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[54] BATTERY LIFE EXTENDER APPARATUS

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Pat. No. 5,864,223.

[51] Int. Cl.⁶ H02J 7/00

[52] U.S. Cl. 320/137; 320/163

[58] Field of Search 320/160, 111,
320/162, 132, 163, 145; 336/83, 120

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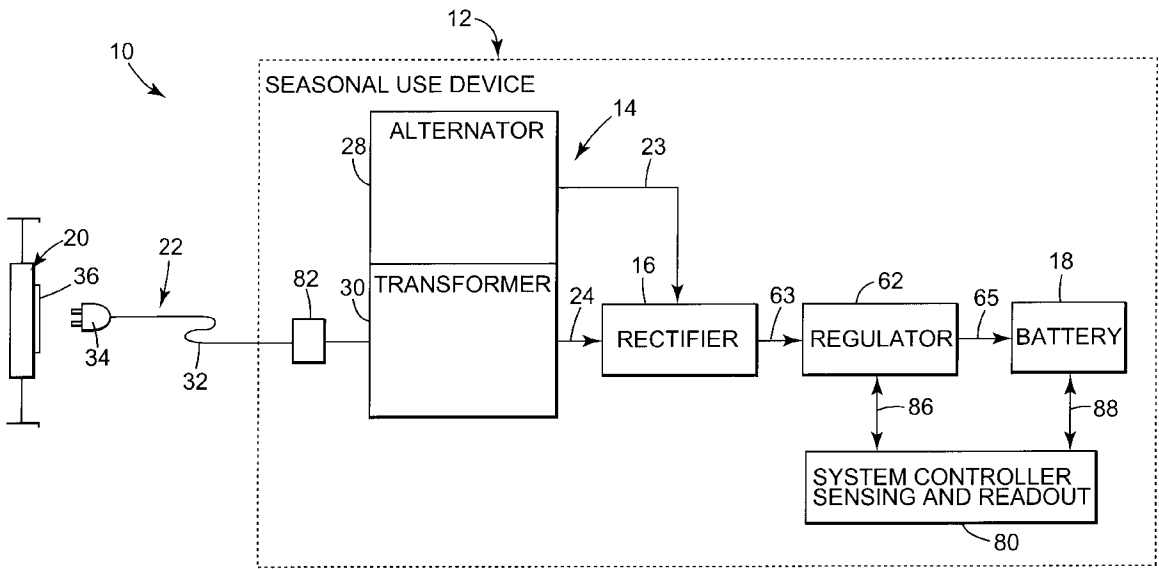
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Assistant Examiner—Gregory J. Toatley, Jr.
Attorney, Agent, or Firm—Dicke, Billig & Czaja, P.A.

[57] ABSTRACT

Apparatus for extending the battery life of a seasonal-use battery. The apparatus is an improvement in a seasonal-use device having a battery charging system, wherein the battery charging system includes a voltage step-down device coupled to the charging system. The improvement includes a mechanism integral the battery charging system for providing a maintenance current to the battery proximate the battery's self-discharge rate. A mechanism is provided for coupling the battery charging system to an external power source. The apparatus for extending the battery life may also be coupled to the seasonal-use device system controller.

