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[54] **PRINTER DRIVING CIRCUIT FOR ROCKABLY MOUNTED SETTABLE PRINT WHEELS**
1 Claim, 2 Drawing Figs.

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[50] **Field of Search** 101/93RC, 90; 340/172.5, 19–24, 146.1; 328/121–123, 190–196; 235/61.9, 61.8, 61.7

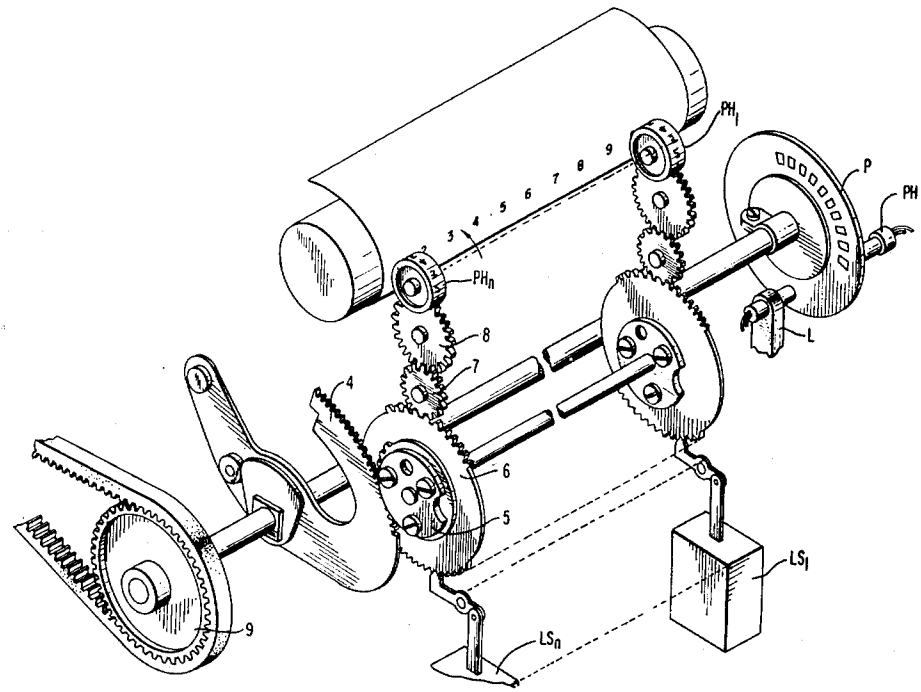
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ABSTRACT: A printer driving circuit for printing multi-digit decimal numbers stored in a shift register is disclosed. The circuit comprises a single controlling circuit capable of interrogating the rotary position of gang rotated printer wheels, and by this interrogation, each of the stored digits to be printed is interrogated in succession to determine whether the corresponding printer wheel is to be locked or not. By repeating the interrogation cycle for all the digits to be printed each of the printer wheels are locked in predetermined positions. Thus, the control circuit is minimized by using the time division principle.



