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(54) **ELECTRONIC BATTERY MODULE (EBM) WITH BIDIRECTIONAL DC-DC CONVERTER**

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(57) **ABSTRACT**

A telecommunication switching station includes telecommunication equipment, a DC power supply having an output connected to the telecommunication equipment, and a plurality of rechargeable DC power supplies connected in parallel with the output of the DC power supply. Each DC power supply includes a pair of power supply terminals, a rechargeable battery, and a bidirectional DC-DC converter module connected between the rechargeable battery and the pair of power supply terminals. The DC power supply provides power to the telecommunication equipment and recharges the plurality of rechargeable DC power supplies. The plurality of rechargeable DC power supplies serve as a back-up for the DC power supply.

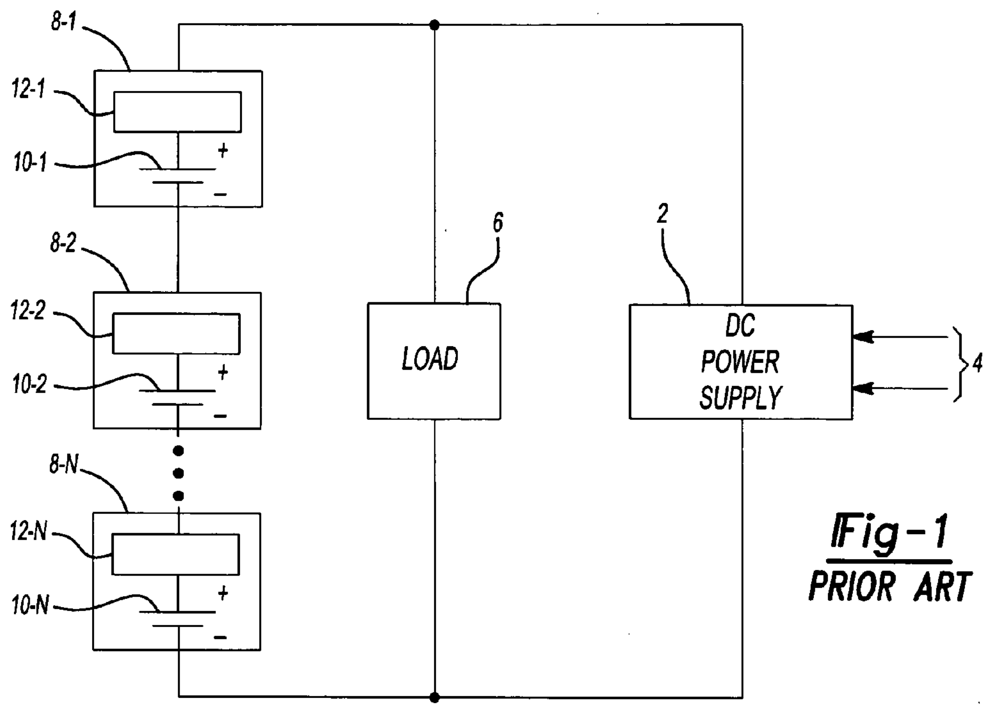

Fig-1
PRIOR ART

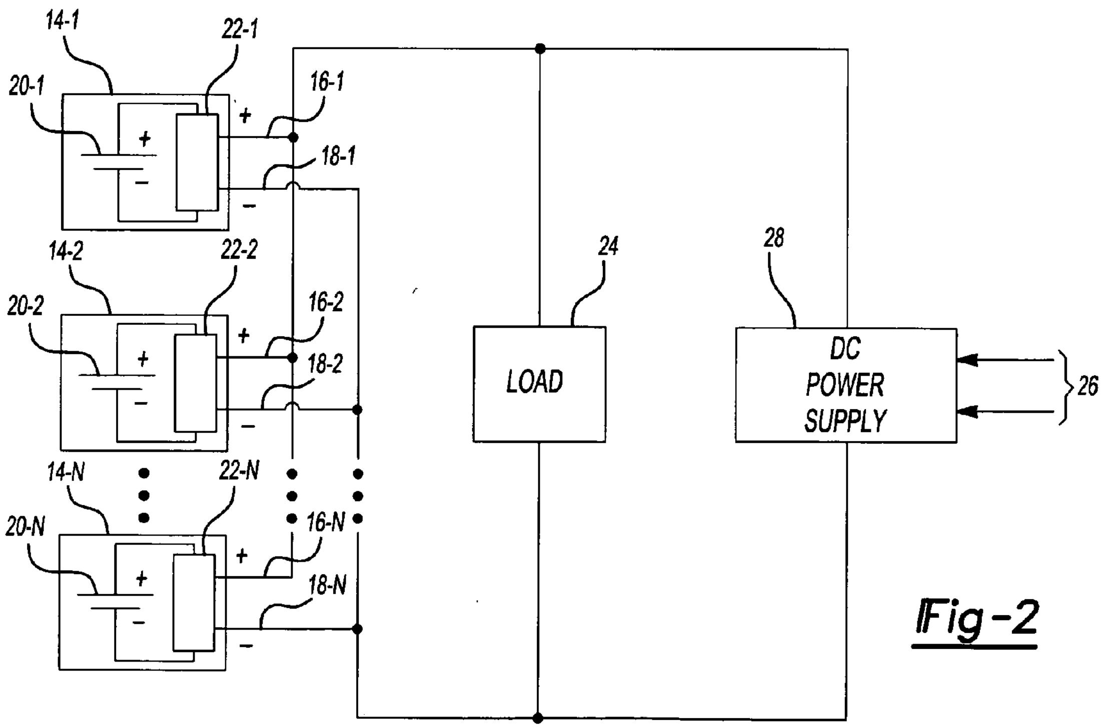

Fig-2

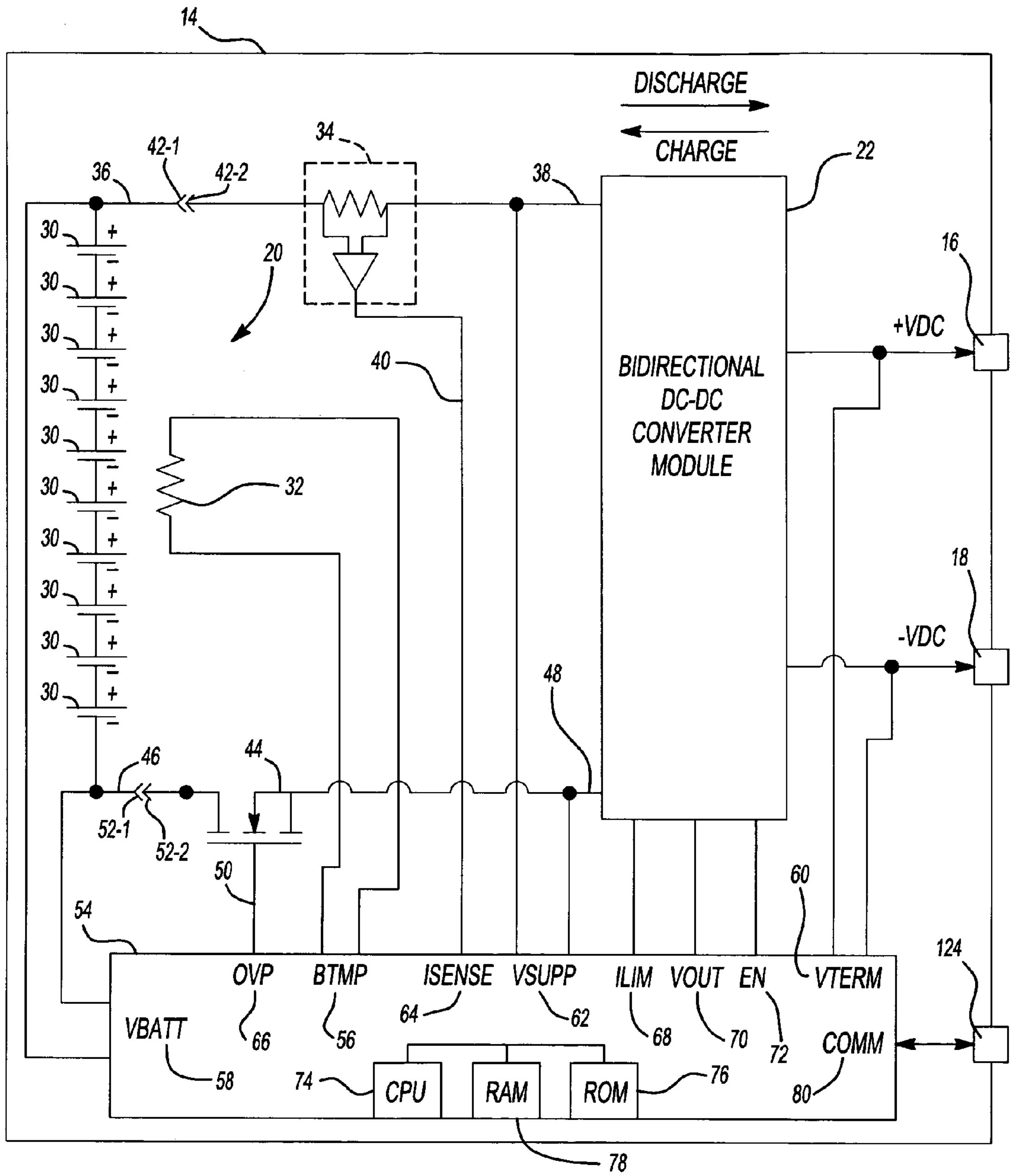
14
DISCHARGE
CHARGE
22
34
42-1
42-2
36
38
30
20
16
+VDC
40
BIDIRECTIONAL
DC-DC
CONVERTER
MODULE
32
18
-VDC
48
46
44
52-1
52-2
50
60
54
124
OVP
BTMP
ISENSE
VSUPP
ILIM
VOUT
EN
VTERM
VBATT
66
56
64
62
68
70
72
COMM
58
74
CPU
RAM
ROM
76
80
78

