

*R TMD***TITLE OF INVENTION****PORTABLE TERMINAL APPARATUS**

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a portable terminal apparatus, and in particular to a portable terminal apparatus which is equipped with a memory back-up system.

DESCRIPTION OF THE PRIOR ART

Conventionally, there have been a wide variety of portable terminal apparatus such as for example, an electronic note book, an optical character reader, a bar code reader, a pocket computer, a remote controller for various household electric appliances and the like which are each provided with a main battery for driving circuits, and a backup battery for holding memorized data when the main battery runs out. Such a backup battery is constructed to be charged by the main battery and thus serves as a small secondary rechargeable battery. The backup battery of the previous portable terminal apparatus is discharged within a certain time interval after the main battery is removed from the terminal apparatus, the time interval being usually deemed to be between few months and one year although the time interval is varied in response to the capacity of the memory assembled in the portable terminal apparatus.

This means that the backup battery runs out, causing the memory to disappear when the main battery remains removed from the portable terminal battery over the certain time interval or otherwise runs out even if the main battery is still attached with the portable terminal apparatus. Moreover, no alarm can instantly be expected without such a main battery.

In the event that the main battery is exchanged for a new main battery with the backup battery running out, the voltage level of the backup battery is instantly raised by the new main battery so that the voltage level of the backup battery becomes normal when a main switch forming part of the portable terminal apparatus is operated to allow a voltage monitoring circuit also forming part of the portable terminal apparatus to be energized. This leads to such a possibility that the voltage level of the memory is lowered in the past, thereby making it impossible to confirm whether or not the memory is damaged.

Fig. 6 shows a graph illustrating the voltage V_A of the backup battery varied in response to lapse of time. As will be seen from Fig. 6, the voltage V_A of the backup battery gradually declines after the main battery is removed at a time t_0 from the portable terminal apparatus and exceeds a memorized data guaranteed lowest voltage level V_0 at a time t_1 . If the main battery is replaced by a new main battery at a time t_2 , the voltage of the backup battery is raised within a few seconds to its normal voltage

V1 at a time t_3 when the main switch is put on to energize the portable terminal apparatus.

In this instance, the backup battery is recharged immediately after the main battery is changed by a new main battery. The voltage drop of the backup battery, however, cannot be detected by a voltage monitoring circuit. This may cause such a disadvantage that the main circuit fails to produce acceptable digital information due to the damaged memory data.

If, on the other hand, the backup battery is recharged when the main switch is put on to supply the main circuit with electricity from the new main battery, the backup battery cannot be recharged immediately after the main battery is changed by a new main battery but can be recharged when the main switch is put on. In this case, the backup battery may be soon exhausted resulting from the fact that the backup battery is recharged only when the main switch is put on. This may result in a drawback that the memory is likely to be damaged after the new main battery is installed in the terminal apparatus.

On the other hand, another method may be considered as a method of determining whether the memorized data is held in the memory to memorize a specific cord in the memory and to examine whether the specific cord remains in the memory. This method is designed to memorize the specific code data in any one of memory chips which are generally deviated in their threshold voltages at which the memorized data may disappear. For this reason, the memorized data other than that of the specific code are likely to disappear from the memory chips, thereby making it impossible to determine whether all the memorized data remains in the memory chips or not. For the portable terminal apparatus equipped with only one memory chip, there is a possibility that the memory chip accidentally has one part in which a specific code is held memorized and other part in which all the memorized data disappear. Similarly, this case encounters the same problem as in the above.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a portable terminal apparatus which can overcome the previously mentioned drawbacks and ensure to check whether the memorized data are damaged or not when the main battery is replaced by a new main battery under the state that the main circuit is disconnected from the main battery by the main switch.

According to one aspect of the present invention there is provided a portable terminal apparatus for producing digital information in accordance with predetermined procedures. The portable terminal apparatus comprises a procedural data memory for



storing predetermined procedural data representative of part of the predetermined procedures at a voltage higher than its predetermined guaranteed lowest voltage, a digital information producing unit for producing the digital information on the basis of the procedural data stored in the procedural data memory, a replaceable main battery for supplying the procedural data memory and the digital information producing unit with electricity at a voltage higher than the guaranteed lowest voltage of the procedural data memory, a rechargeable backup battery for substituting for the main battery and supplying the procedural data memory with electricity at a backup voltage higher than the guaranteed lowest voltage when the main battery is discharged to its voltage lower than the backup voltage, and a recharging unit for recharging the backup battery by receiving the voltage from the main battery. The portable terminal apparatus further comprises control means for controlling the digital information producing unit and the recharging unit, and a main switch element operable to electrically connect the main battery and the digital information producing unit and to have the digital information producing unit produce the digital information on the basis of the procedural data. The control means includes a voltage detection unit for detecting the voltage of the backup battery to produce voltage detection data, a delay element for delaying the starting of recharging the backup battery by the recharging unit until the voltage detection unit detects the voltage of the backup battery, a data holding unit for holding the voltage detection data until the main switch element is operated to electrically connect the main battery and the digital information producing unit, and a judgment unit for judging on whether the procedural data are normally stored in the procedural data memory on the basis of the voltage detection data when the main switch element is operated to electrically connect the main battery and the digital information producing unit.