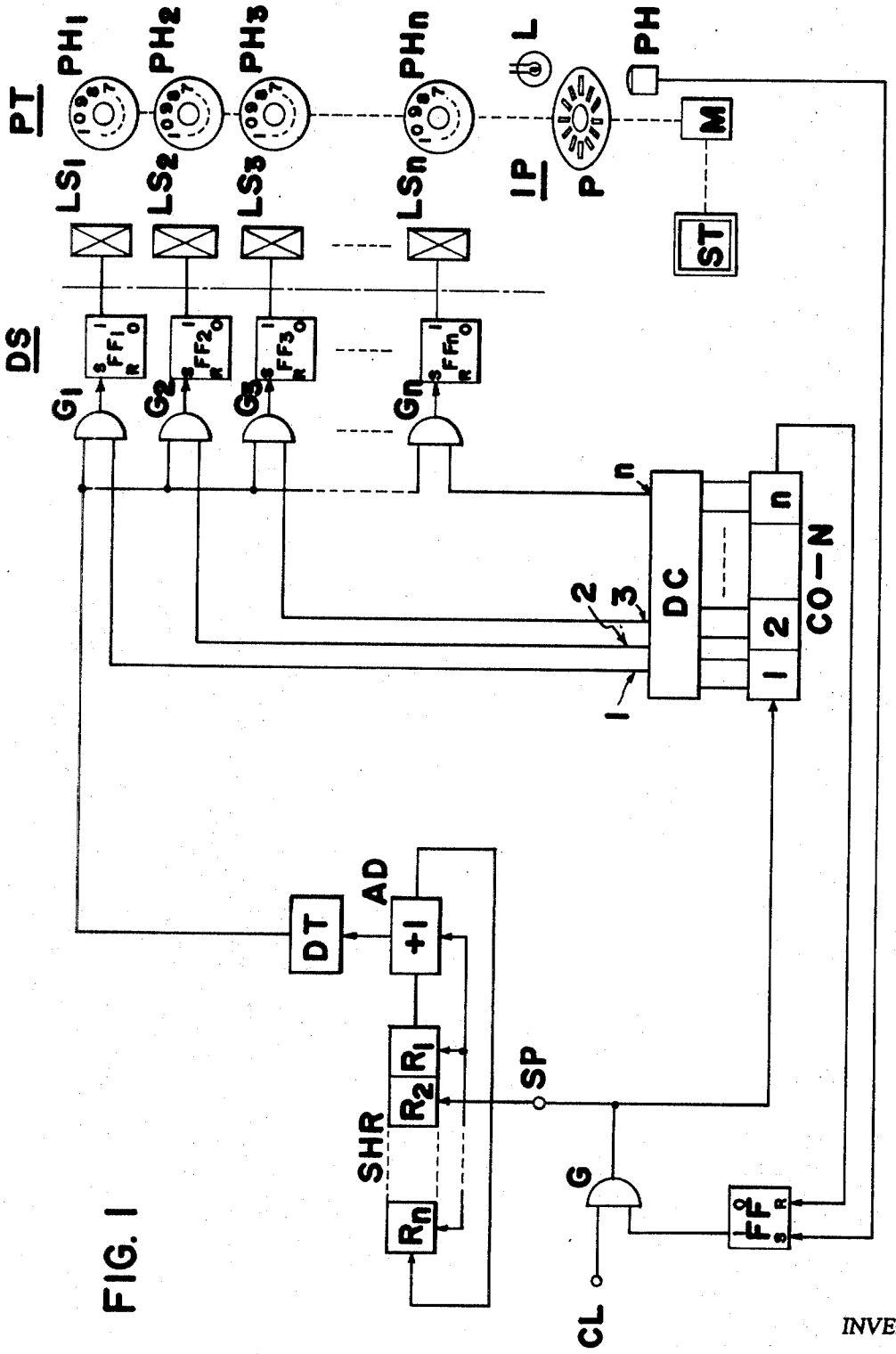


FIG. 1

INVENTOR

BY

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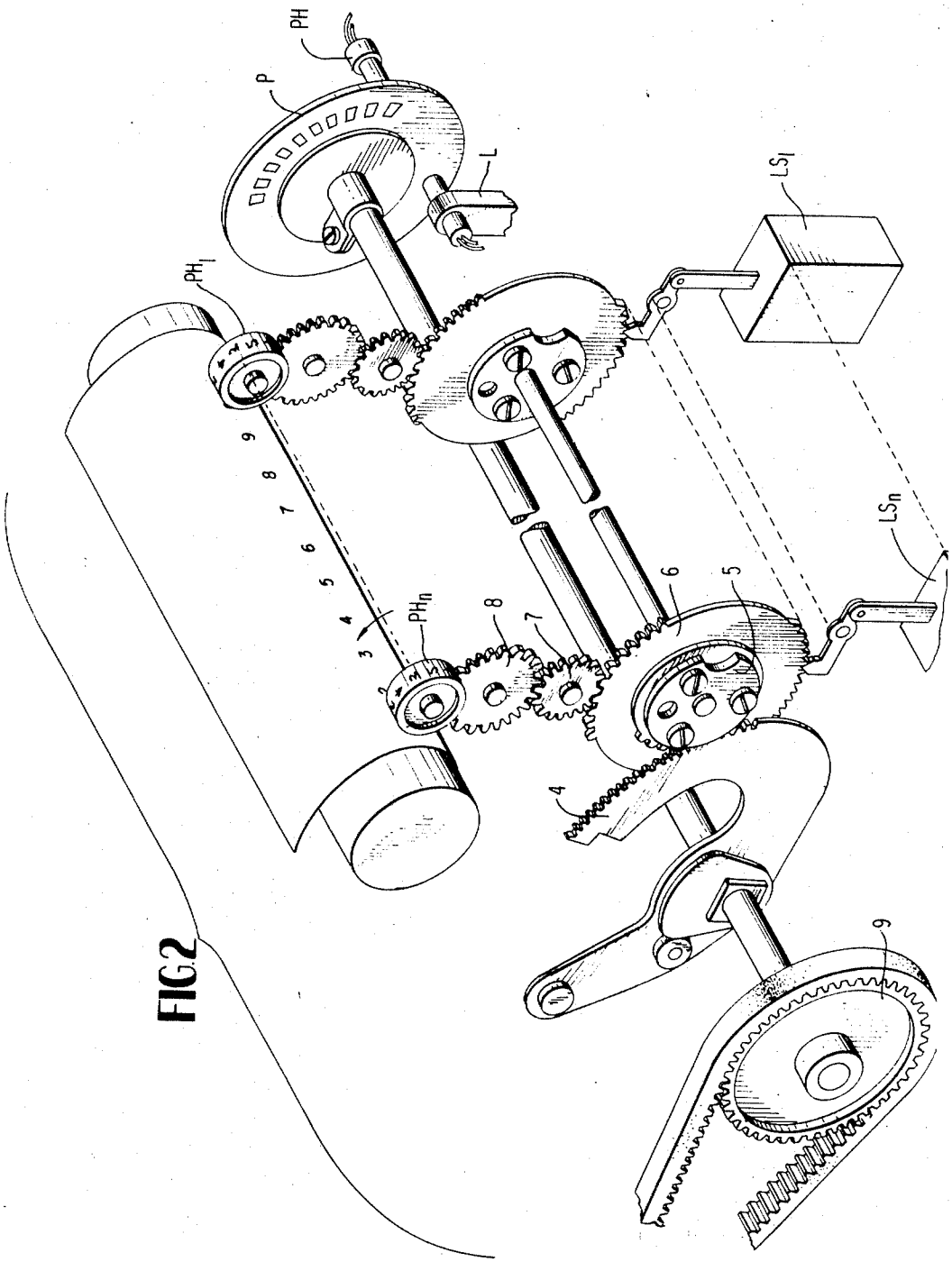


FIG2

PRINTER DRIVING CIRCUIT FOR ROCKABLY MOUNTED SETTABLE PRINT WHEELS

BACKGROUND OF THE INVENTION

This invention relates to a printer driving circuit for driving a printer to indicate multi-digit decimal numbers stored in a digital memory circuit, such as a shift register.

The printer, in which the driving circuit of the present invention can be employed, comprises a plurality of print wheels each representing a digit of multi-digit number to be printed out and having numerals **0** to **9** inscribed thereon and rotated in synchronism, and an interrogation pulse generator to generate an interrogation pulse at each angular position of the print wheels. Under the control of the interrogation pulse, each print wheel is locked at a position representing a digital position corresponding to a number stored in the corresponding value of a digit register. The complete setting of numerals of the print wheels to be printed is thereby accomplished in a cyclical manner. Thereafter, a printing order signal is generated to print out the thus set digits simultaneously.

A known driving circuit for such a rotary wheel type printer includes a decoder to convert a number stored in a storing means into a multi-digit decimal number to be printed and ten-position switches, one for each digit of the multi-digit number to be printed. Each ten-position switch is actuated by said decoder so as to energize a locking solenoid of each print wheel in a certain operative relation with interrogation pulses generated by the interrogation pulse generator and to set the print wheel at an angular position corresponding to a digit assigned thereto.

Such known printer driving circuit has a disadvantage in that the circuit construction becomes very complicated as the number of the digits to be printed is increased.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to obviate the aforesaid difficulty of the known printer driving circuit. The system of the invention has as one of its features the provision of a single controlling circuit, which comprises one decoder and a circuit able to act as a ten-position switch. This sole controlling circuit is selectively actuated in succession to drive the printer for each digit of a multi-digit number stored in a storing means, by the time division principle.

