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Manor et al.

(54) **BATTERY POWERED CHARGER**

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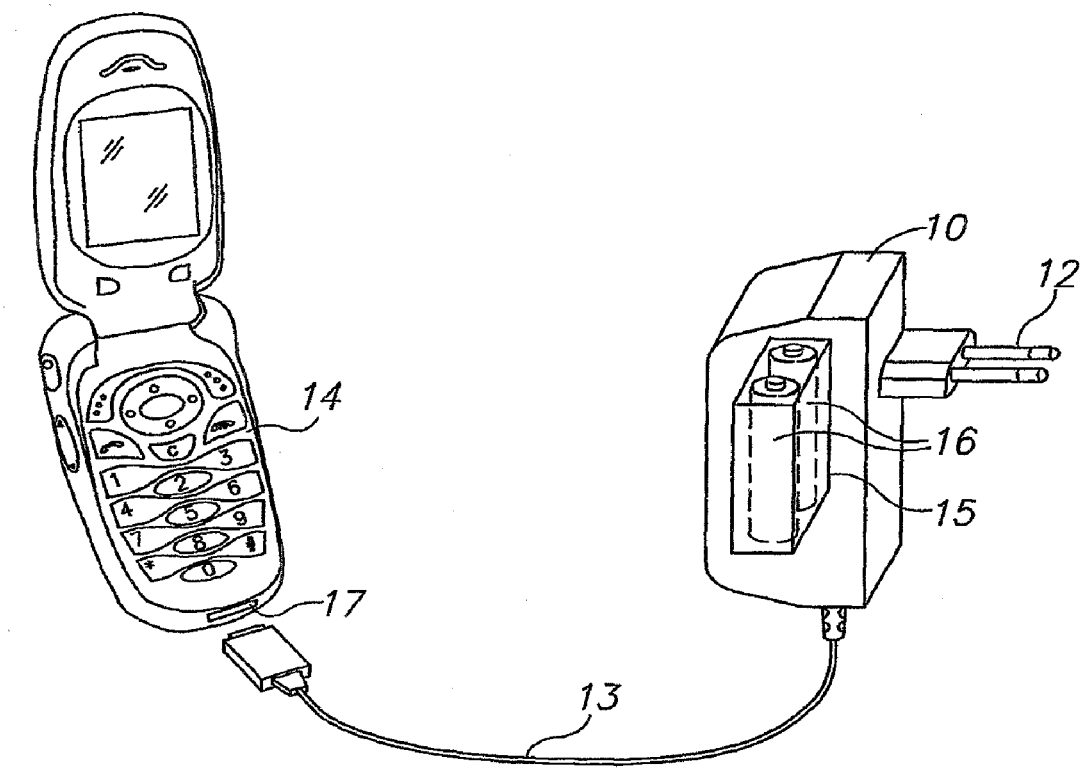
(57) **ABSTRACT**

A charger for recharging the batteries of a portable electronic device even when no external power source is available. A battery or cell is installed within the charger, and when no access is available to a fixed power source into which the charger can be plugged, the internal battery or cell can be used to recharge the electronic device. The internal battery can be a primary battery or a secondary battery. In the latter case, the internal battery can be maintained in a charged state by means of circuitry which, when the charger is plugged into the external power source, charges the internal battery as well as the battery of the electronic device. The external power source can be either an AC power wall socket, in which case the charger includes AC/DC voltage conversion circuits, or a car lighter socket, or the DC output of a conventional wall charger.



