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Sato et al.

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[54] **MOTOR CONTROL UNIT FOR TABLE-TYPE ELECTRONIC CALCULATOR WITH PRINTER**

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[52] **U.S. Cl.** **197/17,** 235/61, 197/12

[51] **Int. Cl.** **B41j 23/08**

[58] **Field of Search** ..... 197/11-17, 197/1; 200/33; 235/61; 101/93 C

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[57] **ABSTRACT**

The motor operating a printer is on only for as long as necessary to print each keyed-in character, and shuts off for idle periods. The depression of a keyboard key produces a signal which discharges a capacitor, whereby a motor drive transistor is rendered conductive to start the motor. A control circuit is provided which responds to a signal produced for each revolution of the motor and to a clock pulse signal produced in response to a depressing operation of the keyboard to permit the passage of a character pulse synchronized with the rotation of a printer drum to thereby initiate a printing operation. After the printing operation, in the absence of a depressing operation of the keyboard, the charging of the capacitor causes the drive motor to stop, thus enabling an automatic start and stop of the motor in accordance with a depressing operation of the keyboard.

4 Claims, 2 Drawing Figures

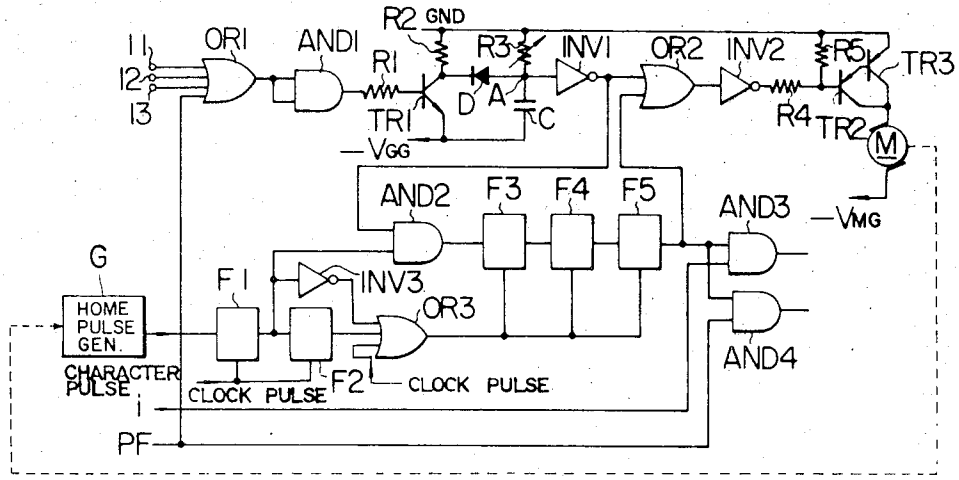
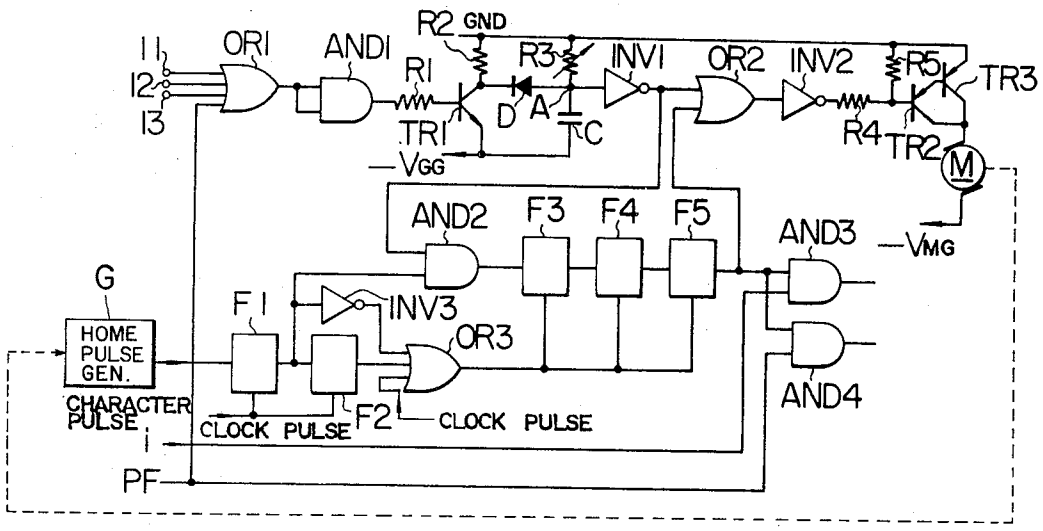