Other objects and advantages of the present invention will readily come to mind during the course of the following discussion.

DESCRIPTION OF THE DRAWING

FIG. 1 of the accompanying drawings shows a schematic circuit diagram of the printer driving circuit according to the present invention.

FIG. 2 of the drawings is a perspective view of the printer mechanism according to the present invention.

DESCRIPTION OF THE INVENTION

FIG. 1 of the drawings, **PT** at the right hand side shows generally a printer which comprises a plurality of print wheels PH_1 to PH_n representing each decimal digit to be printed. Numerals **0** to **9** are inscribed on each of the print wheels. Locking solenoids LS_1 to LS_N act to stop rotation of the corresponding print wheels PH_1 to PH_N, respectively. An interrogation pulse generator **IP** at the middle right comprises a rotary disk **P** having ten slits bored therethrough in correspondence with numerals **0** to **9** inscribed on each of the print wheels, a lamp **L**, and a photoelectric transducer means **PH** to generate interrogation pulses upon detection of light beams coming from the lamp **L** through the slits on the rotary disk **P**. A motor **M** drives the print wheels PH_1 to PH_n, as well as the rotary disk **P** interconnected in a link with the print wheels. **ST** shows schematically a starting button of the whole device.

A shift register **SHR** at the left side of the drawing comprises a plurality of digit registers R_1 to R_n, each of which stores information concerning the numerals of each digit to be printed. An adder **AD** acts to add the number "1" to the numeral stored in the most significant digit register R_1 of the shift register **SHR**.

The most significant digit register R_1 of the shift register **SHR** is interconnected through the adder **AD** back to the input terminal of the least significant digit register R_n at the extreme left end in the shift register **SHR**, so as to form a closed loop. The digits stored in each digit register are shifted cyclically in succession in the shift register by way of the adder **AD** when a shift pulse is applied to the shift pulse input terminal **SP**. A coincidence circuit **DT** checks the value of the digit stored in the adder **AD**, and only when the value of the digit in the adder **AD** coincides with a predetermined value, for instance "0", the circuit **DT** generates an output pulse.

A digit selecting circuit **DS** at the right hand side of the drawing comprises digit selecting gates G_1 to G_n, a digit counter **CO—N** having a counting capacity of n which corresponds to the number of digits storable in the shift register **SHR**, a decoder **DC** to generate a gate control signal to open and close one of the digit selecting gates G_1 to G_n according to the number counted by the digit counter **CO—N**, and flip-flop circuits FF_1 to FF_n to retain the output signal from the gate circuits G_1 to G_n.

In the circuit shown in the left bottom corner, **G** is an AND gate, **FF** is a flip-flop circuit and **CL** is a clock pulse input terminal. The output terminal of the photoelectric transducer **PH** controlled by the interrogation pulse generator **IP**, shown at the right middle of the drawing, is connected to a set signal input terminal **S** of the flip-flop circuit **FF** at left bottom corner, while a set signal output terminal **1** of the flip-flop circuit **FF** is connected to a control signal input terminal of the AND gate **G**.

The clock pulse input terminal **CL** is connected via the AND gate **G** to the input terminal **SP** of the shift register **SHR** and to an input terminal of the counter **CO—N** of the digit selecting circuit.

A carry signal output terminal of the digit counter **CO—N** at the middle bottom leads to a reset input terminal **R** of the flip-flop circuit **FF** at the left bottom portion of the drawing. An output terminal of the coincidence detection circuit **DT** leads in parallel to input terminals of each digit selecting gate circuit G_1 to G_n of the digit selecting circuit **DS**. The control signal input terminal of each digit selecting gate G_1 to G_n is connected to the corresponding output terminal **1** to n of the decoder **DC**, respectively. The output terminals of the digit selecting gate circuits G_1 to G_n are connected to the locking solenoids LS_1 to LS_n of the printer **PT** through the flip-flop circuits FF_1 to FF_n, respectively.

