

[54]	HIGH-SPEED PRINT-OUT ARRANGEMENT USING CONTINUOUSLY ROTATING STEP MOTOR	3,668,652	6/1972	Zahn	340/172.5
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[75]	Inventor: Peter Liermann, Moglingen, Germany	3,353,648	11/1967	Amada et al.	197/55
		3,366,214	1/1968	Tubert	197/48
[73]	Assignee: Robert Bosch GmbH, Stuttgart, Germany				
[22]	Filed: Jan. 7, 1972				
[21]	Appl. No.: 216,133				

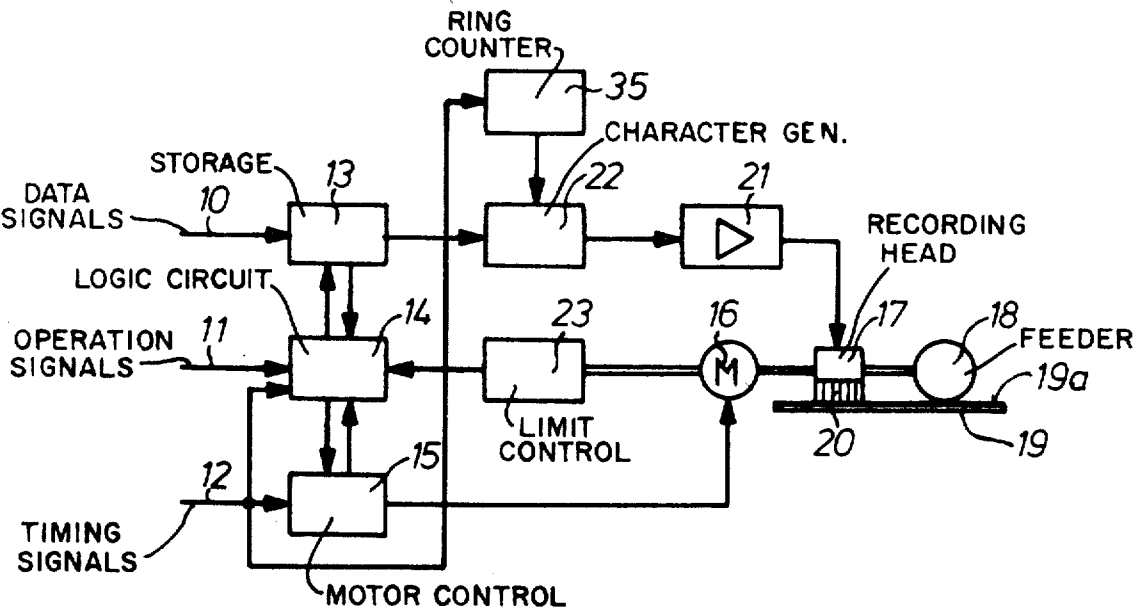
Primary Examiner—Gareth D. Shaw
Assistant Examiner—Paul R. Woods
Attorney—Michael S. Striker

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[51]	Int. Cl. G06k 15/10
[58]	Field of Search 197/55, 1, 48; 340/172.5

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	3,670,861 6/1972 Zenner et al. 197/1 R X

[57] ABSTRACT
Step motor moves print-out means across the print-out receiving surface. Motor is started at least one step before beginning of print-out. Timing for step motor and print-out control derives from a desk calculator whose input numbers, computed totals, etc., are to be printed out.