FIG. 1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I2
I3
ORI
ANDI
R2
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R1
R3
INVI
OR2
INV2
R5
TR3
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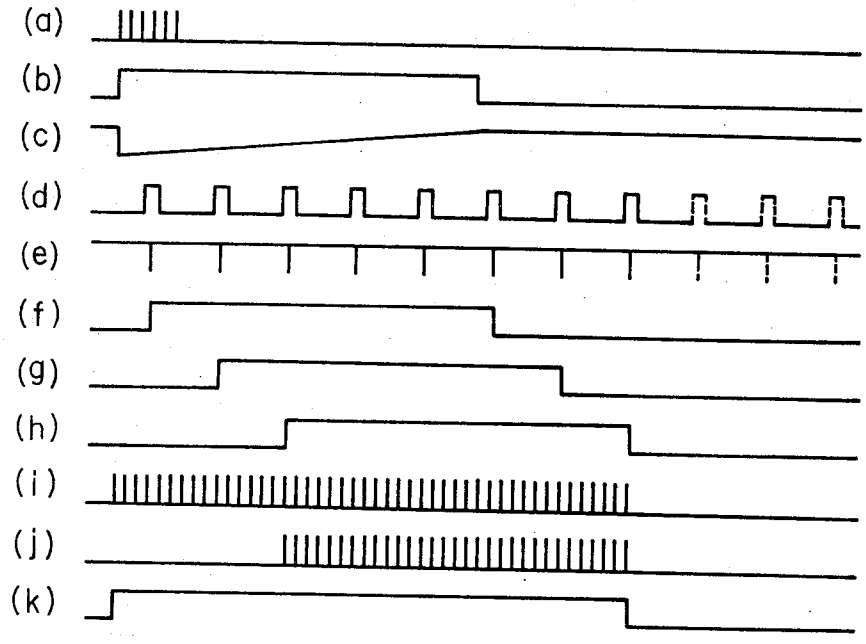
A
C
R4
TR2
M
VGG
AND2
F3
F4
F5
AND3
VMG
G
F1
INV3
OR3
HOME PULSE GEN.
CHARACTER PULSE
CLOCK PULSE
F2
CLOCK PULSE
AND4
PF

FIG. 2


(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)

MOTOR CONTROL UNIT FOR TABLE-TYPE ELECTRONIC CALCULATOR WITH PRINTER

BACKGROUND OF THE INVENTION

The invention relates to a motor control unit for table-type electronic calculator with a printer, and more particularly to such a unit in which the start and stop of the printer driving motor is automatically controlled by a depressing operation of the keyboard.

In an apparatus having a motor, for example in a table-type electronic calculator having a printer, the usual practice of operating the motor is to provide a main switch which is turned on and stays on until manually turned off. With such an arrangement, the motor remains rotating even when the calculator is not in actual use, which causes unnecessary and undesirable noise and a temperature rise within the apparatus.

SUMMARY OF THE INVENTION

An object of the invention to overcome the above-described drawbacks and to provide a motor control unit capable of reducing noise and temperature rise by activating the motor only for a given time interval following the operation of a keyboard key.

