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(54) **CONTROL SYSTEM FOR CHARGING BATTERIES AND ELECTRONIC APPARATUS USING SAME**

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H01M 10/46 (2006.01)
H02J 9/06 (2006.01)

(52) **U.S. Cl.** **320/128**

(58) **Field of Classification Search** 320/128, 320/161, 162, 164

See application file for complete search history.

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(57) **ABSTRACT**

A control system for charging enabling efficient charging of rechargeable batteries in an electronic apparatus which charges its rechargeable batteries by using a charger circuit when driving the apparatus by using an external power source, including first detecting unit for detecting a differential value between a maximum permissible charging current allowed by the rechargeable batteries and a charging current flowing to the rechargeable batteries; second detecting unit for detecting a maximum usable current by detecting a differential value between a maximum supplyable current allowed by the external power source and the current consumption of the apparatus; third detecting unit for detecting a differential value between a maximum useable current and the charging current flowing to the rechargeable batteries; and control unit for controlling the system in accordance with the differential values detected by the first and third detecting units so that the charger circuit generates the maximum charging current within the range where the charging current flowing to the rechargeable batteries does not exceed either of the permissible charging current and the maximum useable current.

80 Claims, 15 Drawing Sheets

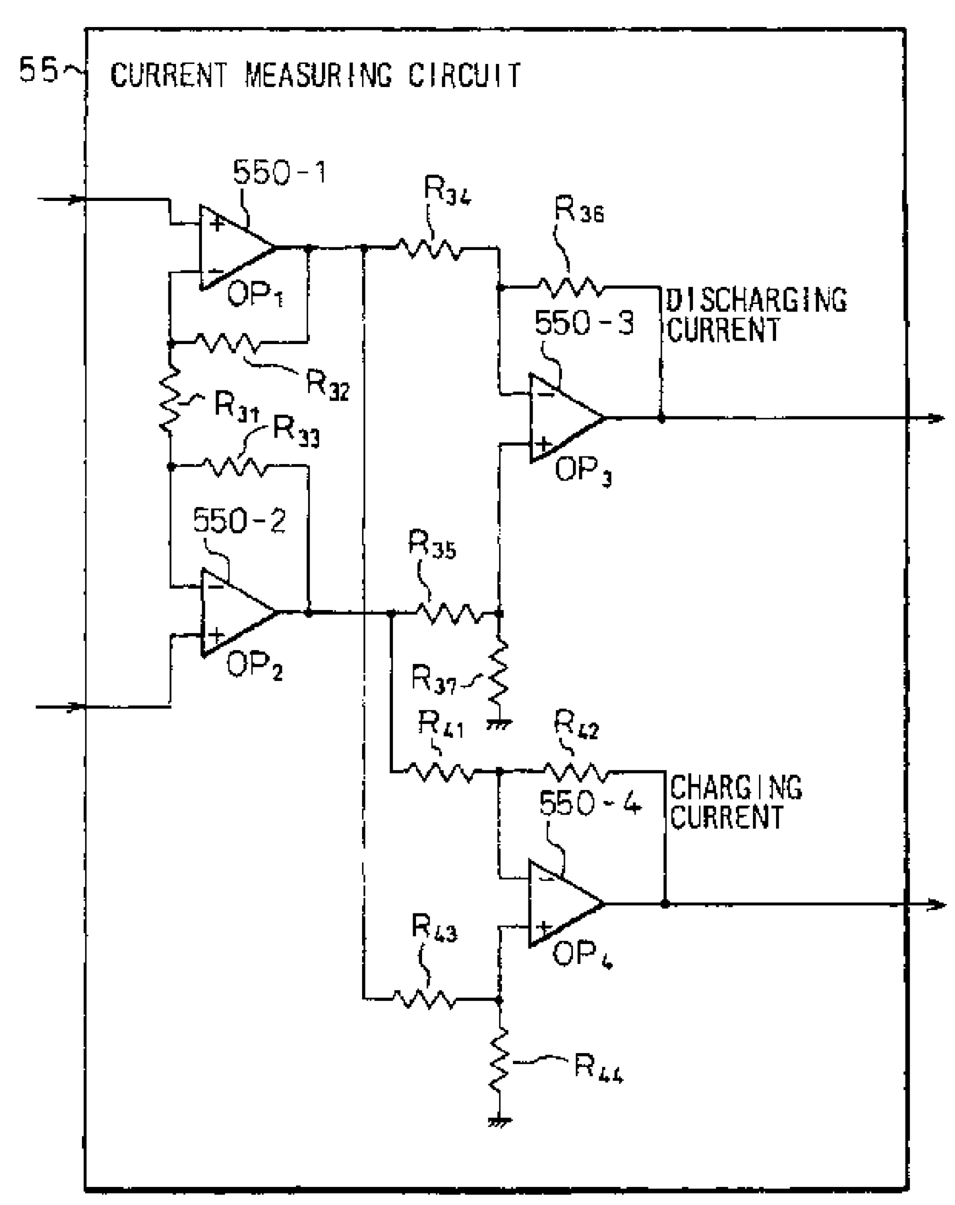

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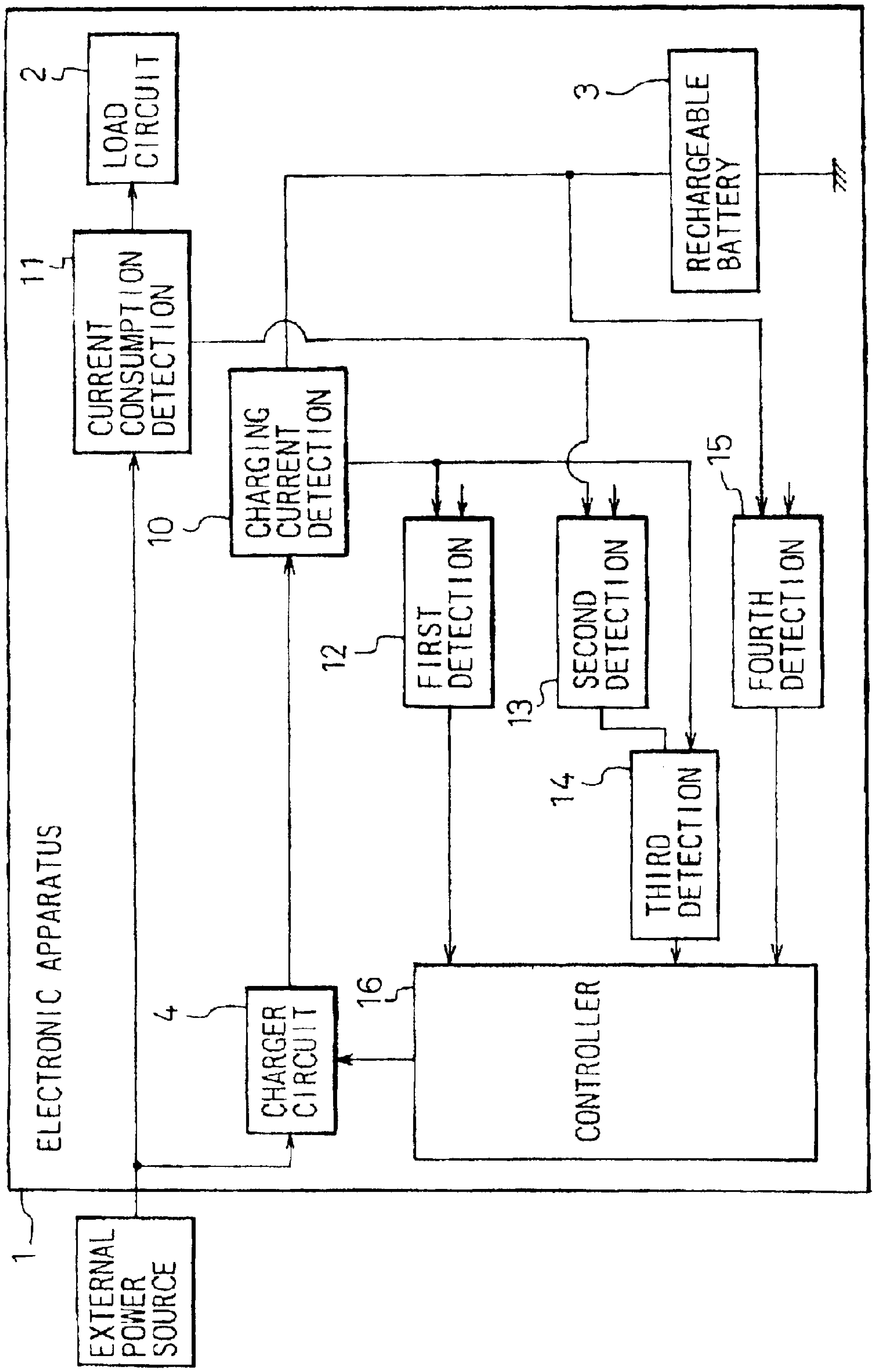
Fig.1



ELECTRONIC APPARATUS
1
EXTERNAL POWER SOURCE
2
LOAD CIRCUIT
3
RECHARGEABLE BATTERY
4
CHARGER CIRCUIT
10
CHARGING CURRENT DETECTION
11
CURRENT CONSUMPTION DETECTION
12
FIRST DETECTION
13
SECOND DETECTION
14
THIRD DETECTION
15
FOURTH DETECTION
16
CONTROLLER

Fig. 2

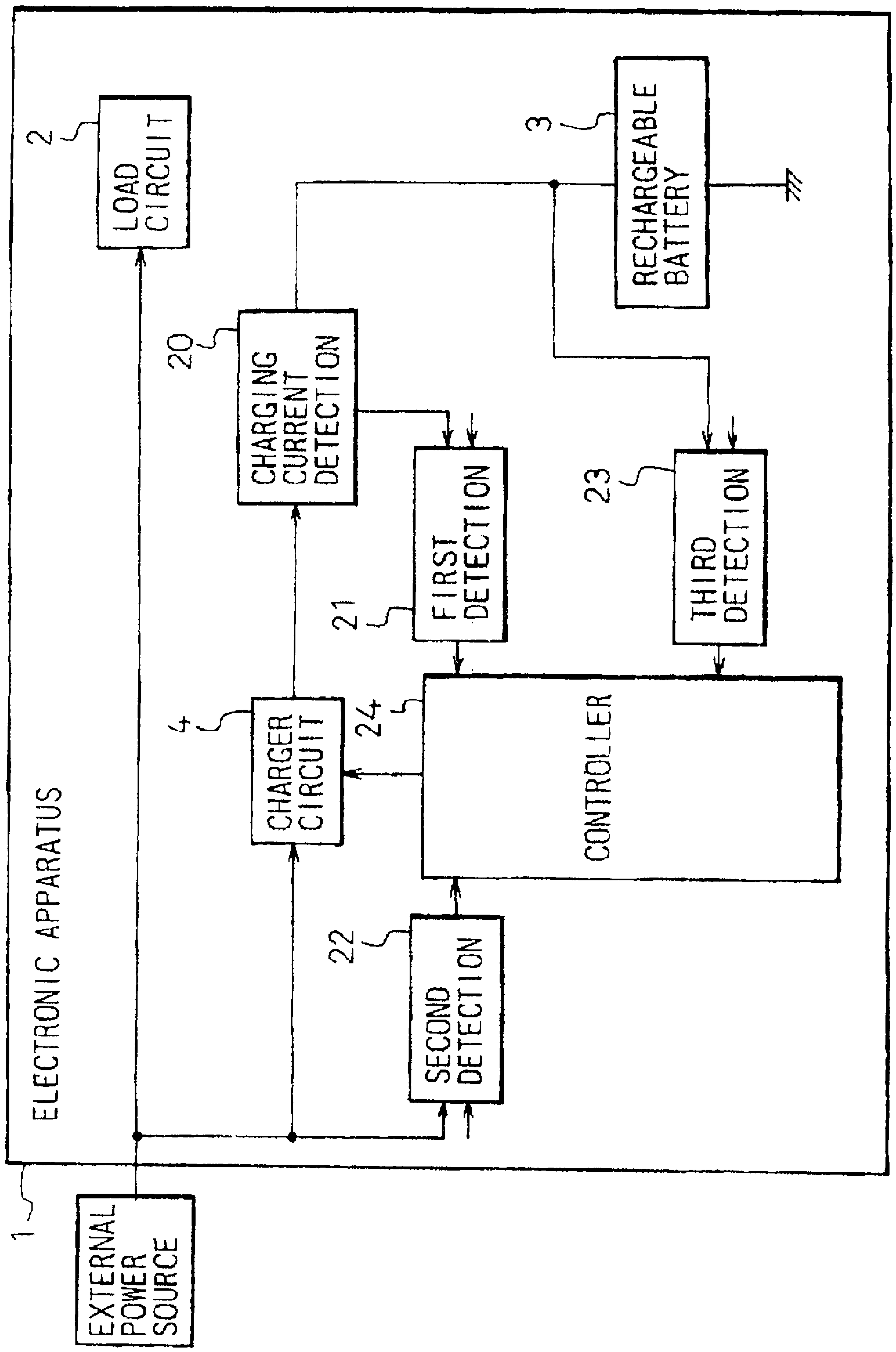

ELECTRONIC APPARATUS
EXTERNAL POWER SOURCE
1
LOAD CIRCUIT
2
RECHARGEABLE BATTERY
3
CHARGER CIRCUIT
4
CHARGING CURRENT DETECTION
20
FIRST DETECTION
21
SECOND DETECTION
22
THIRD DETECTION
23
CONTROLLER
24

Fig.3A

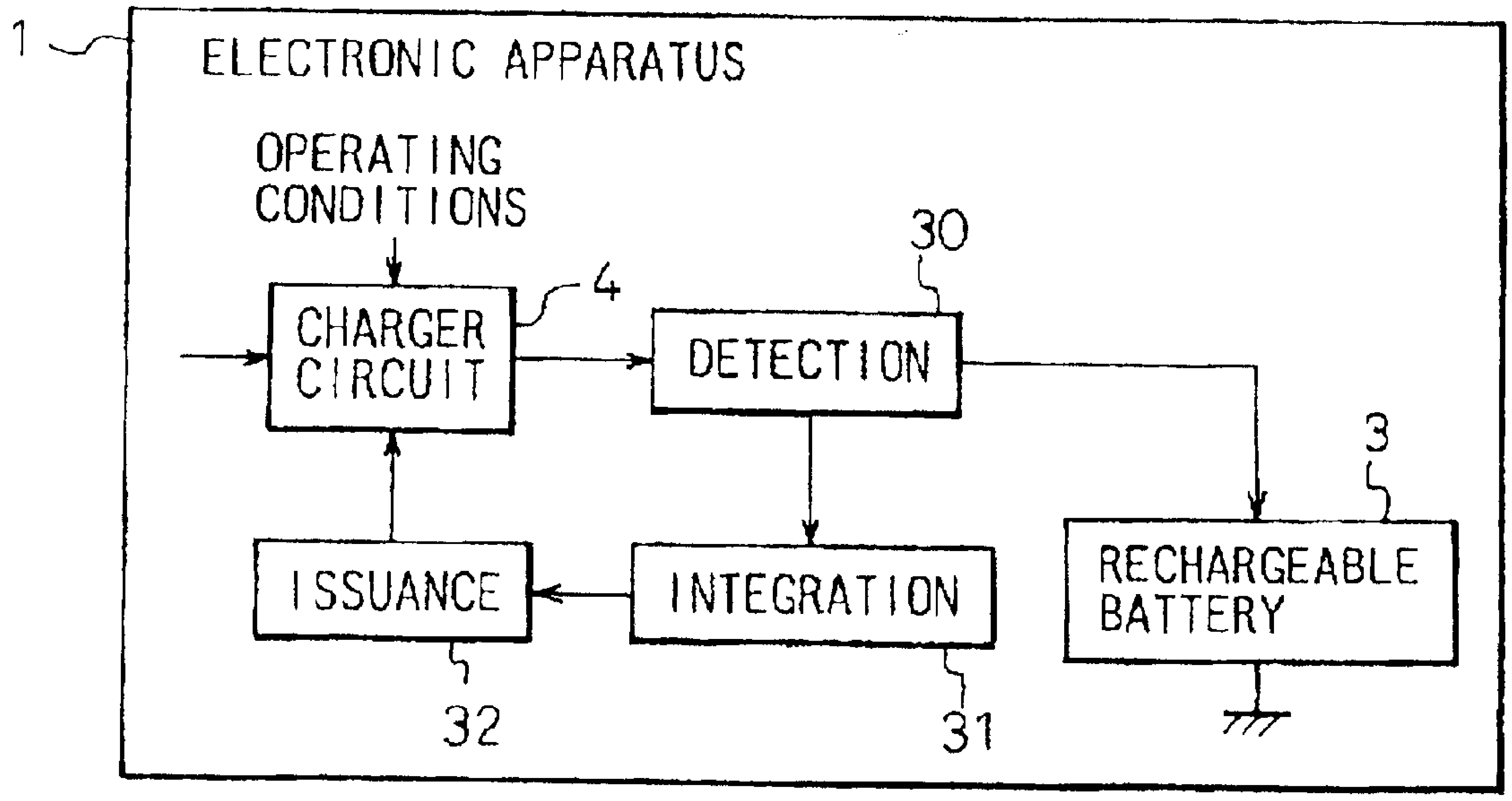

1
ELECTRONIC APPARATUS
OPERATING CONDITIONS
CHARGER CIRCUIT
4
30
DETECTION
3
RECHARGEABLE BATTERY
ISSUANCE
INTEGRATION
32
31