Fig-3

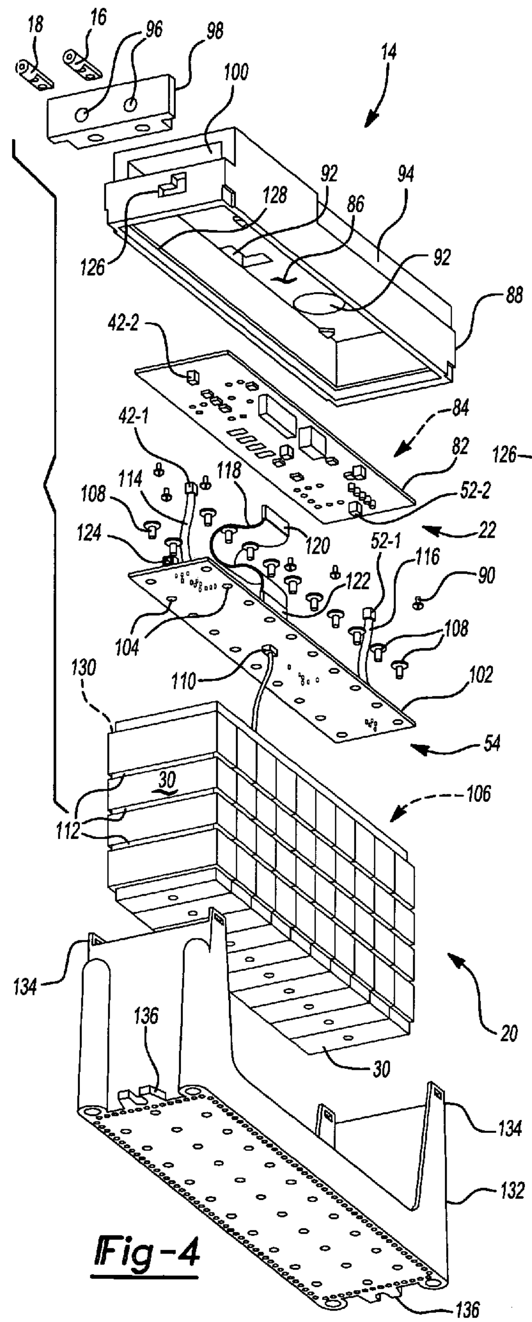
18
16
96
98
14
100
92
128
94
86
126
92
88
42-2
84
82
42-1
118
114
108
52-2
22
124
120
52-1
116
90
104
122
108
110
102
130
54
30
106
112
134
136
20
30
134
132
136

Fig-4

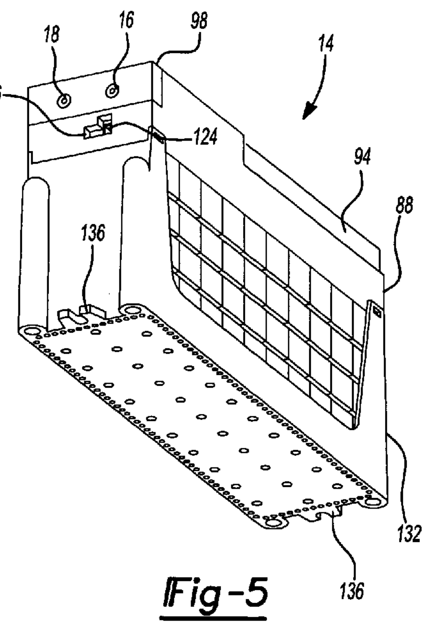
18
16
98
14
126
124
94
88
136
132
136

Fig-5

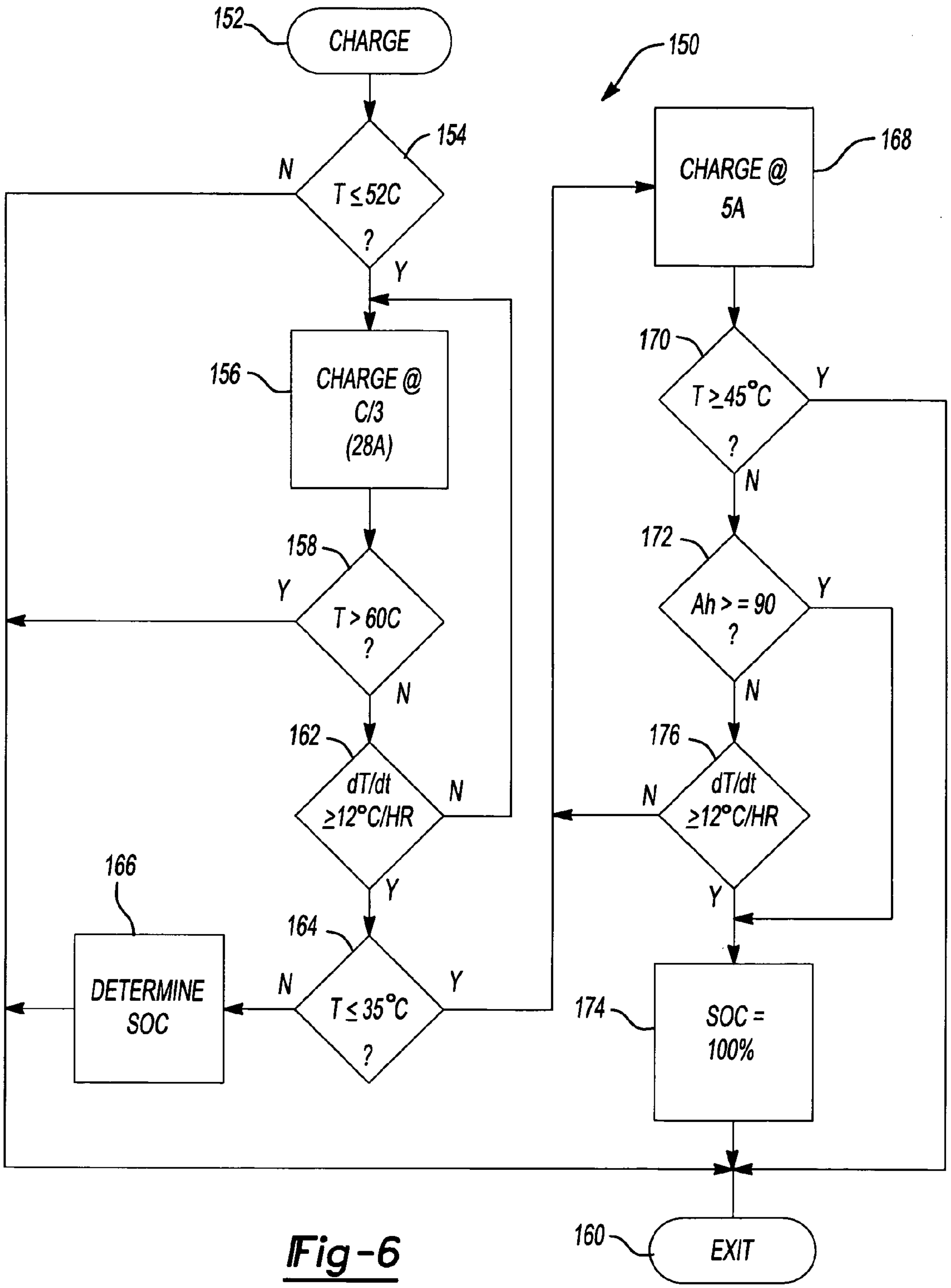
152
CHARGE
150
154
N
T ≤ 52C ?
Y
168
CHARGE @ 5A
156
CHARGE @ C/3 (28A)
170
T ≥ 45°C ?
Y
N
158
Y
T > 60C ?
N
172
Ah >= 90 ?
Y
N
162
dT/dt ≥12°C/HR
N
Y
176
N
dT/dt ≥12°C/HR
Y
166
DETERMINE SOC
164
N
T ≤ 35°C ?
Y
174
SOC = 100%
160
EXIT