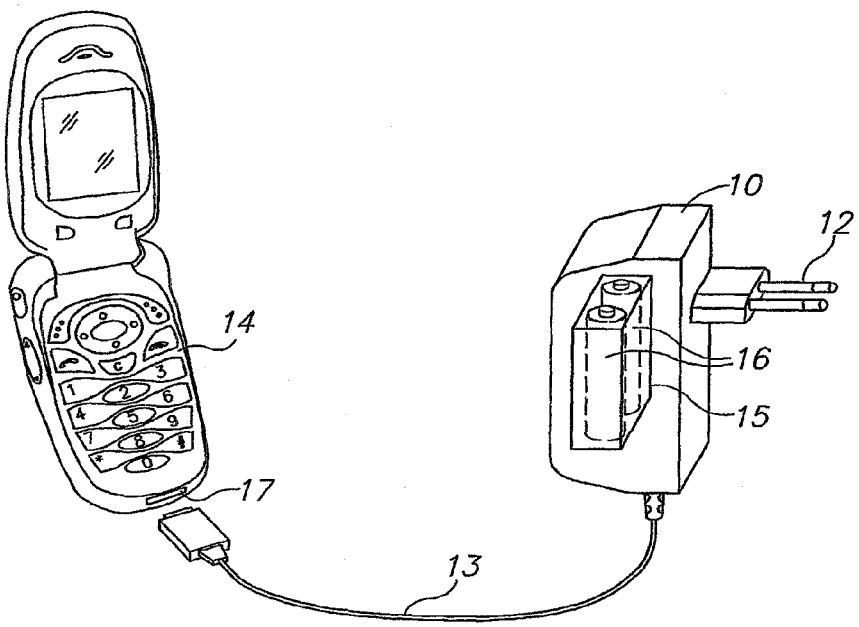


FIG.1

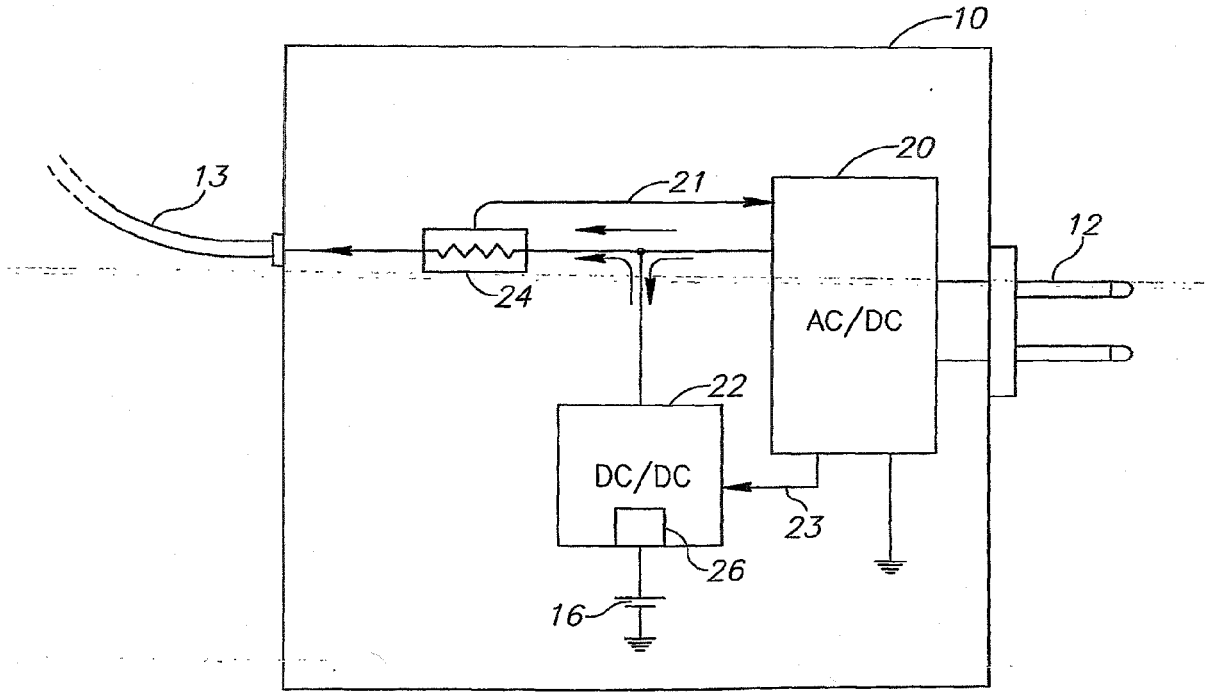


FIG.2

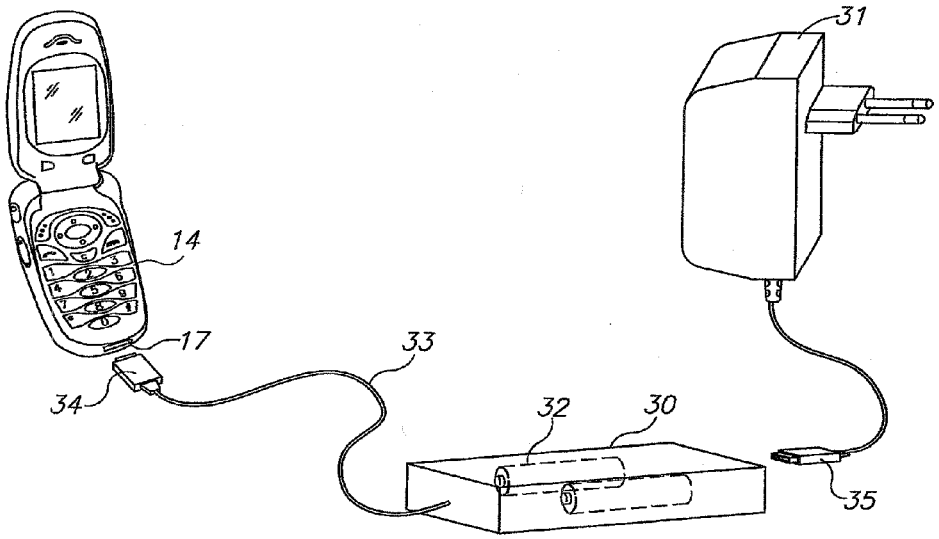


FIG.3

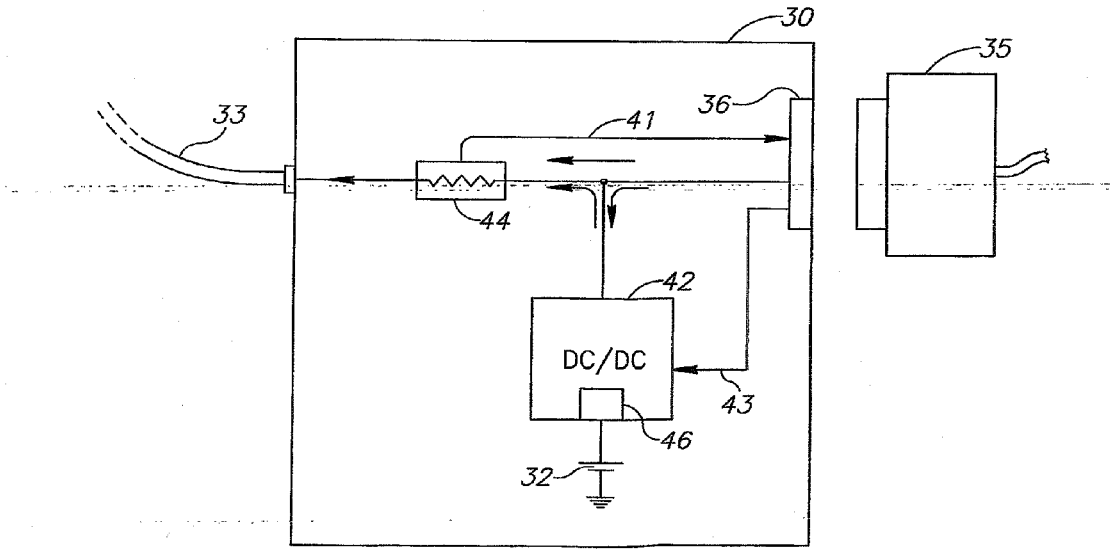


FIG.4

BATTERY POWERED CHARGER

FIELD OF THE INVENTION

[0001] The present invention relates to the field of charging devices for portable electronic equipment, especially those for use with mobile telephones.

BACKGROUND OF THE INVENTION

[0002] Portable electronic devices generally use internal rechargeable batteries for operation. In order to maintain the internal batteries in a state of charge, the device is generally recharged at regular intervals using a wall mains adaptor unit, whose function is to convert the comparatively high voltage AC mains voltage available at wall sockets, to a low voltage suitable for inputting to the device's charging input. At the same time, such a wall charger often regulates the charging profile to the internal batteries of the electronic device, in order to maximize charging efficiency, and to ensure safe charging. Other types of charger unit utilize the low voltage DC power source available in automobiles, such as the cigarette lighter socket, in order to charge the device's internal batteries. Such external power sources will be known as fixed power sources in this application. Furthermore, the term "wall charger" will generally be used in this application to include any type of charger which is generally plugged into a fixed power source.

[0003] However, an AC mains power source, or a car lighter socket, is not always available when the battery of the portable device requires charging, and the user then has to either carry with him spare charged batteries, which could be a safety hazard, or must purchase such batteries, which is not always a simple task, as many portable devices, and especially mobile phones, use dedicated battery packs which are not widely available. Even then, such battery packs are often supplied in a non-charged state.