The above voltage detection unit may have a timing signal generator for generating a timing signal and outputting the timing signal in case when the voltage detection unit detects during delay time produced by the delay element that the voltage of the backup battery is decreased to its voltage lower than the guaranteed lowest voltage of the procedural data memory, and when the timing signal is inputted to the data holding unit to have the data holding unit hold the voltage detection data from the voltage detection unit. The data holding unit may have a latch circuit for latching the voltage detection data from the voltage detection unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of a portable terminal apparatus in accordance with the present invention will be more clearly understood from the following



description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic block diagram defining the portable terminal apparatus according to the present invention,

Fig. 2 is a circuit diagram showing a timing signal generator and a latch circuit forming part of the portable terminal apparatus,

Fig. 3 is a graph showing the voltage of a backup battery varied in response to lapse of time when a main battery is removed from the portable terminal apparatus embodying the present invention,

Fig. 4 (a) is a graph showing a voltage signal V_x outputted from an RC delay circuit forming part of the timing signal generator of the voltage detection unit and varied in response to lapse of time when a new main battery is installed in the portable terminal apparatus;

Fig. 4 (b) is a graph showing a voltage signal V_y outputted from an inverter element forming part of the timing signal generator of the voltage detection unit and varied in response to the voltage signal V_x ;

Fig. 5 (a) is a graph showing a voltage signal V_A outputted by the backup battery to a procedural data memory forming part of the portable terminal apparatus;

Fig. 5 (b) is a graph showing a voltage detection signal V_P outputted from the voltage detection unit to a latch circuit forming part of the portable terminal apparatus;

Fig. 5 (c) is a graph showing a voltage signal V_Y outputted from the inverter element of the timing signal generator of the voltage detection unit;

Fig. 5 (d) is a graph showing a timing signal V_T outputted from the timing signal generator of the voltage detection unit;

Fig. 5 (e) is a graph showing a voltage signal V_{OUT} outputted from the latch circuit; and

Fig. 6 is a graph similar to Fig. 3 but showing the voltage of a backup battery varied in response to lapse of time when a main battery is removed from the conventional portable terminal apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figs. 1 and 2 of the drawings, a preferred embodiment of a portable terminal apparatus according to the present invention is shown as generally comprising a plurality of memory elements 11, 12 and 13, a main circuit 20, a main battery 31, a backup battery 32, a recharging unit 40 and a main switch element 81. All the above elements and parts are housed in a single portable housing forming part of the portable terminal apparatus but not shown in the drawings.

The portable terminal apparatus is designed to be energized by the main battery

31 and operated to produce digital information in accordance with predetermined procedures during a normal operation. The portable terminal apparatus serves as for example an electronic note book, an optical character reader, a bar code reader, a pocket computer, a portable digital camera, a remote controller for various household electric appliances or the like.

Each of the memory elements 11 to 13 is adapted to store predetermined procedural data at an operation voltage higher than its predetermined storage guaranteed lowest voltage V_0 which is particularly shown in Figs. 3 and 5(a). The memory elements 11 to 13 as a whole constitute a procedural data memory 10 for storing predetermined procedural data which is representative of part of the predetermined procedures of the portable terminal apparatus.

The main circuit 20 includes a digital information producing unit 21 for producing the digital information on the basis of the procedural data in the memory elements 11 to 13. The main circuit 20 further includes a clear signal generator 22 for generating a clear signal SC to be outputted to a latch circuit 61.

The main battery 31 is constituted by a dry battery cell and detachably mounted to the aforesaid portable terminal housing of the terminal apparatus to supply the procedural data memory 10 and the main circuit 20 with electricity at a voltage higher than the guaranteed lowest voltage V_0 of each of the memory elements 11 to 13. The voltage of the main battery 31 is initially set at its normal voltage within a normal voltage range. The main battery 31 has a negative terminal 31a electrically connected to the grounding portion G of the terminal apparatus and a positive terminal 31b electrically connected to each of the memory elements 11 to 13 through a diode 35.