22 Claims, 7 Drawing Sheets



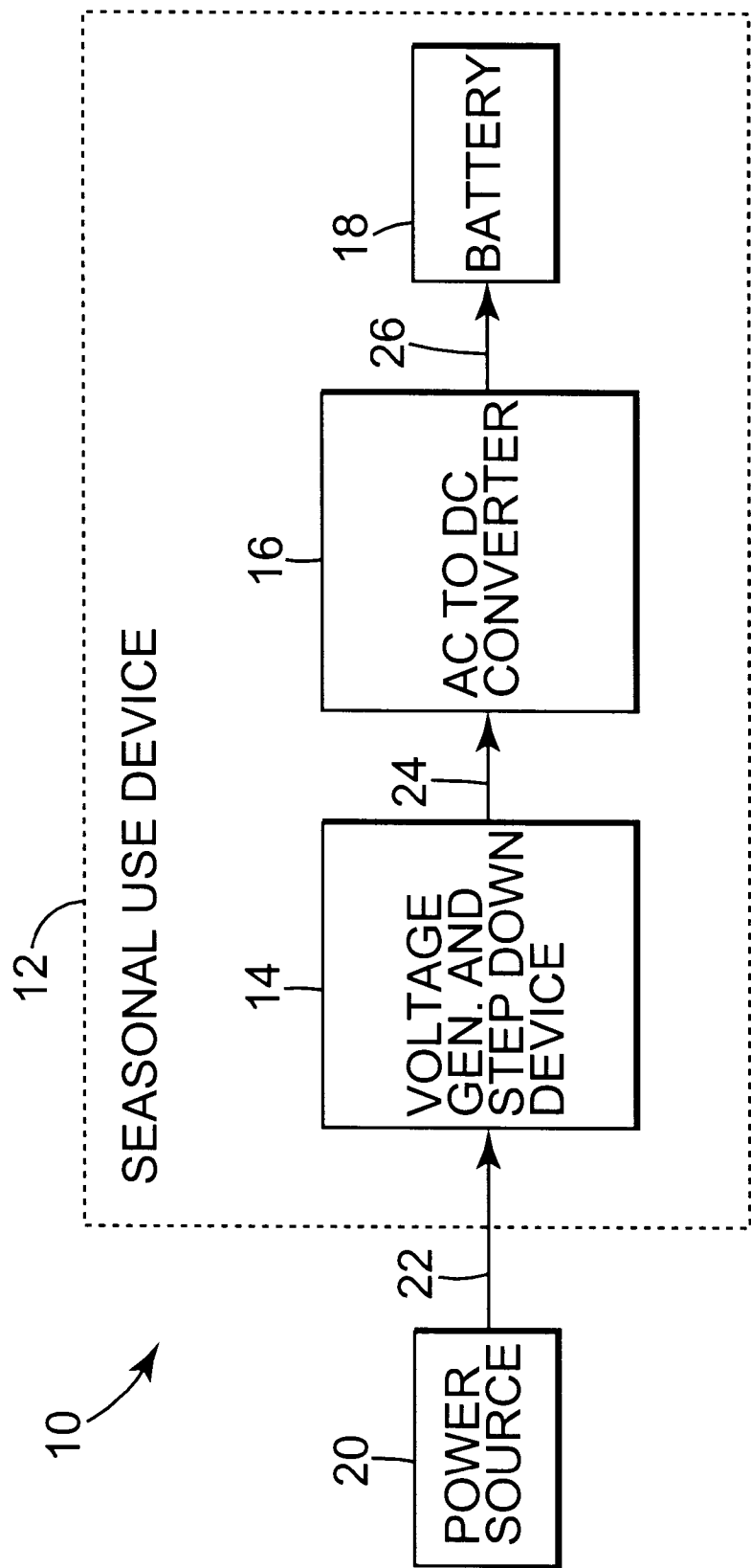


FIG. 1

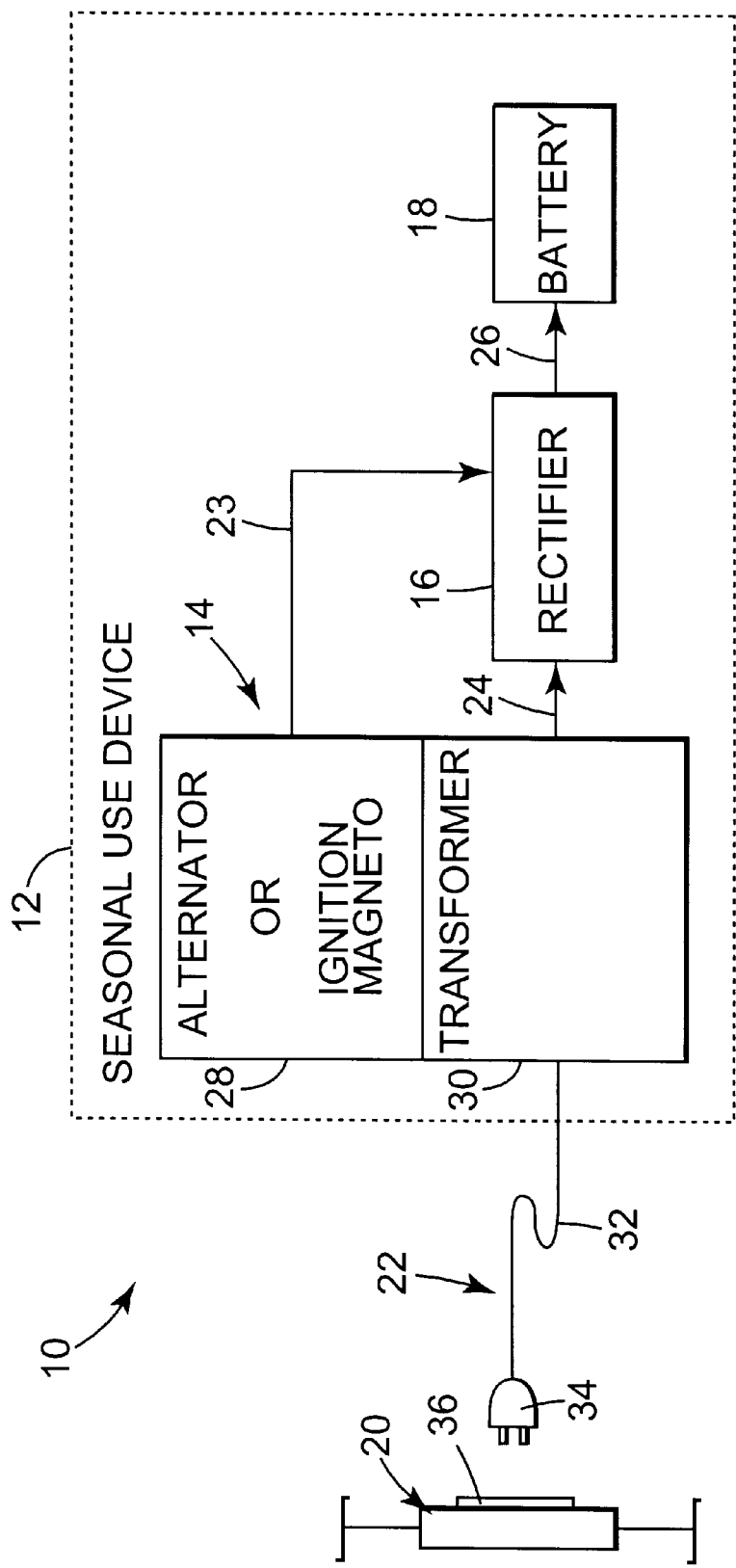


FIG. 2

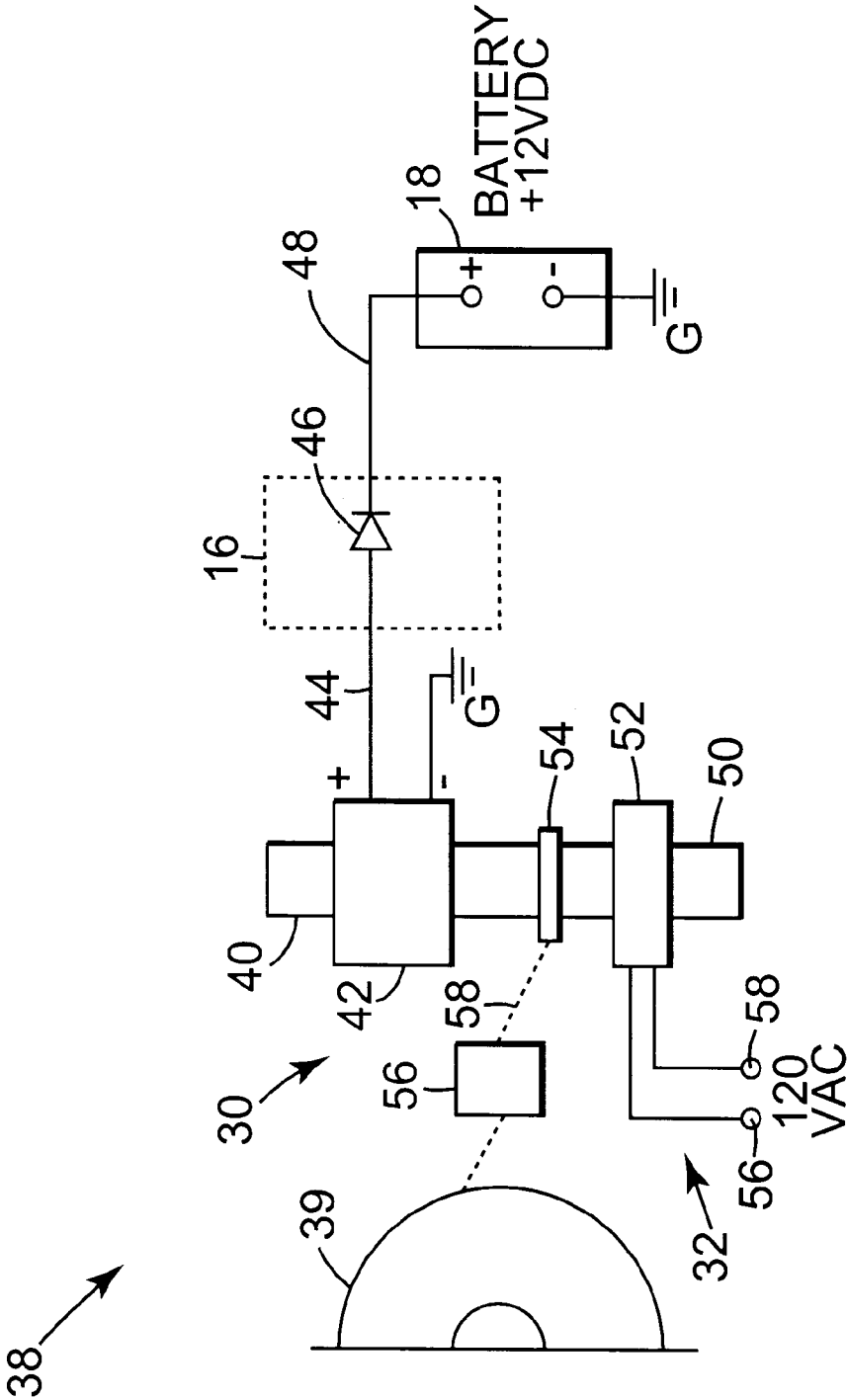


FIG. 3

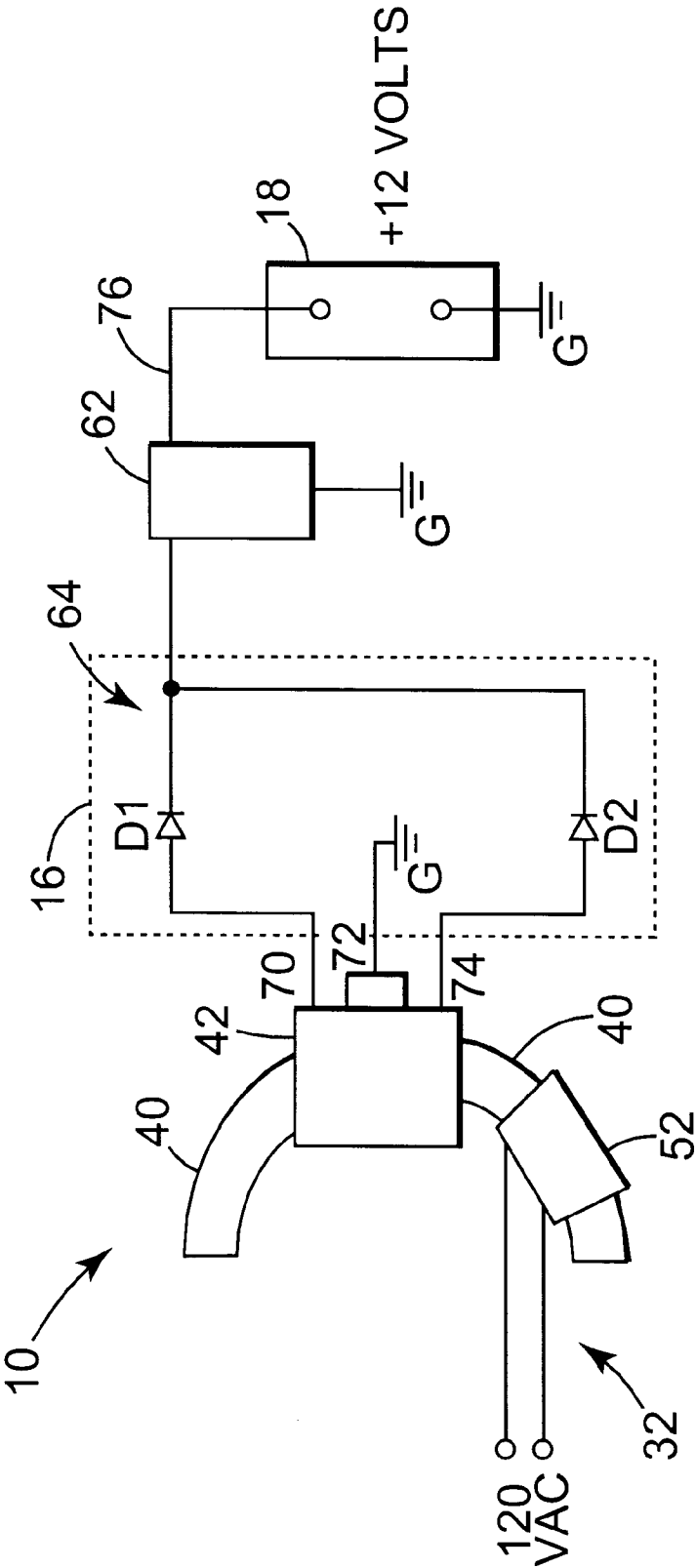


FIG. 4

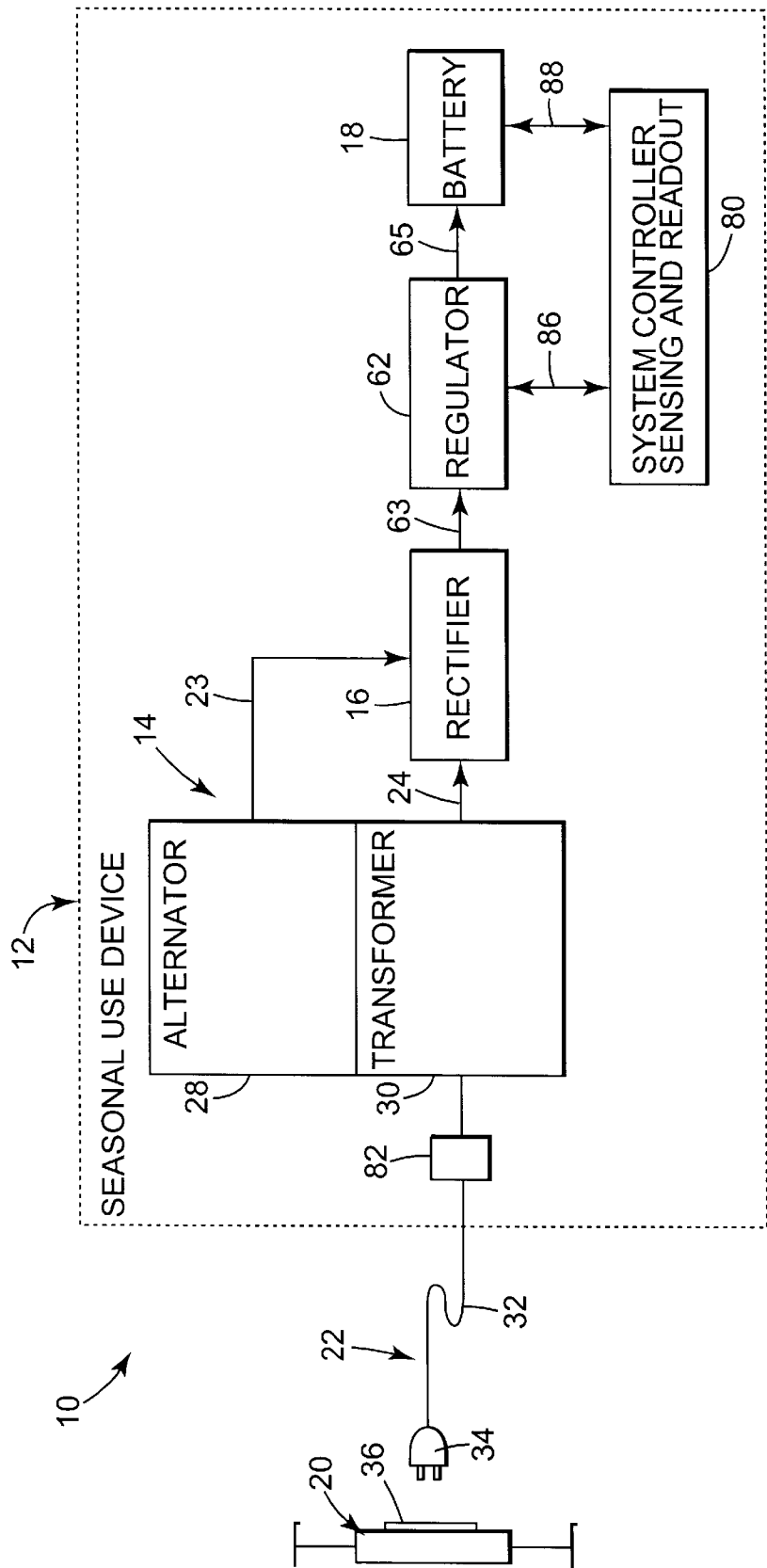


FIG. 5

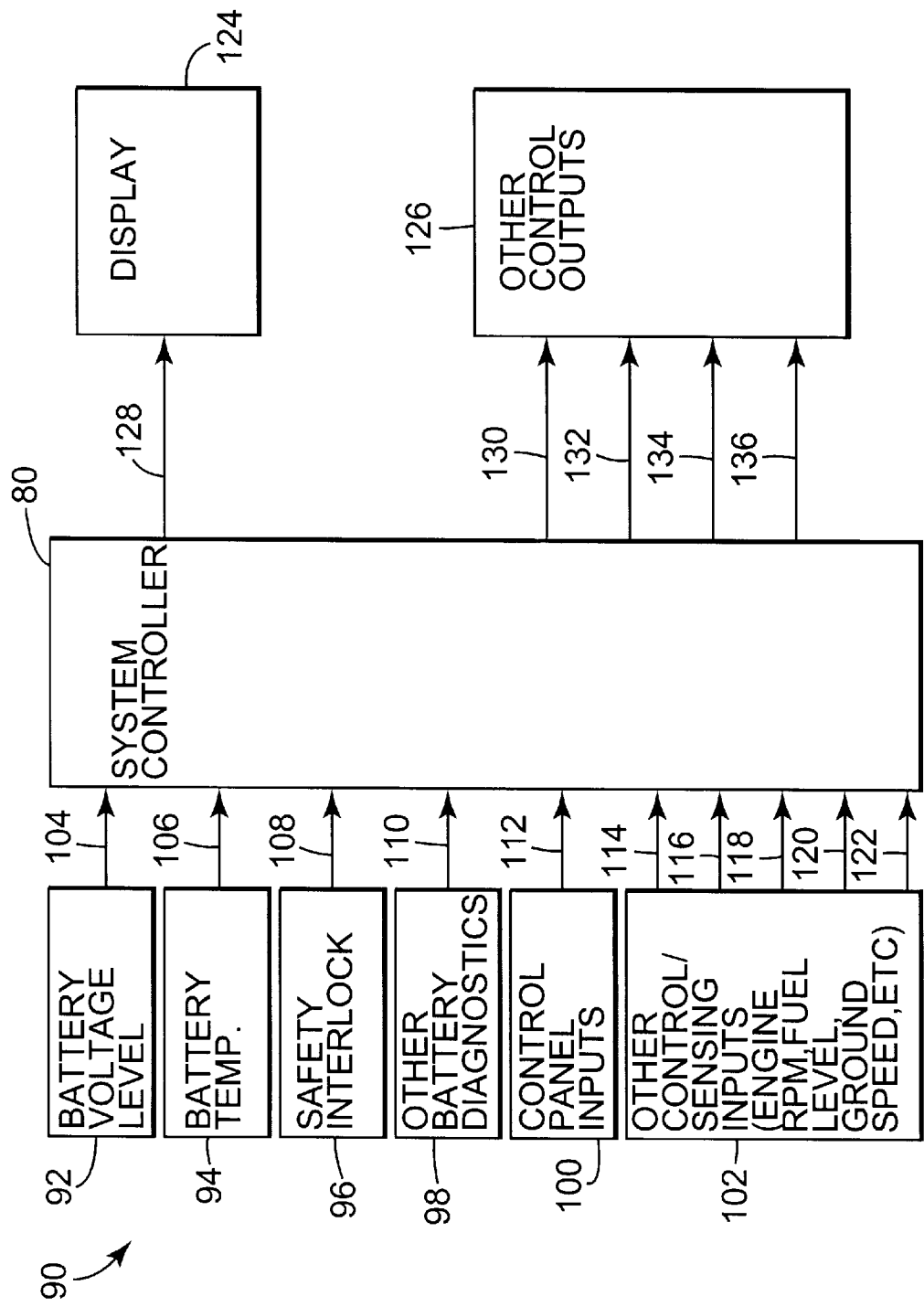


FIG. 6

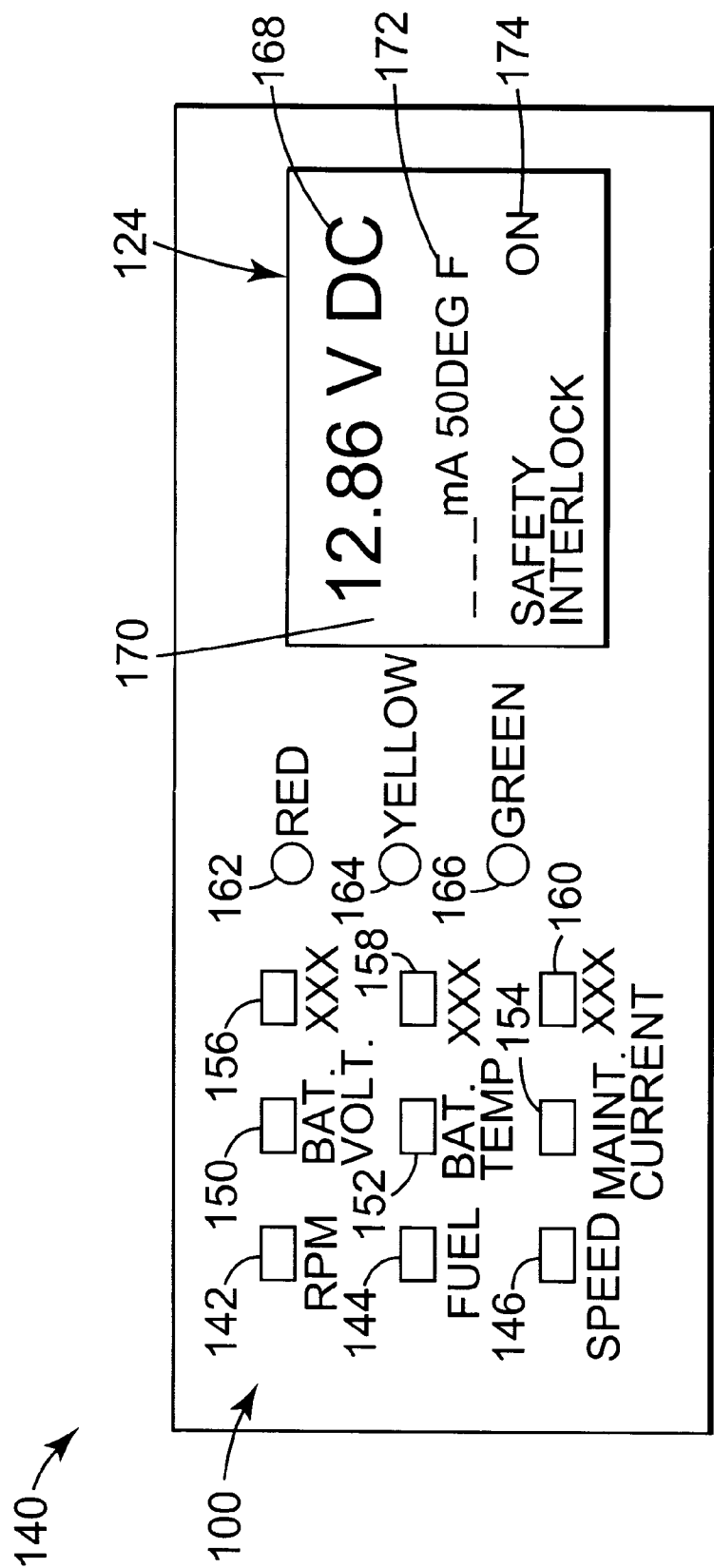


FIG. 7

BATTERY LIFE EXTENDER APPARATUS**CROSS-REFERENCE TO RELATED APPLICATIONS**

This is a continuation application of prior application Ser. No. 08/743,199, filed on Apr. 6, 1998 (set to issue on Jan. 26, 1999, as U.S. Pat. No. 5,864,223).

FIELD OF THE INVENTION

The present invention relates generally to a battery charging system. In particular, the present invention relates to an apparatus for extending the life of a battery used in a seasonal-use device by providing a maintenance current to the battery approximately equal to the battery's self-discharge rate and thereby greatly reducing plate sulfation. The apparatus may be integrated into the seasonal-use device diagnostic, control and charging system.

BACKGROUND OF THE INVENTION

Seasonal-use devices include recreational vehicles and seasonal equipment, such as lawn mowers, yard tractors, personal watercraft, boats, motorcycles, snowmobiles, construction and agricultural equipment. Seasonal-use devices utilize batteries as an electric power source to provide electric start and control power to the device. During operation of the seasonal-use device, the internal battery charging system maintains the charge on the battery.

Because these devices are only used seasonally, the battery is normally stored for a number of months, which results in self-discharging of the battery. Internally, the battery is undergoing a process called plate sulfation, which creates an insulating coating on the plates preventing subsequent full performance from the battery. Once plate sulfation has occurred, even if the battery is fully charged, it will no longer operate at optimum efficiency and full battery capacity.