[0004] One solution to this problem is described in U.S. Pat. No. 6,479,963, for "Rechargeable Battery Packs", to the inventors of the present application, in which a novel battery pack is disclosed which can be fitted with a widely available primary cell to recharge the rechargeable cells of the portable device. Another solution is described in co-pending PCT Application published as International Patent Application No. WO/2006/095353 for "Portable Battery Operated Power Supply", also to inventors of the present application, in which a special external battery pack, preferably containing a rechargeable cell, is used to enable recharging of the device at any location.

[0005] Each of these solutions has its own disadvantage. The former requires that the device be equipped with the special battery pack such as that described in the patent, while the latter requires of the device owner to carry with him/her the special external battery pack, and to ensure that the external battery pack is kept charged by connecting it to a conventional wall charger at the required intervals.

[0006] There therefore exists a need for a portable charging system which overcomes at least some of the disadvantages of prior art systems and methods, to enable the user of portable electronic devices to simply recharge the internal batteries of the device, without the need to have access to a fixed source of charging power.

[0007] Though the term battery is strictly speaking under-

quently, these two terms, battery and cell, may have been used interchangeably in this application, and may also have been thuswise claimed, and the number of cells in the device of the invention is not meant to be limited by use of one or the other term.

[0008] 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.

SUMMARY OF THE INVENTION

[0009] The present invention seeks to provide a new device for providing power to a portable electronic device, either for powering the portable electronic device, or for recharging the batteries of the portable electronic device when no access to an external fixed power source is available. The invention is based on the use of an external charger, such as a wall charger, with an associated auxiliary battery or cell, such that when no access is available to a fixed power source into which the external charger can be plugged, such as a wall power point, or a car lighter socket, the associated auxiliary battery or cell can be used to recharge the battery of the electronic device. The charging device of the present invention preferably incorporates charge control and conversion circuitry for converting the input voltage supplied from the external source to that required to charge the associated auxiliary battery or cell, and to that required for input to the external charger input socket of the electronic device, for powering the electronic device or for charging the electronic device's internal battery. The charge control and converter circuit is preferably a bidirectional converter, in order to control both the charging current from the external source into the associated auxiliary battery, and to control the discharge current from the associated auxiliary battery into the portable electronic device. The circuitry of the battery powered charger of the present invention differs from that of prior art multi-source chargers, such as that described in U.S. Pat. No. 7,166,987 to K. S. Lee et al, for "Portable Charger for Mobile Phone", in that the use of a single bi-directional DC/DC converter as the charge controller for the auxiliary battery enables the provision of a simpler charger structure. The DC output from the external source, whether directly from a car socket, or from an AC/DC wall charger, can be at such a voltage level that it can be supplied directly to the mobile electronic device power input socket, or, by means of a single bidirectional DC/DC voltage converter, to the auxiliary battery. This same DC/DC converter, by virtue of its bidirectionality, is able also to handle, when required, the flow of current and the voltage conversion from the battery out to the mobile device, such that effectively all of the charge control and conversion functions are performed with a single bidirectional control circuit.

[0010] The charge control circuit also preferably incorporates battery chemistry detection circuitry, such as that described in co-pending International Patent Application PCT/IL2007/001532 for "Charging Methods for Battery Powered Devices", or in similar battery chemistry detection circuits with simpler algorithms, as is known in the art, such that if the associated auxiliary battery or cell is detected as being primary, recharging thereof is disenabled. This feature is even more important in a battery powered wall charger than in a conventional battery charger, since the additional heat generated in a battery powered wall charger when operating,

[0011] According to a first preferred embodiment, the auxiliary battery or cell is installed within the external charger itself, preferably within a dedicated battery cavity. An advantage of this embodiment over the prior art devices described hereinabove is that the electronic device user generally carries a normal wall charger, to enable the electronic device to be charged in the conventional manner. Therefore, the use of the charger of this embodiment of the present invention, while providing the user with an in-the-field charging capability, does not involve the need to carry any additional equipment which the user would not otherwise have to carry with him/her.

[0012] According to a second preferred embodiment of the present invention, the associated auxiliary battery or cell and its charge control circuitry are not housed within the external charger unit itself, but are contained within a separate housing, which can be connected to a conventional external charger by means of a flying lead. Connection to the portable electronic device is performed in the usual manner, through the charging input socket of the device, either by means of a plug, or by means of another flying lead. This embodiment differs from the first embodiment in that the auxiliary battery is housed in a compartment separate from that of the external charger circuits. In that respect, the external charger output can be considered as being equivalent to the wall source of power, or to the car lighter socket source of power.