In the motor control unit according to the invention, the motor is operated for a given time interval following the operation of a keyboard key, and thus noise and temperature rise can be substantially reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an electrical circuit diagram of the motor control unit for a table-type electronic calculator with a printer in accordance with one embodiment of the invention, and

FIG. **2** (*a*) to **2** (*k*) are diagrams illustrating the waveforms of signals appearing in the various parts of FIG. **1**.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring to FIG. **1**, a table-type electronic calculator with a printer with which the motor control unit of the invention is associated includes a plurality of keys on a keyboard (not shown), the depression of any of which produces an input pulse train which is applied to an or-circuit OR_1. For example, when one of the symbol keys of a first group on the keyboard is depressed, a clock pulse train from a clock pulse generator (not shown) is applied to the input terminal **11** of the or-circuit OR_1, and when one of the symbol keys of a second group on the keyboard is depressed, a clock pulse train from the clock pulse generator is again applied to the input terminal **12** of the or-circuit OR_1. If required, the or-circuit OR_1 may include a third input terminal **13** to which a clock pulse train from the clock pulse generator may be applied when any one of the numeral keys on the keyboard is depressed. The output terminal of the or-circuit OR_1 is connected with the both input terminals of and-circuit AND_1, the output terminal of which is connected to the base of an NPN transistor TR_1 through a resistor R_1. The transistor TR_1 has its collector grounded at GND through a resistor R_2 and also connected to the cathode of a diode D, and has its emitter connected with a negative d.c. supply $-V_{GG}$. The anode of the diode D is connected with the junction A between a resistor R_3 and a capacitor C, which

constitute an integrating circuit connected in series between the negative d.c. supply and ground. The junction A is connected with the input terminal of an inverter INV_1. When a numeral key is depressed, a pulse train as shown in FIG. **2** (*a*) is applied through the or-circuit OR_1 and and-circuit AND_1 to the base of the transistor TR_1, which therefore conducts. As a result, the capacitor C is short-circuited through the diode D and transistor TR_1, and the charge thereon is instantaneously discharged to bring the potential at A to a low potential level shown in FIG. **2** (*c*). This results in a high potential output from the inverter INV_1, which is applied through an or-circuit OR_2 and an inverter INV_2 to the base of a PNP transistor TR_2, thereby rendering PNP transistors TR_2 and TR_3 conductive to cause a d.c. motor M to rotate during the high level signal shown in FIG. **2** (*b*). The transistor TR_2 and TR_3 constitute a drive circuit for the d.c. motor M. The base of the transistor TR_2 is connected through a resistor R_4 to the output terminal of the inverter INV_2 and grounded through a resistor R_5. The emitter and collector of the transistor TR_2 are connected with the base and collector, respectively, of the transistor TR_3, which has its emitter grounded and its collector connected to a negative d.c. supply $-V_{MG}$ through the d.c. motor M. The d.c. motor M represents the drive source for a printer (not shown) contained in the table-type electronic calculator with which the motor control unit of the invention is associated. The d.c. motor M is associated with a home pulse generator G which produces a pulse for every revolution of the motor. The pulse train from this pulse generator G is shown as a home pulse train in FIG. **2** (*d*), which is applied to a flipflop circuit F_1. The application of a clock pulse from a suitable clock pulse generator (not shown) causes the flipflop circuit F_1 to be set when the home pulse is applied, and causes the flipflop circuit to be reset when the home pulse is not applied. The output of the flipflop circuit F_1 is applied to a flipflop circuit F_2 together with the clock pulse from the clock pulse generator. Upon application of a clock pulse thereto, the flipflop circuit F_2 is set when the flipflop circuit F_1 is set, and is reset when the flipflop circuit F_1 is reset. The output of the flipflop circuit F_1 is also applied to an inverter INV_3, the output of which is applied to an or-circuit OR_3 together with the output from the flipflop circuit F_2 and the clock pulse from the clock pulse generator. The or-circuit OR_3 produces a pulse train, shown in FIG. **2** (*e*), which is in synchronism with the home pulse train. The outputs from the flipflop circuit F_1 and inverter INV_1 are applied to an and-circuit AND_2, the output of which is applied to a flipflop circuit F_3 together with the output from the or-circuit OR_3. The application of the output from the or-circuit OR_3 to the flipflop circuit F_3 results in this flipflop circuit F_3 being set when the output from the and-circuit AND_2 is applied thereto, and results in the circuit F_3 being reset when the output from the and-circuit AND_2 is not applied thereto.

