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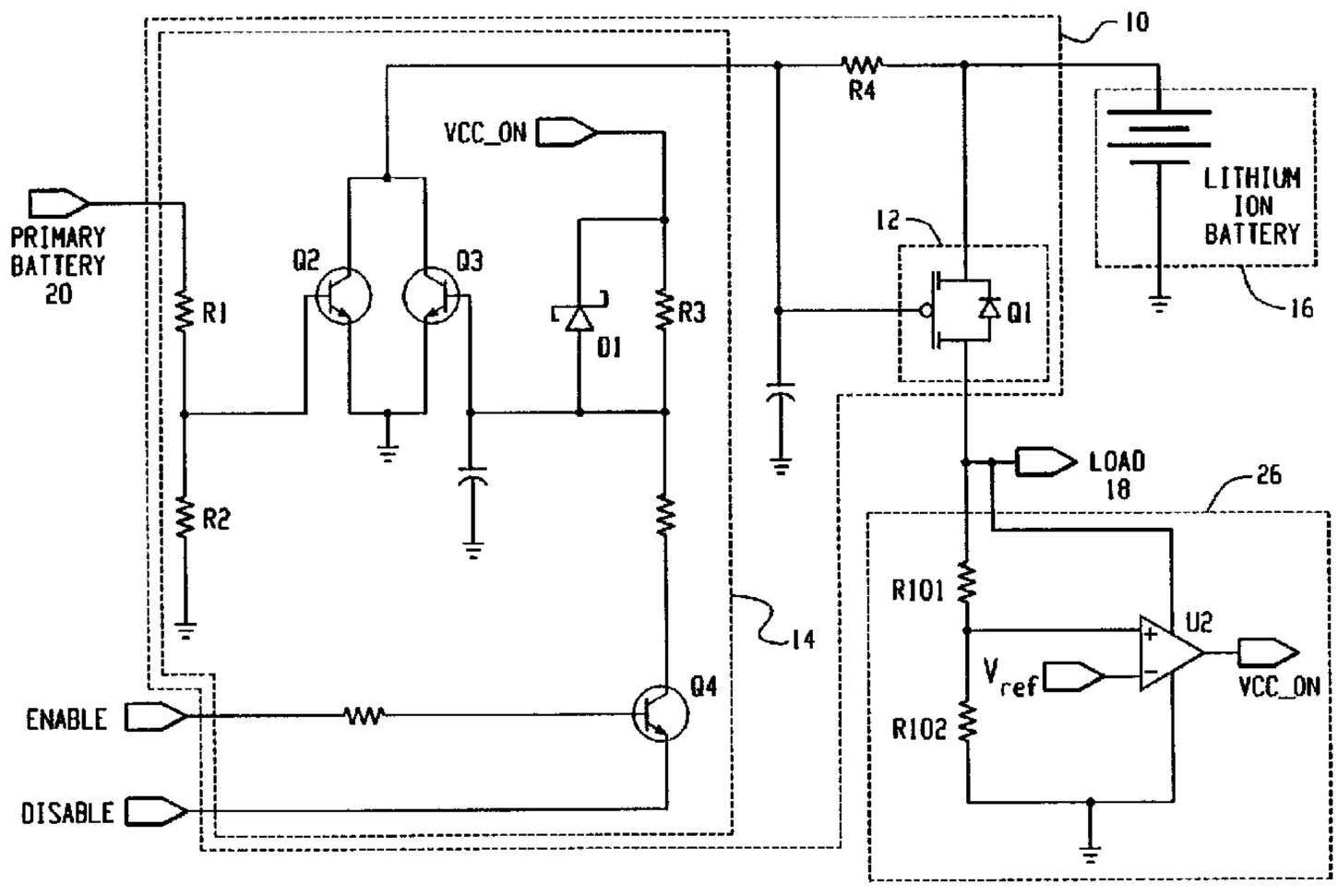
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(54) **SYSTEME SECTIONNEUR DE BATTERIE**
(54) **BATTERY DISCONNECT SYSTEM**



(57) A battery disconnect system is provided for a device having a battery and load. The battery disconnect system includes a switch that is operative to connect the battery to the load when the switch is in a closed state. The switch is also operative to disconnect the battery from the load when the switch is in an open state. The battery disconnect system also includes a switch controller that is coupled to the switch. The switch controller is operative to cause the switch to enter the closed state in response to receipt of a first signal from a first external source. The switch controller is also operative to cause the switch to enter the open state in response to receipt of a second signal from a second external source.

ABSTRACT OF THE DISCLOSURE

A battery disconnect system is provided for a device having a battery and load. The battery disconnect system includes a switch that is operative to connect the battery to the load when the switch is in a closed state. The switch is also operative to disconnect the battery from the load when the switch is in an open state. The battery disconnect system also includes a switch controller that is coupled to the switch. The switch controller is operative to cause the switch to enter the closed state in response to receipt of a first signal from a first external source. The switch controller is also operative to cause the switch to enter the open state in response to receipt of a second signal from a second external source.

Battery Disconnect System

BACKGROUND OF THE INVENTION

This application claims the benefit, under 35 U.S.C. § 119(e), of United States Provisional Application Serial No. 60/132,391 filed May 4, 1999.

The present invention is directed toward the field of battery protection systems. In particular, the invention is directed to a battery disconnect system for disconnecting a battery from its load during long periods of inactivity to reduce the likelihood that the battery will become damaged due to excessive battery discharge.

Many batteries such as rechargeable batteries may be irreparably damaged if they are discharged too deeply. Lithium-based batteries are especially susceptible to this hazard.

Many devices having built-in rechargeable batteries can expose their rechargeable battery to this excessive discharge hazard. Even when not in use, the rechargeable battery remains connected to the device's load. The small load the device presents to the rechargeable battery during inactive periods will cause the rechargeable battery to slowly discharge, potentially damaging the battery.

This problem is amplified when devices having rechargeable batteries are transferred from a manufacturer to a retailer. Prior to being sold to an end-user, the device may be warehoused or placed on shelves for weeks or months before the end-user first uses the device. The period of time that the device remains in the warehouse or on the retailer's shelf may be sufficient to allow the battery to become over-discharged and damaged. To alleviate this problem, it is desirable to have a method of preventing the device from over-discharging during periods of long inactivity.

One method of addressing this problem has been for manufacturers to position plastic tabs between the battery and the power terminal to physically disconnect the load from the battery. Upon

purchase of the device, the customer is then instructed to remove the tab thereby reconnecting the load to the device.

