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(54) **Surgical tables with integral power supply**

(57) A surgical table having an integral power supply, the surgical table comprising a patient support surface carried on a column, a plurality of electrical devices in the surgical table to be driven by the integral power supply, the electrical devices including a trend actuator for varying the inclination of the patient support surface relative to the horizontal, the power supply comprising a main battery for storing electrical charge and electrically connected to provide electrical power to the plurality of electrical devices, a main battery control circuit connected to the main battery for receiving electrical

power therefrom, and for monitoring the supply of power to the plurality of electrical devices from the main battery, a main battery level indicator connected to the main battery control circuit, an emergency battery for storing electrical charge and electrically connected to provide electrical power to the trend actuator, an emergency battery control circuit connected to the emergency battery for receiving electrical power therefrom and for monitoring the supply of power to the trend actuator from the emergency battery, and an emergency battery level indicator connected to the emergency battery control circuit.

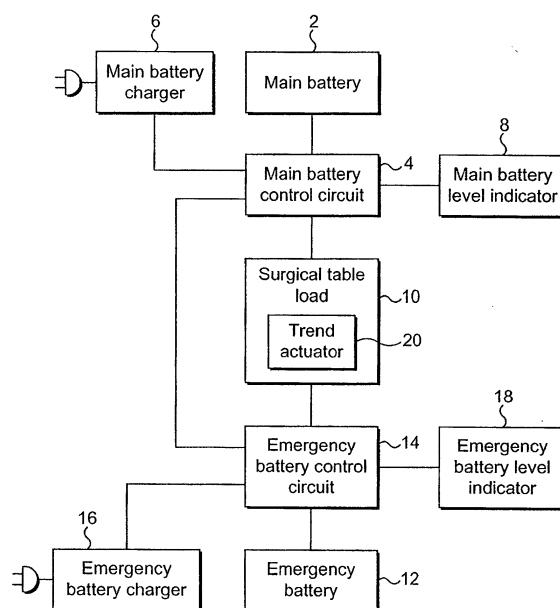


FIG. 1

Description

[0001] The present invention relates to a surgical table with an integral power supply.

[0002] Surgical tables are known which incorporate an integral power supply for driving parts of the surgical table, in particular motors for moving various parts of the surgical table so as to dispose the surgical table in a particular orientation. For example a surgical table which comprises a multi-section patient support surface carried on a column can be configured whereby sections of the patient support surface may be movable relative to each other and relative to the column and the column can be raised or lowered. The various parts of the surgical table which are movable can be driven by various actuators or drive means, for example electric motors. Furthermore, the integral power supply for the surgical table may drive other parts or functions of the surgical table, for example displays.

[0003] It is known to provide a surgical table having an integral power supply in the form of a rechargeable battery. The battery is typically charged by an integral battery charger, which can be connected to an external supply of electrical power. Since surgical tables are used in surgical procedures, it is essential that the battery remains sufficiently charged to be able to drive the table. Most particularly, it is a requirement of surgical tables that if a patient on the table suffers a cardiac arrest, an emergency source of electrical power is available in order, very quickly, in an emergency procedure, to cause the table to perform a Trendelenberg or reverse Trendelenberg movement (in both cases referred to in the art as a "trend" movement) so as to lower or raise the head of the patient.

[0004] In order to provide such emergency back-up electrical power, it is known to provide surgical tables incorporating an integral power supply in conjunction with a trolley incorporating a reserve power supply, for example back-up emergency battery, which can be quickly connected to the surgical table to provide emergency power. The need for a trolley is inconvenient in an operating theatre and can cause delays in supplying the emergency power. The emergency power must be sufficient to perform the emergency trend operation. Obviously, it is essential that the emergency back-up power is always fully operational, otherwise catastrophic results could occur. Therefore, it is necessary for the medical staff using the surgical table to be able to know with assurance that the required power is available prior to commencing an operation.

[0005] It is an aim of the present invention to provide a surgical table incorporating an improved integral power supply.