The type of battery most commonly used in seasonal-use vehicles is a lead-acid battery. Typically, lead-acid batteries will self-discharge at an approximate rate of 1 percent per day, yielding a battery which is approximately 80 percent discharged after just six months. The discharge condition of the battery causes the battery's plates to sulfate, resulting in a shortened battery life. It has been found that batteries allowed to self-discharge for six month periods usually have a life of about two years or about $\frac{1}{3}$ the normal life expectancy and then must be replaced.

Diesel engines are popular since diesel engines can extract up to 50 percent greater energy from the same cost of fuel as compared to gasoline engines. Due to the high compression ratios of the diesel engines, they require very large battery packs for starting. These large battery packs are very costly, making it important to extend the battery life as long as possible.

Known battery charging system devices and methods include such apparatus disclosed in U.S. Pat. No. 3,568,031 to Eberts (Vehicle Power Supply for Battery Charging and Load Supply); U.S. Pat. No. 3,870,855 to Edlund et al. (Electric Heating and Battery Charging System for Motor Vehicle); U.S. Pat. No. 3,898,547 to Poole (Electric Vehicle Charger Shut-Off Interlock System); U.S. Pat. No. 5,017,856 to Johnson, Jr. (Battery Charging System); and U.S. Pat. No. 5,272,431 to Nee (Automatic Power Connector for Recharging Electric Vehicles).

U.S. Pat. No. 4,935,688 to Mystry et al. suggest that over time, the common lead-acid battery cell corrodes at the