This method has many disadvantages. One disadvantage is that it poses significant impediments to the manufacturer's quality assurance program. During a quality assurance inspection, the tab must be removed to allow the inspector to test whether the product functions, and then must be reinstalled in the product, which may be extremely difficult. This method also can reduce the product's overall reliability due to the addition of mechanical controls. Another shortcoming is that the end-user has to ensure that the rechargeable battery is properly installed and connected after removal of the tab.

Other proposed methods include adding mechanical switches that can add significant resistance to the battery path thereby degrading performance. Also, the mechanical nature of the switches often results in a reduction of overall product reliability.

Another method of addressing the problem has been the use of commercially available Lithium battery pack protection circuits. These battery pack protection circuits measure the lithium cell voltage and disconnect the battery from the load if the battery voltage drops below 2.5 volts or other predetermined thresholds. One disadvantage of this method is that several hours are required for the battery to be charged back to a useable state after the battery pack protection circuit has disconnected the battery from the load - an unacceptable result for electronic devices that are designed to function with little, if any perceived downtime. Another disadvantage is that disconnecting the load after the battery voltage has dropped to a pre-determined level such as 2.5 volts does not guarantee that the battery will not be damaged. The battery will continue to discharge as a result of self-discharge and power drain from the protection circuit. Lithium cells become damaged if they are discharged below a low voltage level (typically 2.5 volts) for more than a few

minutes. Consequently, the battery may still over-discharge when utilizing a load-disconnecting method that does not compensate for self-discharge and power drain and thereby does not protect against damage to the lithium cell.

Therefore, there remains a need in this art for a battery protection system that can disconnect the load from the battery to prevent the battery from over-discharging without the use of a removable mechanical interlock device. There remains a further need for a system that can disconnect the load from the battery before the battery has been significantly discharged.

SUMMARY OF THE INVENTION

The present invention overcomes the problems noted above and satisfies the needs in this field for a battery disconnect system that includes the feature of disconnecting a battery from its load while the battery is almost fully charged. The present invention provides a method for protecting the internal rechargeable battery in a device by electrically disconnecting the internal rechargeable battery from the load when the device will not be needed for a long time. The present invention further provides a method for quickly reconnecting the battery to the load in a manner that requires little action by the end-user.

The present invention is particularly useful for products that charge an internal, non-removable rechargeable battery from a primary user-replaceable battery or other user-connected external power source. This invention can conceal the fact that the product uses an internal non-removable rechargeable battery because the product can be constructed to appear to turn on and off when the primary user-replaceable battery is inserted or removed.

The present invention provides many advantages over the presently known battery protection systems. Not all of these advantages are simultaneously required to practice the invention as claimed, and the following list is merely illustrative of the types of benefits that may be provided,

alone or in combination, by the present invention. These advantages include: (1) disconnecting the rechargeable battery based on a primary battery or external power source not being available for a programmed period of time; (2) disconnecting the rechargeable battery from a charging source when the rechargeable battery is nearly fully charged; (3) reconnecting the battery based on a primary battery or external power source being made available; (4) providing a method whereby a manufacturer can ship a device with an internal rechargeable battery fully charged and ready for use but with the rechargeable battery electrically disconnected from the load, and in which the user can electrically connect the rechargeable battery to the load in a few seconds by simply installing a primary battery or plugging in an external power source; (5) increasing the shelf life of a device having the invention; and (6) providing an over temperature safety disconnect.

In accordance with the present invention, a battery disconnect system is provided for a device having a battery and load. The battery disconnect system includes a switch that is operative to connect the battery to the load when the switch is in a closed state. The switch is also operative to disconnect the battery from the load when the switch is in an open state. The battery disconnect system also includes a switch controller that is coupled to the switch. The switch controller is operative to cause the switch to enter the closed state in response to receipt of a first signal from a first external source. The switch controller is also operative to cause the switch to enter the open state in response to receipt of a second signal from a second external source.

In one embodiment, the first external source is an external battery, the first signal is a pre-defined level of power generated by the external battery, the second signal is a logic signal, and the second external source is the load. In an alternate embodiment, the first external source is an AC power source instead of an external battery, and the first signal is either the actuation of a reset switch or the presence of an adequate power supply from the AC power source.

In accordance with the present invention a device is provided. The device includes a battery for providing power, a load configured to consume power provided by the battery, and a switch coupled between the battery and the load. The switch is operative to connect the battery to the load when the switch is in in a closed state. The switch is also operative to disconnect the battery from the load when the switch is in in an opened closed state. The device also includes a switch controller coupled to the switch. The switch controller is operative to cause the switch to enter the closed state in response to a first signal from a first external source. The switch controller is also operative to cause the switch to enter the open state in response to a second signal from a second external source.

In accordance with the present invention, a method of storing a device having an internal rechargeable battery and a load is provided. The method includes the steps of providing a switch in the device that is coupled between the internal rechargeable battery and the load, charging the internal rechargeable battery, and placing the switch in a state that electrically disconnects the internal rechargeable battery from the load.

In accordance with the present invention, a method for controlling the operating environment of a rechargeable battery in an electronic device is provided. The method includes the steps of providing a switch in the device that is operative to couple a load and the rechargeable battery, charging the rechargeable battery, and placing the switch in a state that electrically disconnects the rechargeable battery from the load.

In one embodiment the method also includes the steps of providing an external power source to the device, detecting the external power source, and placing the switch in a state whereby the rechargeable battery is electrically connected to the load.

In accordance with the present invention, a rechargeable battery system having a load and a rechargeable battery is provided. The rechargeable battery system comprises an electronically

controllable switch for placing the rechargeable battery system into a first state or the second state wherein the rechargeable battery is electrically connected to the load when the rechargeable battery system is in the first state and the rechargeable battery is not electrically connected to the load when the rechargeable battery system is in said second state. The system also includes a switch controller operable to signal the switch to place the rechargeable battery system into the first state or the second state in response to the occurrence of a pre-defined condition.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more apparent from the following description when read in conjunction with the accompanying drawings wherein:

FIG. 1 sets forth a block diagram of the battery disconnect system installed in a device;

FIG. 2 sets forth a schematic view of a preferred embodiment of the battery disconnect system installed in a device; and

FIG. 3 sets forth a schematic view of an alternate embodiment of the battery disconnect system installed in a device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, figure 1 is a schematic view of a preferred embodiment of the battery disconnect system **10** of the present invention which is implemented in an electronic device **8** in which a load draws upon a battery. Although the battery disconnect system **10** is particularly useful for electronic devices having rechargeable batteries such as wireless handheld communication devices (e.g., two-way pagers, one-way pagers, wireless e-mail devices, cellular telephones) cordless tools (e.g., drills, hedge trimmers, cordless screw drivers) and others, it may alternatively be used for devices that have non-rechargeable batteries.

