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Weiss

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[54] **MINIATURE CALCULATOR HAVING PUSH-BUTTON ON-OFF SWITCH**

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[52] **U.S. Cl.** ..... **323/22 T,** 200/159 R, 307/247 A, 320/13, 323/38, 340/365 E

[51] **Int. Cl.** **G05f 1/56**

[58] **Field of Search**..... 320/13; 323/16, 19, 22 T, 323/38; 340/365 E

[56] **References Cited**

UNITED STATES PATENTS

2,751,549	6/1956	Chase	323/22 T
3,263,156	7/1966	Isaacs	323/22T
3,611,332	10/1971	Slater	323/22 T

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Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

A miniature calculator is provided with a keyboard having a small opening which has a recessed operating switch which may be pressed by the user. The operating switch is recessed so that accidental operation of the switch is difficult. When the calculator is turned on and the button is pressed, the calculator will turn off. When the calculator is off, and the button is depressed for less than 2 seconds, the calculator will turn on. If the calculator is off and the button is depressed for longer than 2 seconds, the calculator will switch off after the two second delay, since this is an apparent accidental depression. A logic circuit controls the connection of a regulated power supply to the calculator circuitry in accordance with the condition of the push button in the keyboard. The regulated power supply is a current supply which contains circuitry which eliminates the "low end" problem wherein regulated output voltage is provided even after substantial decrease of the battery voltage. The calculator also has a display time-out circuit such that the numerals of the display flash on and off at a relatively short duty cycle of, for example, 2 percent, after the display has been on for a given time in order to conserve battery power. A low battery voltage circuit is also provided to cause the flashing of a dot in the display.