positive cell electrode due to the oxidizing conditions resulting from the repeated application of charging current to the cell. Mystry et al. No. '688 suggests minimizing the oxidation of the plates of electrolytic battery cells during flow charge by the application of a small additional current.

Other known mechanisms include "Off-Season Automatic Battery Maintainers" which suggest a wall-mount mechanism for maintaining full charge in a battery during long storage periods. The battery maintainer is wall mounted and plugs into a 120 volt outlet. Battery clamps are provided for coupling the maintainer to the vehicle battery. The battery maintainer provides a $\frac{1}{2}$ amp to 1 amp charge as needed to the battery.

The disadvantage of present off-the-shelf battery maintainers is that they are not application specific. They have a preset maintenance current, which may result in maintaining small motorcycle batteries at far too high a current level, thereby destroying the motorcycle battery in a single off season. Likewise, the same battery maintainer may be unable to maintain large battery packs found in large agricultural tractors, resulting in discharge and battery sulfation. Further, no monitoring and control is built into the battery maintainers to prevent the above-stated problems from occurring.

Due to the high replacement cost of batteries and the environmental sensitivity to lead-based and other types of batteries, it is desirable to extend the life of these batteries. It is desirable to have an apparatus for providing a seasonal-use battery with a small amount of current equal to the battery's self-discharge current during storage, extending the battery life and preventing battery sulfation. Further, it is desirable to provide a battery life extender and control apparatus which is integrated into the existing battery charging system of the seasonal-use device, including the seasonal-use device control and display system, and which is application specific.

SUMMARY OF THE INVENTION

The present invention is an apparatus for extending the life of a battery used in a seasonal-use or periodic use device by providing a maintenance current to the battery approximately equal to the battery self-discharge rate, and thereby preventing plate sulfation. The apparatus is integrated into the seasonal-use device battery charging system. The apparatus may also be integrated into the seasonal-use device control diagnostic system. The apparatus, in accordance with the present invention, provides an economically feasible method of extending battery life.

In one embodiment, the present invention is an improvement to a seasonal-use device having a battery charging system, including a transformer coupled to an alternator system. The improvement includes a mechanism integral the battery charging system for providing a maintenance current to the battery approximately equal to the battery self-discharge rate. A mechanism is provided for coupling the battery charging system to an external power source.

The transformer of the battery charging system may include a secondary winding coupled to a secondary transformer core. The mechanism for providing a maintenance current coupled to the secondary transformer core may include a primary winding. The primary winding may be coupled to the mechanism for coupling, the battery charging system to the external power source.

In one embodiment, the mechanism for coupling is a power cord, and the external power source is a conventional outlet coupled to a 120 volt power system. It is also

recognized that the present invention may be coupled to other power sources, such as a 240 volt power source.