The battery disconnect system **10** preferably comprises a switch **12** and a switch controller **14** which controls the operation of the switch **12**. The switch **12** and switch controller **14** are coupled to a rechargeable battery **16** and electrical load elements **18** contained within the electronic device **8**. The battery disconnect system **10** in one of its modes connects the rechargeable battery **16**, which provides power to the electrical load elements **18**, to the electrical load elements **18** and to disconnect the rechargeable battery **16** from the electrical load elements **18** contained within the electronic device **8**. The load **18** comprises the circuitry that performs the functions carried out by the electronic device **8** and could include a CPU or other type of controller for controlling the circuitry of the electronic device **8**.

The present invention is particularly useful with hand held electronic devices such as that described in commonly assigned U.S. patent application serial number 09/106585 filed June 29, 1998, which is incorporated herein by reference. The hand held electronic device may include any combination of the following elements: a transmitter/receiver subsystem connected to a digital signal processor for digital signal processing of incoming and outgoing data transmissions, a power supply and power management subsystem for distributing and managing power to the device components, a microprocessor that controls the operation of the device, a display, memory, an output port, and a keyboard or other entry device.

The preferred battery disconnect system **10** also interfaces with a primary battery or external power source **20**, which is used to charge the rechargeable battery **16** to a charged state. A charger **22** in the electronic device **8** transfers energy from the primary battery or external power source **20** to the rechargeable battery **16** during the charging process. The primary battery **20** could be an alkaline battery such as an AA alkaline battery or any other type of battery. The external power source preferably is rectified power from an AC power source such as rectified 110 VAC. The charger in this instance would be physically external to the device.

The battery disconnect system **10** responds to inputs from sources such as the rechargeable battery **16**, the primary battery or external power source **20**, load elements **18** such as a CPU within the load, or an external input **24**. In response to the inputs, the battery disconnect system **10** either connects the rechargeable battery **16** to the load **18** so that the rechargeable battery **16** supplies power to the load **18** or alternatively disconnects the rechargeable battery **16** from the load **18** so that no energy is drained from the rechargeable battery **16**.

The present invention has many advantages over current systems. In current electronic devices that use non-lithium-based rechargeable batteries, the device is shipped from the manufacturer with the rechargeable battery completely discharged so that the rechargeable battery does not become damaged if it remains unused for a long period of time prior to use by the consumer. But, before a consumer can use the device, the consumer must charge the battery for a long period of time of up to 24 hours.

In systems using lithium-based rechargeable batteries, devices are shipped with the rechargeable battery fully charged but mechanically disconnected from the load through the use of some type of mechanical interlock system. To use these devices, the consumer must first remove the mechanical interlock system and make sure that the rechargeable battery is properly connected to the device. These systems thus require the consumer to knowingly and actively undertake to connect the rechargeable battery prior to using the device and do not provide a method for the user to return the device to a storage condition prior to long periods of inactivity.

The present invention provides a method that is more user-friendly for the consumer. Before the device **8** is shipped by the manufacturer, the manufacturer can fully charge the rechargeable battery **16** and use the switch **12** and switch controller **14** to disconnect the battery **16** from the load **18**. When the consumer is ready to use the device **8**, the consumer merely installs the primary

battery or external power source **20**. In a matter of seconds, the controller **14** closes the switch **12** thereby making the device **8** ready for use with a fully charged rechargeable battery **16**.

The preferred switch **12** is a MOSFET device, but a number of other devices could be used such as a BJT or IGBT, an electro-mechanical switch, an electro-optical switch, a vacuum tube, or others without departing from the spirit of the invention. With a MOSFET device as the switch **12**, there may be some residual current flow even when the switch **12** is open, but the current flow is so small compared to the load current being disconnected and the normal self-discharging current of the rechargeable battery **16** that the residual current flow can be considered insignificant.

When the end user receives the device **8**, the user will install a new primary battery **20** such as an AA alkaline cell or connect the device **8** to an external power source **20**. The switch controller **14**, based on this input, commands the switch **12** to close, and the device **8** will turn on. In the case where the primary battery **20** is installed, it appears to the user, as a result of logical controls on device **8** (preferably programmed in firmware on the device) that the device **8** is running exclusively from the primary battery that the user had just installed. This can reduce the confusion that can be generated when a user learns that a device **8** contains a second built-in battery **16**. Once the CPU in the load **18** begins to operate, the CPU exerts a second signal to the switch controller **14** which, in turn, transmits a command to the switch **12** to remain in the closed state.

When the user removes the primary battery **20** (e.g., to change the battery) or when the user disconnects the external power source **20**, the switch **12** does not immediately transition to the open state. Although one of the switch controller **14** input signals has been removed, the switch **12** remains closed because the signal from the load **18** remains present.

The length of time the device **8** continues to operate after the primary battery or external power source **20** is removed is a parameter to be determined by the manufacturer, and can be chosen to give the device **8** the "feel" of a slow loss of power or can be chosen to simulate a rapid loss of

power. For example, in a pager having a primary battery **20**, the pager could be programmed to cause the display to flash the message "low battery" for several seconds and then go blank upon removal of the primary battery **20**. In this case, the switch **12** remains closed and will continue to supply power to the load **18**. But, to the user the device **8** will appear to be powered off. When the user installs a new primary battery **20** in the device **8**, the CPU will detect the new primary battery **8**, and will re-enable the display. The load **18** will remain powered during this period thereby allowing real-time clocks in the device **8** to remain in-sync and stored data to remain in memory. Moreover, the user will not have to reboot or reset the device **8**.

But, if the device **8** is to be stored for an extended period of time, the user can be instructed to remove the primary battery **20** or disconnect the external power source **20**. The CPU will initially blank the screen as described above. After a preprogramed period of time (e.g., 24 hours), the load **18** signals the switch controller **14** to command the switch **12** to open thereby disconnecting the rechargeable battery **16** from the load **18**. This allows the rechargeable battery **16** to be stored in a nearly fully charged state without a significant current drain thereby extending the life of the rechargeable battery **16**.