Referring now to FIG. 2 of the drawings wherein like reference characters designate the same or corresponding parts illustrated schematically in FIG. **1**, there is shown in perspective the printing mechanism of the invention. The operation of this mechansim is as follows: When an instruction for print is delivered, arm **4** moves upwardly under the urging of the cam associated therewith. The cam is mounted on the same shaft as rotary disk **P**, and the two are driven by drive wheel **9**. When arm **4** moves upwardly, friction clutch assemblies **5**, which are mounted on a common shaft, rotate thereby causing gear elements **6**, **7** and **8** and print heads PH_1 to PH_n to rotate. Upon the respective operations of the locking solenoids LS_1 to LS_n, the pawls associated therewith engage with the teeth of gears **6** to stop the rotation. At this time the desired decimal number on the print heads is in a position facing the paper to be printed. After the setting of the desired number on all of the print heads, the print heads move toward the paper as indicated by the arrow and complete the printing.

The operation of the printer driving circuit according to the present invention will now be described in further detail.

Upon depression of a start button **ST** at the right bottom corner of the drawing, the printer **PT** is energized for operation. The rotary disk **P** and print wheels PH_1 to PH_n of the printer **PT** are driven by the motor **M** in synchronism with

each other. The ten slits bored through the rotary disk **P** intermittently complete and interrupt the passage of the light beam from the lamp **L**, so that the photoelectric transducer **PH** detects the thus intermittently passed light beam to generate corresponding interrogation pulses. A first interrogation pulse generated in response to the light beam through the first slit on the disk **P** sets the flip-flop **FF**, so as to open the AND gate **G** by an ouput signal derived therefrom. At this time each print wheel PH_1 to PH_n occupies a position corresponding to the first slit and has the numeral "9" brought to a predetermined printing position. When the AND gate **G** opens, a clock pulse applied at the clock pulse input terminal **CL** passes through the gate circuit **G** and leads on one hand to the shift signal input terminal **SP** of the shift register **SHR** and on the other hand to the input terminal of the digit counter **CO—N** of the digit selecting circuit **DS**.

The shift register **SHR** is so constructed to shift the digits stored in each digit register thereof through the adder **AD** in response to the clock pulses, starting from the most significant digit register R_1 to the least significant digit register R_n in a cyclical manner. Thus, upon introduction of the first clock pulse, the shift register **SHR** shifts, so that the digits stored in the most significant digit register R_1 of the shift register **SHR** is shifted to the adder **AD** and a numeral "1" is added thereto. At the same time the resultant number is transferred to the least significant digit register R_n. Simultaneously, the detected number "1" in the digit counter **CO—N** is converted by the decoder **DC**, and the most significant digit selecting gate G_1 is opened by the output from the decoder **DC**. The coincidence circuit **DT** checks whether the digit appearing in the adder **AD**, which is the sum of the numeral just previously stored in the digit register R_1 of the shift register **SHR** and value "1", is "0" or not.

Let it be assumed now that the digit stored in the digit register RD_1 was "9". Then the digit currently stored in the adder **AD** becomes "0", and hence, the coincidence circuit **DT** generates an output signal, which is applied to the flip-flop FF_1 through the then opened digit selecting gate G_1 to set the flip-flop FF_1, so as to actuate the locking solenoid LS_1 to lock the most significant digit print wheel PH_1 at the position of numeral "9".

On the other hand, if the digit stored in the digit register R_1 was other than "9", the current digit in the adder **AD** would not be "0", and the coincidence circuit **DT** would not produce an output signal. Hence, the flip-flop circuit FF_1 would not be set, so that the print wheel PH_1 would not be locked.

Upon reception of second clock pulse to the shift register **SHR** and the digit counter **CO—N**, each of the digits stored in the shift register **SHR** is shifted to the adjacent digit register. Thus, a numeral which was originally stored in the second digit register R_2, is now shifted to the adder **AD** and "1" is added thereto, and at the same time, the resultant number is shifted to the least significant digit register R_n. Simultaneously, a counted number "2" in the digit counter **CO—N** is converted by the decoder **DC**, and the output signal from the decoder **DC** opens the digit selecting gate circuit G_2 located at the second digit position. The coincidence circuit **DT** checks whether the digit in the adder **AD**, which is the sum of the digit originally stored in the second digit register R_2 and "1", is "0" or not.