The present invention may include a primary transformer core extension. The primary winding may be coupled about the primary transformer core extension. A mechanism may be provided for coupling the primary transformer core extension to the secondary transformer core.

The present invention may be integrated into the seasonal-use device system controller. A battery sensor may be coupled to the system controller, having an output signal representative of a sensed battery diagnostic characteristic.

One preferred embodiment of the present invention integrates the battery life extender apparatus and associated maintenance current generation into the seasonal use device closed loop monitoring, display, control and charging system utilizing such existing functions on modern seasonal use devices.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described with reference to accompanying drawings where like numbers refer to like parts in several views, and wherein:

FIG. 1 is a schematic block diagram of a battery life extender system in accordance with the present invention;

FIG. 2 is another embodiment of a battery life extender system in accordance with the present invention;

FIG. 3 is a schematic diagram showing one preferred embodiment of the battery life extender system shown in FIG. 2;

FIG. 4 is a schematic diagram showing another preferred embodiment of the battery life extender system shown in FIG. 2;

FIG. 5 is another block diagram showing another embodiment of the battery life extender system in accordance with the present invention;

FIG. 6 is a block diagram of one embodiment of the battery life extender system integrated with a seasonal-use device system controller; and

FIG. 7 is a top view of a seasonal-use device control panel.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is an apparatus for extending the life of a battery used in a seasonal-use or periodic use device by providing a maintenance current to the battery approximately equal to the battery self-discharge rate, and thereby preventing plate sulfation. The apparatus may be integrated into the seasonal-use device battery charging system and control diagnostic system, providing an economically feasible method of extending battery life. Although the specification refers to extending the battery of a seasonal use device, it is recognized that the present invention may be used with other types of devices, such as a periodic use device.

Although the present invention described herein is for use with a seasonal-use device, such as a snowmobile, personal watercraft, or other seasonal-use device, it is recognized that the present invention may be used to extend the battery life of any seasonal-use or periodic use battery. Known seasonal-use devices in which the present invention may be used to extend battery life include construction equipment, agricultural equipment, lawn and garden equipment, all terrain vehicles, mopeds, motorscooters, motorcycles, boats, per-

sonal watercraft, trolling motors, snowmobiles, motorhomes, travel trailers, private aircraft, and other seasonal-use devices.

It is recognized that the present invention may be used to extend the life of any seasonal-use battery, such as lead-acid batteries, and similar battery systems. The battery life extender apparatus will keep all types of batteries in a fully charged "ready" condition. At the end of the off season, when the seasonal use device is taken out of storage, the battery is fully charged and ready to go, instead of being in a discharged state.

FIG. 1 shows a battery life extender apparatus in accordance with the present invention generally at 10. The battery life extender apparatus 10 is for use with a seasonal-use device 12. The battery life extender apparatus 10 is located integral the seasonal-use device 12, and may utilize a portion of the existing seasonal-use device 12 battery charging system.

The battery life extender apparatus 10 generally includes a voltage step-down device 14, an AC-to-DC converter 16, and a seasonal-use device battery 18. The voltage step-down device 14 may be releasably coupled to an external power source 20, indicated at 22. Voltage step-down device 14 is electrically coupled to AC-to-DC converter 16, indicated at 24. The AC-to-DC converter 16 is electrically coupled to battery 18, indicated at 26.

The battery life extender apparatus 10 utilizes a major portion of the seasonal-use device 12 battery charging system for off-season maintenance of the battery 18. Power source 20 is utilized to provide power for supplying a small current to battery 18, which is equal to the battery 18 self-discharge current during storage. For example, a typical lead-acid battery will self-discharge about 1 percent per day yielding a battery which is approximately 80 percent discharged after 6 months, causing the battery plates to sulfate, resulting in a shortened battery life. The present invention provides the battery with a small current equal to the battery's self-discharge current during storage. The value of the self-discharge current is unique to each battery type and size. Testing has found that for a conventional lead-acid battery, the required maintenance current preferable range is 0.4 milliamp to 1.6 milliamp per amp hour battery rating. In one preferred embodiment, the maintenance current is 1 milliamp per amp hour battery rating.

The following table shows sample battery self-discharge currents for known seasonal use devices for a 12 volt DC battery at 25° C.:

TABLE 1

Device or Vehicle	Battery Size in Ampere Hours	Battery Self-Discharge Current	Estimated Maximum Maintenance Current
Moped	6 AH	2.5 mA	10 mA
Motorcycle	12 AH	5 mA	20 mA
Riding Lawn Mower	25 AH	10 mA	40 mA
Garden Tractor	40 AH	17 mA	68 mA
Mid-Size Auto	65 AH	27 mA	108 mA
Mid-Size Truck	100 AH	42 mA	168 mA
Large Ag. Tractor	240 AH	100 mA	400 mA

The battery self-discharge rate varies with storage temperature. Batteries will self-discharge at a higher rate when stored in a warm environment, and will discharge at a slower rate when stored in a cold environment when initially fully charged.

The unique battery life extender apparatus **10** in accordance with the present invention is integrated into the existing charging circuit of the seasonal-use device, resulting in a simple and economic method of extending battery life for seasonal-use devices. The battery life extender apparatus **10** is very economically feasible, since it utilizes a portion of the seasonal-use device's existing battery charging system.

FIG. 2 shows one preferred embodiment of the battery life extender apparatus **10**. In this embodiment, the voltage generator and step-down device **14** includes a conventional vehicle alternator or ignition magneto **28** coupled to a transformer **30**. Further, the vehicle alternator or ignition magneto **28** is coupled to rectifier **16**, indicated at **23**. For example, a simple charging circuit (such as those found in a lawn and garden tractor) uses a rotating permanent magnet on the ignition magneto for generating a rotating magnetic field to induce a charging current during use of device **12**. For more complex charging systems, such as those used in personal watercraft or agricultural tractors, the voltage generator **28** is an alternator or other rotating device having multiple charging coils.

When the device is in use, the voltage generator **28** induces a voltage on a magnetic core (not shown), which produces an AC voltage approximately equal in magnitude to the desired battery voltage. In this embodiment, AC-to-DC converter **16** is a full wave or half wave rectifier. The AC-to-DC converter receives the AC voltage signal from the alternator or ignition magneto **28** and converts it to a DC voltage equivalent to the desired battery voltage and charging current level. In a typical charging circuit, the voltage generator **28** produces approximately 1-3 amp charging current at rated battery voltage to battery **18** at full engine speed.

For use as a battery life extender apparatus **10** during the off season, the conventional charging system is modified to include AC line input capability, indicated by coupling mechanism **22**. In the embodiment shown, the coupling mechanism **22** is a standard electrical cord **32** having a grounded plug member **34** for coupling to a 120 volt power source at outlet **36**.

To maintain the battery **18** during the off season, transformer **30** is coupled to power source **20** using coupling mechanism **22**. Transformer **30** is sized specifically for the individual battery **18**. Preferably, transformer **30** provides a maintaining current to battery **18** equal to the battery's self-discharge current. For example, for lead-acid batteries, the desired current has been found to be in the range of 0.4 mA to 1.6 mA per ampere-hour rating of the battery.