Fig.3B

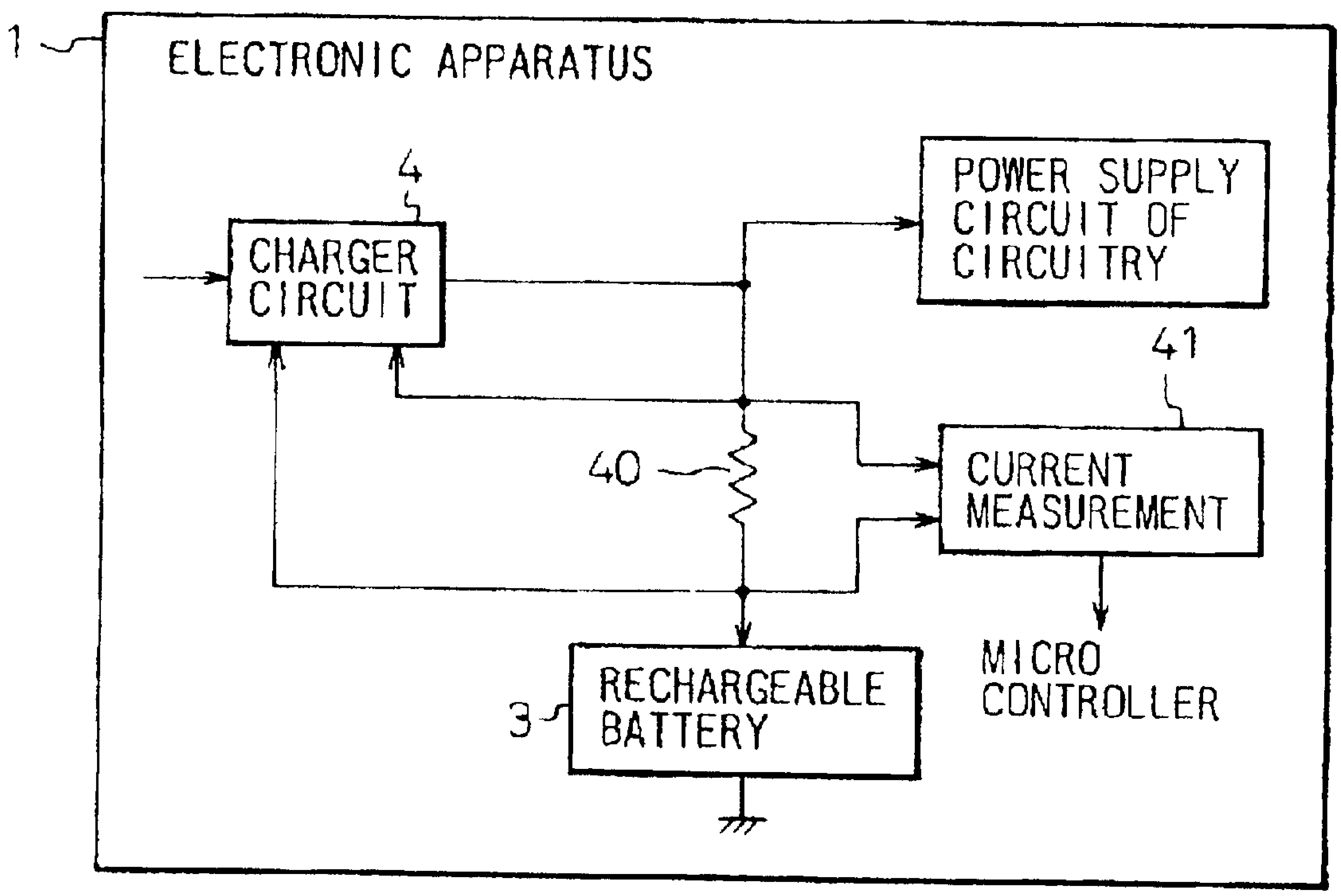

1
ELECTRONIC APPARATUS
4
CHARGER CIRCUIT
POWER SUPPLY CIRCUIT OF CIRCUITRY
41
40
CURRENT MEASUREMENT
RECHARGEABLE BATTERY
3
MICRO CONTROLLER

Fig. 4

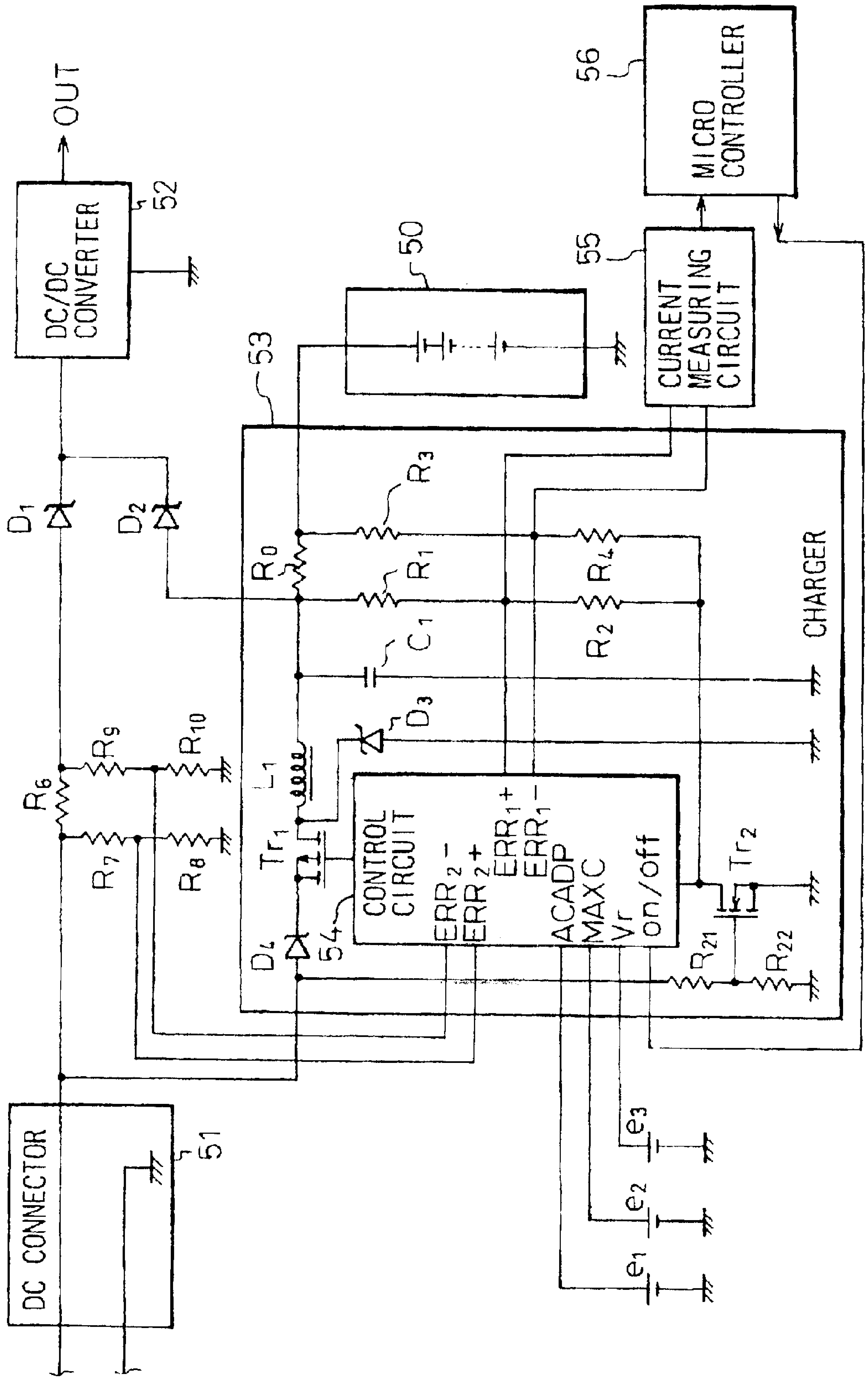
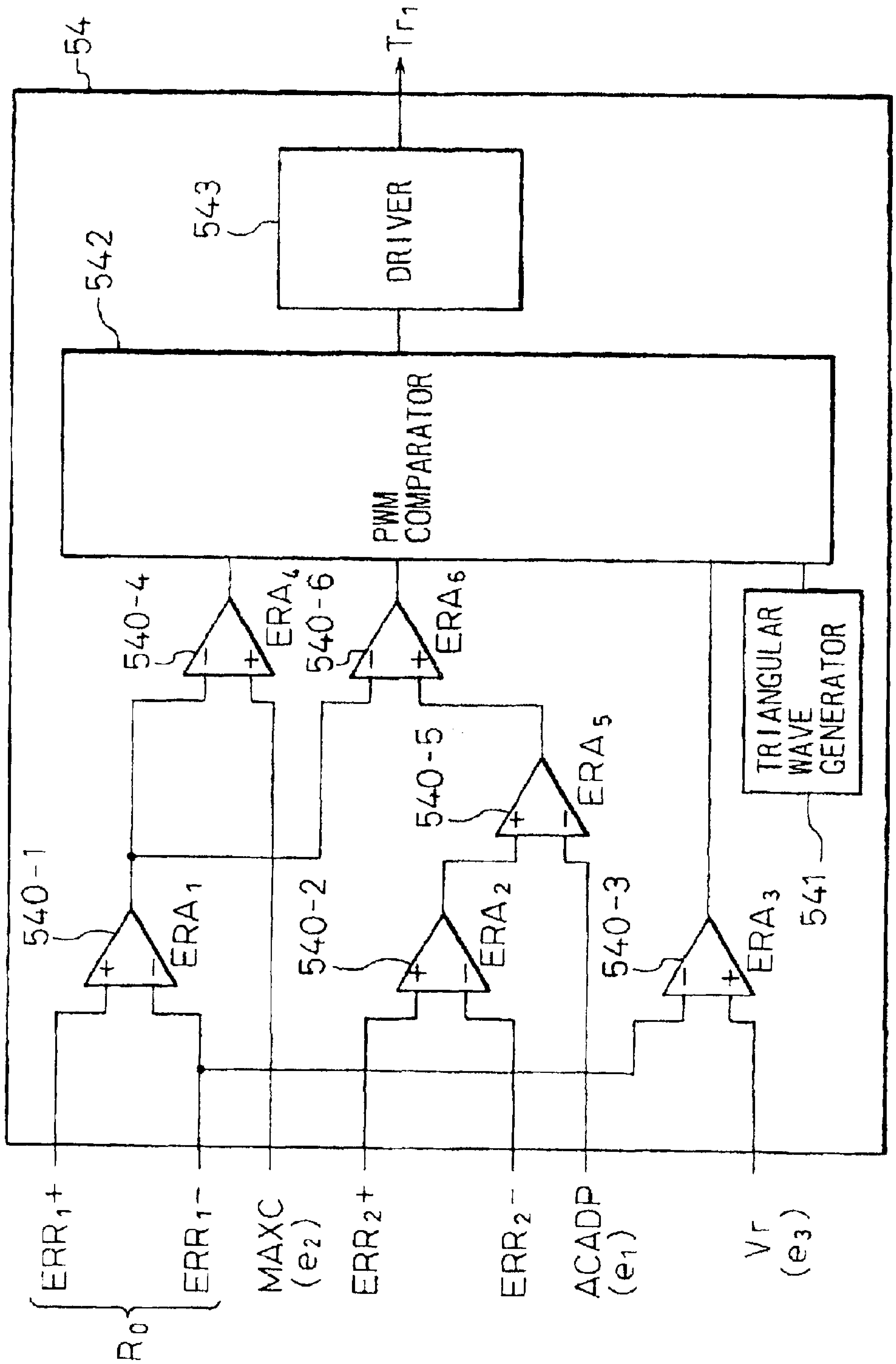

OUT
DC/DC CONVERTER
52
MICRO CONTROLLER
56
50
CURRENT MEASURING CIRCUIT
55
53
D1
D2
R0
R1
R2
R3
R4
C1
CHARGER
D3
L1
R6
R7
R8
R9
R10
Tr1
Tr2
D4
54
CONTROL CIRCUIT
ERR2−
ERR2+
ERR1+
ERR1−
ACADP
MAXC
Vr
on/off
R21
R22
e1
e2
e3
DC CONNECTOR
51

Fig. 5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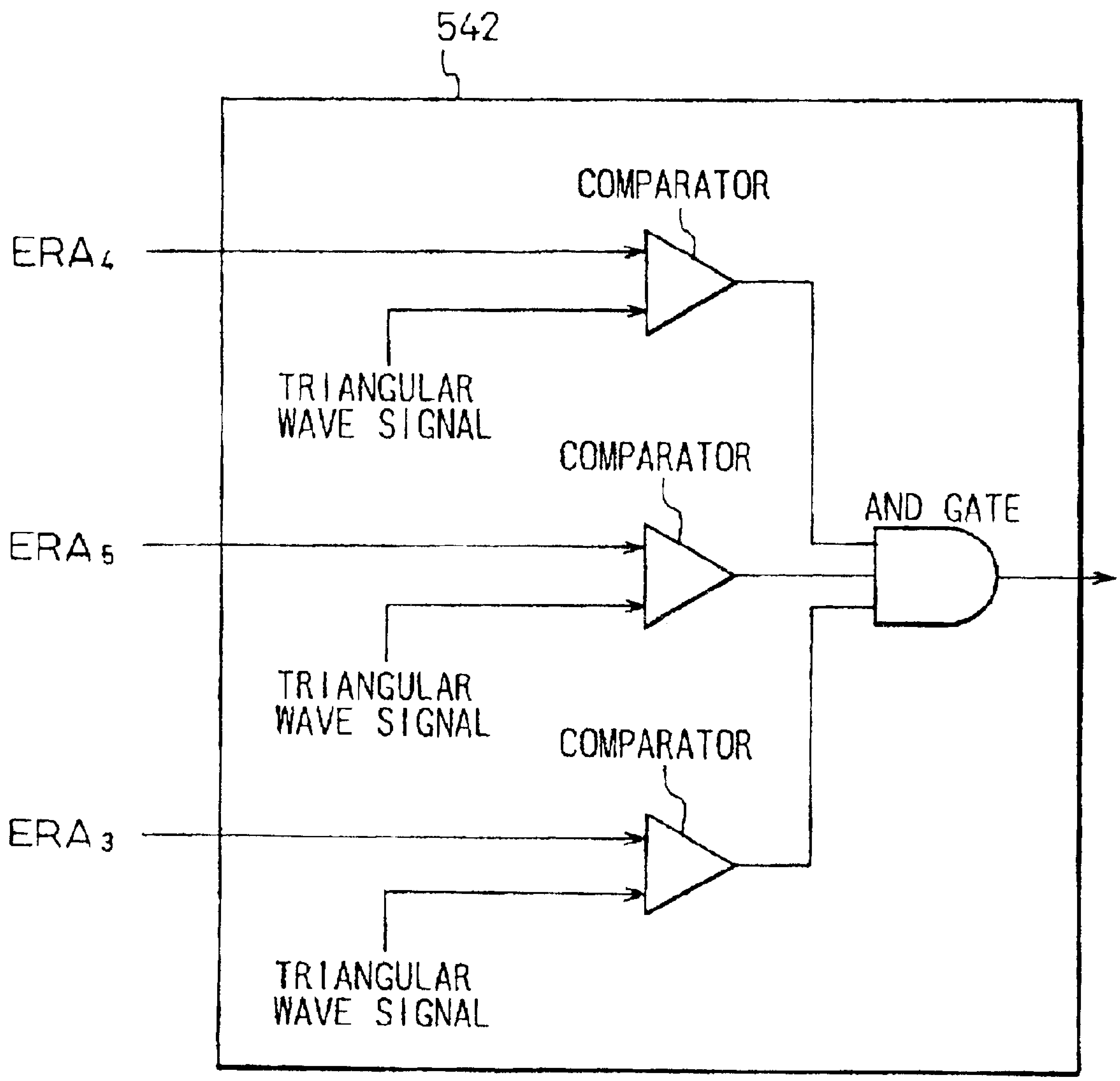
Tr1
543
DRIVER
542
PWM
COMPARATOR
540-4
ERA4
540-6
ERA6
540-5
ERA5
TRIANGULAR
WAVE
GENERATOR
541
540-1
ERA1
540-2
ERA2
540-3
ERA3
ERR1+
ERR1−
MAXC (e2)
ERR2+
ERR2−
ACADP (e1)
Vr (e3)
R0

Fig.6


542
COMPARATOR
ERA4
TRIANGULAR WAVE SIGNAL
COMPARATOR
AND GATE
ERA5
TRIANGULAR WAVE SIGNAL
COMPARATOR
ERA3
TRIANGULAR WAVE SIGNAL

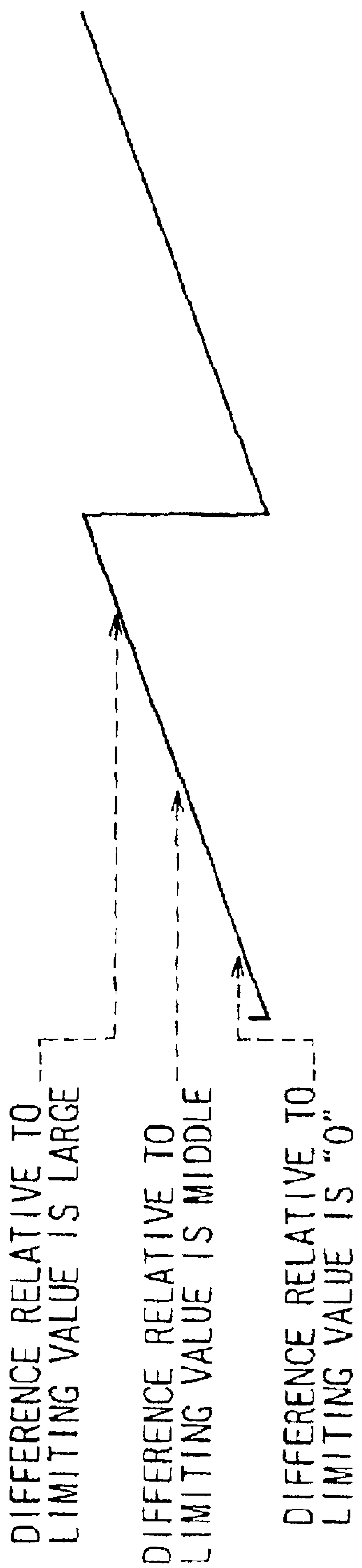

DIFFERENCE RELATIVE TO LIMITING VALUE IS LARGE
DIFFERENCE RELATIVE TO LIMITING VALUE IS MIDDLE
DIFFERENCE RELATIVE TO LIMITING VALUE IS "0"