The backup battery 32 is constituted by a secondary battery cell capable of substituting for the main battery 31 and being recharged. This backup battery 32 has a negative terminal 32a electrically connected to the grounding portion G of the terminal apparatus and a positive terminal 32b electrically connected to each of the memory elements 11 to 13 of the procedural data memory 10 through a diode 42. The backup battery 32 is adapted to supply each of the memory elements 11 to 13 of the procedural data memory 10 with electricity at a backup voltage higher than the guaranteed lowest voltage V_0 when the main battery 31 is discharged to its voltage lower than the backup voltage of the backup battery 32. The backup battery 32 is recharged by the recharging unit 40 to a normal backup voltage V_1 when the main battery 31 has a voltage within the normal voltage range.

The recharging unit 40 has an input terminal 40a electrically connected to the positive terminal 31b of the main battery 31 through a delay element 45 which will become apparent as the description proceeds, and an output terminal 40b electrically

connected to the positive terminal 32b of the backup battery 32 through a diode 41. The recharging unit 40 is designed to repeatedly recharge the backup battery 32 each time for a recharging time interval by outputting electric charge to the backup battery 32 through the diode 41. The recharging time interval is determined by the recharging unit 40 to vary in response to the voltages of the main battery 31 and the backup battery 32. The recharging time interval is defined to start when the voltage of the backup battery 32 is decreased to a predetermined voltage less than the normal backup voltage V_1 but no less than the guaranteed lowest voltage V_0 of the memory elements 11 to 13 of the procedural data memory 10.

The recharging unit 40 is controlled by control means which includes a voltage detection unit 51, the latch circuit 61, the above delay element 45 and a judgment unit 70 forming part of the main circuit 20.

The voltage detection unit 51 has a voltage detector 52 and a timing signal generator 53. The voltage detector 52 has an input terminal 52a electrically connected to positive terminal 32b of the backup battery 32 and an output terminal 52b electrically connected to the timing signal generator 53. The voltage detector 52 is adapted to detect the voltage of the backup battery 32 during a detecting time interval TD' shown in Fig. 4 (b) and Fig. 5(c) and to output through the output terminal 52b a voltage detection signal VP with one of two logic levels "High" or "Low" (see Fig. 5 (b)). More specifically, the voltage detector 52 outputs the voltage detection signal VP of the logic level "High" when the voltage VA (see Fig. 5 (a)) of the backup battery 32 is larger than the guaranteed lowest voltage V_0 of each of the memory elements 11 to 13, and to output the voltage detection signal VP of the logic level "Low" when the voltage VA of the backup battery is equal to or smaller than the guaranteed lowest voltage V_0 of each of the memory elements 11 to 13.

The timing signal generator 53 has an input terminal 53a electrically connected to the voltage detector 52 to receive the voltage detection signal VP from the voltage detector 52 and an output terminal 53b electrically connected to the latch circuit 61 to produce a timing signal VT . The timing signal VT is inputted to the latch circuit 61 to have the latch circuit 61 hold the voltage detection data VP from the voltage detector 52 of the voltage detection unit 51.

As best shown in Fig. 2, the timing signal generator 53 is constituted by an RC(resistor-capacitor) delay circuit 54, an inverter element 57 and a NOR element 58. The RC delay circuit 54 consists of a resistor 55 electrically connected to the positive terminal 31b of the main battery 31 and a capacitor 56 provided between the resistor 55 and the grounding portion G of the portable terminal apparatus. The RC delay circuit 54 is designed to output a voltage signal V_x (see Fig. 4 (a)) on its output

terminal 54a and to delay the rising time of the voltage signal V_x from a battery installation time t_2 when the main battery 31 is replaced by a new main battery 31 and the new battery 31 starts to supply the procedural data memory 10 with electricity. The delay of the rising time of the voltage signal V_x is particularly shown in Fig. 4 (a).

The inverter 57 has an input terminal 57a electrically connected to the output terminal 54a of the RC delay circuit 54 and an output terminal 57b, shown by a NOT symbol, electrically connected to the NOR element 58. The inverter 57 is adapted to invert the logic level of the voltage signal V_x on its input terminal 57a from one of two different levels to the other level, and to output a voltage signal V_Y (see Fig. 4 (b)) opposite to the voltage V_x in the logic level. The output voltage V_Y of the inverter element 57 is varied from one of the two logic levels to the other level when the voltage V_x is increased or decreased with respect to the threshold voltage of the inverter element 57 as shown in Figs. 4 (a) and 4 (b).