Referring to FIG. 3, one method of integrating the battery life extender, apparatus **10** into a seasonal-use device's conventional battery charging system is shown at **38**. In this embodiment, the seasonal-use device's charging system is a very simple battery charging system which includes a flywheel **39** and a transformer **30** having a transformer core **40** and a secondary winding **42**. The transformer secondary winding **42** is coupled to AC-to-DC converter **16**, indicated at **44**. In the embodiment shown, the AC-to-DC converter **16** is a one-half wave rectifier which includes diode **46**. The AC-to-DC converter **16** is coupled to the battery **18**, indicated at **48**.

An additional transformer core extension **50**, having a primary winding **52**, is coupled to the transformer core **40** having secondary winding **42** at coupling device **54**. Primary

winding **52** may be coupled to a standard 120 volt AC outlet, using methods previously described herein, such as a power cord **32**, indicated at terminal **56** and terminal **58**.

It is recognized that the transformer core extension **50** and the transformer core **40** may be manufactured such that the magnetic cores plug or "fit" together forming a common magnetic path. The turns ratio of primary winding **52** and secondary winding **42** are sized for providing the necessary maintaining current to battery **18**. When primary winding **52** is energized by coupling the primary winding **52** to a 120 volt AC source, the secondary winding **42** provides the desired maintenance current to battery **18** approximately equal to the battery's self-discharge rate.

In one embodiment, battery **18** is a 12 volt DC battery, and primary winding **52** is coupled to a conventional 120 volt AC outlet through power cord **32**. The turns ratio between primary winding **52** and secondary winding **42** is 9.3 to 1, wherein the primary winding **52** winds 2250 turns about transformer core extension **50**, and secondary winding **42** winds 242 turns about transformer core **40**. With this embodiment, a maintenance current of 27 milliamps is provided to battery **18** during the off season for a 65 amp hour battery, which is approximately equal to the battery self-discharge rate of about 1 percent per day.

It is also recognized that the battery life extender **10** may include a flywheel interlock **56**, mechanically coupled to core coupling device **54**, indicated by dashed line **58**. When transformer core extension **50** is coupled to transformer core **40**, the flywheel interlock **56** operates to lock the seasonal-use device flywheel (indicated at **60**) stationary. During the off season, the flywheel safety interlock **56** engages the magnet/flywheel such that the engine may not be started or "turned over" when the battery life extender apparatus **10** is in operation. Additionally, the mechanical interlock **56** may open the circuit to the low current starter solenoid. Further, it is recognized that other mechanical interlock (or electrical) mechanisms may be used.

Referring to FIG. 4, another embodiment of the present invention is shown where the battery life extender apparatus **10** is integral a seasonal-use device's battery charging system. The primary winding **52** is coupled onto the single use transformer core **40**. Extending from and electrically coupled to the primary winding **52** is power cord **32** for coupling to a 120 volt power source. It is recognized that the primary winding **52** may be integrated with the power cord **32** to provide the minimal magnetic coupling necessary to supply the very small maintenance current present on the secondary windings. The primary winding **52** may be simply an interlocking receptacle coupled into the end of the power cord **32**, which is plugged into the seasonal-use device at transformer core **40**.

In the embodiment shown, the battery life extender **10** further includes AC-to-DC converter **16** and current regulator **62**. The AC-to-DC converter **16** includes a full wave rectifier **64** having diode **D1** and diode **D2**. The transformer secondary winding **42** has a voltage divider configuration including output terminal **70**, ground **72**, and output terminal **74**. Negative terminal **72** is coupled to ground G. Diode **D1** is coupled between output terminal **70** and current regulator **62**. Diode **D2** is coupled between output terminal **74** and current regulator **62**. Current regulator **62** is coupled between diode **D1**, **D2** and ground G, and is coupled to battery **18**, indicated at **76**.

AC-to-DC converter **16** allows full wave rectification of the output of transformer secondary winding **42**. Current regulator **62** regulates the maintenance current provided to

battery 18. It is contemplated that current regulator 62 may include any device used for regulating or minimizing current in an electrical circuit. In one embodiment, current regulator 62 includes a current regulating transistor together with a Zener diode and resistor reference. In another embodiment, current regulator 62 includes a very sophisticated integrated circuit current regulator such as LM7812 by National Semiconductor Corporation of Santa Clara, Calif.

Referring to FIG. 5, another embodiment of the battery life extender apparatus 10 is generally shown, integrated into the charging system of a seasonal-use device 12. In this embodiment, the battery life extender apparatus 10 is integrated into the seasonal-use device's system controller 80. The system controller 80 controls the device's operation, and further provided diagnostic sensing and control of the seasonal-use device battery charging system and battery life extender apparatus 10. It is recognized that system controller 80 may be any type of device capable of performing logical operations, such as a computer, a microprocessor or microcontroller, a sequence of logic gates, or a combination of these.

Safety interlock 82 is mechanically coupled to the output of transformer 30. The safety interlock 82 disables the battery life extender apparatus 10 and provides electrical isolation at the output of transformer 30 when the battery life extender apparatus 10 is not in use. Rectifier 16 is electrically coupled to regulator 62, indicated at 63. Regulator 62 is electrically coupled to battery 18, indicated at 65. System controller 80 is electrically coupled to regulator 62, indicated at 86, for providing sensing and control signals between system controller 80 and regulator 62 (sensing devices not shown). System controller 80 is electrically coupled to battery 18, indicated at 88, for providing sensing and control signals between system controller 80 and regulator 62 (sensing devices not shown).

Referring to FIG. 6, a block diagram is shown integrating the battery life extender apparatus 10 into a seasonal-use device's system controller 80, is generally shown at 90. The system 90 includes battery voltage level sensor 92, battery temperature sensor 94, safety interlock sensor 96, other battery diagnostic sensors 98, control panel inputs 100, and other control/sensing inputs 102. Battery voltage level sensor 92 is electrically coupled to system controller 80 at input 104. Battery temperature sensor 94 is electrically coupled to system controller 80 at input 106. Safety interlock sensor 96 is electrically coupled to the system controller 80 at input 108. Other battery diagnostic sensors 98 are electrically coupled to system controller 80 at input 110.

The controller panel inputs 100 are electrically coupled to system controller 80 at input 112, and other control/sensing inputs 102 are electrically coupled to system controller 80, indicated by input 114, input 116, input 118, input 120, and input 122. The other control/sensing inputs represent conventional seasonal-use device sensing inputs, such as engine RPM, fuel level, ground speed or water speed, etc.

The system controller 80 provides control outputs to display 124 and other control outputs 126. Display 124 is electrically coupled to system controller 80 at output 128. System controller 80 provides output signals to display 124 based on control panel inputs 100, and other sensor inputs. Similarly, other control outputs 126 is electrically coupled to system controller 80 indicated by output 130, output 132, output 134, and output 136. System controller 80 is responsive to the sensed inputs and provides corresponding other control outputs 126. For example, based on the safety interlock 96 input 108, the system controller 80 may enable

or disable the seasonal-use device engine or disconnect power at the primary winding 52.