2 Claims, 6 Drawing Figures

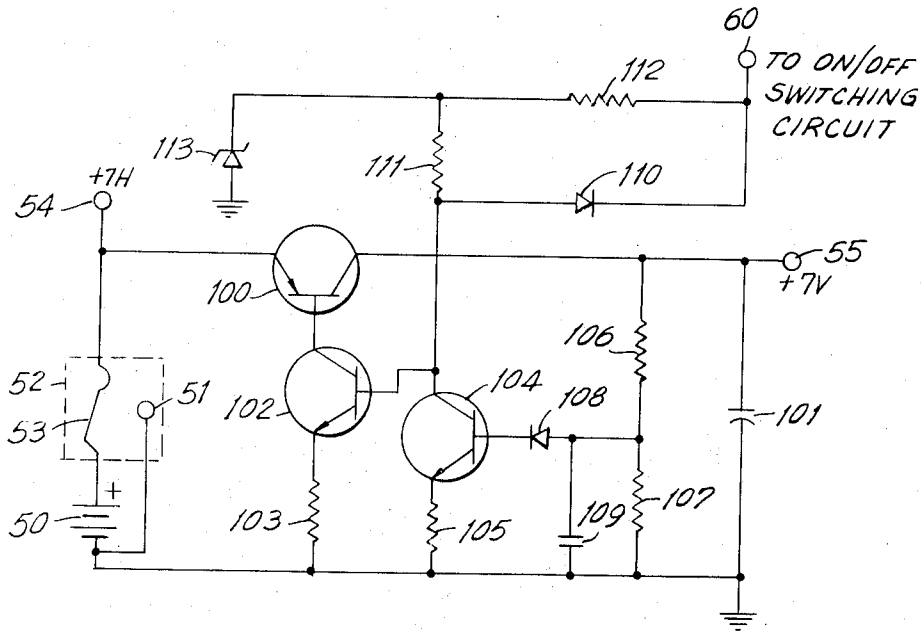


FIG. 1

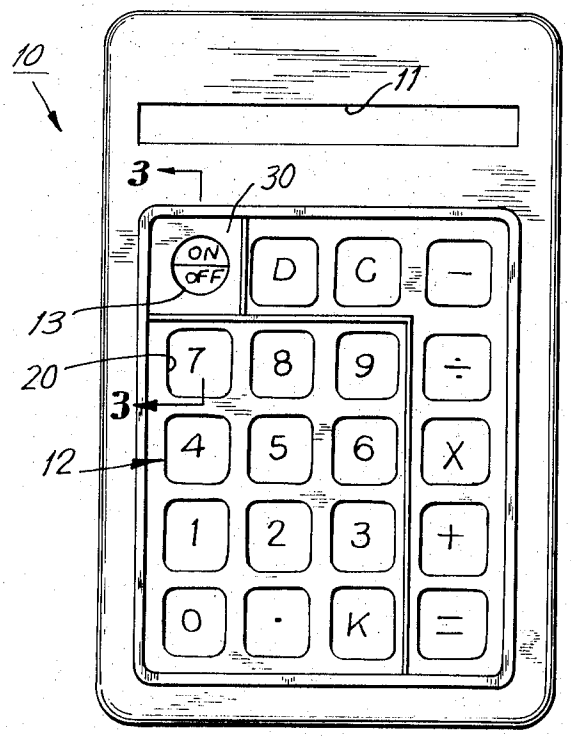
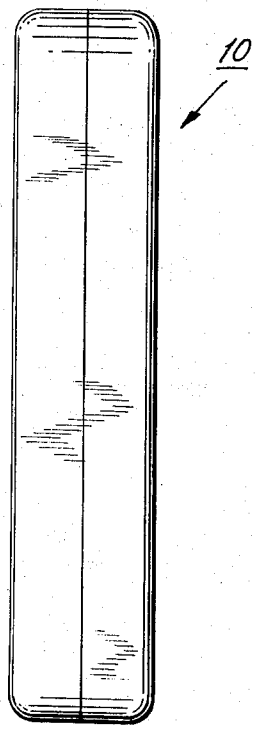


