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(54) **PORTABLE BATTERY OPERATED POWER SUPPLY**

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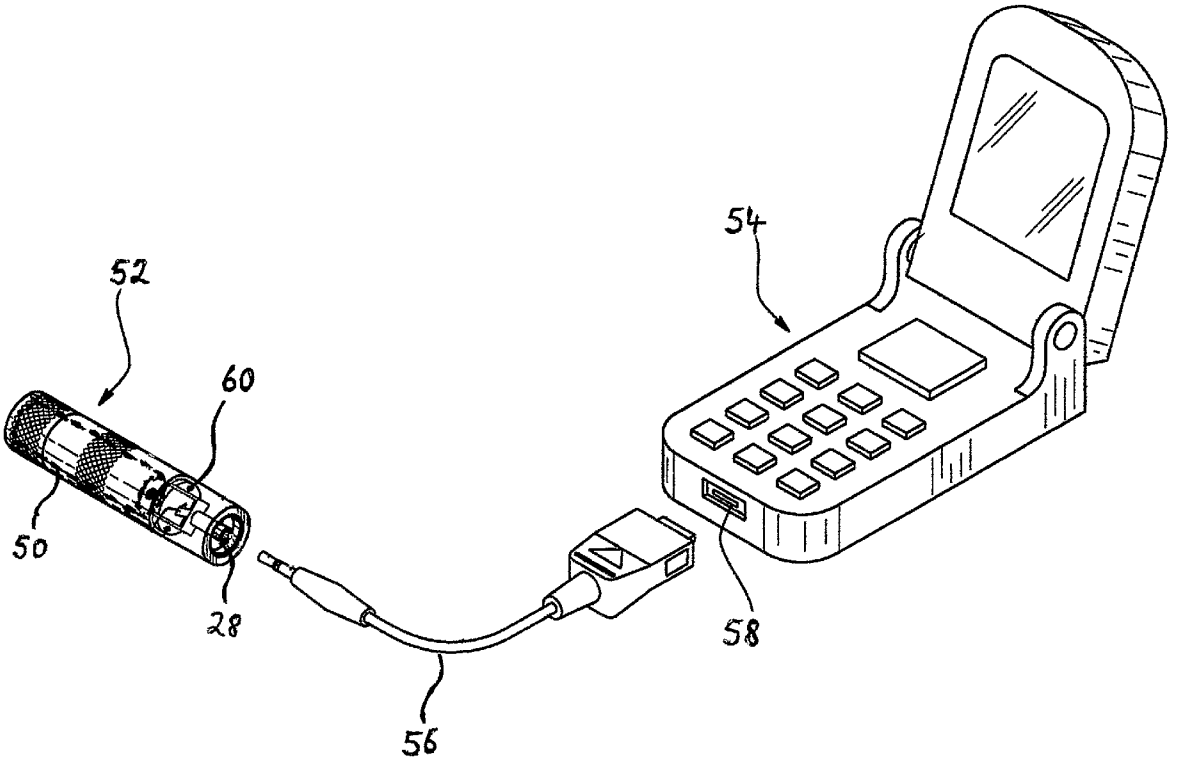
(57) **ABSTRACT**

A portable battery-powered power supply or charger for use with electronic devices containing a primary or secondary battery. In order to control the current flow into and out of its battery, the portable power supply uses a bidirectional charge controller. The battery is installed in a housing which preferably has a single connector port to which a flexible current lead may be plugged. The bidirectional charge controller enables the battery either to supply current to the electronic device, to charge the device's internal battery, or it allows the battery, if it is a secondary battery, to be charged by connection to an externally powered charger, such as a wall mains adapter. Both of these functions are achieved through a single connection port.