The battery diagnostics utilize the existing seasonal-use device system controller 80 and corresponding display 124 to display battery diagnostics and to provide outputs to adjust battery charging levels and maintenance current levels. Further, if the seasonal use battery life extender apparatus 10 is powered during the off season, power is maintained to the system controller 80. Since power is maintained to system controller 80, the system controller 80 can monitor battery diagnostics, indicate the battery diagnostics on the display 124, and provide control outputs based on the sensed battery characteristics to regulate the maintenance current to battery 18.

Referring to FIG. 7, a typical seasonal-use device control panel device (such as for a personal watercraft or other device) is shown generally at 140. The control panel 140 includes the display 124 and the control panel inputs 100. Control panel inputs 100 include display buttons, such as RPM button 142, fuel button 144, speed button 146, battery voltage 150, battery temperature 152, and battery maintenance current 154. The control panel may include other buttons 156, 158 and 160, and may also include indicator lights 162, 164 and 166. Display 124 is responsive to the control panel inputs 100. For example, by pressing battery voltage button 150, the display 124 will display the present battery voltage, such as 12.86 volts DC (168). Similarly, by pressing the maintenance current button 154, the display 124 will display the maintenance current in milliamps (170); by pressing the battery temperature button 152, the display 124 will display the battery temperature (172); or the display 124 may display other important seasonal-use device diagnostics, such as whether the safety interlock is on as indicated at 174.

In operation, the seasonal-use device is merely positioned in a storage area, such as a garage, adjacent a conventional 120 volt power outlet. Referring to the embodiment of FIG. 3, the transformer core extension 50 is coupled to the secondary transformer core 40 using core coupling device 54. Upon coupling the transformer core extension to the transformer core 40, a flywheel interlock 56 locks flywheel 60 in place, such that the seasonal-use device engine may not be started or "turned over" during operation of the battery life extender apparatus 10. Once energized by plugging power cord 32 into the conventional outlet, the battery life extender apparatus 10 provides a maintenance current to battery 18, which is equal to the battery's self-discharge current.

Similarly, referring to FIG. 4, primary winding 52 may be coupled to transformer core 40. By plugging in power cord 32, the battery life extender apparatus 10 is energized, providing the desired maintenance current to battery 18. Further, referring to FIGS. 5, 6 and 7, since during the off-season power is present to maintain the charge on battery 18, system controller 80 and the corresponding display 124 remain operational for controlling and displaying desired diagnostics or battery diagnostics. Further, since system controller 80 is energized, the system controller 80 may adjust battery life extender system outputs 130 based on sensed battery characteristics, such as battery voltage level 92 and battery temperature 94.

It is further recognized that battery characteristics change with the age of the battery. It is recognized that battery diagnostics could sense battery changes, such as battery static voltage and battery cranking voltages, and provide a corresponding readout at display 124. As the battery ages,

the difference between the static voltage and battery cranking voltage gets greater and greater. For example, when a 12 volt battery is new, there may be a 3 volt difference between the static voltage and battery cranking voltage, and near the end of the life of the battery, the difference may exceed 5 volts. Once the difference between the battery static voltage and battery cranking voltage exceeds a desired amount, such as 5 volts, the battery maintainer may be programmed to no longer maintain the battery, but alternatively display a “warning” or beep to warn the device operator that the battery is no longer useable.

It will be understood that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, material and arrangement of parts without exceeding the scope of the invention. Accordingly, the scope of the invention is as defined in the language of the appended claims.

What is claimed is:

1. Apparatus for precluding discharge of a rechargeable battery used in an intermittent-use device, the apparatus comprising:

means for providing to the battery a maintenance direct current proximate the specific battery’s discharge rate while the device is not in use, including a non-voltage regulated power supply having a direct current output, and means for transmitting the direct current to the battery as said maintenance direct current; and

means for coupling the means for providing a maintenance direct current to an external power source.

2. The apparatus of claim 1, further comprising:

means for determining battery diagnostics having one or more diagnostic output signals representative of a determined battery diagnostic including a control mechanism responsive to the diagnostic output signals, wherein the control mechanism regulates the maintenance direct current based on the diagnostic output signals.

3. The apparatus of claim 2, wherein the means for determining battery diagnostics includes a battery sensor.

4. The apparatus of claim 3, wherein the battery sensor is a battery environment temperature sensor.

5. The apparatus of claim 2, wherein the means for determining battery diagnostics monitors the chemical aging of the battery.

6. The apparatus of claim 2, wherein the means for determining battery diagnostics includes a battery voltage sensing mechanism.

7. The apparatus of claim 6, wherein the battery voltage sensing mechanism includes a battery static voltage sensing mechanism.

8. The apparatus of claim 6, wherein the battery voltage sensing mechanism includes a battery cranking voltage sensing mechanism.

9. The apparatus of claim 6, wherein the battery voltage sensing mechanism includes:

a battery static voltage sensing mechanism;

a battery cranking voltage sensing mechanism; and

wherein the control mechanism includes a compare mechanism which compares the battery static voltage output diagnostic to the battery cranking voltage output diagnostic.

10. The apparatus of claim 2, further comprising:

a display mechanism coupled to the control mechanism which includes displays representative of one or more diagnostic output signals.

11. The apparatus of claim 10, wherein the intermittent use device includes a system display, and wherein the display mechanism is part of the system display.

12. The apparatus of claim 2, wherein the control mechanism is integral the intermittent use device.

13. The apparatus of claim 12, wherein the intermittent use device includes a system controller, and wherein the control mechanism is part of the system controller.

14. A method of precluding discharge of a rechargeable battery used in an intermittent-use environment, the method comprising the steps of:

providing to the battery a maintenance direct current proximate the specific battery’s discharge rate while the device is not in use, including providing a non-voltage regulated power supply having a direct current output, and transmitting the direct current to the battery as the maintenance current; and

coupling the power supply to an external power source.

15. The method of claim 14, further comprising the steps:

determining battery diagnostics, including the step of providing one or more diagnostic output signals representative of a determined battery diagnostic; and

regulating the maintenance current in response to the diagnostic output signals.

16. The method of claim 15, wherein the step of determining battery diagnostics includes the step of sensing a characteristic of the battery.

17. The method of claim 16, wherein the step of sensing a characteristic of the battery includes the step of sensing battery environment temperature.

18. The method of claim 15, wherein the step of determining battery diagnostics includes the step of monitoring the age of the battery.

19. The method of claim 15, wherein the step of determining battery diagnostics includes the step of sensing battery voltage.

20. The method of claim 19, wherein the step of sensing battery voltage includes the step of sensing battery static voltage.

21. The method of claim 20, wherein the step of sensing battery voltage includes the step of sensing battery cranking voltage.

22. The method of claim 21, wherein further comprising the steps of:

comparing battery static voltage with battery cranking voltage to determine a compared voltage value;

defining a compared voltage value threshold;

comparing the compared voltage value to the compared voltage value threshold to generate a battery voltage status signal; and

determining a battery status in response to the battery voltage status signal.

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