If the digit in the adder **AD** is "0", or if the digit originally stored in the second digit register R_2 was "9", then the coincidence circuit **DT** produces an output signal to set the flip-flop FF_2 of the digit selecting circuit **DS**, so that the second digit print wheel PH_2 of the printer **PT** is locked at the position of numeral "9".

If the digit in the adder **AD** is not "0", the coincidence circuit **DT** does not produce any output signal, and hence, the print wheel PH_2 is not locked.

Similarly, each time when the 3rd to *n*th clock pulses is applied to both the shift register **SHR** and the digit counter **CO—N**, the digits stored in the shift register **SHR** are shifted in a cyclical manner. In this cycle when the most significant digit in the digit register R_1 is shifted to the adder **AD** to add "1" thereto, and at the same time, the coincidence circuit **DT** checks whether the digit in the adder **AD** is "0" or not, or in other words whether the digits stored in the digit registers include a numeral "9" or not.

If the digit at the adder **AD** is "0", the output signal from the coincidence circuit **DT** sets one of the flip-flop circuits FF_3 to FF_n which corresponds to that digit selecting gate circuit G_3 to G_n which is then opened by the output from the decoder **DC**, as activated by the output from the digit counter **CO—N**. Thus, the print wheel PH_3 to PH_n, corresponding to the thus set flip-flop circuit, is locked at numeral "9".

Thus, upon application of the *n*th clock pulse to the shift register **SHR** and the digit counter **CO—N**, the entire *n* digits originally stored in the shift register have been checked to determine whether any one of them was a "9" or not. At the same time, each digit in the shift register **SHR** has been increased by a value "1" in each of the original digit positions. Then, the counted number in the digit counter **CO—N** of the digit selecting circuit **DS** has been increased to *n*, and the counter circuit **CO—N** produces a carry pulse to reset the flip-flop circuit **FF**. Thus, the gate circuit **G** is closed to block the clock pulses.

The time necessary for checking all the digits at the *n* decimal places of the shift register **SHR**, or the time necessary for generating *n* clock pulses, can be selected sufficiently short, as compared with the time necessary for the print wheels of the printer **PT** to make an angular displacement between adjacent numerals inscribed thereon, such as 9—8 and 8—7, or the time equivalent to the interval of the interrogation pulse.

When those print wheels, which were not locked in the preceding cycle of checking digits on the shift register **SHR**, rotate to the angular position corresponding to the numeral "8" inscribed thereon, the second slit on the rotary disk **P** comes into alignment with the photoelectric transducer **PH**, to allow generation of a second interrogation pulse. The second interrogation pulse sets the flip-flop circuit **FF**, to open the gate **G** by the output therefrom. Thus, the clock pulses can again lead to the shift register **SHR** and to the digit counter **CO—N**. Thereby, each digit stored in the digit registers of the shift register **SHR** is successively shifted and added by "1" in the adder **AD**, starting from the most significant digit register R_1, in the same manner as the preceding cycle. Then, whether the thus added digit is "0" or not, or whether the preceding digit in the register was "9" or not, is checked by the coincidence circuit **DT**.

Since each digit this time stored in the digit registers of the shift register **SHR** had been added by "1" in the adder **AD** in the preceding cycle, any digit which was originally "8" at any digit register now produces value "0" in the adder **AD**, to allow generation of output signal from the coincidence circuit **DT**. The output signal from the coincidence circuit **DT** sets digit selecting flip-flop circuits which corresponds to that digit selecting gate which is then opened by the output from the decoder **DC**, as activated by the output from the digit counter **CO—N**, in the same manner as in the preceding cycle. The print wheel corresponding to the thus set flip-flop circuit of the printer **PT** is thereby locked at position "8".

In the same manner as the preceding cycle, upon completion of applying *n* clock pulses, all the digits stored in each digit register of the shift register **SHR** are checked to determine whether they are "9" or not, which means that such digits are checked whether they were originally "8" or not. When such checking is finished, each digit is increased by "2" from its original value and returned to its originally stored decimal place. Simultaneously, the counted number in the digit counter CO—N increases to *n*, to generate a carry signal to reset the flip-flop circuit **FF** to block the gate circuit **G**.