FIG. 2



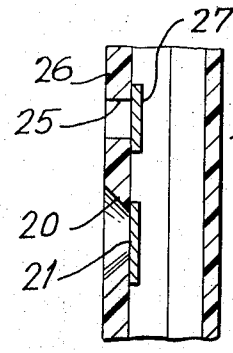


FIG. 3

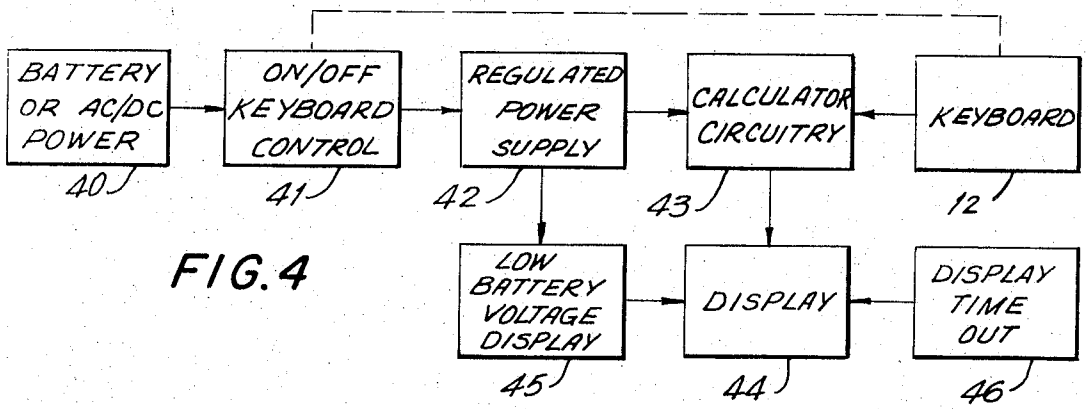


FIG. 4

FIG. 5

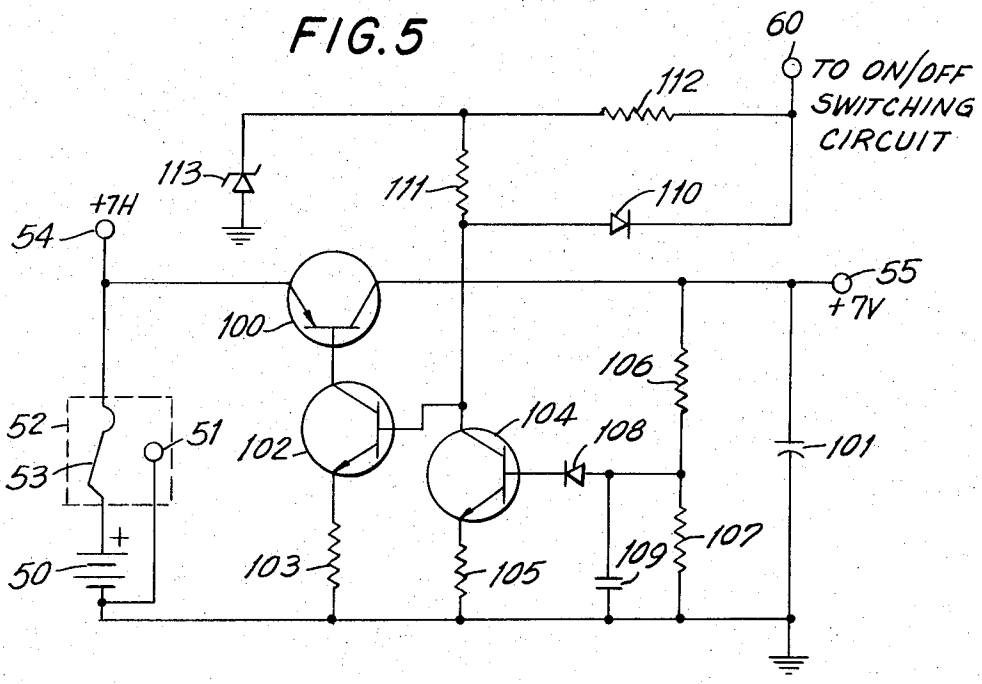
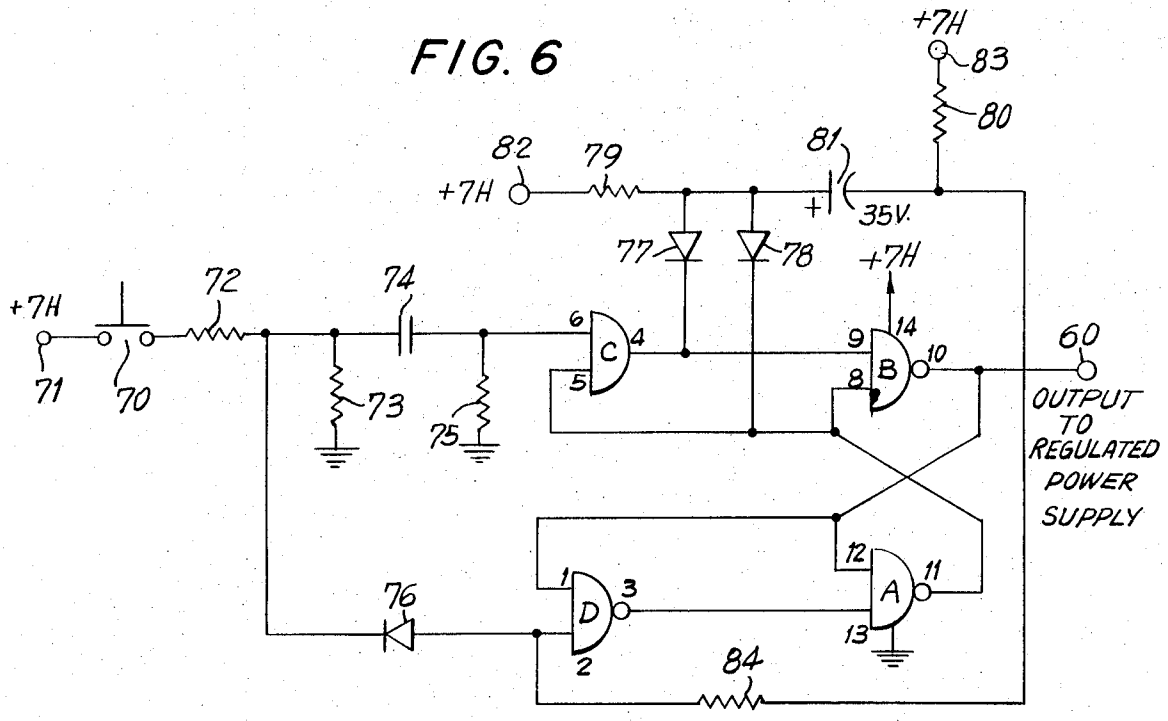