The transistor TR_1 is rendered non-conductive when the input signal occurring as a result of a depressing operation of the keyboard ceases, and hence the capacitor C commences charging to the level of the supply voltage through the resistor R_3. As shown in FIG. **2** (*c*), the voltage on the capacitor C returns to its normal level over a preset time interval after the operation of the keyboard, and the output of the inverter INV_1 is applied to the and-circuit AND_2 during such interval. As

a result, the flipflop circuit F_3 is set in synchronism with a first home pulse as shown in FIG. 2 (*f*), and its output is applied to a flipflop circuit F_4 together with the output from the or-circuit OR_3. The application of the output from the or-circuit OR_3 to the flipflop circuit F_4 causes the circuit F_4 to be set when the flipflop circuit F_3 is set and causes the circuit F_4 to be reset when the flipflop circuit F_3 is reset. Therefore, the flipflop circuit F_4 is set in synchronism with a second home pulse as shown in FIG. 2 (*g*), and its output is applied to a flipflop circuit F_5 together with the output from the or-circuit OR_3. The application of the output from the or-circuit OR_3 to the flipflop circuit F_5 causes the circuit F_5 to be set when the flipflop circuit F_4 is set and causes the circuit F_5 to be reset when the flipflop circuit F_4 is reset. As a consequence, the flipflop circuit F_5 is set in synchronism with a third home pulse as shown in FIG. 2 (*h*), and its output is applied to the or-circuit OR_2 and and-circuits AND_3 and AND_4. To the and-circuit AND_3 is applied a signal as shown in FIG. 2 (*i*), a so-called character pulse train, which is synchronised with the signal produced in response to the depression of a numeral key or a symbol key. The and-circuit AND_3 produces a pulse train of the type shown in FIG. 2 (*j*), which pulse train is applied to an arithmetic unit (not shown) within the table-type electronic calculator to initiate the operation of a printer contained therein. Subsequently, when the d.c. motor M is in the state of steady state rotation, the printer is operated every time a key is depressed to effect a printing operation thereof. The capacitor C is short-circuited by the transistor TR_1 every time a key on the keyboard is operated, thereby being instantaneously discharged to commence recharging. The time period from the short-circuiting of the capacitor C until its charging is substantially complete depends on the values of the capacitor C and resistor R_3. When the keyboard is operated at a time interval less than such time period, the output from the inverter INV_1 is at a high level as shown in FIG. 2 (*b*), so that the d.c. motor M continues its steady state rotation and the pulse from the and-circuit AND_3 places the table-type electronic calculator in an operative condition. When the keyboard ceases to be operated and the charging of the capacitor C is substantially complete, the output from the inverter INV_1 changes to a low level as shown in FIG. 2 (*b*), whereby the output from the and-circuit AND_2 ceases. Subsequently, when an output pulse is produced from the or-circuit OR_3 in synchronism with the home pulse train, the flipflop circuit F_3 is reset as shown in FIG. 2 (*f*). When another output pulse is produced by the or-circuit OR_3 subsequent to the resetting of the flipflop circuit F_3, the flipflop circuit F_4 is reset as shown in FIG. 2 (*g*). When a further output pulse is produced by the or-circuit OR_3 subsequent to the resetting of the flipflop circuit F_4, the flipflop circuit F_5 is reset as shown in FIG. 2 (*h*). When the flipflop circuit F_5 is reset, the transistors TR_2 and TR_3 are rendered non-conductive to interrupt the drive of the d.c. motor M as shown in FIG. 2 (*k*), and also the output from the and-circuit AND_3 ceases, as shown in FIG. 2 (*j*), to make the table-type electronic calculator inoperative. A signal PF which is produced when a suitable paper feed switch (not shown) is manually operated is applied to the and-circuit AND_4 and or-circuit OR_1. This results in producing an output from the and-circuit AND_4 in the similar manner as when the table-type electronic calculator is operated or when a symbol key is depressed, which pulse is applied to the paper feed mechanism (not shown) of the printer to feed a record paper. The waveform shown in FIG. 2 (*k*) represents the waveform of a drive voltage for the motor.