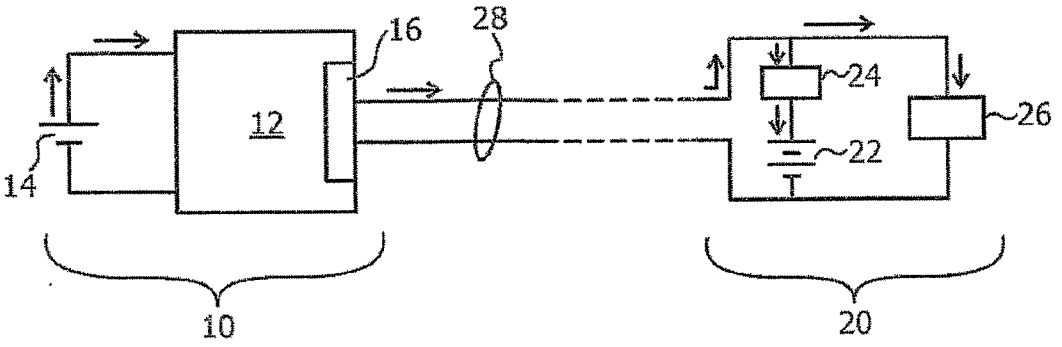


Fig. 1

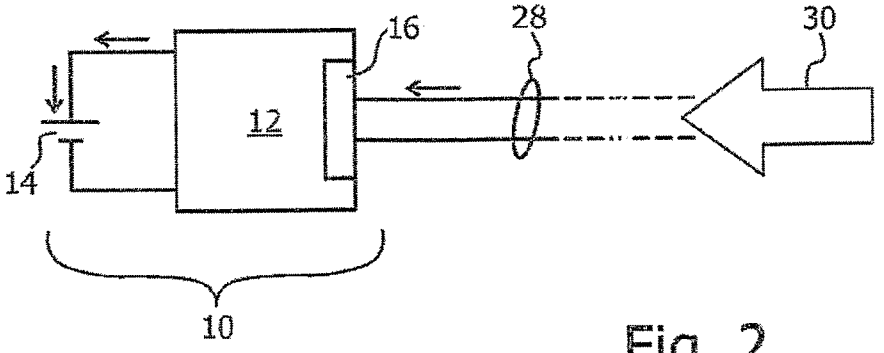


Fig. 2

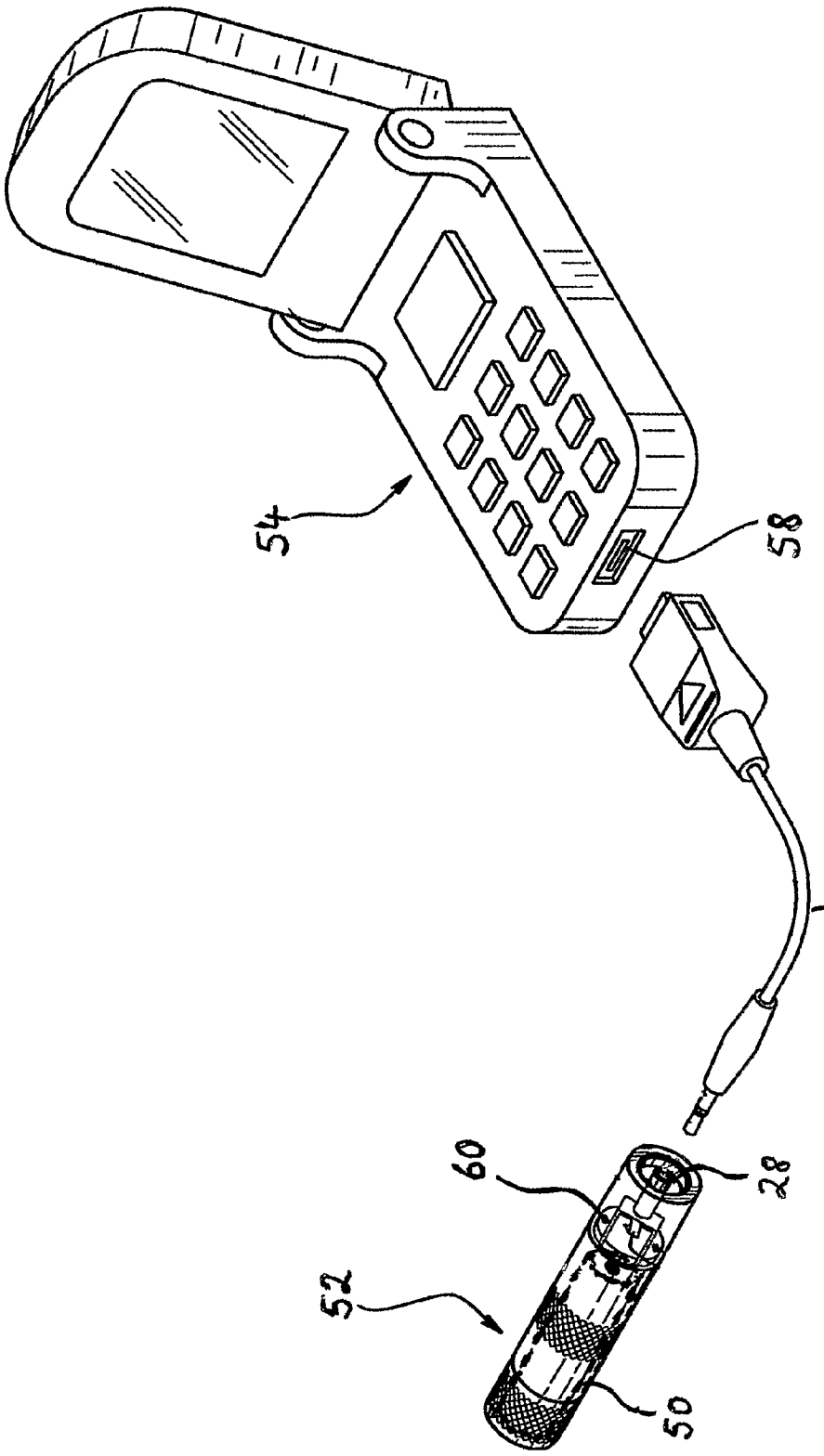


Fig. 3

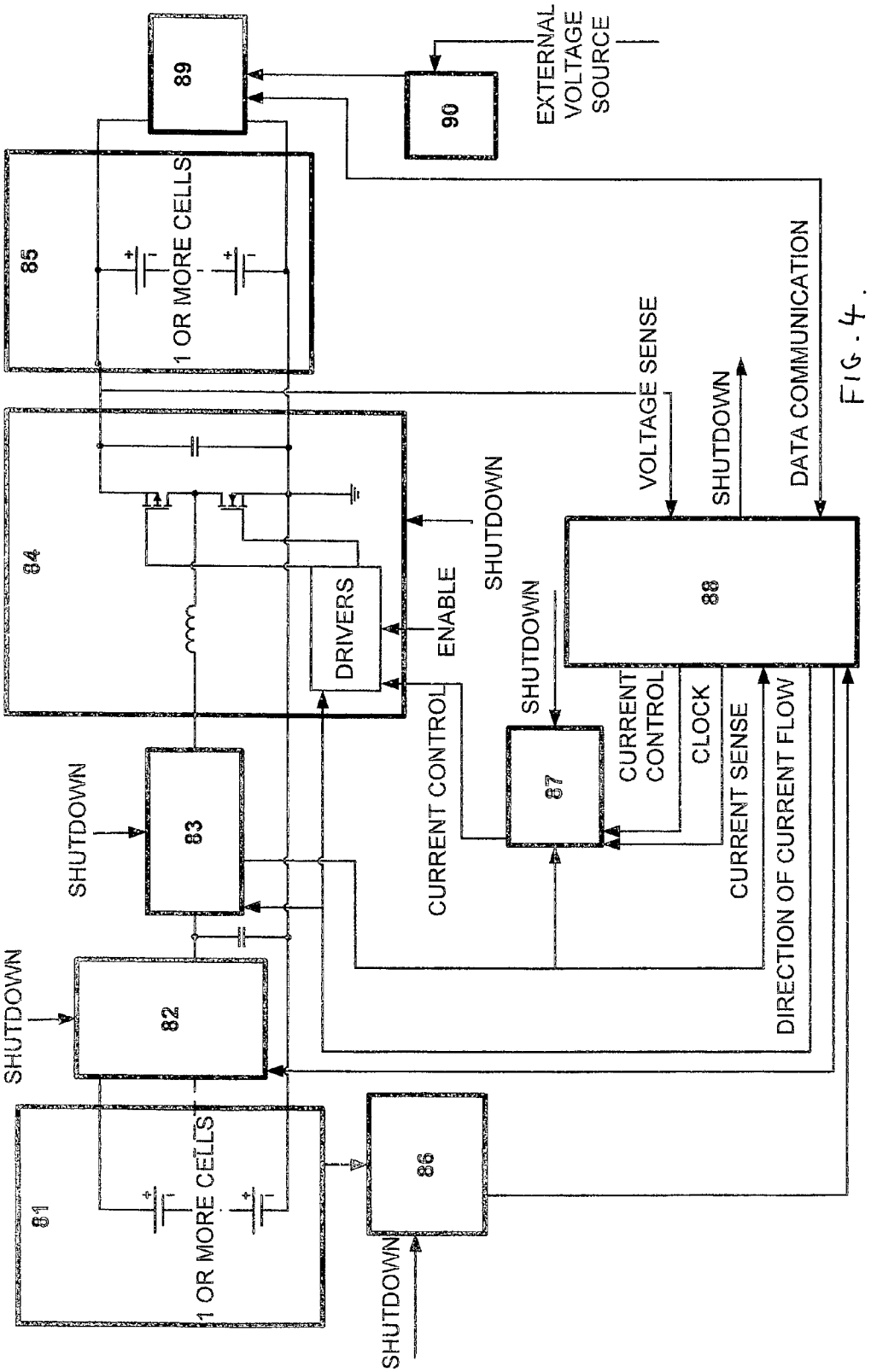

89
90
EXTERNAL VOLTAGE SOURCE
85
1 OR MORE CELLS
VOLTAGE SENSE
SHUTDOWN
DATA COMMUNICATION
84
DRIVERS
ENABLE
SHUTDOWN
88
SHUTDOWN
CURRENT CONTROL
87
CURRENT CONTROL
CLOCK
CURRENT SENSE
DIRECTION OF CURRENT FLOW
SHUTDOWN
83
SHUTDOWN
82
81
1 OR MORE CELLS
86
SHUTDOWN

FIG. 4.

PORTABLE BATTERY OPERATED POWER SUPPLY

FIELD OF THE INVENTION

[0001] The present invention relates to the field of battery equipped power supply systems for use with handheld electronic devices, and especially portable battery operated power supplies for charging the batteries of handheld electronic devices.