23 Claims, 7 Drawing Figures



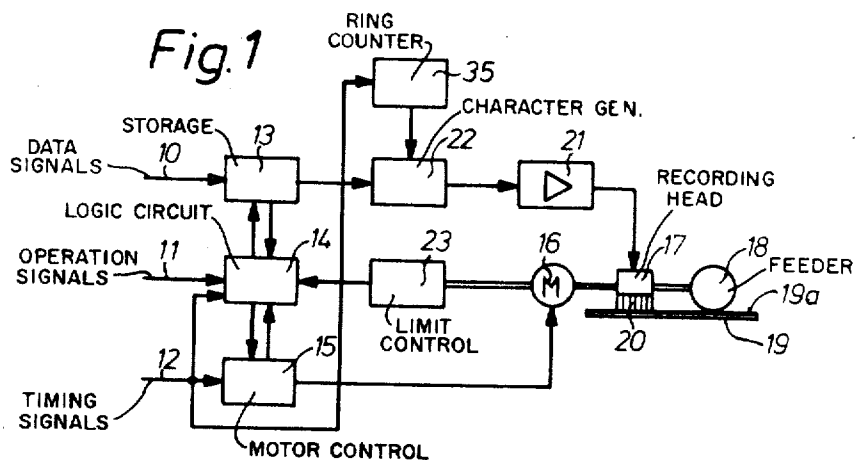


Fig. 2

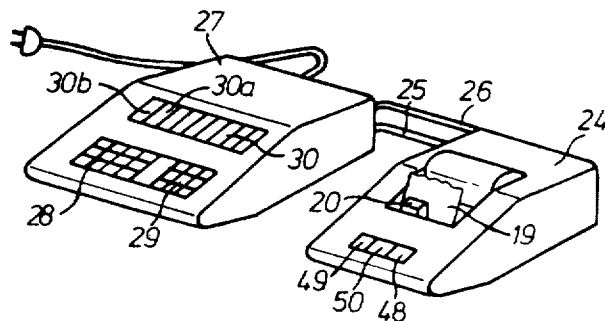


Fig. 3

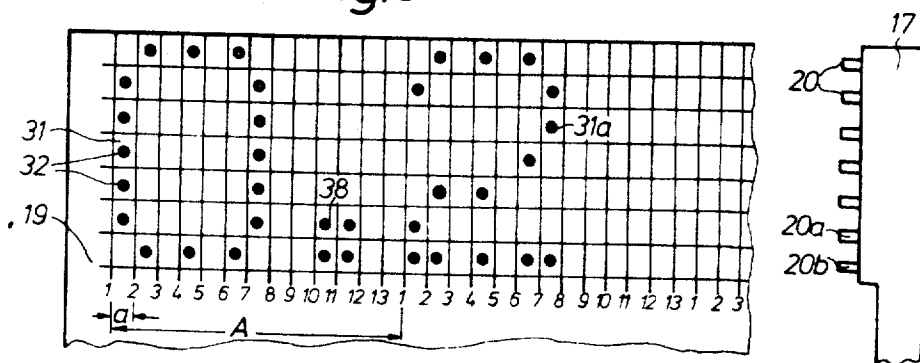


Fig. 4

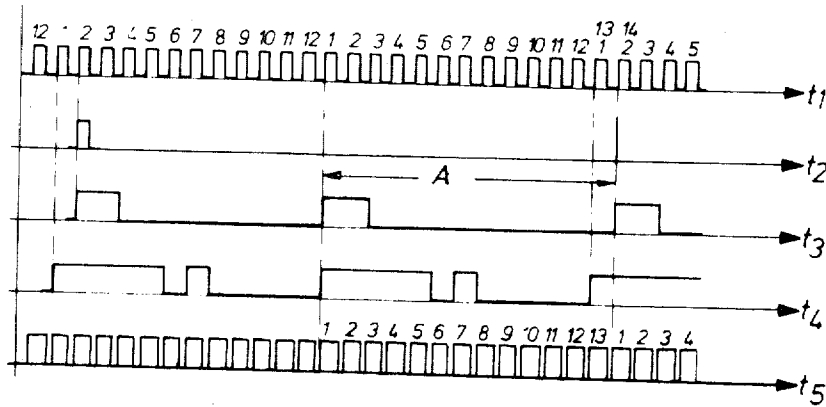


Fig. 5

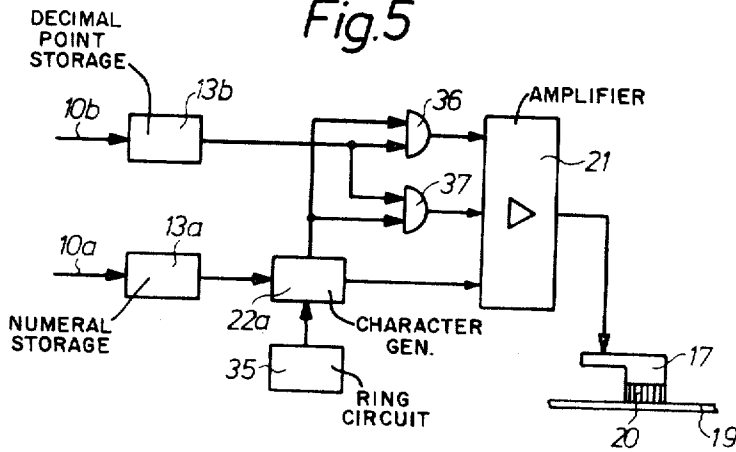


Fig. 6

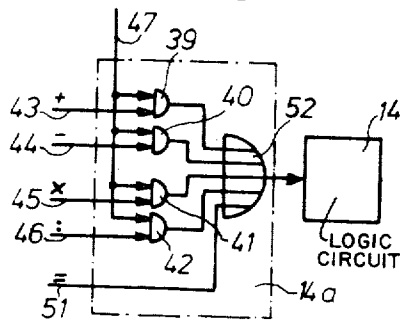
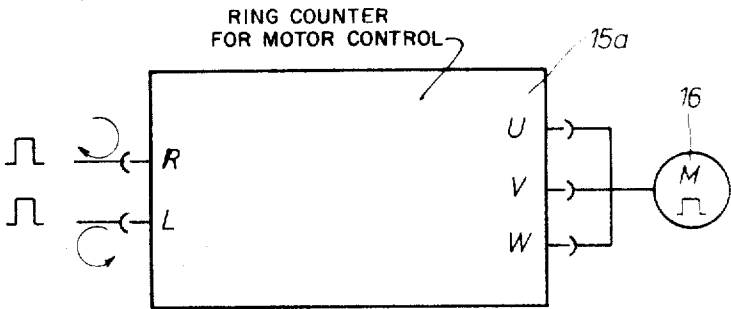


Fig. 7



$\rightarrow \Delta^0$	0	30	60	90	120	150	180
U	+	+	+	0	0	0	+
V	0	0	+	+	+	0	0
W	+	0	0	0	+	+	+

HIGH-SPEED PRINT-OUT ARRANGEMENT USING CONTINUOUSLY ROTATING STEP MOTOR

BACKGROUND OF THE INVENTION

This invention relates to electrical high-speed print-out arrangements. In particular it relates to high-speed print-out arrangements which print out characters, for example numbers, which are supplied to, or generated by, an associated computer means, as for example a desk calculator. More particularly, it relates to such high-speed print-out arrangements wherein the print-out means comprises a plurality of print-out elements recording said character onto record means, while moving in a determined direction from a first end position to a second end position. After the print-out means reach said second end position, the direction of travel is reversed, the record means are advanced in a direction perpendicular to said first direction, and a second line of print is printed out. It should be noted that in this invention the term "print-out" is used in a very general sense to indicate an arrangement whereby a visible output is stored on some record means. This includes but is not limited to actual print on paper.

In known systems of the above-described type distortion of the character or symbol entered onto the record means by the print-out means (i.e., letters, numbers, etc.) by activating said print-out means in dependence on the position of the print-out means relative to an initial position. In accordance with these arrangements, it is necessary to determine at all times the position of the print-out means or writing head. This of course is very expensive since a great deal of equipment is required.

SUMMARY OF THE INVENTION

It is an object of the present invention to furnish an arrangement which prints out characters without distortion and requires relatively little equipment.