[0006] The present invention accordingly provides a surgical table having an integral power supply, the surgical table comprising a patient support surface carried on a column, a plurality of electrical devices in the surgical table to be driven by the integral power supply, the

electrical devices including a trend actuator for varying the inclination of the patient support surface relative to the horizontal, the power supply comprising a main battery for storing electrical charge and electrically connected to provide electrical power to the plurality of electrical devices, a main battery control circuit connected to the main battery for receiving electrical power therefrom, and for monitoring the supply of power to the plurality of electrical devices from the main battery, a main battery level indicator connected to the main battery control circuit, an emergency battery for storing electrical charge and electrically connected to provide electrical power to the trend actuator, an emergency battery control circuit connected to the emergency battery for receiving electrical power therefrom and for monitoring the supply of power to the trend actuator from the emergency battery, and an emergency battery level indicator connected to the emergency battery control circuit.

[0007] An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic diagram of an integral power supply for a surgical table in accordance with a first embodiment of the present invention; and

Figure 2 is a schematic operational overview of a semiconductor chip for incorporation into each of the main battery control circuit and the emergency battery control circuit of Figure 1.

[0008] Referring to Figure 1, there shown a schematic diagram of an electrical power supply integrated into a surgical table in accordance with an embodiment of the present invention. The surgical table comprises, as is conventional, a multi-section patient support surface carried on a column which can be configured whereby sections of the patient support surface may be movable relative to each other and relative to the column and the column can be raised or lowered. The various parts of the surgical table which are movable can be driven by various actuators or drive means, for example electric motors.

[0009] A main battery 2 is provided in the surgical table which is connected to a main battery control circuit 4 which monitors the charging and discharging of the main battery 2. A main battery charger 6 is connected to the main battery control circuit 4. In this embodiment, the main battery charger 6 is integral in the surgical table, but alternatively may be connectable to the surgical table. In use, the main battery charger 6 is connected to an external source of electrical power, for example mains electricity. The main battery 2 typically comprises a rechargeable battery having a typical storage capacity of 10Ah. A main battery level indicator 8 is connected to the main battery control circuit 4. The main battery control circuit 4 is also connected to the surgical table load 10, which constitutes one or more electrical devices driven by the main battery 2 acting as a power source

therefor. The surgical table load 10 therefore comprises one or more electrical motors and/or display devices.

[0010] An emergency battery 12 is also provided integrally in the surgical table 2. The emergency battery 12 is connected to an emergency battery control circuit 14 which, as for the main battery, is in turn connected to an emergency battery charger 16, which may be integral in the surgical table and is connectable to an external source of electrical power, and to an emergency battery level indicator 18. The emergency battery control circuit 14 is connected solely to a trend actuator 20 which comprises a part of the surgical table load 10. In other words, the emergency battery 12 is controlled only to operate the trend actuator 20 for performing a trend operation in an emergency situation, in the event that there is a failure of electrical power from the main battery 2.

[0011] The main battery control circuit 4 is connected to the emergency battery control circuit 14 so as to enable automatic switch over to the emergency battery 12 in the event of failure of the main battery 2.

[0012] The emergency battery 12 is a rechargeable battery which typically has a capacity of 1.2Ah. Thus typically, the emergency battery has electrical capacity which is about an order of magnitude less than that of the main battery 2. The charge stored in the emergency battery 12 is typically sufficient to give enough power to drive a fully loaded table, in other words a surgical table loaded with a patient having a weight corresponding to the maximum design load of the table, for 2.5 minutes to ensure that a trend operation can be carried out by the trend actuator 20.

[0013] The main battery control circuit 4 and the emergency battery control circuit 14 are each required to give the user of the table an accurate measure of the amount of use left in each of the main battery 2 and the emergency battery 12 respectively. It is imperative that this measure is accurate to a few percent so that there is no danger of the batteries failing to drive the table when required. It is obviously essential to know the state of the charge of the emergency battery 12, because prior to commencing any surgical procedure the surgical team must be satisfied that in the event of failure of the main battery 2, sufficient charge is present on the emergency battery 12 to drive at least the trend actuator 20 of the table.

[0014] Each battery control circuit 4, 14 is embodied in a semiconductor chip which accumulates a measure of charge and discharge currents as well as an estimation of the self-discharge of the respective battery 2, 12, and also compensates the charging current for charging rate and temperature. The chip provides an output to the respective battery level indicator 8, 18 which is temperature compensated, which indicates the actual state of charge of the respective battery 2, 12.