The battery disconnect system **10** of the present invention provides another advantage over current battery protection systems. The battery disconnect system **10** allows the rechargeable battery **16** to be disconnected at any desired energy capacity level thereby reducing the likelihood of damage from over-drainage. The rechargeable battery **16** lasts significantly longer when it is stored in a fully charged state as opposed to being stored in a highly discharged state as employed by current battery protection systems that wait until the cell is totally discharged before disconnecting.

Optionally, the switch controller **14** could have an input that monitors the energy level of the rechargeable battery **16** as a fail safe provision. If the energy level falls below a preset level, the switch controller **14** could then command the switch **12** to transition to the open state thereby

disconnecting the load **18** from the rechargeable battery **16** and preventing the rechargeable battery **16** from discharging further and becoming damaged.

A preferred implementation of battery disconnect system **10** of the present invention is shown in figure 2. The preferred battery disconnect system **10** is implemented in a pager device that uses a replaceable AA alkaline battery as the primary battery **20** to charge the rechargeable lithium battery **16**.

The illustrated battery disconnect system **10** functions as follows. When the gate of transistor **Q1** is pulled low by either or both transistors **Q2** and **Q3**, the switch **12** is closed, thereby connecting the lithium battery **16** to the load **18**.

Three conditions must be true in order to open switch **12**. First, the voltage level of the primary battery **20** must be below a predetermined level as determined by the voltage divider **R1/R2** and the base threshold voltage to turn on transistor **Q2**. The voltage level may be below the predetermined level due to either the primary battery **20** voltage being discharged below that level or the primary battery **20** being removed from the device **8**. Second, the **ENABLE** signal must be set high and, third, the **DISABLE** signal must be set low. Both the **ENABLE** and **DISABLE** signals are used to prevent the switch **12** from spuriously closing if these signals become unstable when the load elements **18** are powering down after the switch **12** transitions to the open state.

The comparator **U2** and the low voltage sense resistors **R101** and **R102** combine to form the low voltage cut-off circuit **26** that senses the lithium battery's **16** voltage as delivered to the load **18**. The comparator **U2** compares the voltage across the low voltage sense resistor **R102** with a reference voltage **Vref**, and produces control signal **VCC_ON**, which becomes low as the load voltage falls below the preset level.

To open the switch **12**, therefore, the primary battery **20** voltage must drop below a defined level. When this happens, transistor **Q2** no longer conducts and stops pulling down the gate of

transistor **Q1**. The switch **12** does not open at this point because the transistor **Q3** is still conducting. The transistor **Q3** conducts because its base is biased on through a pull-up resistor **R3** that is coupled to the control signal **VCC_ON**.

After a preprogrammed time period, preferably 24 hours in this embodiment, a load element **18** asserts the **ENABLE** signal high and the **DISABLE** signal low. This causes transistor **Q4** to conduct pulling the base of transistor **Q3** low. Because transistor **Q3** no longer conducts, it stops pulling down the gate of transistor **Q1**. Consequently, the gate of transistor **Q1** is pulled high by pull-up resistor **R4** that is coupled to the rechargeable battery **16**. As a result, switch **12** opens and the rechargeable lithium battery **16** is disconnected from the load **18**. As the voltage presented to the load **18** falls after the switch **12** is opened, the detector **26** senses the falling voltage and sets the control signal **VCC_ON**, to a low level. This serves to hold the transistor **Q3** off by holding the base of the transistor **Q3** low through the diode **D1**, and preventing the transistor **Q3** from turning on spuriously as indeterminate levels are present at the **ENABLE** and **DISABLE** signals as the CPU loses power.

Therefore when a user wants to store the device for a long period of time without use, the user need only remove the primary battery **20** from the system. The system will automatically disconnect the internal battery **16**. Hence, the user need not know that the internal battery **16** exists.

The switch **12** is closed when a primary battery **20** having a sufficiently high output voltage is inserted into the device **8**. A primary battery **20** with a sufficiently high voltage will cause transistor **Q2** to conduct thereby pulling the gate of transistor **Q1** low. Switch **12** will, as a result, connect the lithium battery **16** to the load **18**.

When the load **18** is energized by the lithium battery **16**, the control signal **VCC_ON** will be set high. Transistor **Q3** will then conduct because its base will be biased on through pull-up resistor **R3**.

A second preferred embodiment of the rechargeable battery disconnect system **10** of the present invention is shown in figure 3. In this embodiment, the device **8** uses an external power supply **20** (charger) to charge the internal lithium battery **16**. The charger, in this embodiment, preferably physically resides outside the device. The switch **12** is implemented using a MOSFET device and the switch controller **14** comprises a flip-flop **U1** and a comparator **U2**.

The switch **12** will transition from an open state to a closed state when the device **8** is connected to a functioning charger **20**. The charger **20** causes the **START_N** signal to go low. This clears the flip-flop **U1** causing transistors **Q101** and **Q102** to turn on. Transistor **Q101** is preferably a field effect transistor and it connects the battery **16** to the low voltage sense resistors **R101** and **R102**. Transistor **Q102**, also preferably a field effect transistor, is the switch **12** in this embodiment and connects the battery **16** to the **L_BAT** connection point, which, in turn, supplies power to the load **18**.

To ensure proper functioning of the battery disconnect system **10**, the **CLR** signal is pulled high through pull-up resistor **R103** when the **START_N** signal is floating. The **START_N** signal floats when the charger **20** is not connected to the device **8** or when the charger **20** is malfunctioning.

The switch **12** can be commanded to the open state by various methods. First, by asserting the **ENABLE_D** signal high and causing the **ENABLE_CLK** signal to transition from a low signal level to a high signal level, the **Q** output of the flip-flop **U1** will transition to a high state thereby turning off transistors **Q101** and **Q102** and opening switch **12** providing no external charger is connected. The use of the two active signals **ENABLE_CLK** and the **ENABLE_D** provide some measure of protection against the load **18** accidentally activating the flip-flop **U1** and thereby cutting off power to the device **8**.