In accordance with the present invention, a high-speed print-out arrangement for printing out characters comprises record means, and print-out means mounted in operative proximity to said record means and having a plurality of print-out elements for recording said characters in lines onto said record means in response to data signals applied thereto. The arrangement further comprises data signal furnishing means and transferring means transferring said data signals from said data signal furnishing means to said print-out means in response to timing signals. Step-motor means moves said print-out means across said record means in a first direction from a first to a second end position in response to motor control signals. Timing means furnish a first motor control signal energizing said step motor when in said first end position, thereby starting the movement of said print-out means relative to said record means and furnish said timing signals in synchronism only with subsequent ones of said motor control signals. Thus said step motor is energized at least one step before the first character of one line is printed out. The step motor of the present invention rotates a predetermined angle in response to each motor control signal, each of said angles constituting a step-motor "step." However, the motor rotates continuously during the printing out of one line of print. Starting the motor one step before the print-out of the first character has begun assures a constant rotational speed of the motor during the print-out of all signals. Each motor step following the first motor step is associated with the

print-out of a character in a determined position, that is of a number having a particular place value. This type of system thus requires no position measuring means for measuring the position of the print-out means relative to the record means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram of a printing arrangement in accordance with the present invention;

FIG. 2 is a diagram showing a print-out arrangement of the present invention in association with a desk calculator;

FIG. 3 shows the print-out on the record means furnished by a printing arrangement of the present invention;

FIG. 4 is a timing diagram showing timing and data signals;

FIG. 5 is a block diagram showing the logic circuit for printing out punctuation marks;

FIG. 6 is a block diagram showing logic circuits for selectively printing out end results only; and

FIG. 7 shows the control circuit for the step motor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will now be described with reference to the drawing.

The block diagram of FIG. 1 shows three inputs 10, 11 and 12 at which are furnished timing and data signals, the former for control purposes, the latter for print-out. Specifically, coded signals are applied at input 10. These coded data signals may, for example, signify numbers which are entered into or printed out for an associated desk calculator, herein also referred to as computing means. The coded data signals are stored in a storage 13. Input 11 is that input of logic circuit means 14 whereat operations signals, that is signals signifying particular arithmetic operations to be carried out by the desk calculator, are received. Timing signals are applied at input 12 to motor control means 15 whose output controls the motion of step-motor 16. Step motor 16 in turn moves a feed means 18 and print-out means, namely a recording head 17 having a plurality of print-out elements 20, across record means 19. Elongated record means 19 may for example have a metal coating 19a into which an energized one of the print-out elements 20 burns a small hole. The resulting pattern is shown in FIG. 3. In FIG. 3 the number printed out is 0.2, with the dots 32 forming the digit "0," with the dots 31a forming the digit "2," and with the four dots 38 forming the decimal point. FIG. 3 shows the number 0.2 printed out in two motor steps, the first of which is designated by an O in FIG. 3. Specifically, as the print-out means 17 is moved from left to right in FIG. 3, the elements 20 of print-out means 17 are energized selectively via amplifier 21 and corresponding to signals furnished by a character generator 22. Character generator 22 may be a character generator as set forth in a Texas Instruments Application Re-

port Bulletin A.C. 145 issued by Texas Instruments Deutschland G.m.b.H. It has a first input connected to storage 13 wherein are stored the coded data signals, and a second input connected to a ring counter 35 which forms part of counting means. Specifically, ring counter 35 furnishes the timing signals which control the transfer of data signals furnished by the data signal furnishing means (i.e., supplied at input 10) to the print-out means (i.e., elements 20).