BACKGROUND OF THE INVENTION

[0002] The proliferation of portable battery powered devices, such as cellular telephones, video cameras, portable laptop computers, and the like, has increased dramatically in the last several years and this trend is expected to continue. These devices typically use a rechargeable battery that is built into the device to provide the needed power. The length of time that the battery powers the device is dependent primarily upon the size of the battery and the number of energy consuming features built into the device. For instance, in response to consumer demand, cell phone manufacturers often incorporate into the phones features such as the ability to send and receive digital pictures and/or text messages, and even real-time video transmissions. Unfortunately, the inclusion of these features usually places additional demands on the rechargeable batteries that power the cell phones. The net result is that cell phone run times are becoming shorter due to the increased power demands. At the same time that the electrical demand placed on the battery is increasing, the size and weight of cell phones is decreasing. As the size of the cell phone is reduced, the size of the battery compartment built into the cell phone is also generally reduced. The combination of these two trends, i.e. increased electrical demand and reduced battery size, often causes cell phone users to experience a lost telephone call or data transmission due to the depletion of the phone battery at an inopportune moment. An additional trend that complicates resolution of this problem is that most cell phones require a battery that has specific size and shape characteristics. In order to encourage consumers to purchase replacement batteries from the cell phone manufacturer, the cell phones are made with batteries that have unique shapes, locking mechanisms, voltage requirements, etc. Furthermore, the recharging port built into the cell phones limit the type of charger that can be connected to the cell phone. Collectively, these factors limit the consumer's ability to readily replace the depleted battery with another power source.

[0003] Numerous attempts have been made to develop a versatile portable power supply for cellular telephones. For example, U.S. Pat. No. 6,127,801 to D. Manor, for "Battery Pack Assembly", discloses a power supply that includes a battery pack and a base unit which has bidirectional circuitry. In U.S. Pat. No. 6,479,963 to D. Manor and G. Weinstein, for "Rechargeable Battery Packs", there is described a rechargeable battery pack for use with cellular telephones or other portable devices, including a conventional rechargeable battery for powering the device, and a user-replaceable primary cell for recharging the rechargeable cell when desired by the user, thus acting as a built-in charger for the device. This battery pack uses as its additional energy source a replaceable primary cell or battery, which when depleted, needs to be replaced by a fresh battery. In another example, U.S. Pat. No. 6,709,784 to O. Resch, for "Back-up Battery for a Cellular Telephone" there is disclosed a battery pack that can be plugged into a cellular phone's contact to recharge the phone's built-in rechargeable battery and/or to directly power the cell phone. This invention does not provide any voltage converting circuitry to match the battery pack output voltage to that required for charging the phone's rechargeable battery, and relies on the internal charge control circuits of the phone to ensure correct voltage compatibility. Furthermore, the battery is preferably packaged with the plug that allows the battery pack to be connected to the phone. Consequently, when the battery is depleted, the entire battery pack, including the plug, must be discarded, increasing consumer costs.

[0004] Therefore, there exists a need for an auxiliary direct current power source that uses a commonly available battery that the consumer can readily insert into and remove from a reusable housing, and that can be either a readily available primary cell or battery, or a secondary cell or battery with the added option of recharging the secondary cell or battery inside the device's housing, using the device's usual charging method. The power supply needs to be lightweight, volume-efficient and easily adaptable to a wide array of cell phones or other handheld electronic devices that utilize batteries of various shapes and sizes.

[0005] The disclosures of each of the publications mentioned in this section and in other sections of the specification, are hereby incorporated by reference, each in its entirety.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention seeks to provide, according to a first preferred embodiment of the present invention, a new portable battery-powered power supply or charger for use with electronic devices containing a rechargeable battery. In order to control the current flow into and out of its battery, the portable power supply uses a bidirectional battery charge control system, as fully described in co-pending PCT Patent Application by the present inventors for "Bidirectional Battery Charge Controller", herewith incorporated by reference in its entirety. The battery is installed in a separate housing, connected to the portable electronic device preferably by means of a flexible lead, and plugged thereby into the external charging input of the portable electronic device. In such an embodiment, the bidirectional charge controller is preferably built into the housing containing the battery, usually on a printed circuit board, and enables the battery either to supply current to the device like an external battery powered power supply, or, if it is a secondary battery, allows the battery to be charged by connection to an externally powered charger, such as a wall mains adapter or a car cigarette lighter adapter. The battery can thus be considered to behave as a compact portable external charger for the device, for use, for instance, in situations when the main battery of the device is depleted without access to a mains recharging source of power.

[0007] Control of the current flow into and out of the battery is performed by the bidirectional charge controller. The battery powered power supply of the present invention can be powered by one or more cells, though the most convenient embodiment may be for a single cell to be used. The bidirectional charge controller is such that an external charger, such as a mains wall plug charger, generally used to charge the main rechargeable battery of the electronic device, can also recharge the battery in the portable battery powered power supply of the present invention, on condition that it is a secondary battery.