Fig.7A

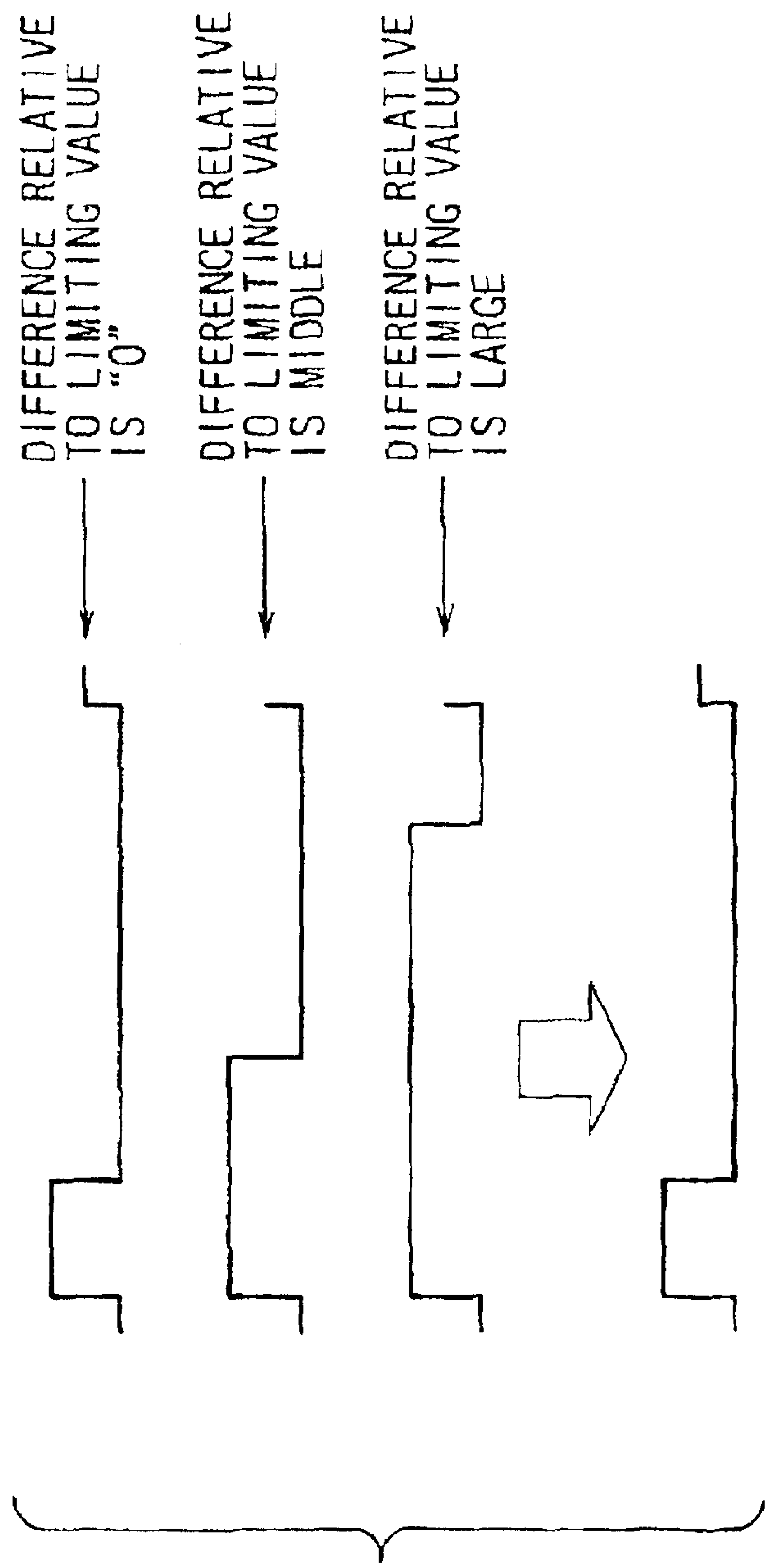
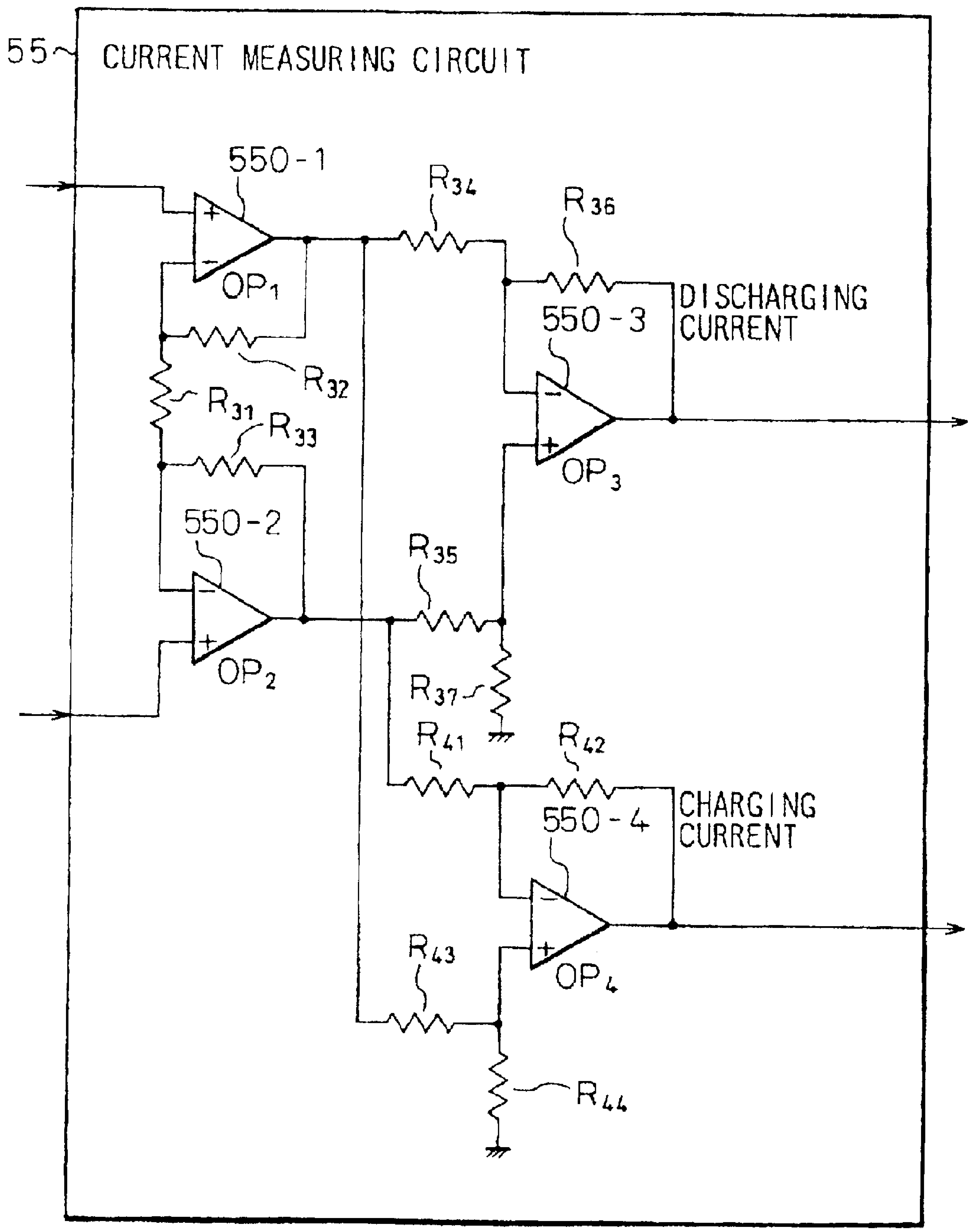

DIFFERENCE RELATIVE TO LIMITING VALUE IS "0"
DIFFERENCE RELATIVE TO LIMITING VALUE IS MIDDLE
DIFFERENCE RELATIVE TO LIMITING VALUE IS LARGE

Fig.7B

Fig.8



55
CURRENT MEASURING CIRCUIT
550-1
OP1
R32
R31
R33
550-2
OP2
R34
R36
DISCHARGING CURRENT
550-3
OP3
R35
R37
R41
R42
CHARGING CURRENT
550-4
OP4
R43
R44

Fig.9A

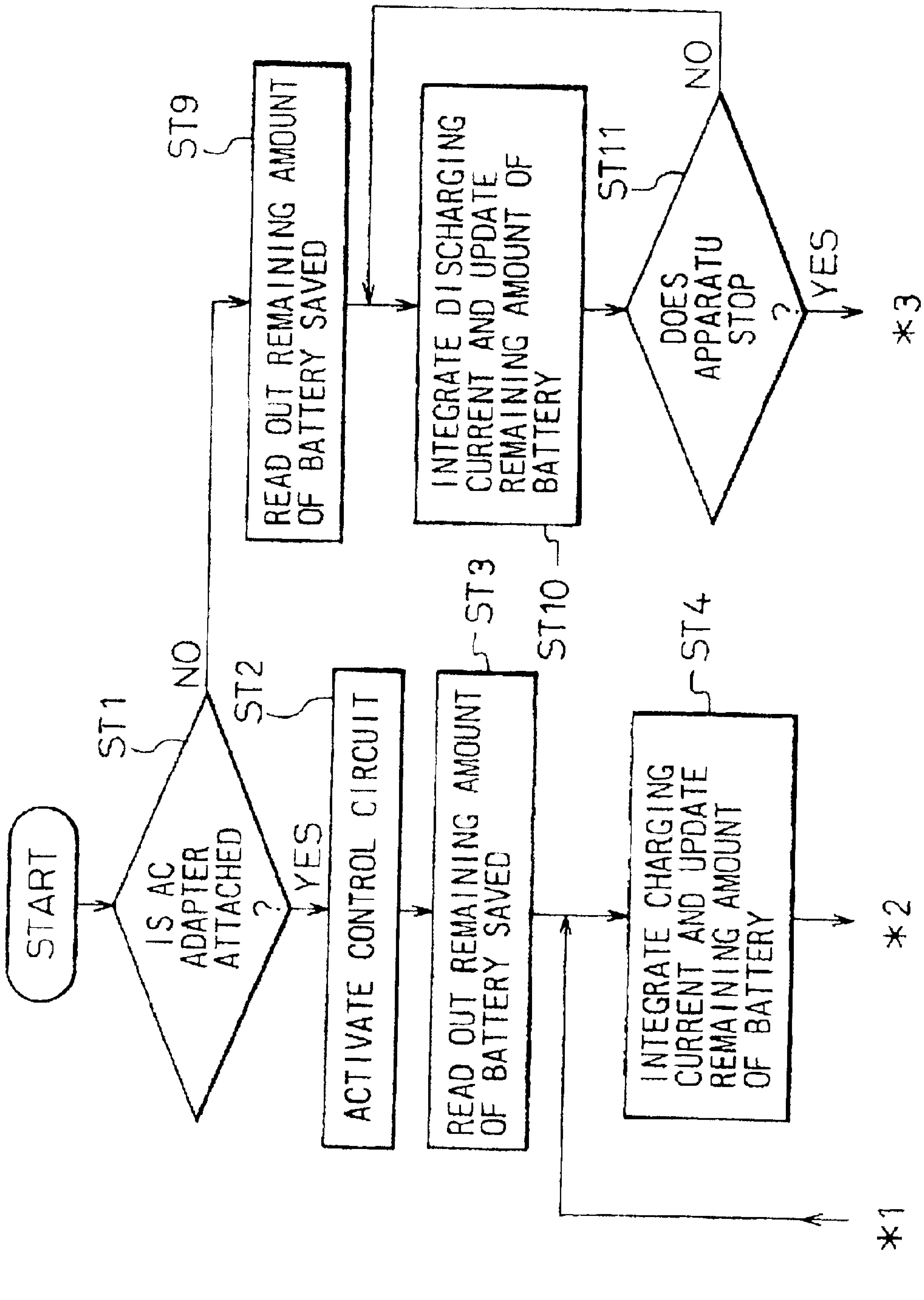

START
IS AC ADAPTER ATTACHED ?
ST1
YES
NO
ACTIVATE CONTROL CIRCUIT
ST2
READ OUT REMAINING AMOUNT OF BATTERY SAVED
ST3
INTEGRATE CHARGING CURRENT AND UPDATE REMAINING AMOUNT OF BATTERY
ST4
*2
*1
READ OUT REMAINING AMOUNT OF BATTERY SAVED
ST9
INTEGRATE DISCHARGING CURRENT AND UPDATE REMAINING AMOUNT OF BATTERY
ST10
DOES APPARATU STOP ?
ST11
NO
YES
*3

Fig.9B

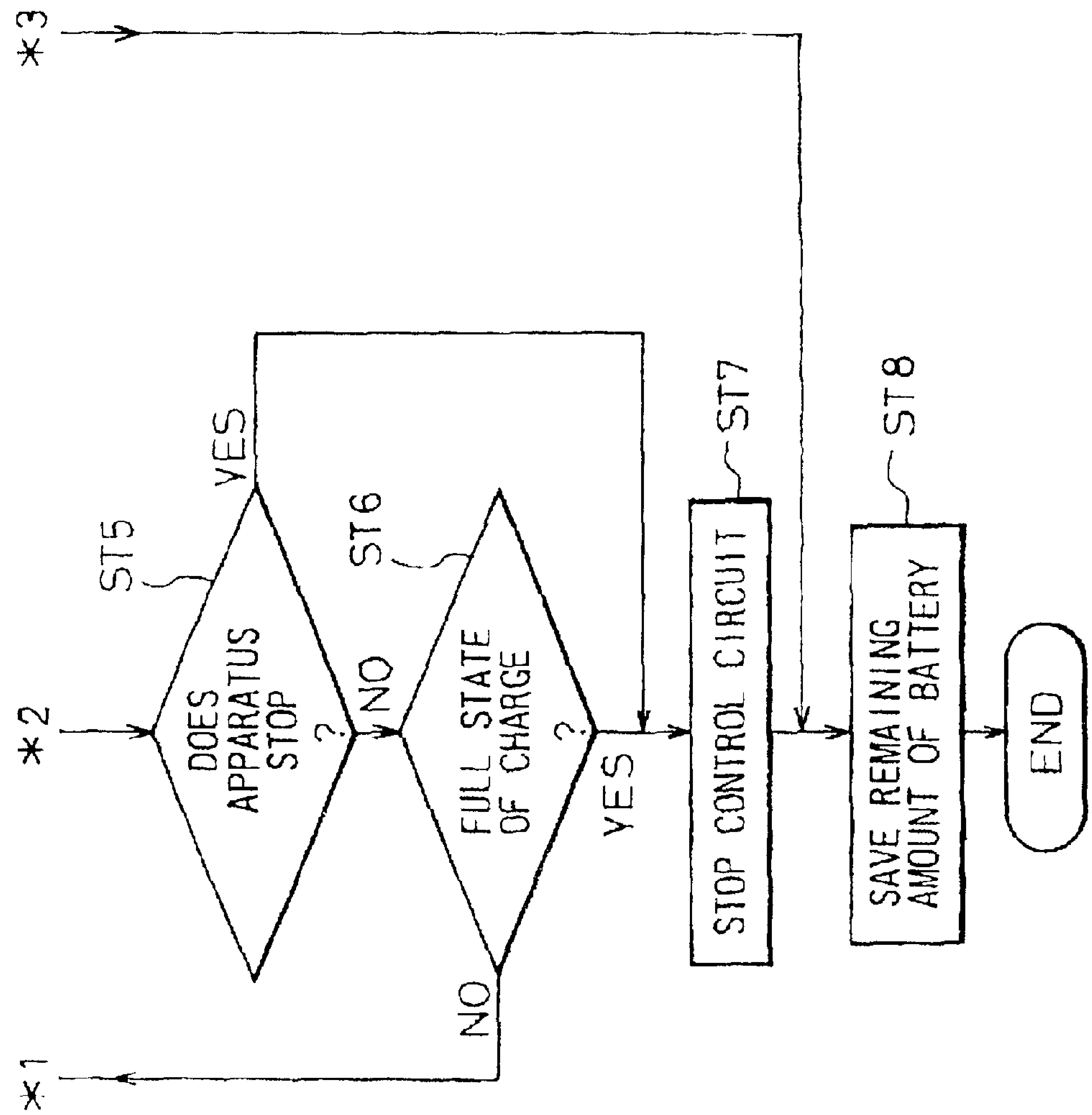

*2
*1
*3
ST5
DOES APPARATUS STOP ?
YES
NO
ST6
FULL STATE OF CHARGE ?
YES
NO
ST7
STOP CONTROL CIRCUIT
ST8
SAVE REMAINING AMOUNT OF BATTERY
END