[0013] The auxiliary battery of the wall charger of the present invention may be either a primary cell, which is readily available from numerous sources for replacement when expended, or a rechargeable cell, in which case, the charger circuits can be arranged such that, once the presence of a secondary cell has been detected, the cell is maintained ready for use in a charged condition, either by being charged if necessary, or by being just trickle charged if already essentially fully charged, every time that the wall charger is connected to the fixed power source.

[0014] According to a further preferred embodiment of the present invention, the presence of a battery in the charger provides it with an advantage over conventional chargers, in enabling easier compliance with the current policy of reducing "stand-by power" of electronic devices. If the associated battery is fully charged, the circuitry of the charger of the present invention need only be powered up when there is need to provide power to the portable electronic device. The presence of the on-board battery enables the charging circuits of the charger to be completely disconnected from the external source, such that no stand-by power at all is used from the wall socket or from the car socket. The internal battery can be used to power a very low-power detection circuit for monitoring the portable electronic device for renewed power demand. Once such a demand is detected, the charging circuits can be reconnected to the external source, and can draw power from the external source as needed. This is in contrast to conventional chargers, which generally have to be left connected in a stand-by status to the external source, drawing a trickle charge current whose need may not be immediate, but which consumes typically 250 mW for a small wall charger unit typically of the order of 5 Watts or less. Additionally, the detection circuits can also monitor the state of charge of the on-board charger battery, either by means of its terminal voltage, or by the elapsed time since the last charging operation, and can then reconnect the external source when not. This then ensures that the internal battery of the charger remains charged even when the charger is in stand-by mode.

[0015] The circuits of the wall charger of the present invention are generally multifunctional and bidirectional, in that they have to be capable of performing at least some of the following functions:

(i) When the charger is plugged into a fixed power source, whether an AC wall power source, or a car socket, or the DC output of a conventional wall charger unit, the circuits should preferably convert the voltage up or down, depending on the voltage supplied, and the voltage required, to a suitable level to provide current for charging or powering the electronic device when it is attached.

(ii) When the charger is plugged into a fixed power source, (as described above) the circuits should be able to convert the voltage to a suitable level to provide current for charging the auxiliary battery or cell of the wall charger.

(iii) The circuits should preferably ascertain whether the auxiliary battery or cell of the wall charger is primary or secondary, so that if primary, the internal battery charging circuit is not enabled.

(iv) When an electronic device is attached to the wall charger, and the charger is not connected to a fixed power source, the circuits should enable the device to draw charging current from the auxiliary battery, whether primary or secondary.

(v) Since the wall charger auxiliary battery, if a secondary battery, needs to be both charged and discharged, the circuitry which controls these functions preferably has bidirectional characteristics, such as is described in PCT Application No. PCT/IL2006/000317, published as International Patent Application No. WO/2006/095352 for Bidirectional Battery Charge Controller, incorporated herein by reference in its entirety. If the wall charger is intended for use only with a primary battery, then bidirectionality is not required.

[0016] There is thus provided in accordance with a preferred embodiment of the present invention, a charger for a battery operated electronic device, the charger comprising:

(i) an input for connection to an external power source supplying current at a first voltage,

(ii) an output for connection to the battery operated electronic device,

(iii) circuitry for supplying the electronic device with current when the charger is connected to the external source,

(iv) a cavity for mounting in the charger at least one battery having a terminal voltage different from the first voltage, and different from the voltage required for inputting to the electronic device, the battery supplying the electronic device with current when the charger is not connected to the external power source,

(v) a bidirectional converter and charge controller adapted to control current supplied from the at least one battery mounted in the charger to the electronic device, and to control current flowing into the at least one battery when the charger is connected to the external power source, and

(vi) circuitry for detecting the chemistry of least one battery.

[0017] In the above described charger, the bidirectional converter and charge controller may preferably be further adapted to convert the first voltage to a voltage suitable for charging the at least one battery, and to convert the terminal voltage to a voltage suitable for inputting to the electronic device. Additionally, the external power source can simultaneously cause current to charge the at least one battery, and to supply the electronic device with current. Furthermore, the current supplied by the charger to the electronic device may preferably be utilized to perform at least one of operating the

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