[0008] The bidirectional charge controller also acts as a voltage converter, to convert the battery voltage to the voltage generally required for powering the electronic device, or for charging the device's rechargeable battery. The device's battery voltage is usually, though not always, higher than the battery voltage of the battery powered power supply. The ability of the power supply battery to charge the electronic device's battery is particularly useful since readily available primary or secondary cells can be used in the battery powered power supply, in situations where the main battery is depleted without any access to mains power supply for conventional recharging. Furthermore, the bidirectional charge controller is preferably microprocessor controlled, and is programmed to be able to detect the battery chemistry of the battery, and to disable charging current flow into the battery if primary cell chemistry is detected. Likewise, in the reverse direction, the microprocessor algorithm is preferably able to regulate the charging current from the battery to the electronic device rechargeable battery such that optimal energy transfer is obtained for every stage of the device battery's state of charge.

[0009] It should be noted that the terms battery and cell, though formally distinct (a battery technically being an assembly of more than one cell), are sometimes used in this application interchangeably in relation to the power supply's battery, since the "battery" may either contain a single cell, or several cells. However, the invention is understood to be applicable regardless of whether a cell or a battery is used as the "battery", and the meaning is understood to be sometimes interchanged, as in the widespread popular use of the term battery, when in fact only a single cell is intended.

[0010] There is thus provided in accordance with a preferred embodiment of the present invention, a portable power supply for a battery operated electronic device, comprising:

(i) a housing for containing a battery,

(ii) a rechargeable battery removably disposed within the housing,

(iii) a bidirectional charge controller controlling current flow into and out of the rechargeable battery, and

(iv) a single connecting port for inputting current through the bidirectional charge controller to the rechargeable battery from an external power supply, and for outputting current from the rechargeable battery through the bidirectional charge controller to the electronic device.

[0011] The rechargeable battery preferably has a first terminal voltage, and the device preferably requires a second voltage for operation, and the bidirectional charge controller is such as to convert current output from the rechargeable battery at the first terminal voltage to the second voltage for powering the device.

[0012] In accordance with another preferred embodiment of the present invention the device preferably has an internal rechargeable battery for operation, and the portable power supply battery has a first terminal voltage, and the device battery a second terminal voltage, and the bidirectional charge controller converts current output from the portable power supply battery at the first terminal voltage to the second voltage for charging the device battery.

[0013] In either of the two previous embodiments, the first terminal voltage is preferably lower than the second terminal voltage.

[0014] There is further provided in accordance with still another preferred embodiment of the present invention, a portable power supply as described above, and wherein the bidirectional charge controller determines periodically whether the connecting port is connected to an external power supply to receive charge current or to an electronic device to supply current.

[0015] In order to achieve this, the bidirectional charge controller preferably disconnects the rechargeable battery from the connection port for a predetermined time interval, and determines whether any voltage appearing on the connection port remains essentially constant during the predetermined time interval or shows a drop during the predetermined time interval. The predetermined time interval is preferably less than 500 milliseconds, and the voltage drop during the predetermined time interval is preferably at least 300 millivolts.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

[0017] FIG. **1** is a schematic block circuit diagram of a portable, battery operated power supply, constructed and operative according to a preferred embodiment of the present invention, when supplying current to an electronic device, thereby giving an energy boost to the rechargeable battery in the electronic device when needed;

[0018] FIG. **2** shows the operation of the portable power supply of FIG. **1**, when being charged from an external power source through the bidirectional charge controller to the power supply's rechargeable battery;

[0019] FIG. **3** illustrates schematically a portable battery-powered power supply according to a further preferred embodiment of the present invention, showing its method of connection to an electronic device; and

[0020] FIG. **4** is a block circuit diagram of the power control system of the bidirectional battery charge controller used in the present invention, showing a preferred architecture which enables some of the various features of the power supply of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Reference is now made to FIGS. **1** and **2**, which are schematic block circuit diagrams showing the two modes of operation of the portable battery-powered power supply of the present invention, using the bidirectional charge controller to control the two modes. These figures illustrate the overall arrangement of a battery powered power supply **10** incorporating a bidirectional charge controller **12**, and with its own internal battery power source **14**, constructed and operative according to a preferred embodiment of the present invention.

[0022] In FIG. **1**, the power supply **10** is shown being used to power or charge a portable electronic device **20**, which has its own built-in rechargeable battery **22**, which can preferably be a Li-ion type of battery, and also circuitry **26** to perform the device's function. An internal protection circuit **24** is generally provided to protect the electronic device's built-in rechargeable battery against harmful conditions, including overcharge, over-discharge and excessive temperature.