Fig.10

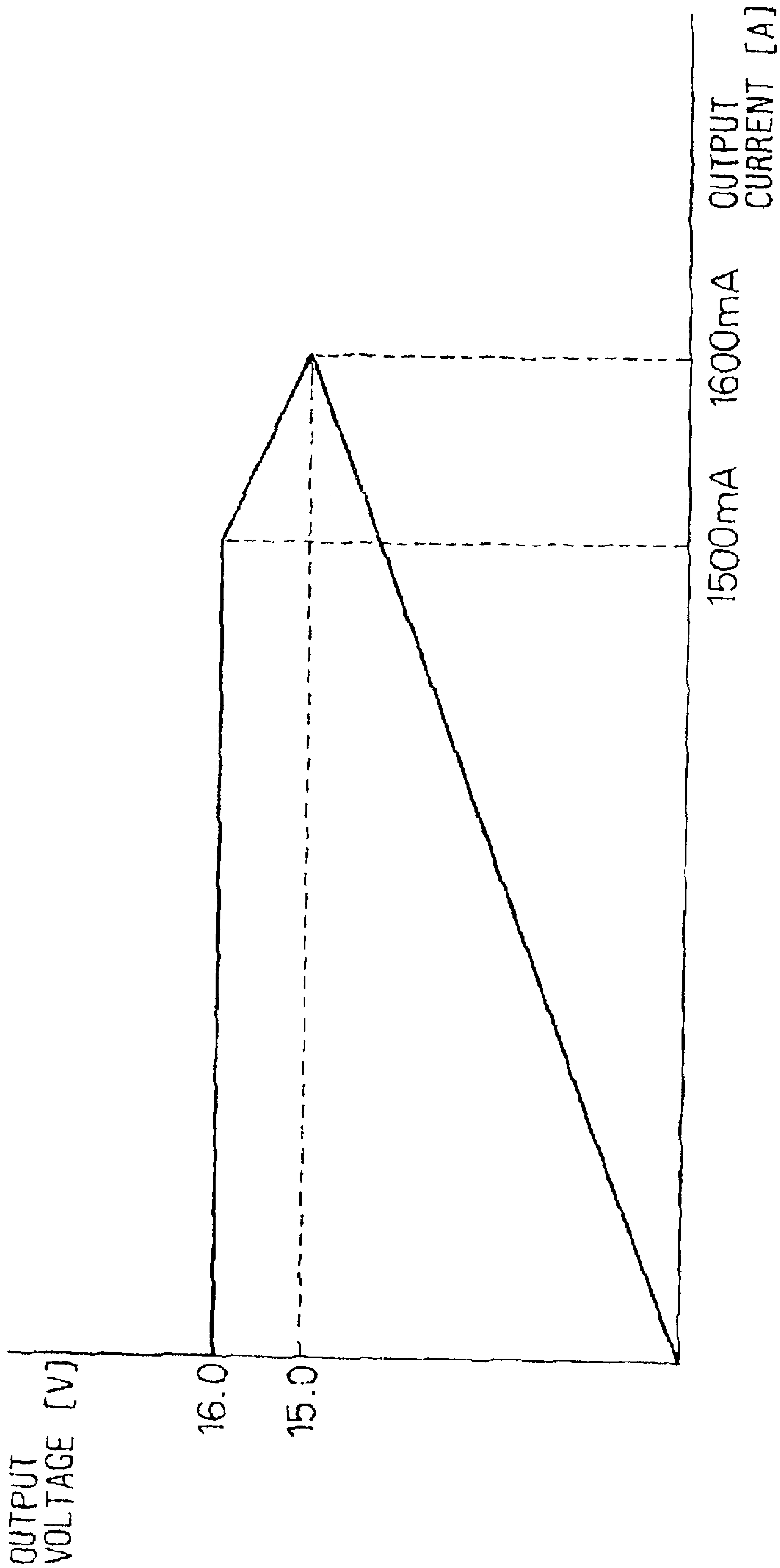


Fig. 11

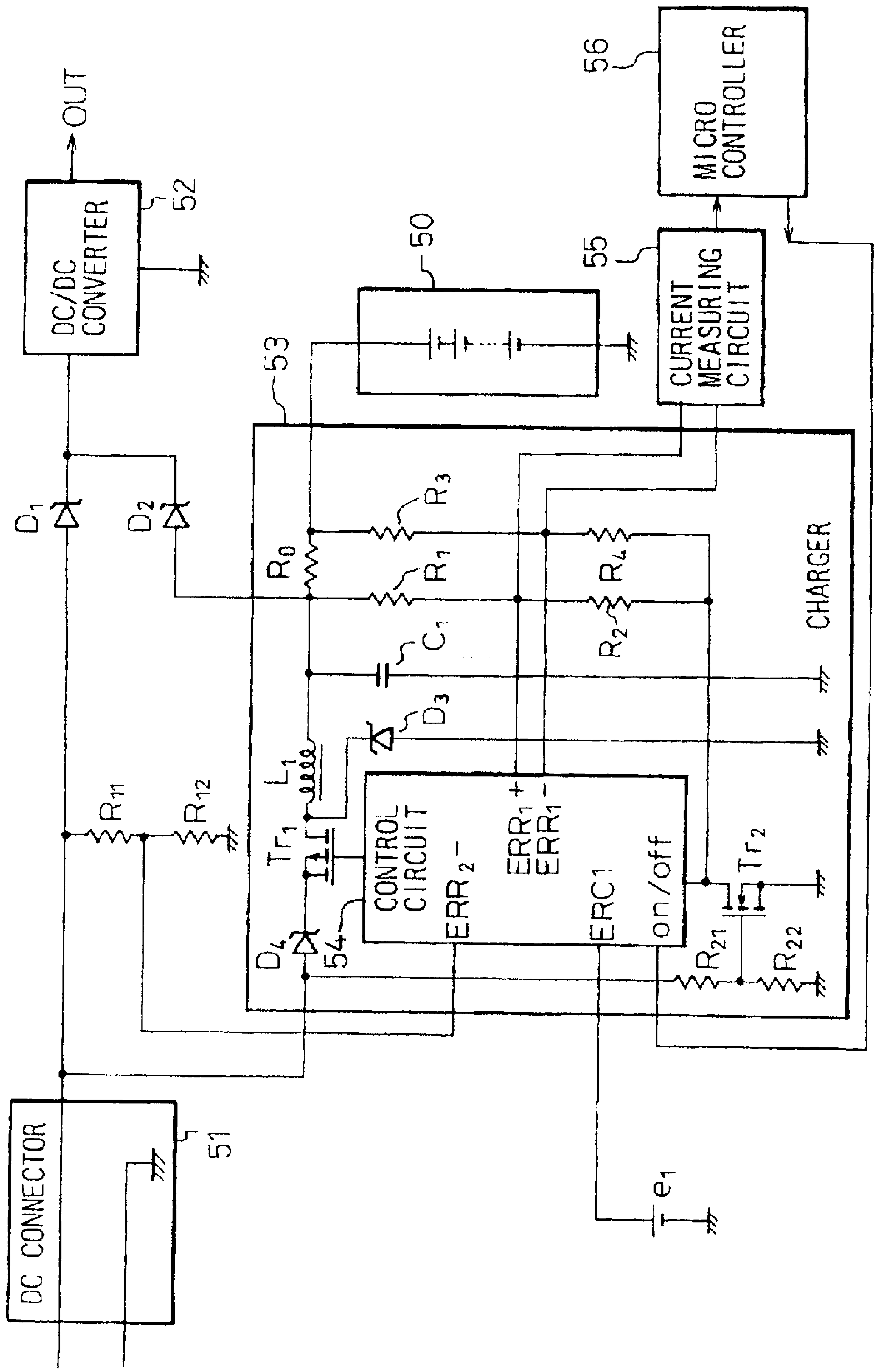

OUT
DC/DC CONVERTER
52
56
MICRO CONTROLLER
55
CURRENT MEASURING CIRCUIT
50
53
D1
D2
R0
R1
R2
R3
R4
C1
D3
L1
Tr1
CONTROL CIRCUIT
54
ERR2 −
ERR1 +
ERR1 −
ERC1
on/off
Tr2
R21
R22
D4
R11
R12
CHARGER
DC CONNECTOR
51
e1

Fig.12

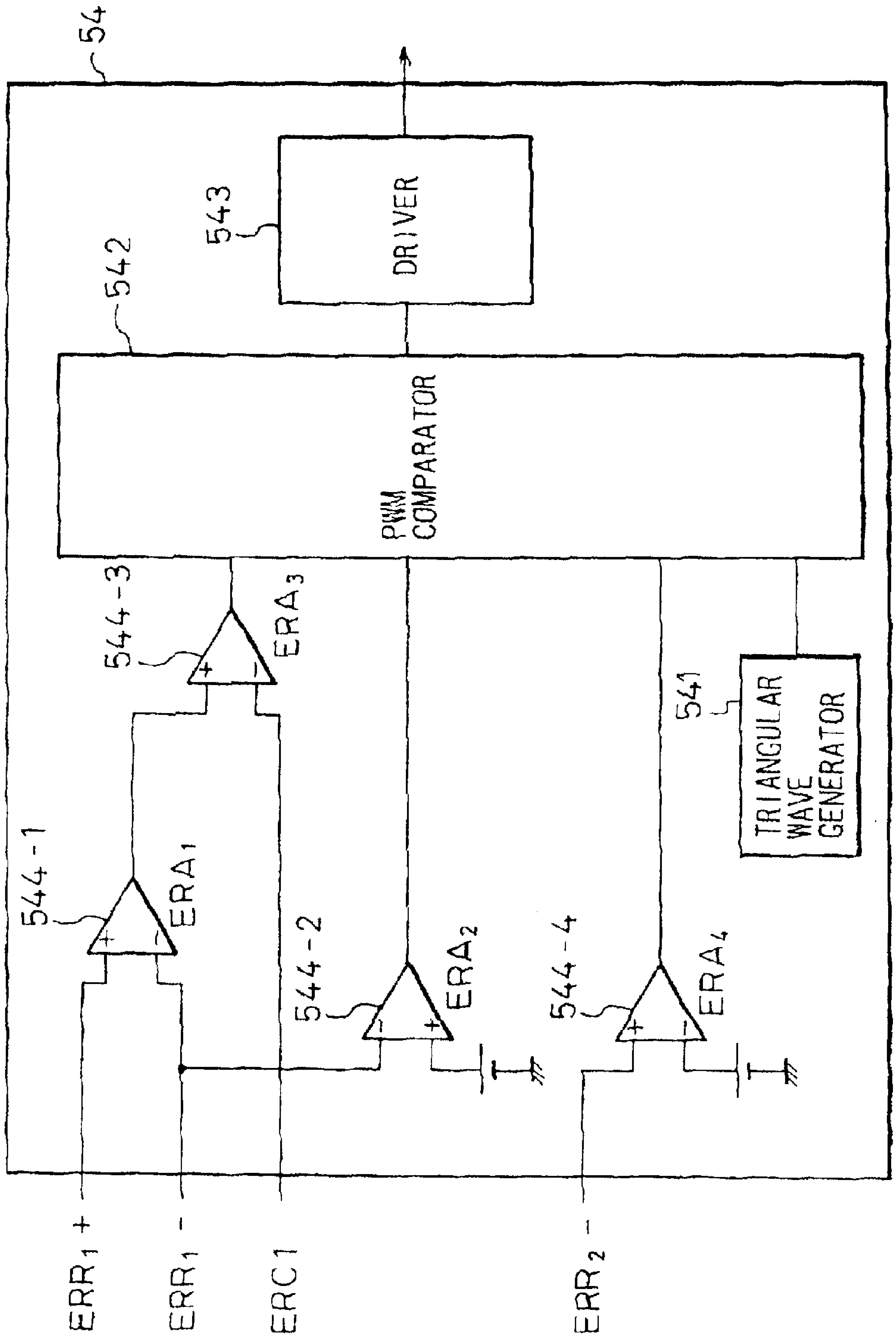

54
543
DRIVER
542
PWM
COMPARATOR
544-3
ERA3
544-1
ERA1
544-2
ERA2
544-4
ERA4
541
TRIANGULAR
WAVE
GENERATOR
ERR1 +
ERR1 −
ERC1
ERR2 −

Fig.13
PRIOR ART

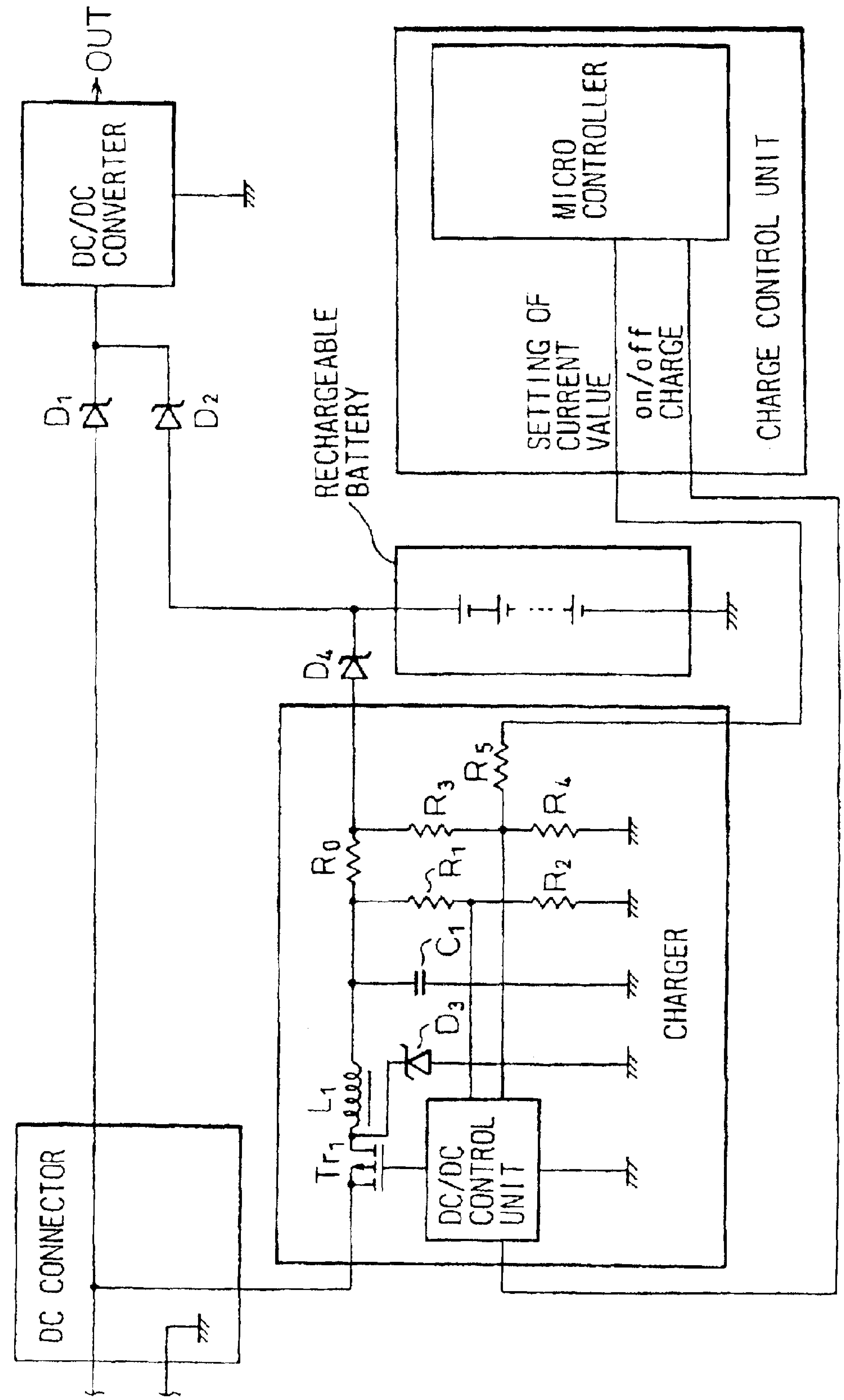
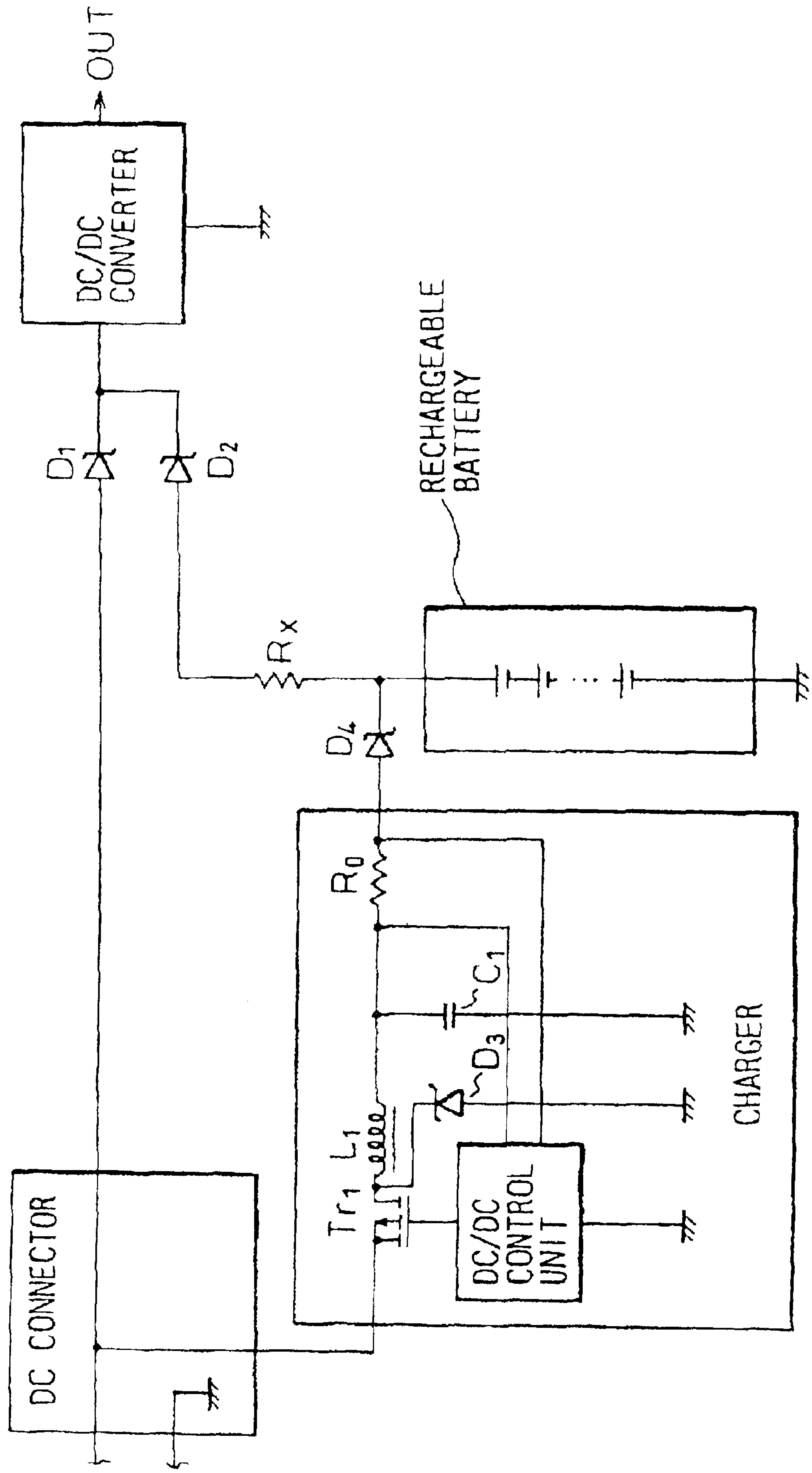


Fig. 14
PRIOR ART



CONTROL SYSTEM FOR CHARGING BATTERIES AND ELECTRONIC APPARATUS USING SAME

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This application is a reissue of U.S. application Ser. No. 08/578,805, now U.S. Pat. No. 5,739,667. More than one reissue application has been filed for the reissue of U.S. Pat. No. 5,739,667. The reissue applications are Ser. No. 10/383,068 and the instant application Ser. No. 09/548,213.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a control system for charging which enables efficient charging of rechargeable batteries, a control system for charging which enables accurate charging of the rechargeable batteries, and an electronic apparatus which enables measurement of the charging/discharging current of the rechargeable batteries by a simple configuration.

2. Description of the Related Art

A portable electronic apparatus such as a notebook computer carries batteries as the power supply for the apparatus. Generally, rechargeable batteries (rechargeable batteries) such as NiCd, NiMH (nickel metal hydride), or Li+ batteries are mounted due to the operating costs of the apparatus, the desire for an instantaneously dischargable current capacity, etc. Also, there are many examples in which a charger is built in so as to enable easy charging of the rechargeable batteries mounted inside the apparatus by just connecting an AC adapter etc. to the apparatus.

In such a portable electronic apparatus, usually the internal rechargeable batteries are used as the power supply of the apparatus, but when operating the apparatus on a desk etc., the apparatus is also operated while drawing power from an external power source through an AC adapter.

If the power which can be supplied from the AC adapter connected to the apparatus is sufficiently larger than the maximum power used by the apparatus and the maximum power necessary for the charging of the rechargeable batteries, it is possible to simultaneously operate the apparatus and charge the internal rechargeable batteries. However, where the capability of the AC adapter is smaller than this, supply of power for both of the operation of the apparatus and the charging of the internal batteries becomes impossible. Therefore, just one of them is performed in accordance with the status of use of the apparatus. AC adapters actually used for such apparatuses are limited in the amount of power which they can supply due to cost and size factors. In general, it is a rare that both operations are simultaneously carried out

Usually, so as to minimize the cost and size of the AC adapter, generally the capability of the AC adapter is set to the larger of the poorer necessary for the charging of the internal rechargeable batteries and the maximum power to be used by the apparatus. Also, in an apparatus designed to operate on the batteries, generally the power for charging the internal rechargeable batteries is larger than the maximum power consumption of the apparatus. This is because if the reverse were true, then the time during which the apparatus could be operated on the batteries would become shorter than the time required for charging the batteries. This would not be practical for a commercial apparatus.

In view of this situation, up until now the method has been adopted of having the charger which is mounted inside the apparatus constantly monitor the status of the apparatus and charge the rechargeable batteries when the power switch of the apparatus is turned OFF, stop the charging to the rechargeable batteries when the power switch of the apparatus has been turned ON, and restart the charging when the power switch of the apparatus is returned to the OFF position. Namely, in this configuration, the charging to the rechargeable batteries was earned out when the apparatus was not being operated and the charging to the rechargeable batteries was stopped when the apparatus was being operated.

With this setup, however, when there is excess capability of the AC adapter, efficient charging cannot be performed. Therefore, recently, the method has been adopted wherein, where the capability of the AC adapter is larger by a certain extent than the maximum power to be used by the apparatus, when the power switch of the apparatus is turned ON, the current for charging the rechargeable batteries is lowered and the charging is continued, and when the power switch of the apparatus is turned OFF, the charging is carried out by the original charging current. Namely, in this configuration, when the apparatus is not being operated, a large charging current is generated for charging the rechargeable batteries, while when the apparatus is being operated, a small charging current is generated for charging the rechargeable batteries.

In a conventional charging system having such a configuration, as will be explained in detail later with reference to the drawings, usually the completion of the charging is detected by using the “history control technique”, that is, monitoring the elapse of time, and “maximum temperature control technique”, that is, monitoring the maximum temperature. Between these two, the most widely used technique has been the detection of the completion of charging by monitoring the elapse of time from the start of the charging.