As shown in FIG. 2, the high-speed printer of the present invention is a portable unit 24 which has a control cable 25 and an energizing cable 26. The other terminal of energizing cable 26 and control cable 25 is connected to a desk calculator 27, which, in a preferred embodiment of the present invention is the desk calculator shown on page 18ff of the Oct. 6, 1969 issue of the publication "Product Engineering." The timing and data signals are all generated in desk calculator 27. They are furnished to the printer 24 via control cable 25. Calculator 27 is an electronic calculator whose output comprises a plurality of indicator lamps 30. These may be Nixie tubes. Said Nixie tubes are herein referred to as data signal furnishing units. Each Nixie tube is energized by a unit energizing signal. The unit energizing signals are supplied sequentially to the Nixie tubes at a frequency of 2 kHz. The Nixie tubes are thus ignited sequentially and at a sufficiently high frequency that the retentivity of the human eye causes the energized Nixie tubes to seem steadily ignited. Each Nixie tube is energized once per cycle and, in the system shown in FIG. 1, one motor step is executed during each of said cycles. Thus, the 2 kHz signals are applied at input 12 to the motor control means 15. It will be noted that calculator 27 has keys 28 which are number keys and keys 29 which are operations keys (for example a division key). In the operation of the equipment a number is first entered into the calculator by activation of keys 28. An operations key 29 is then depressed, which causes the corresponding operation to be set up in the computer. The operation of a key 29 causes an operation signal to appear at input 11 of logic circuit means 14. The first motor control signal is then furnished to motor control means 15 by circuit 14, upon simultaneous receipt of the input signal at input 11 and of an input signal at input 12 which corresponds to the unit energizing signal energizing Nixie tube 30a (see also FIG. 2). Motor control means 15 comprise a ring counter 15a (see FIG. 7) receiving the motor control signals at the first input (R). The ring counter output 15a comprise three flip-flops each of whose states (+,0) is determined by the count of the ring counter 15a. The flip-flop outputs are furnished at a first, second and third output (u , v , w ,) which in turn are applied to the three terminals of the step motor armature. The step motor 16 is a three-phase motor whose armature (stator) is connected in a delta connection. For each motor control signal furnished at said first input, the state of one of the flip-flops changes. The result is a rotating magnetic field which causes the rotor of the step motor to advance one step (for example 30°) in response to each received motor control signal. The states of the flip-flop and the resulting rotor angular position is shown in table form in FIG. 7. FIG. 7 also shows in block diagram form the ring counter 15a having three outputs and two inputs.

The lag between the rotor positions and the position of the above-mentioned rotating field becomes stable

only when after the motor has been energized for at least one step. Further, in the system of FIG. 1, the read-out from storage 13 commences simultaneously with the entering of data into storage 13. Therefore logic circuit 14 blocks the input to storage 13 until such time as coded data signals signifying the character (number) registered by Nixie tube 30b appear shortly at input 10 following the completion of the first motor step. As mentioned above, the read-out from storage 13, under control of timing signals furnished by unit 35 commences immediately. In particular, the output of character generator 22 would, upon receipt of the first timing signal from unit 35, cause the energization of those print-out elements 20 which burn the holes shown in the first column of the raster of FIG. 3. Each subsequent timing signal, furnished in synchronism with the signals arriving at input 12, would time the energization of the elements 20 required to burn the holes in the subsequent columns 2-13. Thus the synchronous motion of the step motor and the furnishing of the signals to print-out elements 20 generate the raster shown in FIG. 3.

As mentioned above, Nixie tubes 30 (in this Example 12 Nixie tubes) are energized cyclically in a predetermined order, namely from left to right. In such an arrangement, the logic circuit means 14 cause a new set of coded data signals to be entered into storage 13 for each fourteenth timing signal applied at input 12. Thus during each cycle data signals signifying a particular character indicated by a particular Nixie tube are stored in storage 13 and the read-out from storage 13 and transfer to the print-out elements 20 occurs in the remainder of the cycle.

When the read head reaches the right edge of record means 19, a control signal is furnished via stage 23 to the logic circuit means 14. Logic circuit 14 in turn generates a signal blocking the input to storage 13 so that no further numbers can be entered therein. Further, the motor control signals are now applied to the second input (L) of the ring counter 15a so that the motor commences to move in the opposite direction, that is from the right to the left edge. In this opposite direction, the feed means 18 for the record means 19 is coupled with the step motor 16 and forwards the record means 19 by one line. Once the write head again arrives at the left edge of record means 19, the control arrangement 23 furnishes a second signal to logic 14. The circuit is now in condition for printing out the next line of numbers. Specifically, in the absence of an operations signal at input 11, no further motor control signals are applied to unit 15, thereby causing the step motor to stop. Further of course the circuit is again in condition to apply motor control signals to the first input of motor control means 15 so that upon receipt of the subsequent operation signal at input 11 the direction of motor advance will again be in the first direction, namely from left to right.

