driven in synchronism with said memory for sequentially opening said gating means in synchronism with the reading out of said information characters to be printed; and
- (l) means driven in synchronism with said drum for switching off all of said thyristors after each one of said power pulses.

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