Further, there are sometimes demands for measurement of the discharging current of the rechargeable batteries as well in such charging processing. Conventionally, such demands have been met by the technique of preparing, separately from a first sense resistor for detecting the charging current of the rechargeable batteries, a second sense resistor for detecting the charging current of the rechargeable batteries and detecting the discharging current of the rechargeable batteries using this second sense resistor.

However, there was a problem in that efficient charging was not possible when, as in the related art, a larger of two levels of charging current was generated for charging the rechargeable batteries when the power switch of the apparatus is turned OFF and a smaller of two levels of charging current was generated for charging the rechargeable batteries when the power switch of the apparatus is turned ON.

Namely, according to this related art the magnitude of the charging current must be set irrespective of the magnitude of the current consumed by the apparatus, so the charging current when the power switch of the apparatus is turned ON must be set to the lowest level, that is, the one for when the current consumption becomes the greatest. Due to this, there was a problem in mat the charging was not performed using the capability of the external power source such as the AC adapter to the fullest extent.

Also, when the power switch of the apparatus was left in the ON position, irrespective of whether or not the apparatus was actually being operated, the rechargeable batteries were charged with a small charging current. Therefore, there was a problem that efficient charging was not performed.

If a method of detecting the completion of charging of the rechargeable batteries by monitoring the elapse of time from the start of the charging is adopted as in the related art where the charging current generated by the charger dynamically changes, there was a problem that the completion of charging of the rechargeable batteries could not be accurately detected.

Further, if the method is adopted of preparing a sense resistor for detecting the charging current of the rechargeable batteries and a separate sense resistor for detecting the discharging current of the rechargeable batteries as in the related art, there was a problem mat two sense resistors became necessary and therefore the charging/discharging current of the rechargeable batteries could not be measured by a simple configuration.

SUMMARY OF THE INVENTION

The present invention was made in consideration with this situation and has as its object to provide a novel control system for charging which enables efficient charging of rechargeable batteries, to provide a novel control system for charging which enables accurate charging of the rechargeable batteries, and to provide a novel electronic apparatus which enables the charging/discharging current of the rechargeable batteries to be measured by a simple configuration.

To attain the above object the present invention provides a control system for charging in an electronic apparatus which charges its rechargeable batteries by using a charger circuit when driving the apparatus by using an external power source, including a first detecting means for detecting a differential value between a maximum permissible charging current allowed by the rechargeable batteries and a charging current flowing to the rechargeable batteries; a second detecting means for detecting a maximum usable current by detecting a differential value between a maximum supplyable current allowed by the external power source and the current consumption of the apparatus; a third detecting means for detecting a differential value between a maximum useable current and the charging current flowing to the rechargeable batteries; and a control means for controlling the system in accordance with the differential values detected by the first and third detecting means so that the charger circuit generates the maximum charging current within the range where, the purging current flowing to the rechargeable batteries does not exceed either of the maximum permissible charging current and the maximum useable current

BRIEF DESCRIPTION OF THE DRAWINGS

The above object and features of the present invention will be mare apparent from the following description of the preferred embodiments with reference to the accompanying drawings, wherein:

FIG. **1** is a view of the configuration of a first embodiment of the present invention;

FIG. **2** is a view of the configuration of a second embodiment of the present invention;

FIGS. **3**A and **3**B are views of the configurations of third and fourth embodiments of the present invention;

FIG. **4** shows a concrete example of the present invention;

FIG. **5** shows a concrete example of a control circuit;

FIG. **6** shows a concrete example of a PWM comparator;

FIGS. **7**A and **7**B are views for explaining the operation of the PWM comparator;

FIG. **8** shows a concrete example of a current measuring circuit;

FIGS. **9**A and **9**B show the flow of processing to be executed by a microcontroller;

FIG. **10** is a graph of the characteristics of an AC adapter;

FIG. **11** shows a fifth embodiment of the present invention;

FIG. **12** shows another concrete example of the control circuit;

FIG. **13** is a view for explaining the related art; and

FIG. **14** is another view for explaining the related art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the preferred embodiments of the present invention, the related art and the disadvantages therein will be described with reference to the related drawings.

A conventional configuration is illustrated in FIG. **13**.

In the figure, the rechargeable batteries are constituted by series-connected battery cells. The DC connector is a connector for receiving power from the outside when operating the apparatus on an external power source such as an AC adapter or charging the rechargeable batteries mounted inside the apparatus by the external power source such as an AC adapter. The DC/DC converter is the power supply circuit for the apparatus which receives power from the external power source supplied via the DC connector or the rechargeable batteries and produces the voltage required by the apparatus.

The charger is a constant current source for producing the power necessary for charging the rechargeable batteries when power is supplied from the outside via the DC connector. The charging control portion is a control mechanism for controlling the start of the charging of the rechargeable batteries or end of the charging in accordance with the state of the power supply from the DC connector or the operation of the apparatus and, at the same time, for controlling the magnitude of the charging current which is generated by the charger.

D_1 and D_4 are protection diodes for preventing reverse current which prevent the flow of power from the rechargeable batteries to the outside when the AC adapter is not operating due to the fact no AC power is being supplied to the AC adapter etc. D_2 is a protection diode for supplying power from the rechargeable batteries to the DC/DC converter when power is not being supplied from the outside and, at the same time, preventing the supply of any voltage supplied from the outside via the DC connector to the rechargeable batteries.

The charger is a DC-DC circuit which operates under a FWM control mode. It is constituted by an ON•OFF controlled main transistor Tr_1 for switching, a choke coil L_1, a fly-wheel diode D_3, a smoothing capacitor C_1, resistors R_0, R_1, R_2, R_3, and R_4 for controlling the current, and a DC/DC control portion for handling constant current control processing. The resistor R_0 is a sense resistor for measuring the current charged to the rechargeable batteries. The voltage drop caused by this current is divided by the resistor R_1 and the resistor R_2 and, at the same time, divided by the resistor R_3 and resistor R_4 and input to the DC-DC control portion. The resistor R_5 is a voltage-dividing resistor for controlling the sense potential of the charging current measured by the resistor R_0 and switches the magnitude of the current which is generated by changing the resistance value of the resistor R_4 which is connected in parallel.

This charger operates so as to generate arbitrarily determined currents by the resistance values of the resistors R_0, R_1, R_2, R_3, and R_4. It operates under two current modes in accordance with the valid or invalid state of the resistor R_5 indicated by the charging control portion. This constant current operation is the same as that of a regulator of a switching mode. Here, when the microcontroller side of the resistor R_5 is in the open state and low level state, the resistor R_5 becomes valid and invalid, respectively.

When the system is constituted in this way, when power is supplied from the outside by connection of the AC adapter or the like to a DC connector, the external power is supplied to the DC/DC converter via the diode D_1. The DC/DC converter produces the voltage required by the apparatus in accordance with this. At this time, the external power is blocked by the diode D_2 from being applied to the rechargeable batteries.

On the other hand, when power is supplied from the outside, the power is supplied to the rechargeable batteries and the charging carried out only when charging has been instructed and the charger is operating. When the charger stops, the circuit is cut by the main transistor Tr_1 and no power is supplied to the rechargeable batteries. If the supply of power from the outside is interrupted, the power of the rechargeable batteries is supplied to the DC/DC converter via the diode D_2, and the DC/DC converter produces the voltage required by the apparatus in accordance with it. At this time, the power is blocked by the diodes D_1 and D_4 from flowing to the outside.

When the charger operates by the supply of power from the outside, the power produced by the charger is given to the rechargeable batteries via the diode D_4, whereby the rechargeable batteries are charged. At this time, the diode D_2 is in a backward biasing state since the voltage which is input from the DC connector is higher than the voltage of the charger. Therefore, the charging current of the rechargeable batteries will not leak to the DC/DC converter side.

During this charging processing, the charging control portion controls the ON•OFF state of the charger and controls the switching of the charging current by constantly monitoring the presence/absence of supply of power from the DC connector and the ON•OFF state of the power switch of the apparatus. Namely, when power is supplied from the outside via the DC connector, when the power switch of the apparatus is in the OFF state and thereby the apparatus is not being operated, it controls the voltage on the microcontroller side of the resistor R_5 so as to generate a larger of two levels of charging currents and charge the rechargeable batteries, while when the power switch of the apparatus is in the ON state and thereby the apparatus is being operated, it controls the voltage on the microcontroller side of the resistor R_5 to generate the smaller of the two levels of charging currents and charge the rechargeable batteries.

With such charging processing, if the charging is not terminated by accurately grasping the completion of the charging, there would be a problem of an adverse effect exerted upon the rechargeable batteries, which would lead to a reduction of the service life of the batteries. For example, if there is insufficient charging, this means that the full capacity of the batteries could not be drawn upon and the operating time of the apparatus on the batteries would be reduced. Also, in rechargeable batteries such as NiCd, NiMH, and Li+ batteries, the only problem with insufficient charging would be that the rated capacity could not be obtained, but in rechargeable batteries such as lead-acid batteries, insufficient charging would cause actual deterioration of the batteries. Also, conversely, when the charging is excessively increased so as to try to fully utilize the capacity of the batteries, the batteries became overcharged, which is a cause of deterioration of batteries.

As a means for determing when the rechargeable batteries are adequately charged, there are the method of monitoring the elapse of time from the start of the charging, the method of monitoring when the voltage of the rechargeable batteries reaches the maximum voltage value, the method of monitoring when the temperature of the rechargeable batteries reaches a maximum temperature value, the method of monitoring when the rate of temperature change of the rechargeable batteries reaches a maximum rate of temperature change, and the method of using the characteristic that the voltage of the rechargeable batteries slightly drops when charging is completed (so-called $-\Delta V$ characteristic). However, when charging over a long time, that is, charging with a small charging current in comparison with the charge capacity, control by monitoring the maximum voltage, control by monitoring the maximum rate of temperature change, and control by monitoring the $-\Delta V$ characteristic are not possible.

In view of this, conventionally, as previously mentioned, usually there is adopted the method of detecting the completion of charging by using the "history control technique" and the "maximum temperature control technique". Between these two, the former, that is, the technique of detecting the completion of charging by monitoring the elapse of time from the start of charging has been particularly widely used.

Also, as previously mentioned, there are sometimes demands for measurement of the discharging current of the rechargeable batteries as well in such charging processing. Conventionally, as shown in FIG. **14**, such demands have been met by the technique of preparing, separately from the sense resistor R_0 for detecting the charging current of the rechargeable batteries, a sense resistor R_x for detecting the discharging current of the rechargeable batteries and detecting the discharging current of the rechargeable batteries using this sense resistor R_x.

The above conventional configurations, however, suffered from the problems mentioned above.

The present invention provides a novel control system for charging which enables efficient charging of rechargeable batteries, a novel control system for charging which enables accurate charging of the rechargeable batteries, and a novel electronic apparatus which enables the charging/discharging current of the rechargeable batteries to be measured by a simple configuration.

The basic configurations of the embodiments of the present invention will be illustrated in FIG. **1** through FIG. **3**A and **3**B.

In the figures, **1** is an electronic apparatus provided with the present invention. It is provided with a load circuit **2** for executing the signal processing, a rechargeable battery **3** for supplying power to the load circuit **2**, and a charger circuit **4** for generating a charging current for the rechargeable battery **3** by using power from an external power source.

The electronic apparatus **1** illustrated in FIG. **1** is provided with a charging current detecting means **10** for detecting the charging current flowing to the rechargeable battery **3**; a current consumption detecting means **11** for detecting the current consumed by the load circuit **2**; a first detecting means **12** for detecting a differential value between a maximum permissible charging current allowed by the rechargeable battery **3** and the charging current which is detected by the charging current detecting means **10**; a second detecting means **13** for detecting a maximum useable current by detecting a differential value between a maximum supplyable current allowed by the external power source and the current consumption detected by the current consumption detecting means **11**; a third detecting means **14** for detecting a differential value between the maximum useable current detected by the second detecting means **13** and the charging current detected by foe charging current detecting means **10**; a fourth detecting means **15** for detecting a differential value between the maximum permissible supply voltage allowed by the rechargeable battery **3** and the voltage applied to the rechargeable battery **3**; and a control means **16** for controlling the charging current generated by the charger circuit **4**.

The electronic apparatus **1** illustrated in FIG. **2** is provided with a charging current detecting means **20** for detecting a charging current flowing to the rechargeable battery **3**; a first detecting means **21** for detecting a differential value between the maximum permissible charging current allowed by the rechargeable battery **3** and the charging current detected by the charging current detecting means **20**; a second detecting means **22** for detecting a differential value between the lowest permissible output voltage allowed by the external power source and the voltage which is output by the external power source; a third detecting means **23** for detecting a differential value between the maximum permissible supply voltage allowed by the rechargeable battery **3** and the voltage which is applied to the rechargeable battery **3**; and a control means **24** for controlling the charging current which is generated by the charger circuit **4**.

The electronic apparatus **1** illustrated in FIG. **3**A is provided with a detecting means **30** for detecting the charging current flowing to the rechargeable battery **3**; an integrating means **31** which integrates the charging current which is detected by the detecting means **30**; and an issuing means **32** for issuing a charging end command to the charger circuit **4**.

The electronic apparatus **1** illustrated in FIG. **3**B is provided with a sense resistor **40** for detecting the charging current flowing to the rechargeable battery **3** on the rechargeable battery **3** side from the connection point between the charger circuit **4** and the power simply circuit of the apparatus and, at the same time, provided with a current measuring means **41** for receiving the voltages at the two ends of the sense resistor **40** as inputs, discriminating which of the two input voltages is bigger, and producing a voltage in accordance with the differential value between these two input voltages.

In the first embodiment illustrated in FIG. **1**, when the apparatus is driven using power supplied from an external power source, the control means **16** performs the control according to the differential values detected by the first detecting means **12**, third detecting means **14**, and the fourth detecting means **15** so that the charger circuit **4** generates the maximum charging current within the range where the charging current flowing to the rechargeable battery **3** does not exceed either of the minimum permissible charging current and the maximum useable current and the voltage to be applied to the rechargeable battery **3** does not exceed the maximum permissible supply voltage.

Namely, when one or more of the differential values detected by the first detecting means **12**, third detecting means **14**, and the fourth detecting means **15** exceeds the limit value, the differential value which exceeds the limit value to the most extent is specified. When none exceeds the limit value, the differential value nearest zero is specified. The charging current which is generated by the charger circuit **4** is controlled so that the specified differential value becomes the zero value.

According to the control processing of this control means **16**, in the first embodiment illustrated in FIG **1**, the rechargeable battery **3** is charged with the maximum charging current within a range allowed by both of the rechargeable battery **3** and the external power source, and therefore rapid charging of the rechargeable battery **3** at the time of operation of the electronic apparatus **1** becomes possible.

On the other hand, in the second embodiment illustrated in FIG. **2**, when the apparatus is driven by using power given from an external power source, the control means **24** performs control according to the differential values detected by the first detecting means **21**, the second detecting means **22**, and the third detecting means **23** so that the charger circuit **4** generates the maximum charging current with a range where the charging current flowing to the rechargeable battery **3** does not exceed the permissible charging current, the output voltage which is output by the external power source is not lowered to less than the lowest permissible output voltage, and the voltage to be applied to the rechargeable battery **3** does not exceed the maximum permissible supply voltage.

Namely, when one or mare of the differential values detected by the first detecting means **21**, second detecting means **22**, and third detecting means **23** exceeds the limit value, the differential value that exceeds the limit value to the greatest extent is specified. When none exceeds the limit value, the differential value nearest zero is specified. The charging current which is generated by the charger circuit **4** is controlled so that the specified differential value becomes the zero value.

According to the control processing of this control means **24**, in the second embodiment illustrated in FIG. **2**, the rechargeable battery **3** is charged with the maximum charging current within a range allowed by both of the rechargeable battery **3** and the external power source, and therefore rapid charging of the rechargeable battery **3** at the time of operation of the electronic apparatus **1** becomes possible.

On the other hand, in the third embodiment illustrated in FIG. **3**A, when the charger circuit **4** generates a charging current which changes in accordance with the operating state of the apparatus so as to charge the rechargeable battery **3**, the detecting means **30** detects the charging current flowing to the rechargeable battery **3**, the integrating means **31** receives this detection result and integrates the detected charging current, and the issuing means **32** receives this integration result and decides whether or not the total value of the integrated charging current and the current capacity possessed by the rechargeable battery **3** at the time of start of the charging has reached the maximum current capacity of the rechargeable battery **3** and, when deciding it has, issues a command for ending the charging to the charger circuit **4**.

In this way, in the third embodiment illustrated in FIG. **3**A, even if the charging current generated by the charger circuit **4** dynamically changes, it becomes possible to accurately detect the completion of charging of the rechargeable battery **3** by using the charging current

On the other hand, in the fourth embodiment illustrated in FIG. **3**B, the charger circuit **4** generates a charging current of a constant current mode to be used for the charging of the rechargeable battery **3** by using the charging current detected by the sense resistor **40**. In this sense resistor **40**, the discharging current from the rechargeable battery **3** will also flow. The current measuring means **41** receives the charging/discharging current flowing through this sense resistor **40**. When it has, for example, two input ports, the means **41** outputs a voltage in accordance with the magnitude of the charging current to one input port when the charging current flows through the sense resistor **40**, and outputs a voltage in accordance with the magnitude of the discharging current to the other input port when the discharging current flows through the sense resistor **40**.

In this way, in the fourth embodiment illustrated in FIG. **3**B, by making joint use of one resistor for the sense resistor for the detection of the charging current and the sense resistor for the detection of the discharging current, it becomes possible to measure the charging/discharging current of the rechargeable battery **3** with a simple configuration.

Below, the present invention will be explained in further detail according to specific examples.

One specific example of the present invention will be illustrated in FIG. **4**.

In the figure, **50** is a rechargeable battery, that is, a rechargeable battery constituted by the series-connected battery cells; **51**, a DC connector, that is, a connector for receiving power from the outside when operating the apparatus by an AC adapter or when charging the rechargeable battery **50** mounted inside the apparatus by the AC adapter; **52**, a DC/DC converter, that is, a power supply circuit for the apparatus which receives the supply of power from an external power source supplied via the DC connector **51**, or from the rechargeable battery .**50** and thereby produces the voltage required by the apparatus; **53**, a charger, that is, a constant current source for producing the power necessary for charging the rechargeable battery **50** when the power is supplied from the outside via the DC connector **51**; **54**, a control circuit constructed inside the charger **53**, that is, a control mechanism for executing constant current control under the PWM control mode; **55**, a current measuring circuit, that is, a measuring circuit for measuring the charging/discharging current of the rechargeable battery **50**; and **56**, a microcontroller, that is, a charging control mechanism for issuing commands for the start and end of the charging.

D_1 and D_4 are protection diodes for preventing reverse current which prevent power from flowing out from the rechargeable battery **50**-to the outside when the AC adapter is not being operated due to the fact AC power is not supplied to the AC adapter etc. D_2 is a protection diode for supplying the power from the rechargeable battery **50** to the DC/DC converter **52** when the power is not supplied from the outside and, at the same time, for preventing the voltage from being applied to the rechargeable battery **50** when the power is supplied from the outside via the DC connector **51**.