The switch **12** can also be commanded to the open state by a low voltage cut off circuit **26**. The comparator **U2** and the low voltage sense resistors **R101** and **R102** combine to form the low

voltage cut off circuit **26**. The low voltage sense resistors **R101** and **R102** are coupled to the battery **16** through transistor **Q102** and sense the rechargeable battery's **16** voltage. The comparator **U2** compares the voltage across low voltage sense resistor **R102** with a reference voltage **Vref**. If the battery **16** voltage falls too low, which, in turn, drives the voltage across the low voltage sense resistor **R102** below the reference voltage **Vref**, the low voltage cut-off circuit **26** generates a low voltage signal on the **PR** (pre-set) signal input on flip-flop **U1**. When the **PR** signal input on the flip-flop **U1** is driven low, the **Q** output of the flip-flop **U1** transitions to a high state which, in turn, switches the transistors **Q101** and **Q102** off. As a result, the switch **12** is opened and the battery **16** is disconnected from the **L_BAT** signal and the load **18**.

The diode **D2** ensures that both the transistors **Q101** and **Q102** are turned on when the device **8** is connected to the charger **20** and overrides the turn-off signal from the low voltage cut-off circuit **26**. When the **START_N** signal is held low, the diode **D2** pulls the gate of transistors **Q101** and **Q102** low thereby causing the transistors **Q101** and **Q102** to conduct even when the lithium battery **16** voltage is low enough to trigger the low voltage cut-off circuitry **26** to generate a low **PR** signal.

The switch controllers **14** described above with reference to figures 2 and 3 are a preferred way of implementing the switch controller **14**. It is understood that one of ordinary skill in the art could use other elements or arrangements such as logic arrays, programmable logic, micro-controllers, microprocessors, discrete logic gates, discrete analog components or others to construct the switch controller **14** without departing from the spirit of the invention.

For clarity, it is to be understood that the charger and the external power supply may be physically positioned outside the device. For instance, in the second embodiment, it is envisioned that an external power source may be incorporated within an external charger. The external power source-charger combination could be in the form of a power docking cradle. The cradle may then

be portable. Hence, the internal rechargeable battery in the device may be charged when placed into the external cradle.

Having described in detail the preferred embodiments of the present invention, including preferred modes of operation, it is to be understood that this invention and operation could be constructed and carried out with different elements and steps. The preferred embodiments are presented only by way of example and are not meant to limit the scope of the present invention which is defined by the following claims.

What is claimed:

1. A battery disconnect system for a device having a battery and a load, said battery disconnect system comprising:

(a) a switch configured to be coupled between the battery and the load and having an open state and a closed state, said switch being operative to connect the battery to the load when in said closed state, said switch also being operative to disconnect the battery from the load when in said open state; and

(b) a switch controller coupled to said switch, said switch controller having a first input configured to receive a first signal from a first external source and a second input configured to receive a second signal from a second external source, said switch controller being operative to cause said switch to enter said closed state in response to said first signal, said switch controller also being operative to cause said switch to enter said open state in response to said second signal.

2. The battery disconnect system according to claim 1 wherein the first external source is a second external battery.

3. The battery disconnect system according to claim 1 wherein the first external source is an AC power source.

4. The battery disconnect system according to claim 1 wherein the second external source is said load.

5. The battery disconnect system according to claim 1 wherein the second signal is a logic signal.

6. The battery disconnect system according to claim 1 wherein said switch comprises a MOSFET device.

7. The battery disconnect system according to claim 1 wherein said switch comprises a BJT device.

8. The battery disconnect system according to claim 1 wherein said switch comprises an IGBT device.

9. The battery disconnect system according to claim 1 wherein said switch controller is operative to cause said switch to enter said open state in response to a low energy level signal from the battery.

10. The battery disconnect system according to claim 1 further comprising the battery and wherein said battery is a rechargeable battery.

11. A device comprising:

(a) a battery for providing power;

(b) a load configured to consume power provided by said battery;

(c) a switch coupled between said battery and said load and having an open and a closed state, said switch being operative to connect said battery to said load when in said closed state, said switch also being operative to disconnect said battery from said load when in said open state; and

(d) a switch controller coupled to said switch, said switch controller having a first input configured to receive a first signal from a first external source and a second input configured to receive a second signal from a second source, said switch controller being operative to cause said switch to enter said closed state in response to said first signal, said switch controller also being operative to cause said switch to enter said open state in response to said second signal.

12. The device according to claim 11 wherein the first external source is a second battery.

13. The device according to claim 11 wherein the first external source is an AC power source.

14. The device according to claim 11 wherein the second source is said load.

15. The device according to claim 11 wherein the second signal is a logic signal.

16. The device according to claim 11 wherein said switch comprises a MOSFET device.

17. The device according to claim 11 wherein said switch comprises a BJT device.

18. The device according to claim 11 wherein said switch comprises an IGBT device.

19. The device according to claim 11 wherein said switch controller is operative to cause said switch to enter said open state in response to a low energy level signal from said battery.

20. The device according to claim 11 wherein the device is a pager.

21. The device according to claim 11 wherein the device is a cellular phone.

22. The device according to claim 11 wherein the device is an electric tool.

23. The device according to claim 11 wherein said battery is a rechargeable battery.

24. The device according to claim 23 further comprising a charger coupled to said rechargeable battery when said switch is in said closed state, said charger being operative to direct energy to said rechargeable battery.

25. A battery disconnect system for a device having a battery and a load, said battery disconnect system comprising:

(a) switching means for connecting the battery to the load in a first operating state and for disconnecting the battery from the load in a second operating state; and

(b) switch controller means operatively coupled to said switching means for causing said switching means to enter said second operating state in response to a first signal from a first external source and for causing said switching means to enter said first operating state in response to a second signal from a second external source.

26. A device comprising:

(a) a battery for providing power

(b) a load configured to consume power provided by said battery;

(c) switching means for connecting said battery to said load in a first operating state and for disconnecting said battery from said load in a second operating state; and

(d) switch controller means operatively coupled to said switching means for causing said switching means to enter said second operating state in response to a first signal from a first external source and for causing said switching means to enter said first operating state in response to a second signal from a second source.

27. A method of storing a device having an internal rechargeable battery and a load, said method comprising the steps of:

(a) providing a switch in the device coupled between the rechargeable battery and the load;

(b) charging the rechargeable battery; and

(c) opening said switch so that the rechargeable battery is electrically disconnected from the load.

28. A method for controlling the operating environment of a rechargeable battery in an electronic device having a load, the method comprising the steps of:

(a) providing a switch in the device that is operative to couple the load to the rechargeable battery;

(b) charging the rechargeable battery; and

(c) placing said switch in a state that electrically disconnects the rechargeable battery from the load.

29. The method of claim 28 further comprising the steps of:

(d) providing an external power source to the device;

(e) detecting said external power source; and

(f) placing said switch in a state whereby the rechargeable battery is electrically connected to the load.