Fig-6

ELECTRONIC BATTERY MODULE (EBM) WITH BIDIRECTIONAL DC-DC CONVERTER

FIELD OF THE INVENTION

[0001] The present invention relates generally to rechargeable DC power supplies having an integral DC-DC converter.

BACKGROUND OF THE INVENTION

[0002] Rechargeable DC power supplies are useful in many types of applications. For example, cellular towers and other stationary applications use rechargeable DC power supplies as an uninterruptible power source. The rechargeable DC power supplies provide backup power during a main grid outage.

[0003] Referring now to **FIG. 1**, an example application of rechargeable DC power supplies is shown. A direct current (DC) power supply **2** receives power from a main grid **4**. The DC power supply **2** generally provides power to a load **6** and to a plurality of rechargeable DC power supplies **8-1**, **8-2**, . . . , **8**-N, referred to collectively as rechargeable DC power supplies **8**. Each rechargeable DC power supply **8** includes a corresponding battery **10** and charging control circuit **12**.

[0004] The battery **10** provides a voltage that is less than a load voltage needed by the load **6**. If the DC power supply **2** becomes inoperative, the series-connected rechargeable DC power supplies **8** provide the load voltage. However, because the rechargeable DC power supplies are connected in series, the load **6** may not receive sufficient voltage if one of more of the rechargeable DC power supplies **8** is in a discharged or open circuit condition.

SUMMARY OF THE INVENTION

[0005] A telecommunication switching station includes telecommunication equipment, a DC power supply having an output connected to the telecommunication equipment, and a plurality of rechargeable DC power supplies connected in parallel with the output of the DC power supply. Each DC power supply includes a pair of power supply terminals, a rechargeable battery, and a bidirectional DC-DC converter module connected between the rechargeable battery and the pair of power supply terminals. The DC power supply provides power to the telecommunication equipment and recharges the plurality of rechargeable DC power supplies. The plurality of rechargeable DC power supplies serve as a back-up for the DC power supply.

[0006] In other features, each of said rechargeable DC power supplies further includes a control module that communicates an enable signal to a respective one of said bidirectional DC-DC converter modules. The respective bidirectional DC-DC converter module selectively creates an open circuit condition between said pair of power supply terminals in accordance with said enable signal.

[0007] In other features, each of said rechargeable DC power supplies further includes a data communication port in communication with a respective one of said control modules. Each of said rechargeable DC power supplies can further includes a battery temperature sensor positioned in proximity of a respective one of said rechargeable batteries and providing a battery temperature signal to a respective one of said control modules. Each battery temperature sensor is positioned inside of said respective one of said rechargeable batteries.

[0008] In other features, each rechargeable DC power supplies further includes a current sensor providing a signal to a respective one of said control modules and being connected between a respective one of said rechargeable batteries and a respective one of said bidirectional DC-DC converter modules. The signal can be indicative of a magnitude and direction of current flow through said respective one of said rechargeable batteries.

[0009] In other features, each of the rechargeable DC power supplies further includes a switch having a control input and being connected between a respective one of said rechargeable batteries and a respective one of said bidirectional DC-DC converter modules and wherein said switch opens and closes in response to said control input.

[0010] In other features, each of said control modules can communicate a desired output voltage signal to said respective one of said bidirectional DC-DC converter modules. The respective one of said bidirectional DC-DC converter modules regulates a load voltage across a respective one of said pair of power supply terminals in accordance with said desired output voltage signal.

[0011] A rechargeable DC power supply includes a housing including an interior, an exterior, and an integral heat sink including a heat absorbing surface formed in said interior and a heat dissipating surface formed in said exterior. The rechargeable DC power supply includes a rechargeable battery having battery terminals positioned in said interior, power supply terminals positioned at said exterior of said housing, anda first printed circuit board (PCB) assembly including a bidirectional DC-DC converter module connected between said battery terminals and said power supply terminals. The first PCB assembly is in coplanar contact with said heat absorbing surface.