The raster resulting from the above-described print-out operation will now be discussed in more detail with reference to FIG. 3. Each step A of motor 16 comprises thirteen intervals a which are equal to the interval between successive timing pulses furnished by unit 35, that is the interval between corresponding points on successive ones of said timing pulses. The first seven intervals are used for the print-out of a numeral, while the second six intervals are used to create the space between successive numerals. It will be noted that ele-

ments 20 are energized during the first, second, fourth, sixth, and seventh intervals only. In these intervals the voltages applied through amplifier 21 to the writing electrodes causes the dot-like burnt out portions 32 to be formed on the metallic surface of record carrier 19. Thus the timed successive energization of the recording elements 20 causes a numeral 31 to be formed which corresponds to the coded data signals appearing at input 10 of the system.

The timing of the system will now be discussed with reference to FIG. 4. It should be noted that FIG. 4 shows the pulses at various points of the system of the present invention as a function of time. On the line labelled t_1 the pulses supplied by desk calculator 27, namely the pulses appearing at input 12 which have a pulse repetition frequency of 2 KHz are shown. These are the pulses which in the calculator successively energize the indicator tubes. They are thus cyclically repetitive, each cycle containing twelve pulses. Line t_2 shows the control pulse appearing at input 11 which initiates the first motor step. It is assumed that an operations key has been depressed in the calculator 27. Following such a key depression the second pulse of the pulse sequence of line t_1 initiates the first motor control signal. The motor control pulses, namely the pulses applied at the first input of unit 15 are shown in line t_3 . It is seen that the first one is initiated by the pulse shown in line t_2 and that subsequent ones of the motor control pulses are generated for each fourteenth pulse of the pulse sequence of line t_1 . It should be noted that line t_1 , t_2 , and t_3 are all plotted with the same time scale. However, line t_4 is not. Line t_4 shows, as an example, the possible state of four input lines to storage 13. That is, this line shows the signal appearing at the input 10 of storage 13 during the time interval covered by, for example, pulse 1 of the pulse sequence of line t_1 . This represents the character which is shown by Nixie tube 30b. Since it is different from that indicated by Nixie tube 30a, the signals will change at the input 10 in synchronism with the receipt of the second pulse of line t_1 . The same input will appear at input 10, however, at the time of the corresponding pulse in the subsequent cycle. Finally, line t_5 shows the timing pulses timing the transfer from storage 13 to recording means 17. These pulses thus are the pulses at the output of unit 35. It will be seen that they appear in synchronism with the pulses of line t_1 , but each pulse has approximately double the duration in time as the pulses of line t_1 . As mentioned before the first seven pulses in each cycle result in the forming of the numeral on the record means, while the second six are used for spacing between consecutive numerals.

FIG. 5 is a block diagram of the circuitry required for printing out punctuation marks or decimal points. A decimal point is indicated by an indicator tube 30 of calculator 27. This decimal point is transferred to the high-speed printer 24 in a similar manner as the other numerals during the cycle associated with the preceding numeral. Thus the storage 13 is divided into a storage section 13a which receives the coded data signals corresponding to the numeral and a section 13b which is the punctuation or decimal point storage. Each storage section has separate inputs here shown schematically as a single input 10a and 10b, respectively. The contents of storage 13a control the character generator 22a which is controlled by the timing pulse generator 35 which furnishes, as discussed above, thirteen timing pulses α within each motor step A. For the first seven

of the steps, as mentioned above, the signals from storage 13a are transferred into energizing signals for writing electrodes 20 by character generator 22a. The signal in storage 13b is applied in common to inputs of two AND gates 36 and 37 whose second inputs are energized by the tenth and eleventh timing pulse. The outputs of the AND gate are applied through amplifier 21 to the lowest two writing electrodes, namely electrodes 20a and 20b. The resulting output is shown in FIG. 3. It comprises, as can be seen, two dots on top of each other during the tenth and the eleventh interval within the cycle.