Similarly, when an interrogation pulse is generated at the printer **PT**, it opens the gate circuit **G** to allow passage of *n* clock pulses, in succession and this cycle is repeated. In

response to each clock pulse, the digit stored in the adder **AD**, which is the sum of the previous digit in the digit register R_1 of the shift register **SHR** and "1", is checked to determine whether it is "0" or not, by means of the coincidence circuit **DT**. Since all the digits stored in the shift register **SHR** in each cycle are added successively by "1" in each cycle to their original values, each numeral originally stored at any digit register of the shift register **SHR** necessarily produces "0" value in the adder **AD** in the course of generation of ten such interrogation pulses in synchronism with the numeral position of the print wheel. It is apparent from the foregoing that when "0" is attained in the adder **AD**, the printer wheel corresponding to that particular digit is brought to that predetermined angular printing position where the numeral corresponding to the originally stored digit is inscribed.

Thus, by repeating the aforesaid cycle ten times, each cycle comprising turning the print wheels to one of the ten angular positions corresponding to one of ten numerals 0 to 9 and applying *n* clock pulses both to the shift register **SHR** and to the digit counter CO—N, each and every original digit stored in the shift register can be set on the corresponding print wheel of the printer PT, respectively.

When *n* digits to be printed are all set on the corresponding *n* print wheels of the printer, respectively, then a printing order signal is delivered to print out the *n* digits simultaneously.

According to the present invention, the value of the digit stored in the adder **AD** to be checked by the coincidence circuit **DT** is not restricted to a value of zero "0", but any predetermined numerical value can be used. If such numerical value to be checked by the coincidence circuit **DT** is changed, the first numeral to be set on the print wheels of the printer **PT** must be adjusted accordingly.

As described in the foregoing, according to the system of the present invention, a single digit driving circuit, which is adapted to drive the printer at only one digit at a time, can be used for printing a multi-digit number by applying the single digit driving circuit selectively to each digit of the number to be printed, in succession by using the time division method, while an adder is used to add "1" to the digit stored in the most significant digit register, and the thus added digit is shifted to the least significant digit register in a cyclical manner, so that a simplified detecting circuit can be used to check the value of each digit simply by comparing the thus increasing digit against a certain predetermined numerical value. Consequently, the construction of the printer driving circuit can be materially simplified.

According to the present invention, any digit of a number can be printed simply by increasing the capacity of the digit counter of the digit selecting circuit. Thus, the printer driving circuit according to the present invention can be used particularly advantageously in printing numbers having a large order of the digits.

I claim:

1. A printer driving circuit for printing decimal numbers, comprising:

a. a shift register for storing said decimal numbers, said shift register having a plurality of digit registers corresponding in number to the number of digits to be printed and each storing information for the value of the number of each corresponding digit to be printed;

b. an adder connected between the most significant and the least significant digit registers of said shift register for adding the number "1" to the value of the number stored in the most significant digit register;

c. means for connecting a source of clock pulses to said shift register to cause the decimal numbers stored in said shift register to be successively shifted from the most significant digit register via said adder to the least significant digit register in a cyclical manner;

d. a plurality of print wheels each having decimal numerals 0 to 9 inscribed thereon and rotated in synchronism successively into positions representing each number;

e. locking means associated with each print wheel for locking said print wheels in printing position;

f. a coincidence circuit connected to said adder to produce an output signal by checking the number which currently appears in the adder to determine whether or not it corresponds to a predetermined constant value in order to determine whether the information stored in each of the digit registers coincides with the numerical position of each of the corresponding print wheels;

g. a digit selecting circuit including a digit counter connected to receive said clock pulses and having a capacity corresponding to the number of digits of the shift register, a decoder circuit to which the output of the counter is applied, and gating means connected to each output of the decoder and the output of said coincidence circuit for controlling each of said locking means to lock said print wheels in a position corresponding to the digit stored in respective ones of said digit registers of said shift register and to thereafter prevent the rotation of said print wheels;

h. an interrogation pulse generator coupled to said print wheels for producing interrogation pulses in synchronism with the rotation of said print wheels; and

i. a gate circuit connected to receive each interrogation pulse to allow passage of said clock pulses to both said shift register and said digit counter, said gate circuit being blocked by a carry signal generated by said digit counter.