[0012] In other features, a battery tray is connected to said housing and contains said rechargeable battery. The rechargeable battery can include a plurality of rechargeable cells having cell terminals. A second PCB assembly can be positioned on said cell terminals and include PCB traces connecting said cell terminals to form said battery terminals. The housing can nest on said rechargeable battery.

[0013] In other features, the rechargeable DC power supply can include a battery temperature sensor positioned in proximity of said rechargeable battery and connected to said second PCB assembly. The battery temperature sensor can be located inside of said battery.

[0014] In other features, a control module is positioned in the interior of said housing and has a data communication port. A connector in communication with said data communication port can be accessible from said exterior of said housing.

[0015] A rechargeable DC power supply system for providing power to a DC load, includes a plurality of rechargeable DC power supplies. Each rechargeable DC power supply includes a rechargeable battery, a pair of power supply terminals, a bidirectional DC-DC converter module connected between said rechargeable battery and said power supply terminals, and a controller module receiving at least one signal indicative of a condition of said rechargeable battery and communicating an enable signal to said corresponding bidirectional DC-DC converter module in accordance with said condition. Said power supply terminals of said plurality of rechargeable DC power supplies and said load are connected by parallel connections. One of said enable signals causes a respective one of said corresponding rechargeable DC power supplies to electrically connect and disconnect from said load. Each of said rechargeable DC power supplies can include a data communication port that communicates data indicative of said condition.

[0016] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0018] **FIG. 1** is a functional block diagram of a load connected to a DC power supply and series-connected rechargeable DC power supplies according to the prior art;

[0019] **FIG. 2** is a functional block diagram of a load connected to a DC power supply and parallel-connected rechargeable DC power supplies;

[0020] **FIG. 3** is a functional block diagram of a rechargeable DC power supply including a bidirectional DC-DC converter;

[0021] **FIG. 4** is an exploded view of a rechargeable DC power supply;

[0022] **FIG. 5** is a perspective view of the rechargeable DC power supply of **FIG. 4**; and

[0023] **FIG. 6** is a method of operating a rechargeable DC power supply.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. For purposes of clarity, the same reference numbers will be used in the drawings to identify similar elements. As used herein, the term module and/or device refers to an application specific integrated circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group), and memory that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable components that provide the described functionality. For purposes of clarity, the same reference numerals will be used to identify similar elements.

[0025] Referring now to **FIG. 2**, a plurality of rechargeable DC power supplies **14-1**, **14-2**, . . . , **14**-N, referred to collectively as rechargeable DC power supplies **14**, are shown. The rechargeable DC power supplies **14** include corresponding positive **16** and negative **18** power supply terminals that are connected in parallel. Each rechargeable DC power supply **14** has a corresponding rechargeable battery **20** and a bidirectional DC-DC converter module **22** connected between the battery **20** and the positive **16** and negative **18** power supply terminals. A battery voltage of each battery **20** can be less than a DC load voltage needed by a load **24**. Examples of loads include, by way of non-limiting example, telecommunication equipment including multiplexers and/or switching circuitry, cellular communications transmitters and/or receivers, and electric and hybrid electric vehicles. The bidirectional DC-DC converter modules **22** convert the battery voltage to the load voltage and vice versa. In some embodiments, the battery voltage is about 12V and the load voltage is between about 24V and 48V. The load **24** connects to the positive **16** and negative **18** power supply terminals.

[0026] A main grid **26** provides power to a DC power supply **28**. The DC power supply **28** has positive and negative outputs connected to the load **24** and to the positive **16** and negative **18** power supply terminals. The main grid **26** can be an AC line voltage, such as provided by a public electric utility, or a DC line voltage such as may be provided by an alternative energy source such as solar cells and/or generators.

[0027] When the main grid **26** is powered, the DC power supply **28** provides power to operate the load **24** and to recharge the batteries **20**. The bidirectional DC-DC converter modules **22** reduce the load voltage to the battery voltage and regulate a charging current provided to the batteries **20**.

[0028] When the main grid **26** loses power, the rechargeable DC power supplies **14** provide power to operate the load **24**. The bidirectional DC-DC converter modules **22** increase the battery voltage to the load voltage.

[0029] Turning now to **FIG. 3**, a functional block diagram of the rechargeable DC power supply **14** is shown. The rechargeable battery **20** has at least one rechargeable cell **30**, such as, by way of non-limiting example, nickel-metal hydride, nickel-cadmium, lithium-ion, and/or lead-acid cells. The rechargeable cells **30** can connect in series, parallel, or series-parallel. A battery temperature sensor **32** can be positioned in proximity of the battery **20**. In some embodiments, the temperature sensor **32** is positioned between two of the cells **30** and near a center of mass of the battery **20**. By way of non-limiting example, the battery temperature sensor **32** can be a thermistor having a negative temperature coefficient.

[0030] A current sensor **34** can connect between a positive battery terminal **36** and a positive module terminal **38** of the bidirectional DC-DC converter module **22**. The current sensor **34** provides a current signal **40** indicative of a magnitude of battery current flowing through the battery **20**. In some embodiments, the current signal **40** also provides an indication of a direction of the battery current. First mating connectors **42-1** and **42-2**, referred to collectively as the first connector **42**, can be used between the positive battery terminal **36** and the current sensor **34**. The first connector **42** facilitates installation and removal of the battery **20**.