The NOR element 58 has a first input terminal 58a electrically connected to the output terminal 52b of the voltage detector 52, a second input terminal 58b electrically connected to the output terminal 57b of the inverter element 57, and an output terminal 58c electrically connected to the latch circuit 61.

In Fig. 2, the NOR element 58 is represented by a combination of an OR symbol and a pair of NOT symbols. This means that the NOR element 58 is constituted by first and second negation input portion on the input terminals 58a, 58b represented by the NOT symbols and an OR portion having the output terminal 58c and represented by the OR symbol. The voltage detection data V_P of the voltage detector 52 is applied to the first input terminal 58a of the NOR element 58, whilst the output voltage signal V_Y of the inverter element 57 is applied to the second input terminal 58b of the NOR element 58. The NOR element 58 is operative to output a timing signal V_T of the logic level "High" on its output terminal 58c if all inputs V_Y and V_P to the first and second input terminals 58a, 58b are "Low".

The latch circuit 61 is designed to serve as a data holding unit for holding the voltage detection data. The latch circuit 61 has a data input terminal 61a electrically connected to the output terminal 52b of the voltage detector 52 of the voltage detection unit 51, a timing input terminal 61b electrically connected to the output terminal 58c of the NOR element 58, an output terminal 61c electrically connected to the digital information producing unit 21 of the main circuit 20, a reset terminal 61d electrically connected to the clear signal generator 22 of the main circuit 20, and a set terminal 61e electrically connected to the positive terminal 31b of the main battery 31.

The latch circuit 61 is adapted to latch the logic level voltage of the voltage detection data V_P from the voltage detector 52 when the timing signal V_T is inputted

to the timing input terminal 61b of the latch circuit 61. The latch circuit 61 is also adapted to output an output signal VOUT representative of the logic level voltage of the voltage detection data VP latched by the latch circuit 61. The logic level voltage latched by the latch circuit 61 is maintained by the latch circuit 61 until the latch circuit 61 is reset to the logic level "High" by the clear signal SC from the clear signal generator 22 of the main circuit 20.

The delay element 45 has an input terminal 45a electrically connected to the positive terminal 31b of the main battery 31 and an output terminal 45b electrically connected to the recharging unit 40. The delay element 45 is adapted to delay the starting time of the above recharging time interval of the recharging unit 40 for a predetermined delay time interval TD from the end of the detecting time interval TD' shorter than the delay time interval TD. In other words, the starting of recharging the backup battery 32 is delayed by the recharging unit 40 and the delay element 45 until the voltage detection unit 51 detects the voltage of the backup battery 32. The delay time interval TD is defined as a time interval starting from the battery installation time t2 and ending at a recharge start time t2' when the recharging unit 40 starts to recharge the backup battery 32. During the delay time interval TD produced by the delay element 45, the timing signal VT is generated by the timing signal generator 53 in case when the voltage detection unit 51 detects that the voltage of the backup battery 32 is decreased to its voltage lower than the guaranteed lowest voltage V0 of the procedural data memory 10. The detecting time interval TD' is defined to start at the battery installation time t2 and to end at the time t4 (see Figs. 4(b) and 5(c)) when the voltage detection data VP is produced by the voltage detection unit 51.

The judgment unit 70 is adapted to judge on whether the procedural data are normally stored in the memory elements 11 to 13 of the procedural data memory 10 on the basis of the output signal VOUT representative of the voltage detection data VP latched by the latch circuit 61. The judgment of the judgment unit 70 is performed when the main switch element 81 is operated to electrically connect the main battery 31 and the main circuit 20.

The main switch element 81 has a battery side terminal 81a electrically connected to the positive terminal 31b of the main battery 31 and a main circuit side terminal 81b electrically connected to the main circuit 20. The main switch element 81 is operable to electrically connect the main battery 31 and the main circuit 20, and to disconnect the main battery 31 from the main circuit 20.

When the main switch 81 is put on to electrically connect the main circuit 20 to the main battery 31, the main circuit 20 is energized by the main battery 31 to produce the digital information on the basis of the procedural data of the memory elements 11

to 13. The clear signal is outputted by the clear signal generator 22 of the main circuit 20 at a time t_5 after the main switch element 81 is operated to energize the digital information producing unit 21 of the main circuit 20 by the main battery 31. When the latch circuit 61 is reset by the clear signal SC from the clear signal generator 22, the logic level voltage latched by the latch circuit 61 is cleared out. The latch circuit 61 thus holds the voltage detection data VP until the main switch element 81 is operated to electrically connect the main battery 31 and the digital information producing unit 21 of the main circuit 20.