Tr_1 is a main transistor for switching which performs an ON/OFF operation according to the command from the control circuit **54**; L_1, a choke coil; D_3, a fly-wheel diode; and C_1, a capacitor for smoothing.

R_0 is a sense resistor for measuring the charging current flowing to the rechargeable battery **50**. The voltage drop due to the charging current flowing through this sense resistor R_0 is divided by the resistors R_1 and R_2 and, at the same time, divided by the resistors R_3 and R_4 and input to an ERR**1** terminal of the control circuit **54**. R_6 is a sense resistor for measuring the current consumed by the apparatus. The voltage drop due to the consumption of current flowing through this sense resistor R_6 is divided by the resistors R_7 and R_8 and, at the same time, divided by the resistors R_9 and R_{10} and input the ERR**2** terminal of the control circuit **54**.

A voltage e_1 which is given to the ACADP-terminal of the control circuit **54** is for notifying the supplyable maximum current of the AC adapter to the control circuit **54** and is given as a voltage value corresponding to the current value, e_2, which is given to a MAXC-terminal of the control circuit **54**, is for notifying the maximum charging current allowed by the rechargeable battery **50** to the control circuit **54** and is given as a voltage value corresponding to the current value e_3, which is given to a Vr terminal of the control circuit **54**, is for notifying the maximum supply voltage allowed by the battery to the control circuit **54** and is given as the voltage value.

Tr_2 is a switch circuit for protection for preventing the voltage of the rechargeable battery **50** from being supplied to the control circuit **54** and, at the same time, preventing the power from leaking from the rechargeable battery **50** via the resistors R_1 to R_4 by opening the ground side of the control circuit **54** when the power is not supplied from the DC connector **51**. R_{21} and R_{22} are voltage detecting resistors for turning OFF the switch circuit Tr_2 when the power is not supplied from the DC connector **51** by detecting this.

A concrete example of the control circuit **54** will be illustrated in FIG. **5**.

As shown in this figure, the control circuit **54** is constituted by six error amplifiers **540-1** (i=1 to 6), a triangular wave generator **541**, a FWM comparator **542**, and a driver **543**.

This first error amplifier **540-1** (ERA_1) is an amplifier for measuring the voltage drop across the sense resistor R_0 and outputs a voltage proportional to the charging current flowing through the sense resistor R_0. The fourth error amplifier **540-4** (ERA_4) amplifies a differential value between the charging current which is output by the first error amplifier **540-1** and the maximum charging current (e_2) allowed by the rechargeable battery **50** to be given to the MAXC-terminal and inputs the amplified differential value to the PWM comparator **542**.

The second error amplifier **540-2** (ERA_2) is an amplifier for measuring the voltage drop across the sense resistor R_6 and outputs a voltage proportional to the value of the consumption of the current flowing through the sense resistor R_6. A fifth error amplifier **540-5** (ERA_3) amplifies a differential value between the current consumption value output by the second error amplifier **540-2** and the maximum supply current value (e_1) supplyable by the AC adapter to be given to the ACADP-terminal and outputs the same as the maximum useable current value.

A sixth error amplifier **540-6** (ERA_6) amplifies a differential value between the charging current which is output by the first error amplifier **540-1** and the maximum useable current which is output by the fifth error amplifier **540-5** and inputs the same to the PWM comparator **542**. A third error amplifier **540-3** (ERA_3) amplifies a differential value between the apply voltage to the rechargeable battery **50** which is input to the first error amplifier **540-1** and the maximum supply voltage (e_3) allowable by the rechargeable battery **50** which is given to the Vr terminal and inputs the amplified differential value to the PWM comparator **542**.

Here, the error amplifier **540**-i, receiving as its input the limit value, operates so as to output the prescribed voltage when the measured value and the limit value are equal, output a voltage larger than the prescribed voltage thereof when the limit value is larger than the measured value, and output a negative value or "0" when the measured value is larger than the limit value.

The triangular wave generator **541** produces a triangular wave voltage having a prescribed period and inputs the same to the PWM comparator **542**. The PWM comparator **542** receives as its inputs the voltages output by the fourth error amplifier **540-4**, sixth error amplifier **540-6**, and the third error amplifier **540-3** and the triangular wave voltage output by the triangular wave generator **541** and generates a pulse having a pulse width according to the input voltage. The driver **543** is a driver circuit for driving the main transistor Tr_1, turns ON the main transistor Tr_1 during a period when the PWM comparator **542** outputs a high level and, at the same time, turns the main transistor Tr_1 OFF during a period when the PWM comparator **542** outputs the low level.

A concrete example of me PWM comparator **542** is illustrated in FIG. **6**.

The PWM comparator **542** of this concrete example is constituted by comparison circuits which are provided corresponding to the input voltages from three error amplifiers, compare the output voltages of the error amplifiers and the triangular wave voltage generated by the triangular wave generator **541**, and output a high level when the input triangular wave voltage is smaller, and output a low level when the input triangular wave voltage is larger, and an AND gate which calculates the AND value of the output values of all comparison circuits and outputs the resultant value. Due to this, the comparison circuits generate a pulse having a pulse width according to the output voltage of the error amplifier. The comparison circuit corresponding to the error amplifier with the measured value exceeding the limit value will operate so as not to generate a pulse since the error amplifier outputs a negative value or "0".

According to this configuration, the comparison circuits in the PWM comparator **542** produce a long pulse at a higher level as the margin is larger when the input voltage from the error amplifier is within the range of the limit value and, at the same time, do not produce a pulse when it is not within the range. The AND gate inside the PWM comparator **542** receives the outputs of the comparison circuits and outputs a pulse matching the output from the comparison circuit which outputs the highest level as shown in FIG. **7**B.

Namely, the PWM comparator **542** docs not generate a pulse when one of the input voltages from the three error amplifiers exceeds the limit and, at the same time, specifies the one nearest the limit value when mere is no input voltage exceeding the limit value and generates a pulse of the high level having a length in accordance with this.

Responding to the generation of pulse of this PWM comparator **542**, the driver **543** turns the main transistor Tr_1 ON during a period when the PWM comparator **542** outputs an high level, and while turns the main transistor Tr_1 OFF during a period when the PWM comparator **542** outputs a low level, thereby to control the magnitude of the charging current which is generated by the charger **53** so that the output voltage of the error amplifier which becomes the origin of generation of the pulse from the PWM comparator **542** becomes a zero value.

With a control circuit **54** of this configuration, the charger **53** charges the rechargeable battery **50** by a charging current limited by whichever of the charging current which is detected by the sense resistor R_0 (with a limit value which is the maximum charging current allowed by the rechargeable battery **50** and the maximum useable current value which is output by the fifth error amplifier **540-5**) and, the voltage applied to the rechargeable battery **50** (with a limit value which is the maximum supply voltage allowed by the rechargeable battery **50**) reaches the limit value first.

In this way, the rechargeable battery **50** is charged by the maximum charging current within the range allowed by both of the rechargeable battery **50** and the AC adapter, and therefore it becomes possible to rapidly charge the rechargeable battery **50** at the time of the operation of the electronic apparatus **1**.

Further explaining the charging operation of the concrete example of FIG. **4**, since the AC adapter is connected to the DC connector **51**, when power is supplied from the outside, the external power is supplied to the DC/DC converter **52** via D_1, and the DC/DC converter **52** produces the voltage (OUT) required by the apparatus in accordance with this.

At this time, if an instruction for charging is issued from the microcontroller **56** to the control circuit **54**, the control circuit **54** starts the following operation to generate the charging current

Namely, when current consumption through the DC/DC converter **52** is detected by the sense resistor R_6, the maximum useable current of the AC adapter which becomes useable in that current consumption state is found. By this, it performs control so that the charging current of the rechargeable battery **50** which is detected by the sense resistor R_0 does not exceed the minimum useable current value thereof and, at the same time, performs control so that the charging current thereof does not exceed the maximum charging current allowed by the rechargeable battery **50**. Then, it performs control so that the voltage supplied to the rechargeable battery **50**, which is detected by the sense resistor R_0, does not exceed the maximum supply voltage allowed by the rechargeable battery **50**.

Assume that in the embodiment of FIG. **4**, the maximum charging current allowed by the rechargeable battery **50** is 1000 mA, the capacity of the rechargeable battery **50** is 1000 mAH, the maximum current supplyable by the AC adapter is 1500 mA, the maximum value of the consumption of current to be used when the apparatus operates is 1100 mA, an average value of the consumption of current to be used by the apparatus at the time of operation is 400 mA, and me current consumption when the apparatus does not operate is 0 mA. At the same time, assume that there is no limitation on the supply voltage in the rechargeable battery **50**.

When the apparatus is not operating, all of the current which is supplied from the AC adapter can be used as the charging current of the rechargeable battery **50**, and therefore charging at the minimum current value 1000 mA allowable by the battery becomes possible. Accordingly, the charging ends in about 1 hour at this time.

On the other hand, when the apparatus is operating, the current consumption dynamically changes in a range of from 0 to 1100 mA. In the present invention, charging will be carried out while dynamically changing the charging current in a range of from 1000 mA to 400 mA matching with this dynamic change. The average current consumption of the apparatus is 400 mA, and therefore also this charging current becomes 1000 mA on the average. This charging current of 1000 mA is a value no different from that when the apparatus is not operating. Accordingly, even if the apparatus is operating, the charging can be carried out in about 1 hour.

In this way, the present invention adopts a method of charging by the minimum capability of the AC adapter by dynamically changing the charging current of the charger **53** in accordance with the current consumption on the apparatus side by providing a function of measuring the current consumption on the apparatus side. Thus, it becomes possible to greatly shorten the charging time of the rechargeable battery **50**.

Contrary to this, the related art does not adopt a configuration for dynamically detecting the dynamically changing power consumption on the apparatus side, therefore is designed considering the maximum power consumption. Due to this, when the maximum power consumption at the time of the operation of the apparatus is 1100 mA and the maximum current supplyable by the AC adapter is 1500 mA, the current value which can be used by the charger **53** becomes 400 mA. As a result, irrespective of the current consumption, the charging is always carried out at 400 mA at the time of operation of the apparatus and therefore a charging time of about 3 hours becomes possible.

In this way, in the present invention, by charging in accordance with the capability of the external power source, it becomes possible to greatly shorten the charging time of the rechargeable battery **50**.

Next, an explanation will be made of the function of the current measuring circuit **55** provided in the embodiment of FIG. **4** and the microcontroller **56**.

The current measuring circuit **55** is provided for measuring the magnitude of the current flowing through the sense resistor R_0.

This sense resistor R_0 acts as a resistor for controlling the constant current of the charger **53** as mentioned above, and further, as seen from the circuit configuration of FIG. **4**, is provided in the path of the discharging current of the rechargeable battery **50**. Namely, at the time of the charging of the rechargeable battery **50**, the charging current flows through this sense resistor R_0, while when the AC adapter is not connected to the DC connector **51**, the power of the rechargeable battery **50** is given to the DC/DC converter **52**. Accordingly, the discharging current will flow through this sense resistor R_0. Thus, this current measuring circuit **55** will measure both of the charging current flowing to the rechargeable battery **50** and the discharging current flowing out of the rechargeable battery **50**.

A concrete example of this current measuring circuit **55** will be illustrated in FIG. **8**.

As shown in this figure, the current measuring circuit **55** is constituted by a first operational amplifier **550-1** (OP_1), a second operational amplifier **550-2** (OP_2), a third operational amplifier **550-3** (OP_3) and a fourth operational amplifier **550-4** (OP_4). This first operational amplifier **550-1** (OP_1) receives as input one of the voltages of the two ends of the sense resistor R_0 at a plus (non-inverting) terminal, while connects fee minus terminal to a minus (inverting) terminal of the second operational amplifier **550-2** via the resistor R_{31}. The second operational amplifier **550-2** receives as input the other voltage of the sense resistor R_0 at the plus terminal, while connects the minus terminal to the minus terminal of the first operational amplifier **550-1** via the resistor R_{31}. The third operational amplifier **550-3** receives as input the output voltage of the first operational amplifier **550-1** at the minus terminal via the resistor R_{34}, while connects the plus terminal to the ground via the resistor R_{37}. The fourth operational amplifier **550-4** receives as input the output voltage of the second operational amplifier **550-2** at the minus terminal via the resistor R_{41}, while grounds the plus terminal via the resistor R_{44}.

By this configuration, the current measuring circuit **55** amplifies a differential value between the value input to the plus terminal of the first operational amplifier **550-1** and the voltage input to the plus terminal of the second operational amplifier **550-2** and outputs the result.

Namely, the third operational amplifier **550-3** amplifies the voltage difference when the input voltage of the plus terminal of the first operational amplifier **550-1** is higher than the input voltage of the plus terminal of the second operational amplifier **550-2**. Due to this, it outputs a voltage proportional to the discharging current flowing through the sense resistor R_0. Also, the fourth operational amplifier **550-4** amplifies the voltage difference and outputs the result when the voltage at the plus terminal of the first operational amplifier **550-1** is lower than the input voltage at the plus terminal of the second operational amplifier **550-2**. Due to this, it outputs a voltage proportional to the charging current flowing through the sense resistor R_0.

In this way, the current measuring circuit **55** is designed to measure both of the charging current and the discharging current flowing through the sense resistor R_0 and discriminates whether the current flowing through the sense resistor R_0 is the charging current or the discharging current and produces a voltage in accordance with the magnitude of the current.

On the other hand, the microcontroller **56** performs the charging control processing by controlling the control circuit **54** in accordance with the result of measurement of this current measuring circuit **55**.

FIGS. **9**A and **9**B show the flow of processing executed by the microcontroller **56**.

First, at step **1** (ST) as shown in the flow of processing of FIGS. **9**A and **9**B, the microcontroller **56** detects whether or not (he AC adapter is attached. This processing is executed by monitoring the output voltage of the AC adapter although this was omitted in the embodiment of FIG. **4**.

When it is detected at this step **1** that the AC adapter is attached, the processing routine goes to step **2**, at which charging of the rechargeable battery **50** is indicated by activating the control circuit **54**. In the subsequent step **3**, the remaining amount of battery power of the rechargeable battery **50** is read out. Subsequently, at step **4**, the output voltage of the current measuring circuit **[50]** *55* is read to read the charging current flowing through the sense resistor R_0 and this is integrated to update the remaining amount of battery power of the rechargeable battery **50**.

Next, at step **5**, it is detected whether or not an instruction for stopping the apparatus has been issued. When it is detected that no command for stopping the apparatus has been issued, the processing routine goes to step **6**, at which it is decided whether or not the remaining amount of battery power has reach full charge. When it is decided that it has not reached full charge the processing routine returns to step **4**, at which the remaining amount of battery power continues to be updated. When it is decided that it has reached full charge, the processing routine goes to step **7**, at which the control circuit **54** is stopped. At the subsequent step **8**, the remaining amount of battery power is saved and the processing is ended.

Next at step **5**, when it is detected that an instruction for stopping the apparatus has been issued, the processing routine immediately goes to step **7**, at which the control circuit **54** is stopped. At the subsequent step **8**, the remaining amount of battery power is saved and the processing is ended.

On the other hand, when it is detected at step **1** that the AC adapter has not been attached, that is, when the power of the rechargeable battery **50** is supplied to the DC/DC converter **52**, the processing routine goes to step **9**, at which the remaining amount of battery power of the rechargeable battery **50** which has been saved is read out. Subsequently, at step **10**, the output voltage of the current measuring circuit **55** is read to read the discharging current flowing through the sense resistor R_0 and this is integrated, thereby to update the remaining amount of battery power of the rechargeable battery **50**. Subsequently, at step **11**, it is detected whether or not an instruction for stopping the apparatus has been issued. When it is detected that no instruction for stopping the apparatus has been issued, the processing routine returns to step **10**, at which the remaining amount of battery power continues to be updated. When it is detected mat an instruction for stopping the apparatus has been issued, the processing routine goes to step **8**, at which the remaining amount of battery power is saved and the processing is ended.

In this way, the microcontroller **56** stops the charging by accurately detecting the completion of charging of the rechargeable battery **50** even if the charging current which is generated by the charger circuit **53** dynamically changes.

The example of FIG. **4** adopted a configuration of inputting the maximum current supplyable by the AC adapter to the ACADP-terminal of the control circuit **54** in advance, but by utilizing the characteristic of the AC adapter, it is also possible to automatically detect the power supply capability of this AC adapter. According to this, it is possible to make the present invention further practical.

An example of the correspondence between the output current [A] and the output voltage [V] possessed by the AC adapter will be illustrated in FIG. **10**. This shows that the AC adapter has a rated output voltage of 16.0V and a rated output current of 1500 mA.

As shown in this figure, the AC adapter maintains a voltage output of the rated output voltage when the output current is less man the rated output current, such as 0 to 1500 mA. If a current more than the rated output current is required, by lowering the output voltage to for example 15.0V, an overload state is notified to the load side. This has the function of cutting off the voltage output after the ultra-overload state is reached when a further larger current is required.

This means that, when the output voltage of the AC adapter is lowered to the prescribed lowest permissible output voltage, the limit of the power supply capability of the AC adapter is reached. By utilizing this characteristic, when the output voltage of the AC adapter is lowered to the lowest permissible output voltage, the charging current of the charger **53** is limited. This means that the maximum supply current of the AC adapter required to be originally input to the control circuit **54** can be omitted in the example of FIG. **4**.

A fifth embodiment of the present invention using that method is illustrated in FIG. **11**.

In the figure, the same elements as those explained referring to FIG. **4** are indicated by the same reference numerals.

The point of difference from the embodiment of FIG. **4** is that a configuration is adopted wherein the resistors R_{11} and R_{12} for monitoring the output voltage of the AC adapter which is connected to the DC connector **51** are provided in place of the sense resistor R_6 and the resistors R_7 to R_{10} and the output voltage of the AC adapter divided by these resistors R_{11} and R_{12} is input to ERR**2** minus terminal of the control circuit **54**. Note that, the voltage e_1 corresponding to the maximum charging current allowable by the rechargeable battery **50** is input to the ERC**1** terminal of the control circuit **54**. Also, in the embodiment of FIG. **4**, the maximum supply voltage allowable by the rechargeable battery **50** given from the outside is produced in an internal portion of the control circuit **54**.

FIG. **12** illustrates an embodiment of the control circuit **54** used in the embodiment of FIG. **11**.

As shown in this figure, the control circuit **54** used in the embodiment of FIG. **11** is constituted provided with four error amplifiers **544**-i (i=1 to 4) in place of the six error amplifiers **540**-i (i=1 to 6) provided in the control circuit **54** (shown in FIG. **5**) used in be embodiment of FIG. **4**.

This first error amplifier **544-1** (ERA_1) is an amplifier for measuring the voltage drop across the sense resistor R_0 and outputs a voltage proportional to the charging current charging current flowing through the sense resistor R_0. The third error amplifier **544-3** (ERA_3) amplifies a differential value between the charging current which is output by the first error amplifier **544-1** and the maximum charging current (e_1) allowed by (he rechargeable battery **50** to be given to the ERC**1** terminal and inputs this amplified differential value to the PWM comparator **542**.