[0031] A switch **44** selectively connects a negative battery terminal **46** to a negative module terminal **48** of the bidirectional DC-DC converter module **22**. The switch **44** has a switch control input **50** that controls whether the switch **44** is open or closed. In some embodiments, the switch **44** can be a transistor, electromechanical relay, or solid-state relay. Second mating connectors **52-1** and **52-2**, referred to collectively as the second connector **52**, can be used between the negative battery terminal **46** and the switch **44** to facilitate installation and removal of the battery **20**. The DC-DC converter module **22** can include the current sensor **34** and/or the switch **44**.

[**0032**] A control module **54** receives various signals indicative of voltages and current in the rechargeable DC power supply **14**. A battery temperature input **56** connects to the battery temperature sensor **32**. A battery voltage input **58** connects to the positive battery terminal **36** and the negative battery terminal **46**. A terminal voltage input **60** connects to the positive power supply terminal **16** and the negative power supply terminal **18**. A supply voltage input **62** connects to the positive module terminal **38** and the negative module terminal **48**. A current sense input **64** connects to the current signal **40**. The control module **54** senses the load voltage through the terminal voltage inputs **60**.

[**0033**] The control module **54** also provides a number of output signals. An over-voltage protection (OVP) output **66** connects to the switch control input **50**. A current limit signal **68**, a desired output voltage signal **70**, and an enable signal **72** connect to the bidirectional DC-DC converter module **22**. The bidirectional DC-DC converter module **22** uses the current limit signal **68** to limit the battery current. The bidirectional DC-DC converter module **22** uses the desired output voltage signal **70** to establish the load voltage at the positive **16** and negative **18** power supply terminals. For example, the desired output voltage signal **70** can indicate that the load voltage should be set to a value between about 24V and 48V. The bidirectional DC-DC converter module **22** uses the enable signal **72** to turn the positive **16** and negative **18** power supply terminals on and off. The positive **16** and negative **18** power supply terminals are turned on during normal operation. However, if the rechargeable DC power supply **14** is supposed to be providing power to the load **24** and some condition prevents it from doing so, such as the battery **26** is discharged, then the controller **54** can use the enable signal **72** to turn off the positive **16** and negative **18** power supply terminals. This electrically disconnects the rechargeable DC power supply **14** from the load **24** and also prevents it from undesirably discharging the other rechargeable DC power supplies **14**.

[**0034**] A CPU **74** uses the inputs and outputs of the control module **54**. The CPU **74** executes a computer program stored in a read-only memory (ROM) **76**. The ROM **76** can include other types of non-volatile computer memory, such as, by way of non-limiting example, flash, EPROM, and/or EEPROM. The CPU **74** stores variables, such as the load voltage, battery voltage, and battery current, in a random access memory (RAM) **78**. The control module **54** can also have a bidirectional data communication port **80** in communication with the CPU **74**. A user can access the data communication port **80** and interact with the CPU **74** to read the variables from the RAM **78** and/or change the computer program stored in the ROM **76**. By way of non-limiting example, the data communication port **80** can be serial, parallel, RS-232, controller area network (CAN), and/or Ethernet.

[**0035**] Turning now to **FIG. 4**, an exploded view is shown of one of various embodiments of the rechargeable DC power supply **14**. The bidirectional DC-DC converter module **22** can be assembled on a first printed circuit board (PCB) **82**. The first PCB **82** has at least one planar area on an upper surface **84** that comes into coplanar contact with a planar heat absorbing surface **86** located on an interior of a housing **88**. The region of coplanar contact between the planar area of the first PCB **82** and the heat-absorbing surface **86** can contain a material that enhances thermal conductivity, such as a thermal compound or a thermal pad. One or more screws **90** can engage the housing **88** and bias the planar area of the first PCB **82** towards the heat-absorbing surface **86**. Springs and/or clamps can also be used to supplement, or as substitute for, the function of the screws **90**. The heat-absorbing surface **86** can include one or more recesses **92** that accommodate components positioned on the upper surface **84**. An exterior of the housing **88** can include a heat-dissipating portion **94**, such as fins, pins, fluid channels, or other structure to dissipate heat from the housing **88**.

[**0036**] Openings **96** formed in a terminal plate **98** receive the positive and negative power supply terminals **16**, **18**. The terminal plate **98** should be formed of an insulating material to prevent the positive and negative power supply terminals **16**, **18** from shorting together. Alternatively, the terminal plate **98** can be formed from a conductive material and insulators can be positioned in the openings **96** between the positive and negative power supply terminals **16**, **18** and the terminal plate **98**. The housing **88** has an opening **100** that receives the terminal plate **98** and allows the positive and negative power supply terminals **16**, **18** to connect to the first PCB **82**.

[**0037**] The control module **54** can be assembled on a second PCB **102**. The second PCB **102** has a plurality of terminals **104**, such as plated-through holes, adapted to connect to positive and negative terminals located on a top **106** of each cell **30**. Circuit traces on the second PCB **102** connect the terminals **104**. The circuit traces make the connections between the cells **30** and provide the positive and negative battery terminals **36**, **46**. An arrangement of the circuit traces depends on whether the battery **20** includes cells **30** connected in a series, parallel, or series-parallel manner. Fasteners, such as screws **108**, secure the connection between the terminals **104** and the terminals of each cell **30**. Alternatively, the terminals **104** can be adapted to connect directly to the positive and negative battery terminals **36**, **46** when the connections between the cells **30** are integral with the battery **20**.