30. The method of claim 29 wherein the step of placing said switch in a state that electrically disconnects the rechargeable battery from the load takes place in response to the occurrence of at least one condition of a set of pre-defined conditions.

31. The method of claim 30 wherein said condition is the elevation of the rechargeable battery's temperature beyond a preset level.

32. The method of claim 30 wherein said condition is the disconnection of said external power source from the device for a period of time exceeding a preprogrammed duration of time.

33. The method of claim 30 wherein said condition is the failure of said external power source for a period of time exceeding a preprogrammed duration of time.

34. The method of claim 30 wherein said condition is the falling of the rechargeable battery's energy capacity level below a predetermined level.

35. The method of claim 30 wherein said condition is the appearance of a user inputted signal.

36. The method of claim 30 further comprising the step of providing the electronic device.

37. The method of claim 36 wherein said electronic device is a wireless communications device.

38. The method of claim 37 wherein said wireless communications device includes an antenna and communications circuitry.

39. A rechargeable battery system for an electronic device having a load and a rechargeable battery, the system comprising:

(a) an electronically controllable switch operable to place the rechargeable battery system into a first state or a second state wherein the rechargeable battery is electrically connected to the load when the rechargeable battery system is in said first state and wherein the rechargeable battery is not electrically connected to the load when the rechargeable battery system is in said second state;

(b) a switch controller operable to signal said switch to place the rechargeable battery system into one of said first state or said second state in response to the occurrence of at least one condition of a set of pre-defined conditions.

40. The system according to claim 39 wherein the set of pre-defined conditions includes a disconnection condition.

41. The system according to claim 40 further comprising an external power source that is configured to be coupled to device and that is operable to charge the rechargeable battery.

42. The system according to claim 41 wherein said disconnection condition is the passage of a pre-determined period of time after said external power source is decoupled from the device.

43. The system according to claim 41 wherein said disconnection condition is the passage of a pre-determined period of time after the output power level of said coupled external power source falls below a predetermined level .

44. The system according to claim 39 wherein said disconnection condition is a rechargeable battery temperature that exceeds a preset level.

45. The system according to claim 39 wherein said disconnection condition is the falling of the rechargeable battery's energy capacity level below a predetermined level.

46. The system according to claim 39 wherein said disconnection condition is a user-inputted signal.

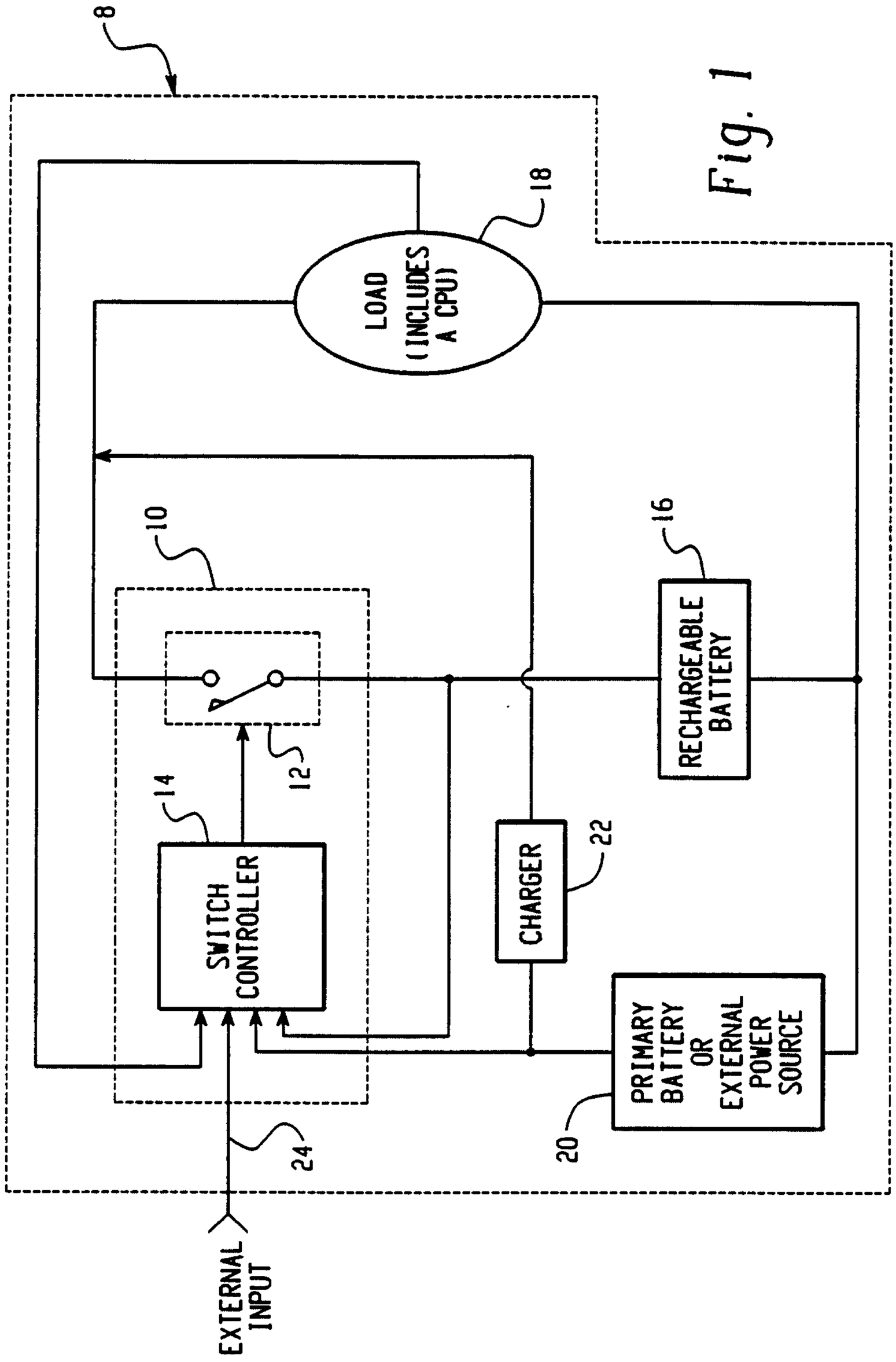

8
LOAD (INCLUDES A CPU)
18
10
16
RECHARGEABLE BATTERY
12
14
SWITCH CONTROLLER
CHARGER
22
PRIMARY BATTERY OR EXTERNAL POWER SOURCE
20
24
EXTERNAL INPUT