60
TO ON/OFF SWITCHING CIRCUIT
112
113
111
110
+7H
54
55
+7V
100
106
52
51
102
104
108
101
53
50
103
105
109
107

FIG. 6


+7H
83
80
82
79
81
+7H
35V.
77
78
+7H
72
74
+7H
6
C
4
5
9
14
B
10
8
60
71
70
73
75
OUTPUT TO REGULATED POWER SUPPLY
12
11
1
D
3
A
76
2
13
84

MINIATURE CALCULATOR HAVING PUSH-BUTTON ON-OFF SWITCH

BACKGROUND OF THE INVENTION

This invention relates to a miniature calculator and more specifically relates to a novel on-off control circuit for a miniature calculator in combination with a mechanical construction for the calculator housing which eliminates accidental actuation of the calculator display and which eliminates troublesome and expensive components of the prior art miniature calculators. More specifically, and in accordance with the invention, a novel on-off circuit is controlled by a push button switch which is placed at the bottom of a relatively deep opening in the casing. This on-off circuit is used to turn on and off a novel power supply which is used to drive the calculator circuit.

While the novel on-off circuit of the present invention is described herein primarily in connection with miniature calculators, it will be understood by those skilled in the art that the novel circuit and structure has general application for the control of any type of electrical circuit arrangement.

Miniature calculators and other similar types of devices are commonly turned on and off by a conventional slide switch which is operated by an operating handle which usually projects above the surface of the device housing. It has been found that these switches are relatively expensive and are a serious cause of device malfunctioning because of contact problems. Moreover, since the switch often projects above the surface of the housing, the switch device is subject to damage by inadvertently brushing objects across the surface of the housing and is subject to accidental turning on as when a miniature calculator is loaded into a suitcase or other storage container. This would then cause a continuous unintentional battery drain.

In accordance with the present invention, a novel on-off circuit is provided for devices such as miniature calculators, where the on-off circuit is operated by a push-type switch. The control circuit is such that, by pressing the switch a first time, a circuit which is on will be turned off. By pressing the button a second time, a circuit which is off will be placed on. If, however, the button is held closed for more than two seconds (or any other desired delay time), then the circuit will again automatically switch off since it can be presumed that holding down of the button for this relatively long time is due to accidental causes.

A novel mechanical construction is also provided in combination with this novel circuitry whereby the button to be operated in a push-push manner is recessed below the flush surface of the calculator or other device housing surface, and is accessible through a relatively small opening. Therefore, the operator must intentionally operate the push-push type control and it is difficult to operate the control button accidentally.

Further in combination with this novel circuitry, there is provided a novel regulated power supply which avoids the common "low end" problem encountered with miniaturized, inexpensive power supplies for small devices, such as miniature calculators, whereby a regulated output voltage can be obtained from a relatively inexpensive circuitry over a relatively wide range of input battery voltage. Once, however, the input battery voltage decreases below some minimum value, the current supply circuit is switched off.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of a miniature calculator which uses the present invention.

FIG. **2** is a side plan view of the calculator of FIG. **1.**

FIG. **3** is a cross-sectional view through a portion of the calculator of FIG. **1** to illustrate the manner in which the on-off switch, which is a push-push type switch, is depressed below the surface of the calculator housing.

FIG. **4** is a schematic block diagram of the operating circuit of the calculator of FIGS. **1** and **2.**

FIG. **5** is a circuit diagram which shows the battery power supply circuit and the regulated power supply circuit of FIG. **4.**

FIG. **6** shows the on-off keyboard control switch of FIG. **4.**

DETAILED DESCRIPTION OF THE DRAWINGS

Referring first to FIGS. **1** and **2,** there is shown a miniature calculator which is contained within a plastic housing **10.** Housing **10** contains a window **11** which has a numerical display therein of conventional type, and which could consist, for example, of a plurality of LED devices which present a digital display having, for example, nine positions. Any desired display can be used in connection with the present invention.