In the system described so far, each number either entered into the calculator or a subtotal calculated by said calculator would be printed out. It may for some purposes be desirable to print out only the final or end result. For this purpose the circuitry shown in FIG. 6 is used. FIG. 6 shows a logic circuit 14a whose inputs are connected to the various arithmetic operations keys, that is a key 43 which is an addition key, key 44, 45 and 46 which are subtraction, multiplication and division keys, respectively. A further input to logic circuit 14a is the "total" or end result input 51. If all of these inputs were connected directly to the inputs of an OR gate 52, as is key 51 in FIG. 6, and the output of OR gate 52 were applied to input 11 of control logic 14, the circuit would operate to print out all numbers entered into or calculated by calculator 27. However, keys 43-46 are, instead, connected to the first input of respective AND gates 39-42. The second input of these and gates is connected to a selection key 48 (see in FIG. 2) via a line 47. If key 48 is not activated, a "1" signal appears on line 47 causing any of the AND gates 39-42 whose other input is activated to furnish a signal to the input of OR gate 52 which in turn is applied to control logic 14 via line 11. However, if key 48 is activated, a "0" signal appears on line 37 which blocks all AND gates. Even the depression of an operations key can then not cause an output of any of the AND-gates 39-42. Therefore OR-gate 52 can only deliver an output to control logic 14 upon activation of the total key 51. It is thus seen that activation or lack of activation of key 48 will determine whether or not all numbers or just the final or end results will be printed out.

It will be noted that in the description of the preferred embodiment, the high-speed printing arrangement has been described in conjunction with a particular type of desk calculator. The invention is, however, not to be limited to high-speed printers for this type of calculator only. For example storage 13 can be designed in such a way that it can accommodate all characters to be printed out in any given line. Further, the timing pulses may be derived from the data signals as they are being entered into storage 13, rather than separately as described above. In this case the control circuit 14 causes the motor to be energized and, following one or several initial steps, the symbols stored in storage 13 are furnished synchronously with the motor control signals to character generator 22 and then transferred, again in synchronism with the rotation of the motor, to the recording elements 20 via amplifier 21.

While the invention has been illustrated and described as embodied in a high-speed print attachment operating in conjunction with a particular type of desk calculator, it is not intended to be limited to the details shown, since various modifications, circuit and struc-

tural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. High speed print-out arrangement for printing out characters, comprising, in combination, record means; print-out means mounted in operative proximity to said record means and having a plurality of print-out elements for recording said characters in lines onto said record means in response to data signals applied thereto; data signal furnishing means for furnishing said data signals; transfer means for transferring data signals from said data signal furnishing means to said print-out means only in response to timing signals following a predetermined timing signal; step motor means for moving said print-out means continuously across said record means in a first direction from a first to a second end position in response to motor control signals, said step motor means rotating a predetermined angle constituting one step in response to each of said motor control signals; and timing means for furnishing said motor control signals including a first motor control signal for energizing said step motor means when in said first end position, thereby starting the movement of said print-out means relative to said record means, and for furnishing said timing signals in synchronism with said motor control signals, said timing signals including said predetermined timing signal furnished in synchronism with a motor control signal subsequent to said first motor control signal, whereby said step motor is energized at least one step before the first character of any one line is printed out.

2. The arrangement set forth in claim 1, wherein said step motor means has a rotor; wherein each of said motor control signals signifies an angular position of said rotor; and wherein said rotor assumes the corresponding predetermined angular position upon application of said motor control signal to said motor.

3. The arrangement set forth in claim 2, wherein said data signal furnishing means comprise coded data signal furnishing means furnishing substantially simultaneously coded data signals signifying a character to be printed; and wherein said transfer means comprise storage means storing said coded data signals thereby furnishing stored data signals, and read-out means applying said stored data signals to said print-out elements under control of said timing signals.

4. An arrangement as set forth in claim 3; and further comprising computing means associated with said high-speed printing arrangement, said computing means comprising said coded data signal furnishing means and synchronizing circuit means furnishing computer timing signals for timing the operation of said coded data signal furnishing means; further comprising first connecting means connecting said computer means and said high-speed print-out arrangement.

5. An arrangement as set forth in claim 4, wherein said coded data signal furnishing means comprise a plu-

ality of mutually independent data signal furnishing units, each operative in response to a corresponding unit energizing signal; and wherein said synchronizing circuit means further comprise means furnishing said unit energizing signal cyclically and in a first predetermined order within each cycle.