Fig. 1

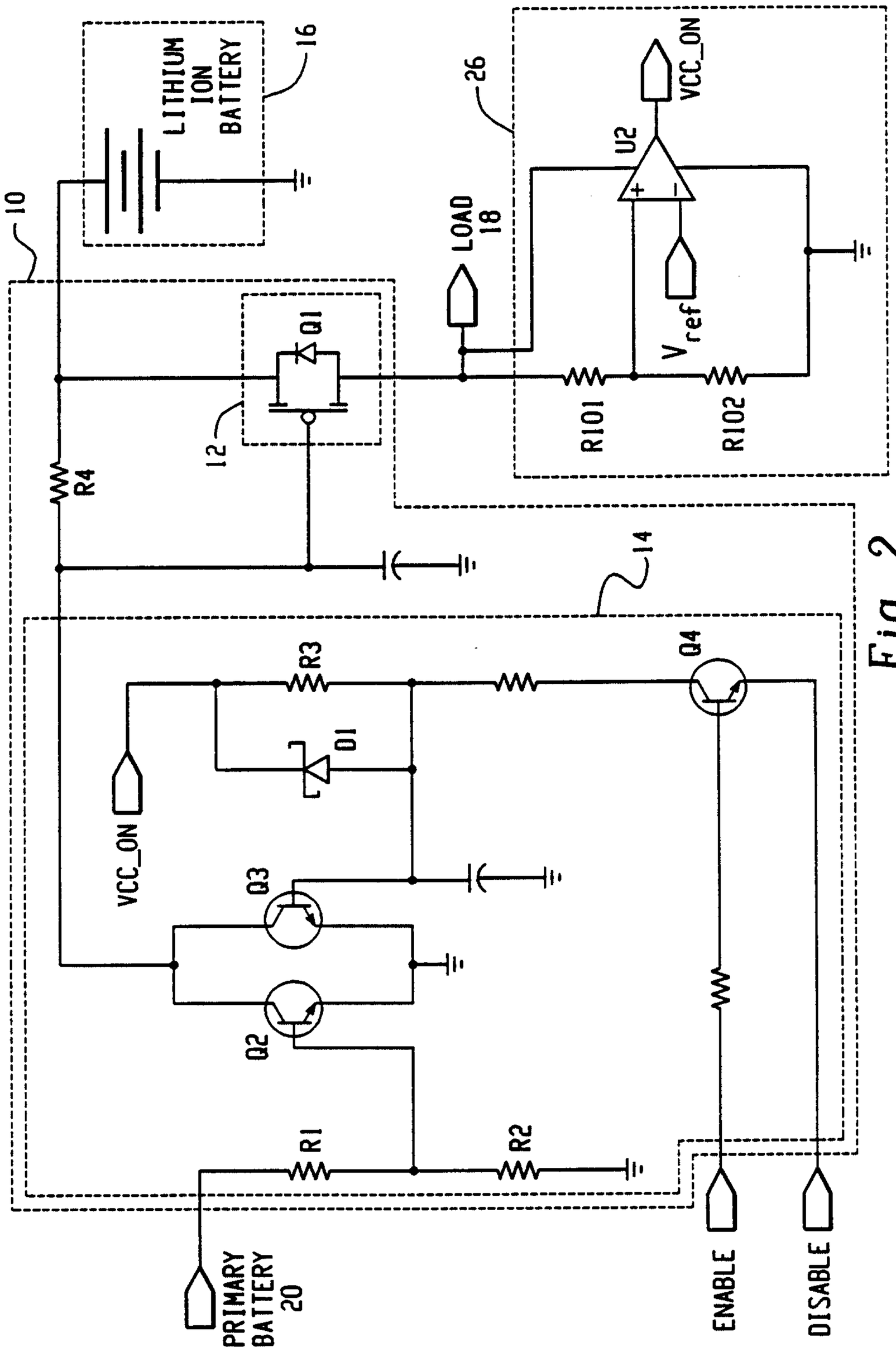

LITHIUM ION BATTERY
16
26
VCC_ON
U2
LOAD
18
10
Q1
12
V_{ref}
R101
R102
R4
14
R3
Q4
D1
VCC_ON
Q3
Q2
R1
R2
PRIMARY BATTERY 20
ENABLE
DISABLE