A keyboard **12** is then provided, shown in FIG. **1,** which can be a conventional keyboard in all respects with the exception of the on-off control **13.** Thus, the keyboard may contain the conventional button input keys which can be depressed in order to enter various numerals or functions of conventional nature into the calculator circuitry, which is contained within the housing **10** and which result in calculation results to be displayed in the display **11.**

While the keyboard members of keyboard **12** may be conventional buttons, they may also be formed of bevelshaped openings which lead to a conductive flexible member which is depressed when one of the exposed numeral or operation areas is pressed by the operator's finger in order to deliver a suitable input into the calculator circuitry associated with the particular key area which is operated.

FIG. **3** schematically illustrates this type of keyboard, where, for example, an opening **20** for numeral **7** in the keyboard **12** of FIG. **1** is shown to have a bezel shape.

A conductive member **21** (or other suitable switching means) is contained at the bottom of bezel-shaped opening **20** which, in a manner unrelated to the present invention, is responsible for delivering a signal to the computer circuitry indicating that the numeral **7** has entered into the calculator.

In accordance with an important feature of the present invention, the on-off control **13** of keyboard **12** is formed of a push button type switch as contrasted to a sliding switch, where the push button type switch has its operating member contained beneath the outer surface of the keyboard or housing, and is depressed within a relatively small opening shown as opening **25** in FIG. **3,** beneath the flush outer surface **26** which surrounds the opening **25.**

Any conventional switching mechanism, schematically illustrated as the member **27**, is recessed to the base of opening **25** and could, for example, be a conventional push button-type switch or, if desired, could be a continuation of the conductive mesh used for actuating the entire keyboard structure where such a keyboard construction is selected.

The term push button switch is used here to indicate a type of switching circuit which, when pressed, will cause an output from a power supply to change state. Thus, if the computer circuit is on and the switch is operated, the computer power supply will be turned off. Conversely, if the computer circuit is off and the switch is operated, the power supply will turn on. In accordance with a further feature of the invention, and as will be later seen, if the power supply is off and the switch is pressed closed for a time period longer than some predetermined time, for example, two seconds, the power supply will again turn off since it is likely that the button has been depressed and is held depressed by accidental means.

By recessing the push-button switch to the base of a relatively deep hole, it becomes unlikely that the switch can be unintentionally operated. By way of example, on-off switches of the prior art have been accidentally operated when devices were placed in a drawer or a briefcase, and other stored objects are pressed against the switch. This then causes a continuous and unintentional drain on the relatively small capacity battery provided with the device. Moreover, it is possible to damage the prior art switching handle which conventionally projects outwardly and above the surface of the device housing.

In accordance with the present invention, it has been found that a finger-operated push-button switch is well protected against accidental operation and is still conveniently operable by the human finger when the opening **25** has a diameter of about ⅜ of an inch, with the switch button surface recessed below the outer surface of the housing by about 0.062 inches.

It is further possible to make it easier for the user to find the on-off switch location in an easy manner by placing the entire on-off switch area on a bezel **30** shown in FIG. **1**, which allows the user to quickly locate a raised or a depressed surface by feel and without having to look at the calculator. The bezel surface can, for example, be raised by about 0.010 inches over the major portion of the keyboard surface.

The calculator circuitry which is contained within the housing **10** and which is turned on and operated by delivering appropriate information into the keyboard **12** is schematically shown in FIG. **4**. Referring to FIG. **4**, there is schematically shown the input power source which can consist of a battery or a-c to d-c power converter and charger **40**. The input power source **40** is controlled by the on-off keyboard control system **41** which will be described hereinafter in connection with FIG. **6**, and which is controlled from the push-button switch **27** in the keyboard **12** of FIGS. **1** and **3**. Note that in FIG. **4** the keyboard **12** is shown in block diagram and is coupled by the dotted line **42** to the on-off keyboard control circuit **41**.