[**0038**] A connector **110** can be located on the second PCB **102** to make the connection between the battery temperature sensor **32** and the control module **54**. One or more straps **112** can urge the cells **30** together. The straps **112** can help reduce bending moments or other stresses in the second PCB **102**.

[**0039**] A positive battery cable **114**, a negative battery cable **116**, and a ribbon cable **118** provide connections between the first PCB **82** and the second PCB **102**. The positive battery cable **114** has one end connected to the positive battery terminal **36** formed on the second PCB **102**. The other end of the positive battery cable **114** is fitted with the first mating connector **42-1**. The first mating connector **42-1** connects to the second mating connector **42-2**, which mounts on the first PCB **82**. The negative battery cable **116** has one end connected to the negative battery terminal **46** formed on the second PCB **102**. The other end of the negative battery cable **116** is fitted with the first mating connector **52-1**. The first mating connector **52-1** connects to the second mating connector **52-2**, which mounts on the first PCB **82**. One end of the ribbon cable **118** connects to the first PCB **82** and the other end connects to the second PCB **102**. The ends of the ribbon cable **118** can be fitted with connectors **120**, **122** that plug into mating connectors on the first and second PCBs **82**, **102**. The ribbon cable **118** carries the control module **54** signals between the first and second PCBs **82**, **102**. In some embodiments, all hardware except the positive and negative power supply terminals **16**, **18** and the battery temperature sensor **32**, can be on a single PCB. The single PCB would then provide the functionality of the first and second PCBs **82**, **102**.

[**0040**] The second PCB **102** includes a communication connector **124** connected to the communication port **80**. The communication connector **124** aligns with an opening **126** in the housing **88**.

[**0041**] The housing **88** is adapted to nest on top of the battery **20**. In one adaptation, the housing **88** can have a peripheral ledge **128** formed around its interior. The peripheral ledge **128** rests upon a mating ledge **130** formed in a top periphery of the battery **20**. When the housing **88** nests on top of the battery **20**, the interior of the housing **88** encloses the first PCB **82**, the second PCB **102**, and the positive and negative battery terminals **36**, **46**.

[**0042**] A battery tray **132** contains the battery **20** and has upstanding portions **134** that secure to the housing **88**. The battery tray **132** can include integral mounting tabs **136**. The mounting tabs **136** facilitate fastening the rechargeable DC power supply **14** to a supporting surface. **FIG. 5** shows one of various embodiments of an assembled rechargeable DC power supply **14**.

[**0043**] Referring now to **FIG. 6**, a method **150** is shown that can be used to charge the battery **20**. The method **150** can be included in the computer software stored in the ROM **76** and executed by the CPU **74**. Control begins in start block **152** and proceeds to decision block **154**. In decision block **154**, control determines whether the battery temperature is greater than a first predetermined temperature. By way of non-limiting example, the first predetermined temperature can be about 52 deg. C. Control proceeds to block **156** when the determination of decision block **154** yields an affirmative result. In block **156**, control determines a charging current that is approximately equal to one-third of an amp*hour (Ah) rating of the battery **20**. For example, if the battery has a rating of 85 Ah, then control will determine the charging current to be about 28 amperes.

[**0044**] Control proceeds from block **156** to block **158** and determines whether the battery temperature is greater that a second predetermined temperature. In some embodiments, the second predetermined temperature is, by way of non-limiting example, 60 deg. C. Control discontinues charging and proceeds to exit block **160** when the determination of decision block **158** yields an affirmative result. Alternatively, control proceeds to decision block **162** when the determination of decision block **158** yields a negative result. In decision block **162**, control determines whether a battery temperature rate of change is greater than a predetermined rate of change. In some embodiments, by way of non-limiting example, the predetermined rate of change is about 12 deg. C./hr. Control returns to block **156** when the determination of decision block **162** yields a negative result. Alternatively, control proceeds to decision block **164** when the determination of decision block **162** yields an affirmative result.

[**0045**] In decision block **164**, control determines whether the battery temperature is greater than a third predetermined temperature. In some embodiments, by way of non-limiting example, the third predetermined temperature is about 35 deg. C. When the determination of decision block **164** yields a negative result, control proceeds to block **166** and determines a state of charge (SOC) of the battery **20**. In block **166**, the SOC is determined by the equation

$$SOC=100\%-\mathrm{eff}(Tend-25\text{ deg. C.})$$

[**0046**] where eff is a predetermined charge acceptance efficiency of the battery **16** and Tend is the current battery temperature in deg. C. From block **166**, control proceeds to exit block **160**.

[**0047**] Alternatively, if the determination of decision block **164** yields an affirmative result, then control moves to block **168** and charges the battery at a predetermined current. In some embodiments, by way of non-limiting example, the predetermined current is approximately 5 amperes. Control then proceeds to decision block **170** and determines whether the battery temperature is above a fourth predetermined temperature. In some embodiments, by way of non-limiting example, the fourth predetermined temperature is approximately 45 deg. C. Control discontinues charging and proceeds to exit block **160** when the determination of decision block **170** yields an affirmative result. Alternatively, if the determination of decision block **170** yields a negative result, then control proceeds to decision block **172**.