[0023] In FIG. **2**, the battery **14** of the power supply **10** is shown being charged by connection of an external power source **30**, such as a wall mains charger, or an adapter for the power outlet in a car. An important feature of the present invention is that a single output port **28**, is used both for drawing current from the battery **14** of the portable power

supply, and for charging the battery **14** of the portable power supply by means of an external source. This feature is rendered possible only by the use of the bidirectional charge controller **12** built into the portable power supply. The operation of the bidirectional charge controller circuitry is therefore described in some detail below.

[0024] The power supply battery **14** preferably comprises a replaceable, readily available standard-sized cell or cells, for inputting power to the power system of the electronic device **20**. However, this external charging unit of the present invention differs in two major aspects from those described in the prior art mentioned in the Background Section:

[0025] (i) Firstly, the battery **14** can comprise either a primary cell or cells, or a rechargeable cell or cells.

[0026] (ii) Secondly, the battery **14** is connected to the external environment through the bidirectional charge controller **12**, which monitors and controls the flow of current both out of the battery to the power system of the electronic device **20**, and also from an external power source such as a wall charger into the battery **14**. In addition, the bidirectional charger **12** preferably acts as a voltage converter to convert the generally comparatively low battery voltage to the higher voltage required by the power system of the electronic device **20**, and conversely to convert the comparatively higher charging voltage from, for instance, an external wall plug charging adapter, to a lower voltage for charging the battery **14**. If the battery **14** has a higher terminal voltage than that of the electronic device's rechargeable battery **22**, the converter operates accordingly. Usually, a charging controller is included as part of the electronic device circuitry, or within the wall adapter, in order to control the rate of charging from the external wall adapter. This function is included at the input **16** to the bidirectional charge controller of the present invention. This means that the energy transferred through the bidirectional charge controller **12** can flow in two directions—hence the term "bidirectional charger".

[0027] The bidirectional charge controller must be able to accommodate and accordingly control both of these two possible operational applications of the battery **14** of the power supply. In order to fulfill both of these functions efficiently, the bidirectional charge controller **12** is preferably microprocessor-based. It provides a current interface between on the one hand, the single-cell or multiple-cell battery **14**, which preferably contains either a secondary cell such as a Nickel Metal Hydride (NiMH) or a Nickel Cadmium (NiCd), or a primary battery or cell, such as an alkaline battery or a fuel cell, and on the other hand, the single-cell or multiple-cell battery of the electronic device **20**, which preferably contains a Li-ion battery. The power supply battery side is conveniently called the "low voltage side", and the rechargeable battery of the electronic device is conveniently called the "high voltage side", since the nominal operating voltage of the device battery is generally higher than that of the power supply battery. The bidirectional charge controller is able to transfer current and to control battery charging, either from low-voltage to high-voltage side when current is drawn from the battery **14**, or from high-voltage to low-voltage side when an external power source such as a wall plug charger **30** is connected as the high voltage side.

[0028] Reference is now made to FIG. **3** which schematically illustrates a portable battery-powered power supply according to a further preferred embodiment of the present invention, showing the battery **50** installed and ready for use with the electronic device **54**, which contains its own rechargeable battery. The battery **50** is shown packaged into a separate housing **52**, connected to the portable device preferably by means of a flexible lead **56**, and plugged thereby into the external charging input **58** of the portable device. In this embodiment, the bidirectional charge controller is also built into the housing containing the battery, preferably on a printed circuit board **60**. The power supply preferably has only a single connector port **28**, which is used both for inputting current to charge the battery **50** and outputting current to the electronic device **54**.

[0029] The bidirectional charge controller of the portable external charger preferably incorporates all of the functions of the bidirectional charge controller, as described in co-pending PCT Patent Application by the present inventors for "Bidirectional Battery Charge Controller". However, two functions are of particular importance. Firstly, it is important that the unit senses the battery chemistry of the battery inserted into the housing to prevent charging of a primary cell. This is particularly important for the portable power supply application because of the exposed nature of the housing **102**, which could easily come into contact with the user's body during charging, or even be held in the user's hand. Also, it is important that the unit efficiently converts the voltage of the current being controlled depending on whether the auxiliary battery is supplying current or is being charged. This embodiment is important since it involves a portable power source which can be used to power any device having a compatible connector. Thus, since the manufacturer has no control over the type of device the auxiliary battery of the unit is to power, there may be need for additional functions to be incorporated into the control circuits, such as checking the status of the battery of the electronic device to determine that it is suitable to be charged, or providing a visual signal to the user, such as by means of a LED, that the unit contains a cell ready to supply current, and others.