The on-off keyboard control circuit **41** is then connected to control the output of regulated power supply **42** in that circuit **41** turns the regulated power supply on and off. Power supply **42** then drives the main calculator circuitry **43** and display **44**, which may be a conventional LED display **11** in FIG. **1**. The regulated power supply **42** may also be connected to a low battery voltage display **45** which will cause the flashing of a numeral or segment in display **44** to warn the user that the battery in power supply **40** needs replacement or charging.

A display time-out circuit **46** is also provided which is connected to display **44** and will cause the display **44** to flash at a relatively low duty cycle, for example, on for 2% of the time, after the display has been presented for a given time. This feature conserves battery power when the user fails to turn the display off after it has been presented for a given period of time.

The schematically illustrated battery or ac/dc power source **40** is shown in FIG. **5** as including a conventional chargeable battery **50**. Note that battery **50** could be a disposable battery.

The negative or ground side of battery **50** is connected to a grounded bus and to a terminal **51** in a conventional jack **52** which contains a switch **53** connected to the positive side of battery **50**. An output terminal **54** is then used as a source of battery voltage for other components of the circuit used for the calculator and is derived directly from the battery **50** and is unregulated.

All terminals in the circuits to be described hereinafter which are connected to the terminal **54** are identified by a +7H to indicate that the potential at the terminal is unregulated battery voltage (normally at 7 volts). Regulated voltage from the power supply is designated as +7V to indicate that this is 7 volts regulated. Thus, the +7H voltage terminals may vary depending upon the state of charge of the battery and of the current being drawn at a particular instant which might regulate the battery voltage while the voltage +7V will be accurately held to 7 volts, within the capability of the battery to have a given minimum output voltage.

FIG. **5** also shows the power supply regulator circuit which produces an output at terminal **55** which is +7V or a highly regulated output of 7 volts which is relatively constant over a wide variation of input battery voltage. This output at terminal **55** is used to drive other portions of the computer circuitry, and will appear in response to the condition of the on-off control circuit **41** of FIG. **4** which is shown in detail in FIG. **6**.

The operation of the regulated supply circuit of FIG. **5** will be described more fully hereinafter, it being understood for the present that the circuit will produce an output operating voltage for the calculator in response to the appearance at its input control terminal **60** of voltage output from the circuit of FIG. **6**, and will be switched off in response to the disappearance of the voltage signal at terminal **60**.

FIG. **6** shows the novel on-off control circuit of the invention which is operated under the control of a switch **70**, which generally can be any desired type switching device, but preferably is a push button-type switch. The output terminal **60** is shown in FIG. **6** and the voltage at this terminal will ultimately control the turning on and off of the calculator by turning on and off its power supply from the circuit of FIG. **5**.

The circuit of FIG. **6** contains four gates, A, B, C and D, which are integral components of a standard CMOS logic gate, type number CD4011AE. The various pins of the gates A, B, C and D are numbered **1** to **14** as shown. As will be seen more fully hereinafter, gates A

and B are arranged to form a reset flip-flop (commonly termed a latch) while gates C and D provide the logical input to gates A and B to set or reset the flip-flop condition.

In FIG. **6**, the schematically illustrated push-button switch **70** is connected in series with terminal **71**, which is connected to the battery voltage +7 H and in further series with an input resistor **72**. The right-hand end of resistor **72** is connected to a differentiator circuit consisting of resistor **73**, capacitor **74** and resistor **75**, where, as will be seen hereinafter, this differentiator circuit allows the production of an only momentary set command for the flip-flop whenever the push button **70** is closed. Thus, even if the push button **70** is held depressed for an extended period of time, as due to its accidental depression, only one pulse will be applied to gates C and D, as will be later described in more detail.

The reset side of the flip-flop is directly coupled to the push button **70** through the diode **76**, such that any input created by the closing of the push button **70** will be indefinitely valid. Thus, if the push button **70** is held down continuously, the reset mode of operation will ultimately predominate over the set mode of operation which might have been induced by the single pulse passed by the differentiator capacitor **74**.

A reset delay circuit is then formed by diodes **77**, **78**, resistors **79** and **80** and capacitor **81**. The terminals **82** and **83** of this circuit are connected to the +7H battery terminal. Capacitor **81** is also connected to the resistor **84** which is, in turn, connected to terminal **83**. The reset delay circuit described above forms a one-shot type of circuit which prevents reset of the flip-flop before an operator's finger can be removed from the push button **21**.