The second error amplifier **544-2** (ERA_2) amplifies a differential value between the voltage supplied to the rechargeable battery **50** to be input to the first error amplifier **544-1** and the maximum supply voltage value allowable by the rechargeable battery **50** which is given by the internal battery and inputs this amplified differential value to the PWM comparator **542**. The fourth error amplifier **544-4** (ERA_4) amplifies a differential value between the output voltage of the AC adapter which is detected by the resistors R_{11} and R_{12} and the lowest permissible output voltage of the AC adapter which is given by the internal battery (set to for example 15.0V) and inputs this amplified differential value to the PWM comparator **542**.

Responding to the voltages which are output by the third error amplifier **544-3**, second error amplifier **544-2**, and the fourth error amplifier **544-4** and the triangular wave voltage which is output by the triangular wave generator **541**, the PWM comparator **542** generates a pulse having a pulse width dependent on the input voltage. Receiving this pulse, the driver **543** turns the main transistor Tr_1 ON during the period when the PWM comparator **542** outputs the high level and, at the same time, turns the main transistor Tr_1 OFF during the period when the PWM comparator **542** outputs the low level.

This PWM comparator **542** is constituted by comparison circuits which are provided corresponding to the input voltages from three error amplifiers similar to that explained referring to FIG. **6** and which compare the output voltages of the error amplifiers and the triangular wave voltage which is generated by the triangular wave generator **541**, output the high level when the input triangular wave voltage is smaller, and output the low level when the input triangular wave voltage is higher and an AND gate which calculates the AND value of the output values of all of the comparison circuits and outputs the result. Due to this, the comparison circuits generate pulses having pulse widths in accordance with the output voltages of the error amplifiers. The comparison circuit corresponding to (he error amplifier with a measured value exceeding the limit value operates so as not to generate a pulse since that error amplifier outputs a negative value or "0".

Due to this configuration, as shown in FIG. **7**A, the comparison circuits in the PWM comparator **542** produce long pulses of a higher level as me margin is larger when the input voltages from the error amplifiers are within the range of the limit value and do not generate pulses when the input voltages are not within that range. The AND gate inside the PWM comparator **542** outputs a pulse matching with the output from the comparator outputting the short pulse at the highest level as shown in FIG. **7**B responding to the outputs of these comparators.

Namely, the PWM comparator **542** does not generate a pulse when one or more of the input voltages from the three error amplifiers exceeds the limit value and specifies the one nearest the limit value when there is none exceeding the limit value and generates a pulse of the high level having a length in accordance with this.

Responding to the generation of pulses of this PWM comparator **542**, the driver **543** turns the main transistor Tr_1 ON during the period when the PWM comparator **542** outputs the high level and turns the main transistor Tr_1 OFF during the period when the PWM comparator **542** outputs the low level. Thus, the magnitude of the charging current which is generated by the charger **53** is controlled so that the output voltage of the error amplifier which originates the pulse of the PWM comparator **542** becomes the zero value.

Due to the control circuit **54** of this configuration, the charger **53** charges the rechargeable battery **50** by a charging current limited by whichever of the charging current which is detected by the sense resistor R_0 (with a limit value of the maximum charging current allowed by the rechargeable battery **50**), the voltage supplied to the rechargeable battery **50** (with a limit value of the maximum supply voltage allowable by the rechargeable battery **50**), and the output voltage of the AC adapter which is detected by the resistors R_{11} and R_{12} (with a limit value of the lowest permissible output voltage of the AC adapter) first reaches the limit value. That is, the charging current which is generated by the charger **53** is not limited up to the maximum output current allowed by the AC adapter.

In this way, the rechargeable battery **50** is charged by the maximum charging current within a range allowed by both of the rechargeable battery **50** and the AC adapter, and therefore it becomes possible to rapidly charge the rechargeable battery **50** at the time of the operation of the electronic apparatus **1**.

Now, in the fifth embodiment of FIG. **11**, it is assumed that the maximum charging current allowable by the rechargeable battery **50** is 1000 mA, the battery capacity of the rechargeable battery **50** is 1000 mAH, the maximum current supplyable by the AC adapter is 1500 mA, the maximum value of the current used when the apparatus operates is 1100 mA, an average value of the current used by the apparatus at the time of operation is 400 mA, and the current consumption when the apparatus is not being operated is 0 mA. Also, it is assumed that there is no limitation of the supply voltage in the rechargeable battery **50**.

When the apparatus is stopped, all of the current which is supplied from the AC adapter can be used as the charging current of the rechargeable battery **50**, and therefore the charging at the maximum current value 1000 mA allowable by the battery becomes possible. Accordingly, the charging at this time ends in about 1 hour.

On the other hand, when me apparatus is being operated, the current consumption dynamically changes in a range of from 0 to 1100 mA. Here, however, it is assumed that the current consumption of the apparatus is 1000 mA. The charger **53** operates so as to output 1000 mA since the maximum permissible charging current of the rechargeable battery **50** is 1000 mA. However, when the charging current which is generated by the charger **53** reaches 500 mA, the negative current value of the AC adapter becomes 1500 mA, and from a point of time when exceeding this 1500 mA, the output voltage of the AC adapter starts to drop. The control circuit **54** operates so as to limit the output of the charger **53** at the point of time when the output voltage starts to be lowered by monitoring the output voltage of this AC adapter, and consequently, the charging current which is generated by the charger **53** is restricted to the value of 500 mA.

When the current consumption of the apparatus is increased and becomes 1100 mA, a voltage drop of the AC adapter occurs along with the increase of this current consumption. Therefore the charger **53** further decreases the charging current to be generated according to the command of the control circuit **54** and decreases the same down to 400 mA. Subsequently, when the current consumption of me apparatus is decreased and becomes 800 mA, the output voltage of the AC adapter returns to the rated voltage. As a result, the limitation by the output voltage of the AC adapter is released and therefore the charger **53** increases the charging current to be generated according to the command of the control circuit **54** and meets the voltage drop point of the AC adapter at the point of tame when increasing the charging current to 700 mA. The current limitation starts there.

In this way, in the present invention, in accordance with the capacity of the AC adapter, the charging is carried out along with the dynamic change of the current consumption of the apparatus while dynamically changing the charging current in a range of from 1000 mA to 400 mA. The average current consumption of the apparatus is 400 mA, and therefore also this charging current becomes 1000 mA on the average. This charging current of 1000 mA is a current no different from that when the apparatus is stopped, and accordingly even if the apparatus is operating, the charging can be carried out in about 1 hour.

In this way, the present invention adopted a method wherein a function of measuring the current consumption on the apparatus side by monitoring the output voltage of the AC adapter is provided. In accordance with the current consumption on this apparatus side, the charging current of the charger **53** is dynamically changed, thereby to enable constant charging by the maximum capability of the AC adapter. Due to this, the charging time of the rechargeable battery **50** can be greatly shortened.

Contrary to this, the related art does not adopt a structure for dynamically detecting the dynamically changing power consumption on the apparatus side and therefore is designed considering the maximum power consumption. Due to this, when the maximum power consumption at the time of the operation of apparatus is 1100 mA and the maximum current supplyable by the AC adapter is 1500 mA, the current useable by the charger **53** becomes 400 mA. As a result, irrespective of any current consumption of the apparatus, at the time of the operation of the apparatus, the charging is always carried out at 400 mA, and a charging time of about 3 hours becomes necessary.

In this way, in the present invention, by performing the charging in accordance with the capability of the AC adapter, it becomes possible to greatly shorten the charging time of the rechargeable battery **50**.

The present invention was explained according to the illustrated embodiments, but the present invention is not restricted to this. For example, in the concrete examples, the present invention was described by using a rechargeable battery **50** in which the supply voltage is restricted, but it is also possible to use a rechargeable battery **50** in which the supply voltage is not restricted. In this case, it is not necessary to constitute the system so as to limit the charging current by this supply voltage.

As explained above, according to the present invention, where an electronic apparatus is provided with a rechargeable battery, it becomes possible to charge the rechargeable battery by the maximum charging current within a range allowed by both of the rechargeable batteries and the external power source, and therefore it becomes possible to rapidly charge the rechargeable battery at the time of operation of the electronic apparatus.

Further, according to the present invention, even if the charging current of the rechargeable batteries dynamically changes, it becomes possible to accurately detect the completion of charging of the rechargeable batteries.

Further, according to the present invention, by using the same resistor for the sense resistor for the detection of the charging current of the rechargeable batteries and the sense resistor for the detection of the discharging current of the rechargeable batteries, it becomes possible to measure the charging/discharging current of the rechargeable batteries with a simple structure.

We claim:

1. A system for controlling the supply of power from an external power source to rechargeable batteries in an apparatus which can be powered either by the external power source or the rechargeable batteries, comprising:

a first detector for detecting a difference between a maximum permissible charging current allowed by the rechargeable batteries and a charging current flowing to the rechargeable batteries;

a second detector for detecting a maximum useable current by detecting a difference between a maximum suppliable current allowed by the external power source and the current being consumed by the apparatus;

a third detector for detecting a difference between the maximum useable current and the charging current flowing to the rechargeable batteries; and

a controller for controlling power supplied from the external power source to the rechargeable batteries in accordance with the differences detected by the first and third detectors so that the charging current flowing to the rechargeable batteries does not exceed the maximum permissible charging current and does not exceed the maximum useable current.

2. A system for controlling as set forth in claim **1**, further comprising a fourth detector for detecting a difference between a maximum permissible supply voltage allowed by said rechargeable batteries and a voltage applied to said rechargeable batteries, said control means controlling the power supplied from the external power source to the rechargeable batteries in accordance wins the difference detected by the fourth detector so mat the voltage applied to the rechargeable batteries does not exceed the maximum permissible supply voltage.

3. A system for controlling the supply of power from an external power source to rechargeable batteries in an apparatus which can be powered by either the external power source or the rechargeable batteries, comprising:

a first detector for detecting a difference between a maximum permissible charging current allowed by the rechargeable batteries and a charging current flowing to the rechargeable batteries;

a second detector for detecting a difference between a lowest permissible output voltage allowed by the external power source and an output voltage which is being output by the external power source; and

a controller for controlling power supplied from the external power source to the rechargeable batteries in accordance with the differences detected by the first and second detectors so that the charging current flowing to the rechargeable batteries does not exceed the maximum permissible charging current and the output voltage being output by the external power source is not less than the lowest permissible output voltage.

4. A control system for controlling as set forth in claim **3**, further comprising a third detector for detecting a difference between the maximum permissible supply voltage allowed by the rechargeable batteries and a voltage applied to said rechargeable batteries, said control means controlling the power supplied from the external power source to the rechargeable batteries in accordance with the difference detected by the third detector so that the voltage applied to the rechargeable batteries does not exceed the maximum permissible supply voltage.

5. A system for controlling as set forth in claim **1**,

wherein said controller controls the power supplied from the external power source to the rechargeable batteries by determining if either the first or third detector detects a negative difference thus indicating mat the charging current exceeds a maximum,

wherein if either of the first or third detector detects a negative difference, the controller selects the largest negative difference and controls the charging current to increase the largest negative difference to a zero difference, and

wherein if neither of the first or third detector detects a negative difference, the controller selects the largest positive difference and controls the charging current to decrease the largest positive difference to a zero difference.

6. A system for controlling as set form in claim **2**,

wherein said controller controls the power supplied from the external power source to the rechargeable batteries by determining if any of the first third or fourth detector detects a negative difference thus indicating that the charging current or the supply voltage exceeds a maximum,

wherein if any of the first third or fourth detector detects a negative difference, the controller selects the largest negative difference and controls the charging current to increase the largest negative difference to a zero difference, and

wherein if none of the first third or fourth detector detects a negative difference, the controller selects the largest positive difference and controls the charging current to decrease the largest positive difference to a zero difference.

7. A system for controlling as set forth in claim **3**,

wherein said controller controls the power supplied from the external power source to the rechargeable batteries by determining if either of the detector detects a negative difference thus indicating that the charging current exceeds a minimum or the output voltage is less then a minimum,

wherein if either of the detector detects a negative difference, the controller selects the largest negative difference and controls the charging current to increase the largest negative difference to a zero difference, and

wherein if neither of the detector detects a negative difference, the controller selects the largest positive difference and controls the charging current to decrease the largest positive difference to a zero difference.

8. A system for controlling as set forth in claim **4**,

wherein said controller controls the power supplied from the external power source to the rechargeable batteries by determining if any of the detector detects a negative difference thus indicating that a current or a voltage is greater than a maximum or less than a minimum,

wherein if any of the detector detects a negative difference, the controller selects the largest negative difference and controls the charging current to increase the largest negative difference to a zero difference, and

wherein if none of the detector detects a negative difference, the controller selects the largest positive difference and controls the charging current to decrease the largest positive difference to a zero difference.

9. A system for controlling the supply of power from a charger circuit to rechargeable batteries, the rechargeable batteries being used to supply power to a power supply circuit, comprising:

a sense resistor having two ends, located between the rechargeable batteries and a connection point for the charger circuit and the power supply circuit, the sense resistor detecting current flowing into and out of the rechargeable batteries;

a current measurement device having two inputs connected respectively to the two ends of the sense resistor, the current measurement device determining which of the two inputs has a larger voltage and generating a voltage in accordance with the difference between the voltages of the two inputs to thereby measure the current flowing into or out of the rechargeable battery; and

a control circuit regulating to a constant current the current flowing into the rechargeable batteries, based on the current flowing into the rechargeable batteries detected by the sense resistor.

10. A system for controlling as set forth in claim **9**, wherein the control circuit has two inputs connected respectively to the two ends of the sense resistor.

11. An electronic apparatus having an input section for inputting power from a power source and capable of charging a battery by using the power from the input section while the electronic apparatus makes a load operate by applying the power input from the input section to the load, an output voltage of the power source being substantially a constant voltage, the output voltage of the power source falling to less than said constant voltage when the power source outputs more than a predetermined current value, the power applied to the load from the input section varying based on the state of the load, the electronic apparatus comprising:

a power input sensor for obtaining power-input information by sensing an input of the power from the input section;

a charger for charging the battery by using the power from the input section; a charge control circuit for controlling the charging power the charger supplies to the battery based on the power input information obtained by the power input sensor so that a sum of the power applied to the load and the power charged to the battery from the input section is substantially in a current range in which said output voltage of the power source is substantially the constant voltage; and

a charging voltage detector for detecting a charging voltage of the battery, wherein the charge control circuit controls the charging voltage so that the charging voltage detected by the charging voltage detector becomes a value assigned to the battery or lower.

12. An electronic apparatus as set forth in claim 11, further comprising:

a charging current detector for detecting a charging current of the battery, wherein the charge control circuit controls the charging current based on the detected charging current so that the charging current becomes a value assigned to the battery or lower.

13. An electronic apparatus as set forth in claim 11, wherein the power source is able to supply a maximum permissible supply current of the power source in the current range.

14. A charging apparatus for an electronic apparatus that has an input section for inputting power from a power source and is capable of charging a battery by using the power from the input section while the electronic apparatus makes a load operate by applying the power input from the input section to the load, an output voltage of the power source being substantially a constant voltage, the output voltage of the power source falling to less than said constant voltage when the power source outputs more than a predetermined current value, the power applied to the load from the input section varying based on the state of the load, the charging apparatus comprising:

a charger for charging the battery by using the power from the input section;

a charge control circuit for controlling the charging power the charger supplies to the battery, based on the power input information obtained by power input sensor for obtaining the power input information by sensing an input of the power from the input section, so that a sum of the power applied to the load and the power charged to the battery from the input section is substantially in a current range in which said output voltage of the power source is substantially the constant voltage, wherein

the charge control circuit controls the charging current, based on a charging current detected by a charging current detector for detecting the charging current of the battery, so that the charging current becomes a value assigned to the battery or lower.

15. A charging apparatus as set forth in claim 14, wherein the charge control circuit further controls the charging voltage so that a voltage detected by a charging voltage detector for detecting the charging voltage of the battery becomes a value assigned to the battery or lower.

16. A charging apparatus as set forth in claim 14, wherein the power source is able to supply a maximum permissible supply current of the power source in the current range.

17. A charge control circuit for an electronic apparatus that has an input section for inputting power from a power source and a charger for charging a battery by using the power from the input section while the electronic apparatus making a load operate by applying the power input from the input section to the load, an output voltage of the power source being substantially a constant voltage, the output voltage of the power source falling to less than said constant voltage when the power source outputs more than a predetermined current value, the power applied to the load from the input section varying based on the state of the load, the charge control circuit comprising:

a control circuit for controlling the charging power the charger supplies to the battery, based on power input information obtained by a power input sensor for obtaining the power input information by sensing an input of the power from the input section, so that a sum of the power applied to the load and the power charged to the battery from the input section is substantially in a current range in which said output voltage of the power source is substantially the constant voltage, wherein

the control circuit controls the charging voltage so that a voltage detected by a charging voltage detector for detecting the charging voltage of the battery becomes a value assigned to the battery or lower.

18. A charge control circuit as set forth in claim 17, wherein the control circuit controls the charging current based a charging current detected by a charging current detector for detecting the charging current of the battery so that the charging current becomes a value assigned to the battery or lower.

19. A charge control circuit as set forth in claim 17, wherein the power source is able to supply a maximum permissible supply current of the power source in the current range.

20. An electronic apparatus having a charger for outputting a charging current to charge a battery by using power of a power source and supplying the power from the battery to a load to make the load operate, the electronic apparatus comprising:

a sense resistor provided between a connection point between the power source and the charger and the battery, for detecting a charging current flowing into the battery and for detecting a current flowing out from the battery; and

a controller for controlling the charging current from the charger based on a current value measured by using the sense resistor.

21. An electronic apparatus as set forth in claim 20, further comprising:

a current measuring section for discriminating which one of two input potentials applied to both ends of the sense resistor is larger, and for detecting both a charging current and a discharging current from a voltage generated according to a difference between the two input potentials.

22. An electronic apparatus as set forth in claim 20, further comprising:

a remaining-amount determining section for determining a remaining amount of current charged to the battery based on a charging current value measured by the sense resistor.

23. An electronic apparatus as set forth in claim 20, further comprising:

a remaining-amount determining section for determining a remaining amount of current charged to the battery based on a discharging current value measured by the sense resistor.

24. An electronic apparatus having a charger for supplying a charging current to a battery by using power of a power source to make a load operate based on the power supplied from the battery, the electronic apparatus comprising:

a sense resistor disposed between the battery and a connection point between the power source and the charger, for detecting a charging current flowing into the battery in order to control the charging current of the charger; and

a detector for detecting a discharging current by the sense resistor when the power from the battery is supplied to the load.

25. An electronic apparatus having an input section for inputting power from a power source and capable of charging a battery by using the power from the input section while making a load operate by applying the power input from the input section to the load, a current applied to the load from the input section varying based on the state of the load, the electronic apparatus comprising:

a power input sensor which obtains power-input information by sensing an input of the power from the input section;

a charger which charges the battery by using a current from the input section; a charge control circuit which controls the charger to change a current charged to the battery by determining whether an input current from the power source reaches a predetermined value or not in accordance with the power-input information sensed by the power input sensor, so that a sum of the current applied to the load and the current charged to the battery from the input section does not exceed the predetermined value; and

a charging voltage detector which detects a charging voltage of the battery, wherein the charge control circuit controls the charging voltage so that the charging voltage detected by the charging voltage detector becomes a value assigned to the battery or lower.