[0015] The control circuits 4, 14 therefore calculate a value representative of the cumulative amount of charge (in Coulombs) fed to the respective battery by the re-

spective charger. The amount of charge is calculated from the value of the charge current and time, together with charging rate and temperature. The control circuit also calculates the cumulative discharge of electrical charge (in Coulombs) from the respective battery, the discharge being a result of a discharge current fed to the surgical table load or from self-discharge of the battery over time. The discharge of the battery as a result of powering the surgical table load is compensated, dependent on the load taken by the discharge current, and the self-discharge of a battery is compensated for load and temperature. These two values of accumulated charge and accumulated discharge are employed to calculate a nominal available charge (NAC) of the battery which, following a temperature translation, is employed to indicate the actual state of charge of the respective battery at that particular point in time.

[0016] An operational overview of the chip is shown in Figure 2. A charge current for the respective battery fed on input line 22 is fed to a charge rate and compensation device 24 whereby a total charge signal is outputted on line 26 which has been compensated for the charging rate and for temperature. Only current fed into and out of the battery is measured on line 22 and any current flowing from the charger directly to the load is not measured. This may be achieved for example by monitoring a voltage drop across a sense resistor which is in series with the zero voltage line of the battery and the load/charger circuit. If charged activity is detected, the chip sends a signal on line 26 to increment a numerical value representative of the accumulated charge, in a nominal available charge (NAC) register 28. The signal on line 26 is a positive input for incrementing the charge value in the NAC register 28. Typically, the chip detects charge activity for incrementation of the NAC register 28 only when the charge voltage is greater than 250 micro volts. The NAC register 28 calculates the cumulative charge on an incremental basis, in order to give a numerical indicator of total possible charge of the battery.

[0017] The value of the discharge current is fed on a line 30 to a load compensation device 32, which in turn provides an output to the NAC register 28 on line 34. This is a negative input for the NAC register 28 so as to decrease the charge value in the NAC register 28. An output on line 36 from a self-discharge timer for the respective battery is fed to a load and temperature compensation device 38. The self-discharge timer is preset with predetermined values of the proportion of charge lost per day for the particular battery type employed. The load and temperature compensation device 38 sends an output to the NAC register 28 on line 40, which is also a negative signal causing a decrease in the charge in the NAC register 28.

[0018] The load and temperature compensation device 38 also sends an output signal on line 42 to a discharge count register (DCR) 44. The discharge count register 44 also receives a signal on line 46 from the

load compensation device 32. Both of the signals fed to the discharge count register 44 are positive signals leading to an increment in the amount of measured discharge as a result of the discharge current and the self-discharge of the battery.

[0019] The discharge count register in turn sends a qualified transfer signal on line 48 to a last measured discharge register (LMD) 50. The chip uses the last measured discharge register (LMD) 50 as a "measured full" reference at the commencement of each charging cycle. The last measured discharge register (LMD) 50 is set to the programmed full count value representing a preset nominally full value for the battery. The chip then adjusts the contents of the NAC register 28 based on the measured discharge of the battery from full to empty based on the preceding discharge cycle. Accordingly, the chip lowers the value for the battery capacity and takes account of component errors and battery differences, particularly due to variations in battery capacity over successive charging cycles. The LMD register 50 provides a signal on line 52 to the NAC register 28 so that the value of the charge in the NAC register 28 is compensated for battery capacity.

[0020] The NAC register 28 provides an output on line 54 to a temperature translation device 56 which compensates the value for actual temperature. The temperature translation device 56 has an output on line 58 which is fed to a chip-controlled available charge LED display 60 of the respective battery level indicator 8, 18.

[0021] The LED display 60 may comprise a variety of different displays. For example, the display may indicate the amount of charge in the battery using a five-segment display that indicates to a user a graphical representation of the charge state in equal 20% steps. Alternatively, the energy display may have a green LED indicating charge of 80% or above, an amber LED indicating a charge of 20% to 80% and a red LED indicating a charge of less than 20%.

[0022] The present invention accordingly provides a power supply for a surgical table which permits an integral emergency battery to be incorporated into the surgical table, complying with statutory regulations for the provision of emergency power to a surgical table to enable at least a trend operation to be carried out in the event of failure of the main power source of the surgical table. Furthermore, the power supply provides battery level indicators which indicate the actual state of charge at any particular point in time of the respective battery. Furthermore, two battery level indicators are provided, one for the main battery and one for the emergency battery to enable the surgical and medical staff immediately to determine whether or not the surgical table is sufficiently powered up to be employed in any given operation with safety.