The operation of the circuit of FIG. **5** is such that if there is to be an output signal on terminal **60**, it is necessary for the flip-flop to be set. When the flip-flop is reset, there is no signal at terminal **60**, so that the power supply to be described hereinafter in connection with FIG. **5** is cut off.

The circuit of FIG. **5** will operate as follows:

A. If the flip-flop is in the reset condition and there is no output at terminal **60** and the push button **70** is pressed closed for less than 2 seconds, the flip-flop will set and remain set. Thus, an output voltage will appear on the terminal **60** which ultimately will turn on the regulated power supply of FIG. **5**.

B. If the flip-flop is in the set condition, which corresponds to an on condition for the calculator, and the push button **70** is pressed either momentarily or permanently, the flip-flop will reset and remain reset so that there will be zero output at terminal **60** and the power supply for the calculator is turned off.

C. If the flip-flop is in the reset condition and push button **70** is pressed for more than two seconds, the flip-flop will first set but will, after a two second time delay, reset and remain reset. Thus, if the push button **70** is unintentionally or accidentally closed for more than two seconds, the calculator will not unintentionally be turned on for more than the two second time delay.

In the operation of the circuit of FIG. **5**, it was pointed out previously that resistors **73** and **75** and capacitor **74** form a differentiator which insures only a momentary set command to the flip-flop after the button **70** is closed. The two second delay is formed by the delay circuit including capacitor **81**, whereby the initial pulse through capacitor **74** will cause the reset flip-flop to set but, if the button is still depressed at the end of the two seconds, the capacitor **81** will cause the now set flip-flop to again reset. In other words, the capacitor **81** acts as a two-second inhibiting circuit which would prevent the reset of the flip-flop for a two-second period. It is only if the button is released at the end of this two-second period that the capacitor **81** and its associated circuitry do not cause the resetting of the set flip-flop. Thus, at the end of two seconds, the space of the button **70** is interrogated by the diode **76**. If the button is still depressed, the diode **76** would be back-biased at the end of the two-second delay, so that the voltage on pin **2** of gate D goes to a logic **1** to initiate reset of the flip-flop. If, however, the button was released before the end of the two-second time delay, the diode **76** would be forward-biased to prevent the appearance of a voltage at pin **2** so that the flip-flop remains set.

It should be understood that the specific circuit shown in FIG. **6** has extremely wide application to any electronic switching function for producing an output or no output at terminal **60**, and the novel circuit of FIG. **6** is not limited to its use in connection with an electronic calculator. In this regard, it is also extremely useful, but not necessary, that the switch of FIG. **6** be recessed beneath an opening in a flat surface, so that it will not be accidentally actuated. Note, however, that other switching structures can be used in the FIG. **6** circuit and that the novel function of the circuit of FIG. **6** would prevent the inadvertent turning on of a circuit being controlled, if the switch is accidentally closed.

One satisfactory circuit which performs the function stated above using the circuit diagram of FIG. **6** used the following components:

CIRCUIT OF FIG. 6

Resistors	
72	100K
73	2.2 MEG
75	470K
79	2.2 MEG
80,84	10 MEG
Capacitors	
74	0.1Mf, 12V
81	0.01Mf, 35V
Solid State Components	
Gates A, B, C & D	CMOS Logic Gate CD4011AE
Diodes 76, 77 & 78	1N4148

Turning next to FIG. **5**, there is shown the novel regulated power supply which will be turned on and off in response to the appearance of a voltage at terminal **60**. More specifically, when the flip-flop of FIG. **6** is set, the voltage at terminal **60** will rise to +7H to turn on the power supply. When the flip-flop of FIG. **6** is reset, the voltage at terminal **60** will decrease substantially to zero.

The regulated power supply of FIG. **5** contains a series pass transistor **100** connected from the positive terminal **54** to the regulated output terminal **55** which produces a regulated output of 7 volts for the operation of the various calculator circuits.