[0030] Furthermore, the battery of a portable external charger has a number of operational differences from the internal auxiliary batteries described in the embodiments of the co-pending application for hybrid battery use. For instance, before the unit is connected to the electronic device, it has no electrical contact with the power source of the battery of the electronic device. Therefore, the bidirectional charge controller has to be completely self-powered, by means of the cell **14** inserted into the housing. The bidirectional charge controller circuit **60** is thus designed to have a very low standby current load, which can be arranged to be only several tens of microamperes, thus enabling the unit to be ready for use, after insertion of a battery, for periods of months without depleting the battery. Furthermore, even under these conditions, and when not yet connected to a load for charging, it must generate a higher voltage on its output port **28**, suitable for effecting a charge, so that the electronic device detects the presence of a charging device the moment the lead is plugged into the external charging input **58** on the device.

[0031] Furthermore, wall plug and similar external power supply chargers are generally designed to operate with simpler characteristics than those of the bidirectional charge controller of the present invention. Usually, external wall chargers behave as a constant current source, simply pushing charge current into the external charging input of the device, and the charging circuits of the electronic device itself control this inflow of charge current until the battery is full. The

charging algorithm of the bidirectional charge controller of the portable power supply of the present embodiment may thus also preferably be constructed to supply current to the device with similar characteristics. Thus for instance, it will not have to perform any "stop charging" routine when the main battery approaches full charge, since the internal charge control circuitry of the electronic device is designed to follow the entire charge profile. On the other hand, for charging current flowing through the bidirectional charge controller from the wall plug charger to the portable external charger battery, there is still need for a charge current algorithm which will properly control the charging profile of the power supply battery.

[0032] Since the bidirectional charge controller of the portable external charger enables it to be used either for charging or for being charged through the same connector, and without any user intervention to select either of these roles, it is important that the portable external charger can determine for itself whether it is connected to a device as a load, or to a wall charger for recharging of its own battery. A simple voltage test at the connector is insufficient, since a wall charger and the converted voltage to power the device may have similar levels. Therefore, according to another preferred embodiment of the present invention, the portable external charger is provided with a function checking routine, whereby the output voltage at the connector **28** is removed at regular intervals for a short time, typically every few seconds for a duration of the order of a few tenths of a second, and typically less than 0.5 sec., and the connector voltage is measured. If a measurement shows an essentially steady voltage, then it is clear that the portable power supply is connected to a wall charger or another external source of power for charging of its own battery **50**. If on the other hand, the voltage falls during the measurement to a lower level, typically by 0.3 volts or more, then it is clear that the portable power supply is connected to an electronic device for recharging the battery of the device, and the bidirectional charge controller control functions are switched accordingly.

[0033] The battery **50** is preferably a secondary cell, and the use of the bidirectional charge controller circuit then also enables the cell to be charged when desired by connecting the portable power supply to the output socket of an external charger, such as a wall plug charger, or to a car dashboard socket. The portable power supply then has a double and reciprocal function—it can charge the electronic device by connection to the device's charging input connector, and it can be charged itself by connection to an external wall charger output connector. If the device's charging input connector has the opposite gender to the external wall charger output connector, as is the usual arrangement, there will be need for a male-to-female adapter, or alternatively, separate connection leads for the two operations. If a sexless connector is used for the charging function, then no such adapter will be needed.

[0034] Alternatively and preferably, a primary cell can be used as the battery **50**, and the unit then provides all of the advantages of the control functions of the bidirectional charge controller, such as voltage sensing, voltage conversion and charge rate control, but since the battery cannot be recharged, it has to be replaced when depleted.

[0035] The embodiment shown in FIG. **3** is particularly convenient, since it allows the use of a single AA-sized cell, which is widely available and of low cost. The voltage converter circuitry then ensures that the comparatively low voltage of the auxiliary cell is boosted to that required by the electronic device circuitry when the unit is supplying current, and effectively down-converts the external charger voltage output so as to limit the charging current when the cell in the power supply is being charged. It is to be understood though that such an external charger battery can also preferably contain more than one cell.

[0036] Reference is now made to FIG. **4**, which is a block circuit diagram of the power control system of the bidirectional battery charge controller used in the battery powered power supply of the present invention, showing the architecture which enables the operation of the features of the present invention. Although the block diagram of FIG. **4** is for a bidirectional charge controller for use in a hybrid battery application for a portable computer, for instance, the main features are also relevant for the power supply application of the present invention, and will be mentioned hereinbelow.

[0037] The embodiment shown in FIG. **4** is the more common situation wherein the battery powering the electronic device has a higher voltage than the power supply battery. However, the reverse situation can also be found in some devices, wherein the battery powering the device has a lower voltage than the power supply battery and in such a case, some of the circuit functions of the blocks of the embodiment of FIG. **4** need to be reversed, but the overall functional structure is similar.

[0038] The current to or from the battery **81** flows into the bi-directional DC-DC Power Stage **84**, which is a bidirectional voltage conversion unit, allowing current flow from the auxiliary battery **81** to the electronic device battery **85**, or vice versa, and converting the terminal voltage accordingly, depending on the direction of the current flow.