Claims

1. A surgical table having an integral power supply, the surgical table comprising a patient support surface carried on a column, a plurality of electrical devices in the surgical table to be driven by the integral power supply, the electrical devices including a trend actuator for varying the inclination of the patient support surface relative to the horizontal, the power supply comprising a main battery for storing electrical charge and electrically connected to provide electrical power to the plurality of electrical devices, a main battery control circuit connected to the main battery for receiving electrical power therefrom, and for monitoring the supply of power to the plurality of electrical devices from the main battery, a main battery level indicator connected to the main battery control circuit, an emergency battery for storing electrical charge and electrically connected to provide electrical power to the trend actuator, an emergency battery control circuit connected to the emergency battery for receiving electrical power therefrom and for monitoring the supply of power to the trend actuator from the emergency battery, and an emergency battery level indicator connected to the emergency battery control circuit.
2. A surgical table according to claim 1 wherein each battery control circuit includes a register for calculating a value representative of the electrical charge in the battery and outputting a signal representing the value to the respective battery level indicator.
3. A surgical table according to claim 2 wherein each battery control circuit further comprises a device for calculating the input charge from a charging device, a device for calculating an output charge discharged to the plurality of electrical devices or to the trend actuator, and a device for calculating the self-discharge of the respective battery.
4. A surgical table according to claim 3 wherein the device for calculating the input charge includes a device for compensating the charging current from the charging device for the charging rate and the temperature.
5. A surgical table according to claim 3 or claim 4 wherein the device for calculating an output charge includes a device for compensating for the load supplied by a discharge current from the respective battery.
6. A surgical table according to any of claims 3 to 5 wherein the device for calculating the self-discharge of the respective battery includes a device for compensating for temperature and the load to which a self-discharge current is supplied.

7. A surgical table according to any foregoing claim wherein each battery control circuit includes a temperature translation device for compensating the output signal for temperature.

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8. A surgical table according to any foregoing claim wherein each battery level indicator includes a display for indicating the level of charge in the respective battery as a proportion of the total charge capacity of the respective battery.

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9. A surgical table having an integral power supply substantially as hereinbefore described with reference to the accompanying drawings.