A capacitor **101** is connected between terminal **55** and ground. Transistor **100** has its base connected to amplifying transistor **102** which, as will be later seen, can drive transistor **100** to saturation. The emitter of transistor **102** is connected through resistor **103** to

ground. The base of transistor **102** is controlled by the output of transistor **104,** which has its emitter connected to ground through resistor **105.** A voltage divider consisting of resistors **106** and **107** are connected across terminal **55** and ground and their junction is connected to diode **108** and capacitor **109** which control the input to the transistor **104.**

The base of transistor **102** is also connected to the terminal **60** through the diode **110** and through resistors **111** and **112.** Resistors **111** and **112** are also connected to the zener diode **113** as shown.

As pointed out previously, the novel circuit of FIG. **5** avoids the so-called low end problems of inexpensive regulated power supplies of the type necessary for miniaturized calculators. This problem was introduced because the series pass transistor elements required at least a 1 volt drop thereacross, even when the battery voltage was outside of the regulation range. In the circuit of the present invention, if the battery voltage at terminal **54** drops below some given value, the transistor **100** saturates and thereby causes a minimal drop, so that transistor **104** turns off. All current from resistor **111** will then go into the base of transistor **102.** This current is then amplified by transistor **102,** thus driving the base of transistor **100** to saturation, and substantially eliminating the series pass transistor drop.

During the normal operation of FIG. **5,** and assuming that the battery voltage is within its proper limits, the transistor **100** will normally divert more or less current from transistor **102.** Thus, if the output voltage is too low, transistor **104** will turn off until, eventually, the transistor **100** will connect the battery directly to the output terminal **55** without any drop. Note that, for some output to be produced at terminal **55,** voltage must be present at terminal **60.** Thus, if no voltage appears at terminal **60** due to the off state of the circuit of FIG. **6,** there is no current in resistor **111** to be amplified, so that the transistor **100** turns off.

A satisfactory circuit which produced acceptable operation and which was connected as shown in FIG. **5** used the following components:

CIRCUIT OF FIG. 5

Resistors	
103	100 Ω
105	680 Ω
106	30K
107	10K
111	11K
112	1K
Capacitors	
101	4.7Mf, 16V
109	0.1Mf, 12V
Solid State Components	
Transistor 100	EN2907
Transistor 102	538276
Transistor 104	538276
Diode 108	1N4148
Diode 110	1N270
Zener Diode 113	1N755A

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention will be limited, not by the specific disclosure herein, but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. A regulated d-c power supply circuit for a portable battery powered electrical device; said regulated d-c power supply circuit including input terminals connected to a battery power source, a series pass first transistor, output terminals connected in series with said first transistor and said battery power source and having a regulated output voltage appearing thereat; a second transistor connected to inject base current into said first transistor for controlling the conductivity of said first transistor from an off condition to a full saturation condition; a third transistor coupled to said output terminals and to said second transistor and being operable in response to the voltage of said output terminals to control the conductivity of said second transistor such that the base current injected into said first transistor tends to produce a voltage drop across said first transistor as needed to produce a given regulated voltage output at said output terminals; an on-off control circuit for turning said second transistor on and off thereby to turn said first transistor off in the off condition of said control circuit, and for permitting said second transistor to regulate the operation of said first transistor in the on condition of said control circuit; said on-off control circuit comprising a reset flip-flop circuit means connected between said battery and said second transistor, and means for operating said flip-flop circuit means between a set condition and a reset condition which respectively permits and prevents connection between said battery and said electrical device; said means for operating said flip-flop circuit means including a mechanical switch whereby closing of said switch causes said flip-flop circuit means to reset from a set condition and causes said flip-flop circuit means to set from a reset condition.

2. The power supply of claim **1,** wherein said electrical device is contained within an enclosing housing; said housing having an aperture therein; said on-off control circuit including a push button type switch means, whereby application of pressure to said push button type switch means switches said electrical device between first and second operational conditions; said push button type switch means being recessed within said aperture and accessible through said aperture; said aperture having a diameter sufficiently large to enable operation of said switch means by a human finger; said switch means being recessed in said aperture to prevent inadvertent operation of said switch means.

* * * * *