[0039] The magnitude of the current flow into or out of the battery **81** is preferably measured by the bidirectional current sensor **83**, which senses the current flowing through the inductor in the bi-directional DC-DC converter **84**. Since some designs of current sensors need to know the direction of flow, the direction in which the current is sensed is reversed in accordance with the signal received from the Control block **88**.

[0040] The Battery **85** for powering the electronic device **89**, comprising one or more cells, usually contains rechargeable Li-Ion cells. As is usual in such portable electronic devices, a wall charger **90** is provided for charging, if so desired, from an external voltage source, such as a mains power source. The Portable Electronic Device can also receive energy from the Battery **81**. When used in the portable power supply of the present invention, the electronic device **89**, and its batteries **90** are separated from the circuit parts of the bidirectional charge controller by the connection lead **56** of FIG. **3**, linking blocks **84** and **85**. Likewise, the external voltage source **90**, besides being able to charge the electronic device's internal battery **85**, can also be connected directly to this lead **56**, for charging the battery **81** of the portable power supply.

[0041] The Control block **88** is the main control unit of the Bi-Directional Battery Charge Controller, and controls the overall operation of the entire circuit. It receives inputs corresponding to the voltage, current, and also preferably temperature of each cell, and uses the above-mentioned algorithms to control the entire system, including the desired level and direction of current flow. The desired level of current is determined by the Control block **88**. Control levels output from the Control Box **88** or the direction of current flow can be used to shut down the circuit. Data communication

between the portable device **89** and the Control block **88** can be achieved by use of the standard data communication lines adopted in such devices, and are used to communicate user-generated commands from the device, and to send control-generated messages back to the user.

[0042] A number of additional control elements are preferably operative within the architecture of FIG. **4**. A Temperature Sense Block **86** may preferably be connected to the battery **81**, and senses preferably the temperature of each of the cells in the battery **81**. The Current Controller **87** controls the level of current through the DC-DC converter by sending PWM pulses of the appropriate duty cycle, using a current mode control cycle, to the drivers in the Bi-Directional DC-DC Power Stage **84**. The PWM pulses are output according to the desired current level setting received from the control block **88**. The current controller **87** may also receive inputs of the system clock from the control block **88**, and of the actual current level from the current sensor **83**.

[0043] It is appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of various features described hereinabove as well as variations and modifications thereto which would occur to a person of skill in the art upon reading the above description and which are not in the prior art.

1. A portable power supply for a battery operated electronic device, comprising:

a housing for containing a removable rechargeable battery;

a bidirectional charge controller controlling current flow into and out of said rechargeable battery; and

a single connecting port for inputting current through said bidirectional charge controller to said rechargeable battery from an external power supply, and for outputting current from said rechargeable battery through said bidirectional charge controller to said electronic device.

2. A portable power supply according to claim **1** and wherein said rechargeable battery has a first terminal voltage, and said device requires a second voltage for operation, and said bidirectional charge controller converts current output from said rechargeable battery at said first terminal voltage to said second voltage for powering said device.

3. A portable power supply according to claim **1** and wherein said device has an internal rechargeable battery for operation, and wherein said portable power supply battery has a first terminal voltage, and said device battery has a second terminal voltage, and said bidirectional charge controller converts current output from said portable power supply battery at said first terminal voltage to said second voltage for charging said device battery.

4. A portable power supply according to claim **2** and wherein said first terminal voltage is lower than said second terminal voltage.

5. A portable power supply according to claim **1** and wherein said bidirectional charge controller determines periodically whether said connecting port is connected to an external power supply to receive charge current or to an electronic device to supply current.

6. A portable power supply according to claim **5** and wherein said bidirectional charge controller disconnects said rechargeable battery from said connection port for a predetermined time interval, and determines whether any voltage appearing on said connection port remains essentially constant during said predetermined time interval or shows a drop during said predetermined time interval.

7. A portable power supply according to claim **6** and wherein said predetermined time interval is less than 500 milliseconds.

8. A portable power supply according to claim **6** and wherein said voltage drop during said predetermined time interval is at least 300 millivolts.

9. A portable power supply according to claim **3** and wherein said first terminal voltage is lower than said second terminal voltage.

10. A portable power supply according to claim **1** wherein a rechargeable battery is removably disposed within said housing.

11. A portable power supply according to claim **2** wherein said rechargeable battery is removably disposed within said housing.

12. A portable power supply according to claim **3** wherein a rechargeable battery is removably disposed within said housing.

13. A portable power supply according to claim **4** wherein a rechargeable battery is removably disposed within said housing.

14. A portable power supply according to claim **5** wherein a rechargeable battery is removably disposed within said housing.

15. A portable power supply according to claim **6** wherein said rechargeable battery is removably disposed within said housing.

16. A portable power supply according to claim **7** wherein said rechargeable battery is removably disposed within said housing.

17. A portable power supply according to claim **8** wherein said rechargeable battery is removably disposed within said housing.

18. A portable power supply according to claim **9** wherein said rechargeable battery is removably disposed within said housing.

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