6. An arrangement as set forth in claim 5, wherein said timing means comprise logic circuit means activating the input of said storage means once during determined ones of said cycles in such a manner that coded data signals are stored in a second predetermined order corresponding to said first predetermined order.

7. An arrangement as set forth in claim 6, wherein said storage means comprise means storing a number of coded signals corresponding in number to the number of coded data signals required for an individual character only.

8. An arrangement as set forth in claim 6, wherein said storage means comprise means storing a number of coded data signals corresponding in number to the number of coded data signals required for the characters to be printed out in one line of print.

9. An arrangement as set forth in claim 7, wherein the time required for each step of said step motor is equal to the time required for each of said cycles.

10. An arrangement as set forth in claim 9, wherein said timing means comprise distributing means responsive to said unit energizing signals for furnishing, during each step of said step motor, a first sequence of timing pulses energizing said read-out means and a second sequence of timing pulses disabling said read-out means, thereby creating the space between sequential characters.

11. An arrangement as set forth in claim 10, wherein said read-out means comprise logic gating means.

12. An arrangement as set forth in claim 11, wherein said coded data signals comprise punctuation signals signifying a punctuation mark; wherein said storage means comprises additional storage means storing said punctuation signals, thereby furnishing stored punctuation signals; wherein said second sequence of timing pulses comprises a selected punctuation timing pulse; and wherein said logic gating means comprises punctuation gating means connected to said additional storage means and a selected one of said print-out elements, for furnishing said stored punctuation signals to said selected one of said print-out elements in response to said selected punctuation timing pulse.

13. The arrangement as set forth in claim 12, wherein said punctuation gating means comprise a first AND-gate.

14. The arrangement as set forth in claim 12, wherein said second sequence of timing pulses comprises a selected first and second punctuation timing pulse; wherein said additional storage means comprise first and second additional storage means; and wherein said punctuation gating means comprise first and second punctuation means respectively connected to said first and second additional storage means and corresponding selected ones of said print-out elements, for furnishing said stored punctuation signals to said selected ones of said print-out elements in response, respectively, to said first and second selected punctuation timing pulse.

15. An arrangement as set forth in claim 14, wherein said first and second punctuation gating means each comprise an AND-gate.

16. An arrangement as set forth in claim 2, wherein

said step motor means comprise a three-phase motor.

17. An arrangement as set forth in claim 16, further comprising step motor control means connected to the input of said three-phase motor.

18. An arrangement as set forth in claim 17, wherein said step motor control means comprise a ring counter means with first, second and third flip-flop means, each having an output connected to at least one phase of said three-phase motor.

19. An arrangement as set forth in claim 18, wherein said ring counter means having an input connected to said timing means for receiving said motor control signals.

20. An arrangement as set forth in claim 19, further comprising computing means connected to said high-speed print-out arrangement, said computing means having a plurality of externally operable operations-initiating elements, each furnishing a corresponding operation signal in response to such external operation; wherein said computing means further comprise synchronizing circuit means furnishing a plurality of unit energizing signals cyclically and in a predetermined order within each cycle; and wherein said timing means comprise logic means furnishing said first motor control signal in response to the simultaneous presence of an operations control signal and a selected one of said unit energizing signals.

21. An arrangement as set forth in claim 20, wherein said logic means comprise OR-gate means furnishing an OR-gate output signal in response to receipt of one of said operations signals and timing AND-gate means furnishing said first motor control signal in response to said OR-gate output signal and said selected unit energizing signal.

22. An arrangement as set forth in claim 21, wherein said operations-initiating selecting elements comprise operations keys.

23. An arrangement as set forth in claim 22, wherein said high-speed printing arrangement comprise selection means furnishing a selection signal upon external operation; and wherein said logic means further comprise a plurality of AND-gates, each having a first input connected to said selection means, each having a second input connected to one of said operations-initiating elements and an AND-gate output connected to one of said OR-gate inputs; wherein one of said operations-initiating means is an "end result" key; further comprising direct connecting means connecting said "end result" key to an input of said OR-gate means, whereby the absence of operation of said selection means causes print-out of all numbers, while the operation of said selection means causes print-out of "end results" only.

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