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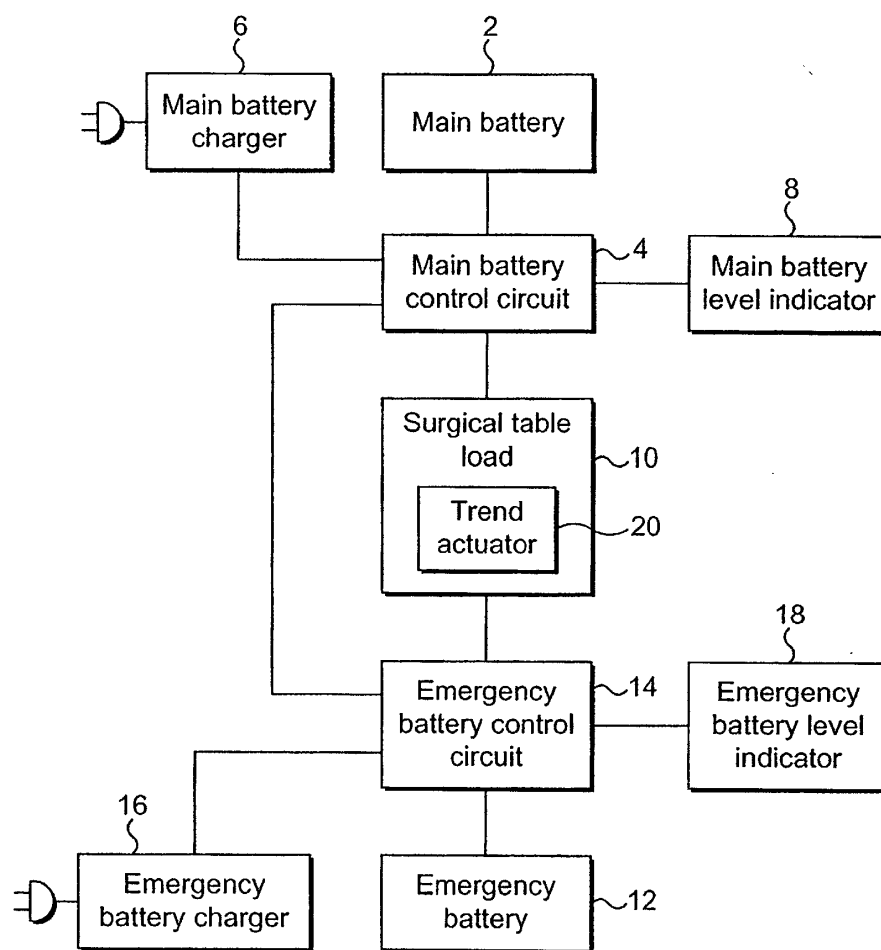
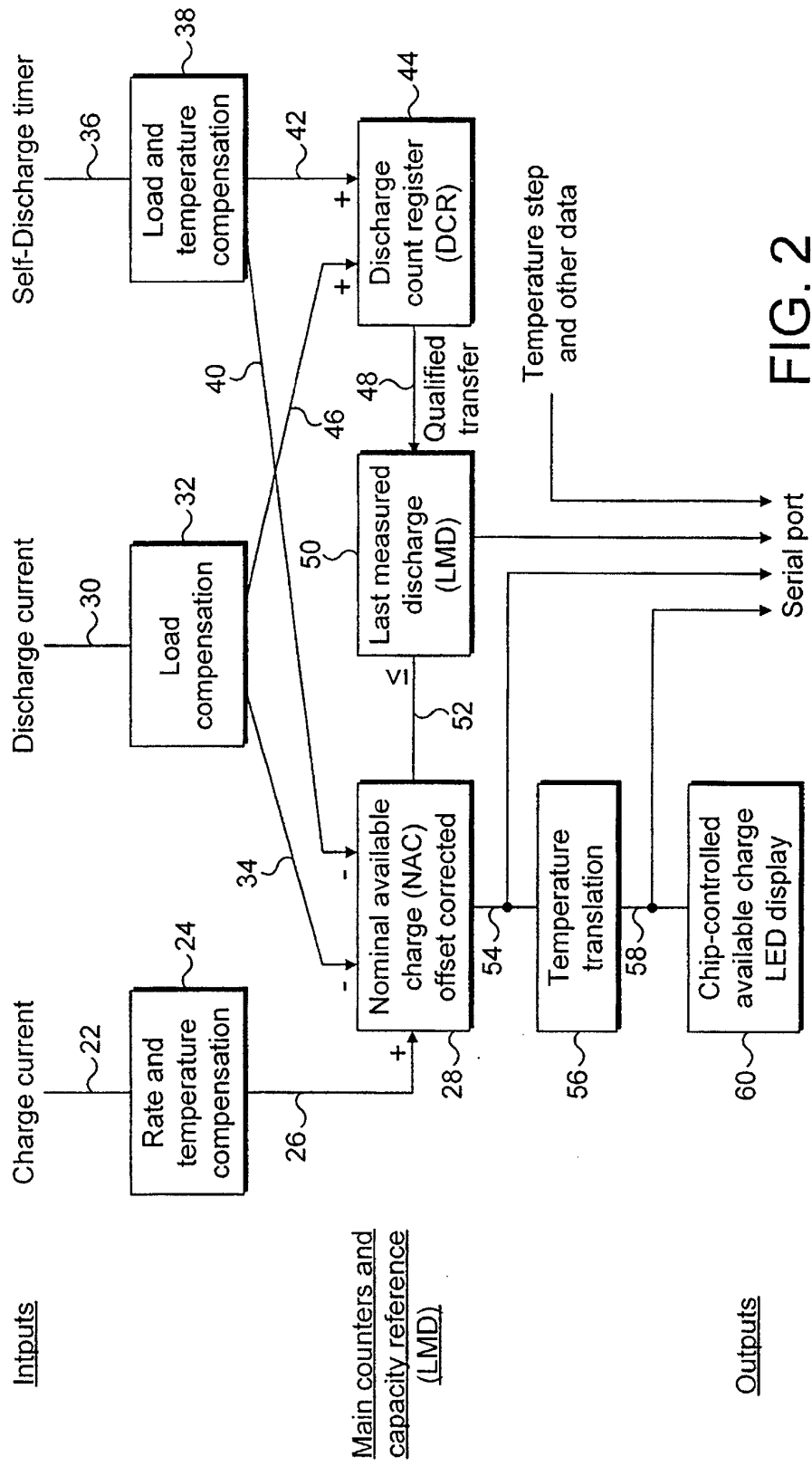


FIG. 1





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 03 25 6260

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		17 December 2003	Birlanga Pérez, J-M
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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