In this manner, with the arrangement according to the invention, the motor which drives the printer is started in response to a signal produced upon depression of a key on the keyboard, and the motor is stopped upon termination of the operation of the keyboard by automatically resetting the motor drive circuit with the home pulse train, so that the motor driving the printer is driven only for a given time interval which is necessary for the printing operation. This permits noises and temperature rise resulting from the motor operation to be substantially reduced.

While in certain prior art devices the motor is started by the operation of a key and is stopped in response to each step feed of the record paper, such an arrangement requires an unalterably intermittent operation of the motor. By contrast, the invention provides for integration of the signals produced in response to the operation of keys, by an integrating circuit the output of which activates the motor, thus providing either intermittent or continuous operation of the motor depending on how fast the keys are struck, and providing a simple and inexpensive arrangement assuring a long life.

It should be understood that the invention is not limited to table-type electronic calculators, but is equally applicable to any apparatus having a motor. The number of flipflop circuits F_3 to F_5 can be suitably chosen depending on the performance of the motor.

What is claimed is:

1. A motor control unit for a table-type electronic calculator with a printer and a keyboard providing character pulse trains in response to the operation of a keyboard key, said unit comprising: an integrating circuit including a capacitor which is discharged by a signal produced in response to the operation of a key on the keyboard and means for charging the capacitor at a defined rate, an electric motor for driving the printer, a drive circuit rendered conductive upon discharge of the capacitor for starting the motor, means for providing a home pulse for each revolution of the motor and a clock pulse train upon the operation of a keyboard key, a control circuit including means for providing an output signal in response to a defined home pulse and a clock pulse train and means for allowing the passage of said character pulse train to the printer during said output signal, said printer including means responding to the output signal from the control circuit to start a printing operation, means for resetting the control circuit upon the charging of the capacitor in the absence of an operation of the key, and means for interrupting the drive circuit to thereby stop the motor in response to said resetting of the control circuit.

2. A device including a printer, a keyboard, means for generating a key signal in response to the operation of each of a plurality of keyboard keys and for generating a character pulse train corresponding to the operated key, and a motor for driving the printer,

wherein the improvment is in a motor control unit comprising:

means for starting the motor in response to said key signal generated in response to the operation of a keyboard key;

means for generating a train of home pulses synchronized with the motor revolutions;

control means connecting the character pulse generating means and the printer and responsive to said home pulse train for applying the character pulse train corresponding to the operated key to the printer in synchronism with a time period starting with a first selected pulse of said home pulse train and ending with a subsequent second selected home pulse; and

means for stopping the motor in response to said subsequent selected home pulse.

3. A device as in claim **2** wherein the first selected home pulse is the N-th home pulse after the motor is started and the second selected home pulse is M home pulses after the first selected home pulse, where N and M are integers of selected values.

4. A device as in claim **2** wherein the control means comprise:

means responsive to the key signal to provide an enabling signal of a defined duration;

means for counting the home pulses after the start of the enabling signal and for selecting the N-th pulse of its count as said first selected home pulse; and

means for counting the home pulses after the end of the said enabling signal and for selecting the M-th pulse of its count as said second selected home pulse.

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