Fig. 2

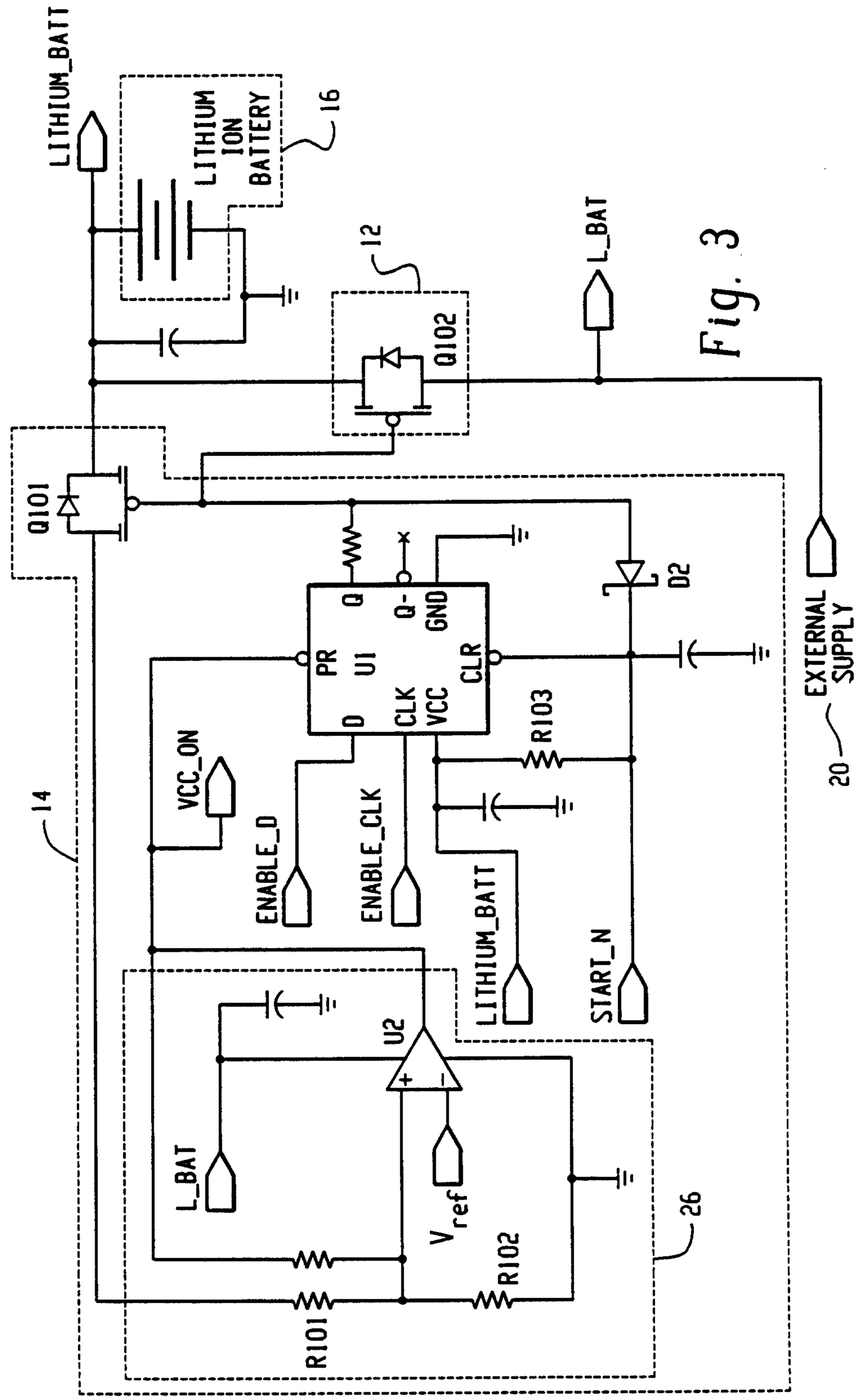
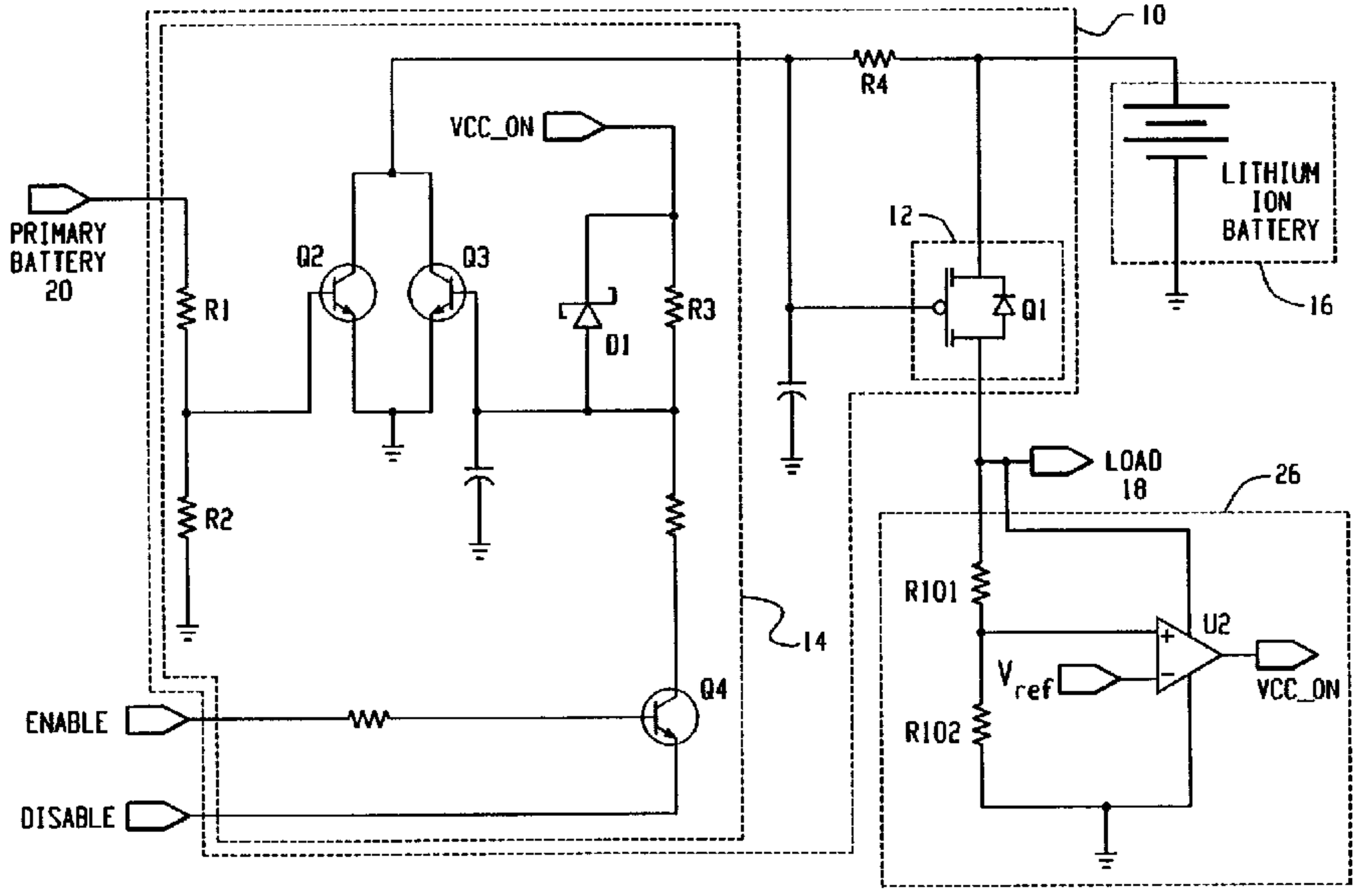

LITHIUM_BATT
LITHIUM ION BATTERY
16
12
Q102
L_BAT
Q101
Q
Q-
GND
PR
U1
CLR
D
CLK
VCC
D2
R103
EXTERNAL SUPPLY
20
VCC_ON
ENABLE_D
ENABLE_CLK
LITHIUM_BATT
START_N
14
U2
L_BAT
V_{ref}
R102
R101
26

Fig. 3


10
R4
VCC_ON
PRIMARY
BATTERY
20
LITHIUM
ION
BATTERY
16
12
Q2
Q3
R1
D1
R3
Q1
LOAD
18
26
R2
14
R101
U2
+
−
V_{ref}
VCC_ON
Q4
R102
ENABLE
DISABLE