26. An electronic apparatus as set forth in claim 25, further comprising:

a charging current detector which detects a charging current of the battery, wherein the charge control circuit controls the charging current based on the detected charging current so that the charging current becomes a value assigned to the battery or lower.

27. An electronic apparatus as set forth in claim 25, wherein the predetermined value is a maximum permissible supply current of the power source.

28. A charging apparatus for an electronic apparatus that has an input section for inputting power from a power source and is capable of charging a battery by using the power from the input section while the electronic apparatus making a load operate by applying the power input from the input section to the load, a current applied to the load from the input section varying based on the state of the load, the charging apparatus comprising:

a charger which charges the battery by using the power from the input section;

a charge control circuit which controls the charger to change a current charged to the battery by determining whether an input current from the power source reaches a predetermined value or not in accordance with the power-input information sensed by a power input sensor which obtains the power input information by sensing an input of power from the input section, so that a sum of the current applied to the load and the current charged to the battery from the input section does not exceed the predetermined value, wherein

the charge control circuit further controls the charging voltage so that a voltage detected by a charging voltage detector for detecting the charging voltage of the battery becomes a value assigned to the battery or lower.

29. A charging apparatus as set forth in claim 28, wherein the charge control circuit controls the charging current, based on a charging current detected by a charging current detector for detecting the charging current of the battery, so that the charging current becomes a value assigned to the battery or lower.

30. A charging apparatus as set forth in claim 28, wherein the predetermined value is a maximum permissible supply power of the power source.

31. A charge control circuit for an electronic apparatus that has an input section for inputting power from a power source and a charger for charging a battery by using the power from the input section and while the electronic apparatus making a load operate by applying the power input from the input section to the load, a current applied to the load from the input section varying based on the state of the load, the charge control circuit comprising:

a charge control circuit which controls the charger to change a current charged to the battery by determining whether an input current from the power source reaches a predetermined value or not in accordance with the power-input information sensed by a power input sensor which obtains the power input information by sensing an input of power from the input section, so that a sum of the current applied to the load and the current charged to the battery from the input section does not exceed the predetermined value, wherein *the control circuit controls the charging voltage so that a voltage detected by a charging voltage detector for detecting the charging voltage of the battery becomes a value assigned to the battery or lower.*

32. A charge control circuit as set forth in claim 31, wherein the control circuit controls the charging current based a charging current detected by a charging current detector for detecting the charging current of the battery so that the charging current becomes a value assigned to the battery or lower.

33. A charge control circuit as set forth in claim 31, wherein the predetermined value is a maximum permissible supply power of the power source.

34. An electronic apparatus connected to an AC adapter which supplies DC power, capable of charging a battery by using power from the AC adapter while making a load operate by using the DC power supplied from the AC adapter, the power given to the load varying based on the state of the load, the electronic apparatus comprising:

a connector which receives the DC power from the AC adapter;

a charger, connected to the battery, which supplies charging power to the battery by using the power from the connector; and

a charge control circuit which controls the charger to control the charging power the charger supplies to the battery so that a sum of the power applied to the load and the power charged to the battery becomes a value assigned in advance.

35. An electronic apparatus as set forth in claim 34, further comprising a charging current detector which detects a charging current supplied to the battery, wherein the charge control circuit controls the charging current so that the charging current becomes equal to or lower than a value assigned to the battery, based on a value of the charging current to the battery detected by the charging current detector.

36. An electronic apparatus as set forth in claim 34, further comprising a charging voltage detector which detects a charging voltage supplied to the battery, wherein the control circuit controls the charging voltage so that the charging voltage becomes equal to or lower than a value assigned to the battery, based on a value of the charging voltage to the battery detected by the charging voltage detector.

37. An electronic apparatus as set forth in claim 34, wherein the value assigned in advance is a maximum permissible supply power of the AC adapter.

38. An electronic apparatus as set forth in claim 34, wherein the charge control circuit controls the charging power the charger supplies to the battery, based on sensed information on the power input from the connector, so that a sum of the power applied to the load and the power charged to the battery becomes the value assigned in advance.

39. A charging apparatus for charging a battery for an electronic apparatus that is connected to an AC adapter and that is capable of charging the battery by using power from the AC adapter while the electronic apparatus making a load operate by using DC power supplied from the AC adapter, the power given to the load varying based on the state of the load, the charging apparatus comprising:

a charger, connected to the battery, which supplies charging power to the battery by using the power from a connector that is connected to the AC adapter to receive the DC power from the AC adapter; and

a charge control circuit which controls the charger to control the charging power the charger supplies to the battery so that a sum of the power applied to the load and the power charged to the battery becomes a value assigned in advance.

40. A charging apparatus as set forth in claim 39, wherein the charge control circuit controls the charging current so that a charging current becomes equal to or lower than the value assigned to the battery, based on a detected value of the charging current to the battery.

41. A charging apparatus as set forth in claim 39, wherein the charge control circuit controls a charging voltage so that the charging voltage becomes equal to or lower than a value assigned to the battery, based on a detected value of the charging voltage to the battery.

42. A charging apparatus as set forth in claim 39, wherein the value assigned in advance is a maximum permissible supply power of the AC adapter.

43. A charging apparatus as set forth in claim 39, wherein the charge control circuit controls the charging power the charger supplies to the battery so that a sum of the power applied to the load and the power charged to the battery becomes the value assigned in advance, based on sensed information on the power input from the connector.

44. A charge control circuit for controlling a charger in an electronic apparatus having a connector connected to an AC adapter to receive DC power from the AC adapter, the charger being connected to a battery and supplying charging power to the battery by using the power from the connector, the electronic apparatus making a load operate by using the DC power supplied from the AC adapter, the power given to the load varying based on the state of the load, the charge control circuit comprising:

a control circuit which controls the charger to control the charging power the charge supplies to the battery so that a sum of the power applied to the load and the power charged to the battery becomes a value assigned in advance.

45. A charge control circuit as set forth in claim 44, wherein the control circuit controls a charging current based on a detected value of the charging current to the battery so that the charging current becomes equal to or lower than a value assigned to the battery.

46. A charge control circuit as set forth in claim 44, wherein the control circuit controls a charging voltage based on a detected value of the charging voltage to the battery so that the charging voltage becomes equal to or lower than a value assigned to the battery.

47. A charge control circuit as set forth in claim 44, wherein the value assigned in advance is a maximum permissible supply power of the AC adapter.

48. A charge control circuit as set forth in claim 44, wherein the control circuit controls the charging power the charger supplies to the battery, based on sensed information on the power input from the connector, so that a sum of the power applied to the load and the power charged to the battery becomes the value assigned in advance.

49. An electronic apparatus capable of charging a battery by using power from a power source while making a load operate by using the power supplied from the power source, the electronic apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source;

a detector which detects the power applied to the load;

a charging current detector detects a charging current to the battery; and

a control circuit which controls the charger to generate the charging power so that a sum of the charging power *supplied to the battery and the power applied to the load that has been detected becomes a value assigned in advance, and which controls the charging current based on the detected charging current so that the charging current to the battery becomes equal to or lower than a charging current value assigned in advance to the battery.*

50. An electronic apparatus capable of charging a battery by using power from a power source while making a load operate by using the power supplied from the power source, the electronic apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source;

a detector which detects the power applied to the load;

a charging voltage detector which detects a charging voltage to the battery; and

a control circuit which controls the charger to generate the charging power so that a sum of the charging power supplied to the battery and the power applied to the load that has been detected becomes a value assigned in advance, and which controls the charging voltage based on the detected charging voltage so that the charging voltage becomes within a voltage value assigned in advance to the battery.

51. An electronic apparatus capable of charging a battery by using power from a power source having a prescribed maximum permissible supply power while making a load operate by using the power supplied from the power source, the electronic apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source;

a detector which detects the power applied to the load; and

a control circuit which controls the charger to adjust the charger to supply the charging power so that the charging power is the prescribed maximum permissible supply power minus the detected power applied to the load.

52. A charging apparatus for an electronic apparatus capable of charging a battery by using power from a power source while the electronic apparatus makes a load operate by using the power supplied from the power source, the charging apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source; and

a control circuit which controls the charger to generate the charging power so that a sum of the charging power supplied to the battery and the power applied to the load detected by a detector which detects the power applied to the load becomes a value assigned in advance, and which controls the charging current, based on a charging current value detected by a charging current detector which detects the charging current to the battery, so that the charging current to the battery becomes equal to or lower than a charging current value assigned in advance to the battery.

53. A charging apparatus for an electronic apparatus capable of charging a battery by using power from a power source while the electronic apparatus making a load operate by using the power supplied from the power source, the charging apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source; and

a control circuit which controls the charger to generate the charging power so that a sum of the charging power supplied to the battery and the power applied to the load detected by a detector which detects the power applied to the load becomes a value assigned in advance, and which controls the charging voltage, based on a charging voltage detected by a charging voltage detector which detects the charging voltage of the battery, so that the charging voltage becomes within a voltage value assigned in advance to the battery.

54. A charging apparatus for an electronic apparatus capable of charging a battery by using power from a power source having a prescribed maximum permissible supply power while the electronic apparatus makes a load operate by using the power supplied from the power source, the charging apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source; and

a control circuit which controls the charger so that the charger supplies the charging power so that the charging power is the maximum permissible supply power minus the power applied to the load that has been detected by a detector which detects the power applied to the load.

55. A charge control circuit for controlling a charger for an electronic apparatus that makes a load operate by using power supplied from a power source and that has the charger for supplying charging power to a battery by using the power from the power source, the charge control circuit comprising:

a control circuit which controls the charger to generate the charging power so that a sum of the charging power supplied to the battery and the power applied to the load detected by a detector which detects the power applied to the load becomes a value assigned in advance, and which controls a charging current, based on a charging current detected by a charging current detector which detects the charging current to the battery, so that the charging current supplied to the battery becomes equal to or lower than a charging current value assigned in advance to the battery.

56. A charge control circuit for controlling a charger for an electronic apparatus that makes a load operate by using power supplied from a power source and that has the charger for supplying charging power to a battery by using the power from the power source, the charge control circuit comprising:

a control circuit which controls the charger to generate the charging power so that a sum of the charging power supplied to the battery and the power applied to the load detected by a detector which detects the power applied to the load becomes a value assigned in advance, and which controls the charging voltage, based on a charging voltage detected by a charging voltage detector which detects the charging voltage to the battery, so that the charging voltage becomes within a voltage value assigned in advance to the battery.

57. A charge control circuit for controlling a charger for an electronic apparatus that makes a load operate by using power supplied from a power source having a prescribed maximum permissible supply power and that has the charger for supplying charging power to a battery by using the power from the power source, the charge control circuit comprising:

a control circuit which controls the charger so that the charger supplies the charging power which is the prescribed maximum permissible supply power minus the power applied to the load detected by a detector which detects the power applied to the load.

58. An electronic apparatus capable of charging a battery by using power from a power source while making a load operate by using the power supplied from the power source, the power applied to the load from the power source varying based on the state of the load, the electronic apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source;

a charging current detector which detects a charging current of the battery; a charge control circuit which controls the charging power the charger supplies to the battery so that a sum of the power applied to the load and the power charged to the battery from the power source becomes a value assigned in advance, and which controls the charging current based on the charging current detected by the charging current detector so that the charging current becomes a limit value assigned to the battery or a lower value; and

a charging voltage detector which detects a charging voltage of the battery, wherein the charge control circuit further controls the charging voltage so that the voltage detected by the charging voltage detector becomes a value assigned to the battery or lower.

59. An electronic apparatus as set forth in claim 58, wherein the pre-assigned value is a maximum permissible supply power of the power source.

60. An electronic apparatus as set forth in claim 58, wherein the charge control circuit controls the charging power the charger supplies to the battery, based on sensed information on the input from the power source, so that a sum of the power applied to the load and the power charged to the battery from the power source becomes the pre-assigned value.

61. A charging apparatus for an electronic apparatus that is capable of charging a battery by using power supplied from a power source while the electronic apparatus making a load operate by using the power from the power source, the power applied to the load from the power source varying based on the state of the load, the charging apparatus comprising:

a charger which supplies charging power to the battery by using the power from the power source; and

a charge control circuit which controls the charging power the charger supplies to the battery so that a sum of the power applied to the load and the power charged to the battery from the power source becomes a value assigned in advance, and which controls the charging current, based on a charging current detected by a charging current detector which detects the charging current to the battery, so that the charging current becomes a value assigned to the battery or a lower value, wherein

the charge control circuit further controls the charging voltage so that a charging voltage detected by a charging voltage detector which detects the voltage charged to the battery becomes a value assigned to the battery or lower.

62. A charging apparatus as set forth in claim 61, wherein the preassigned value is a maximum permissible supply power of the power source.

63. A charging apparatus as set forth in claim 61, wherein the charge control circuit controls the charging power the charger supplies to the battery, based on sensed information on the input from the power source, so that a sum of the power applied to the load and the power charged to the battery becomes the pre-assigned value.

64. A charge control circuit for an electronic apparatus that makes a load operate by using power supplied from a power source and that has a charger for supplying charging power to a battery by using the power from the power source, the power applied to the load from the power source varying based on the state of the load, the charge control circuit comprising:

a control circuit which controls the charging power the charger supplies to the battery so that a sum of the power applied to the load and the power charged to the battery from the power source becomes a value assigned in advance, and which controls the charging current based on a charging current detected by a charging current detector which detects the charging current to the battery so that the charging current becomes a value assigned to the battery or a lower value.

65. A charge control circuit as set forth in claim 64, wherein the control circuit further controls the charging voltage so that a charging voltage detected by a charging voltage detector which detects the voltage charged to the battery becomes a value assigned to the battery or lower.

66. A charge control circuit as set forth in claim 64, wherein the preassigned value is a maximum permissible supply power of the power source.

67. A charge control circuit as set forth in claim 64, wherein the control circuit controls the charging power the charger supplies to the battery, based on sensed information on the input from the power source, so that a sum of the power applied to the load and the power from the power source charged from the power source to the battery becomes the pre-assigned value.

68. A charge control circuit for an electronic apparatus that has an input section for inputting power from a power source and a charger for charging a battery by using the power from the input section while the electronic apparatus makes a load operate by applying the power input from the input section to the load, an output voltage of the power source being substantially a constant voltage, the output voltage of the power source falling to less than said substantially constant voltage when the power source outputs more than a predetermined current value, the power applied to the load from the input section varying based on the state of the load, the charge control circuit comprising:

a control circuit which controls the charging power the charger supplies to the battery, based on power input information obtained by a power input sensor which obtains the power input information by sensing an input of the power from the input section, so that a sum of the power applied to the load and the power charged to the battery from the input section is substantially in a current range in which said output voltage of the power source is the substantially constant voltage, wherein the control circuit controls a charging voltage the charger supplies to the battery so that the charging voltage detected by a charging voltage detector becomes a value assigned to the battery or lower, wherein

the control circuit controls the charging power the charger supplies to the battery, based on sensed information on the input from the power source, so that a sum of the power applied to the load and the power from the power source charged from the power source to the battery becomes the pre-assigned value.

69. An electronic apparatus connected to an AC adapter which supplies DC current, capable of charging a battery by using current from the AC adapter while making a load operate by using the DC current supplied from the AC *adapter, the current given to the load varying based on the state of the load, the electronic apparatus comprising:*

a connector connected to the AC adapter, which receives DC current from the AC adapter;

a charger, connected to the battery, which supplies charging current to the battery by using the current from the connector;

a charger control circuit which controls the charger to control the charging current the charger supplies to the battery so that a sum of the current applied to the load and the current charged to the battery becomes a value assigned in advance; and a charging voltage detector which detects a charging voltage supplied to the battery, wherein

the control circuit controls the charging voltage so that the charging voltage becomes equal to or lower than a value assigned to the battery, based on a value of the charging voltage to the battery detected by the charging voltage detector.

70. An electronic apparatus as set forth in claim 69, further comprising a charging current detector which detects a charging current supplied to the battery, wherein the charge control circuit controls the charging current so that the charging current becomes equal to or lower than a value assigned to the battery, based on a value of the charging current to the battery detected by the charging current detector.

71. An electronic apparatus as set forth in claim 69, wherein the value assigned in advance is a maximum permissible supply current of the AC adapter.

72. An electronic apparatus as set forth in claim 69, wherein the charge control circuit controls the charging current the charger supplies to the battery, based on sensed information on the power input from the connector, so that a sum of the current applied to the load and the current charged to the battery becomes the value assigned in advance.

73. A charging apparatus for charging a battery for an electronic apparatus that is connected to an AC adapter and that is capable of charging the battery by using current from the AC adapter while the electronic apparatus making a load operate by using DC current supplied from the AC adapter, the current given to the load varying based on the state of the load, the charging apparatus comprising:

a charger, connected to the battery, which supplies charging current to the battery by using the current from a connector that is connected to the AC adapter to receive the DC current from the AC adapter; and

a charger control circuit which controls the charger to control the charging power the charger supplies to the battery so that a sum of the current applied to the load and the current charged to the battery becomes a value assigned in advance, wherein

the charge control circuit controls a charging voltage so that the charging voltage becomes equal to or lower than a value assigned to the battery, based on a detected value of the charging voltage to the battery.

74. A charging apparatus as set forth in claim 73, wherein the charge control circuit controls the charging current so that a charging current becomes equal to or lower than the value assigned to the battery, based on a detected value of the charging current to the battery.

75. A charging apparatus as set forth in claim 73, wherein the value assigned in advance is a maximum permissible supply current of the AC adapter.

76. A charging apparatus as set forth in claim 73, wherein the charge control circuit controls the charging current the charger supplies to the battery so that a sum of the current applied to the load and the current charged to the battery becomes the value assigned in advance, based on sensed information on input from the connector.

77. A charge control circuit for controlling a charger in an electronic apparatus having a connector connected to an AC adapter to receive DC current from the AC adapter, the charger being connected to a battery and supplying charging current to the battery by using the current from the connector, the electronic apparatus making a load operate by using the DC current supplied from the AC adapter, the current given to the load varying based on the state of the load, the charge control circuit comprising:

a control circuit which controls the charger to control the charging current the charger supplies to the battery so that a sum of the current applied to the load and the current charged to the battery becomes a value assigned in advance, wherein

the control circuit controls a charging voltage based on a detected value of the charging voltage to the battery so that the charging voltage becomes equal to or lower than a value assigned to the battery.

78. A charge control circuit as set forth in claim 77, wherein the control circuit controls a charging current based on a detected value of the charging current to the battery so that the charging current becomes equal to or lower than a value assigned to the battery.

79. A charge control circuit as set forth in claim 77, wherein the value assigned in advance is a maximum permissible supply current of the AC adapter.

80. A charge control circuit as set forth in claim 77, wherein the control circuit controls the charging current the charger supplies to the battery, based on sensed information on input from the connector, so that a sum of the current applied to the load and the current charged to the battery becomes the value assigned in advance.

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