[**0048**] In decision block **172** control determines whether the battery **20** is sufficiently charged to provide at least 100% of its Ah rating. If the determination of decision block **172** returns an affirmative result, then control proceeds to block **174**. Alternatively, if the determination in decision block **172** returns a negative result, then control proceeds to decision block **176**. In decision block **176**, control determines whether the battery temperature rate of change is greater than a second predetermined rate of change. In some embodiments, by way of non-limiting example, the second predetermined rate of change is about 12 deg. C./hr. Control returns to block **168** when the determination of decision block **176** yields a negative result. Alternatively, control proceeds to block **174** when the determination of decision block **176** yields an affirmative result. In block **174**, control sets the SOC equal to 100%, discontinues charging, and then proceeds to exit block **160**.

[**0049**] The applicant has found the various predetermined values disclosed herein to be suitable for use with a particular type of NiMH battery **16** having an 85 Ah rating. It is appreciated by those skilled in the art that the predetermined values will vary with the type and Ah rating of the battery **20**.

[**0050**] Those skilled in the art can now appreciate from the foregoing description that the broad teachings of the present invention can be implemented in a variety of forms. Therefore, while this invention has been described in connection with particular examples thereof, the true scope of the invention should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, the specification and the following claims.

What is claimed is:

1. A telecommunication switching station, comprising:

telecommunication equipment;

a DC power supply having an output connected to said telecommunication equipment; and

a plurality of rechargeable DC power supplies connected in parallel with said output of said DC power supply, each including:

a pair of power supply terminals;

a rechargeable battery; and

a bidirectional DC-DC converter module connected between said rechargeable battery and said pair of power supply terminals, wherein said DC power supply provides power to said telecommunication equipment and recharges said plurality of rechargeable DC power supplies and said plurality of rechargeable DC power supplies serve as a back-up for said DC power supply.

2. The telecommunication switching station of claim 1 wherein each of said rechargeable DC power supplies further includes:

a control module that communicates an enable signal to a respective one of said bidirectional DC-DC converter modules, wherein said respective bidirectional DC-DC converter module selectively creates an open circuit condition between said pair of power supply terminals in accordance with said enable signal.

3. The telecommunication switching station of claim 2 wherein each of said rechargeable DC power supplies further includes:

a data communication port in communication with a respective one of said control modules.

4. The telecommunication switching station of claim 2 wherein each of said rechargeable DC power supplies further includes:

a battery temperature sensor positioned in proximity of a respective one of said rechargeable batteries and providing a battery temperature signal to a respective one of said control modules.

5. The telecommunication switching station of claim 4 wherein each said battery temperature sensor is positioned inside of said respective one of said rechargeable batteries.

6. The telecommunication switching station of claim 2 wherein each of said rechargeable DC power supplies further includes:

a current sensor providing a signal to a respective one of said control modules and being connected between a respective one of said rechargeable batteries and a respective one of said bidirectional DC-DC converter modules.

7. The telecommunication switching station of claim 6 wherein said signal is indicative of a magnitude and direction of current flow through said respective one of said rechargeable batteries.

8. The telecommunication switching station of claim 1 wherein each of said rechargeable DC power supplies further includes:

a switch having a control input and being connected between a respective one of said rechargeable batteries and a respective one of said bidirectional DC-DC converter modules and wherein said switch opens and closes in response to said control input.

9. The telecommunication switching station of claim 1 wherein each of said control modules further communicates a desired output voltage signal to said respective one of said bidirectional DC-DC converter modules and wherein said respective one of said bidirectional DC-DC converter modules regulates a load voltage across a respective one of said pair of power supply terminals in accordance with said desired output voltage signal.

10. A rechargeable DC power supply, comprising:

a housing including an interior, an exterior, and an integral heat sink including a heat absorbing surface formed in said interior and a heat dissipating surface formed in said exterior;

a rechargeable battery having battery terminals positioned in said interior;

power supply terminals positioned at said exterior of said housing; and

a first printed circuit board (PCB) assembly including a bidirectional DC-DC converter module connected between said battery terminals and said power supply terminals, said first PCB assembly being in coplanar contact with said heat absorbing surface.

11. The rechargeable DC power supply of claim 10 further comprising:

a battery tray connected to said housing and containing said rechargeable battery.

12. The rechargeable DC power supply of claim 10, wherein said rechargeable battery comprises a plurality of rechargeable cells having cell terminals, further comprising:

a second PCB assembly positioned on said cell terminals and having PCB traces connecting said cell terminals to form said battery terminals.

13. The rechargeable DC power supply of claim 10 wherein said housing nests on said rechargeable battery.

14. The rechargeable DC power supply of claim 12 further comprising:

a battery temperature sensor positioned in proximity of said rechargeable battery and connected said second PCB assembly.

15. The rechargeable DC power supply of claim 14 wherein said battery temperature sensor is located inside of said battery.

16. The rechargeable DC power supply of claim 10 further comprising:

a control module positioned in said interior of said housing and having a data communication port; and

a connector in communication with said data communication port and accessible from said exterior of said housing.

17. A rechargeable DC power supply system for providing power to a DC load, comprising:

a plurality of rechargeable DC power supplies, each including:

a rechargeable battery;

a pair of power supply terminals;

a bidirectional DC-DC converter module connected between said rechargeable battery and said power supply terminals; and

a controller module receiving at least one signal indicative of a condition of said rechargeable battery and communicating an enable signal to said corresponding bidirectional DC-DC converter module in accordance with said condition; and

parallel connections between said power supply terminals of said plurality of rechargeable DC power supplies and said load, wherein one of said enable signals causes a respective one of said corresponding rechargeable DC power supplies to electrically connect and disconnect from said load.

18. The rechargeable DC power supply system of claim 17 wherein each of said rechargeable DC power supplies further includes a data communication port that communicates data indicative of said condition.

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