The portable terminal apparatus further comprises an alert element 91 for issuing a warning signal on the basis of judgment of the judgment unit 70 on whether the voltage of the backup battery 32 is decreased to its voltage lower than the guaranteed lowest voltage V_0 of the procedural data memory 10 in the past. The warning signal is representative of the procedural data damaged in the procedural data memory 10.

The portable terminal apparatus further comprises a protection circuit 110 for protecting the main circuit 20. The protection circuit 110 is constituted by a resistor 111 and a diode 112 respectively provided between the main circuit 20 and the latch circuit 61. The resistor 111 and the diode 112 are adapted to form a bypass line 113 for bypassing at least part of the main circuit 20 when the main circuit 20 is out of operation. The diode 112 permits current flow in a direction from the main switch 81 to the output terminal 61c of the latch circuit 61, but limits electric current from the output terminal 61c of the latch circuit 61 to the main circuit 20 when the main circuit 20 is out of operation.

The operation of the above portable terminal apparatus according to the present invention will now be described hereinafter.

<Normal Operation>

The above portable terminal apparatus is energized by the main battery 31 and operated to produce digital information based on the coded procedural data of the procedural data memory 10 in a manner as follows.

When the main battery 31 has a voltage maintained within its normal range, the memory elements 11 to 13 of the procedural memory 10 are energized by electricity supplied from the main battery 31 to have their normal operation voltages higher than their guaranteed lowest voltage V_0 . At this time, the charging unit 40 is energized by the main battery 31 to have the backup battery 32 recharged to its normal backup voltage V_1 sufficient to substitute for the main battery 31.

Under these conditions, the main circuit 20 is energized by the main battery 31 when the main switch 81 is closed to have the main circuit 20 electrically connected

with the main battery 31. With the main circuit 20 being energized, one of the predetermined data processing operations such as for example calculation, remote controlling, character reading, bar code reading and other data inputting can be performed on the basis of the coded procedural data in the procedure memory elements 11 to 13. The main circuit 20 is then operated by the operator to produce digital information on the basis of the operator's request.

<Battery Replacement>

As the portable terminal apparatus is repeatedly energized by the main battery 31 and operated to produce predetermined digital information for a long time period, the voltage of the main battery 31 is gradually decreased.

When the voltage of the main battery 31 is decreased to a certain voltage lower than the normal voltage of the main battery 31, the main circuit 20 is operated to produce a first alerting signal indicative of the voltage of the main battery 31 lower than its normal voltage. At this time, the user of the terminal apparatus is required to replace the main battery 31 by another new battery of the same type.

In the event that the main battery 31 is normally replaced by a new main battery while the voltage of the backup battery 31 is still higher than the guaranteed lowest voltage of each of the procedure memory elements 11 to 13, each of the procedure memory elements 11 to 13 is supplied from the backup battery 32 with electricity at a certain voltage within the normal operation voltage range until the new main battery 31 starts to supply each of the procedure memory elements 11 to 13 with electricity at the normal operation voltage. In this instance, there is no problem on the procedure memory elements 11 to 13 of the procedural data memory 10.

<Excessive Battery Discharge>

If the voltage of the main battery 31 is further decreased resulting for example from natural discharge of the main battery 31 for a long time period, the voltage of the backup battery 31 is decreased to its voltage lower than the guaranteed lowest voltage V_0 of each of the memory elements 11 to 13. In this case, the coded procedural data in the memory elements 11 to 13 may be partly volatilized or completely vanished.

The decrease of the voltage of the backup battery 32 is particularly shown in Fig. 3. In Fig. 3, the voltage V_A of the backup battery 32 is seen as being decreased for a discharging time period T_{NC} including a first time period T_{NB} during which the voltage of the backup battery 32 is decreased to a voltage lower than the guaranteed lowest voltage V_0 of each of the procedure memory elements 11 to 13, and a second time period T_D during which the delay element 45 is operated to delay the recharge starting time t_2' of the battery charging time interval after a new main battery is installed in the terminal apparatus. The delay time period T_D is set at for example 0.1

second or the same level.

As stated above, the coded procedural data in the memory elements 11 to 13 may be partly volatilized or completely vanished when the voltage V_A of the backup battery 32 is decreased to a level lower than the guaranteed lowest voltage V_0 of each of the procedure memory elements 11 to 13 as shown in Fig. 3 and Fig. 5 (a).

In order that the recharging unit 40 is operated to start to recharge the backup battery 32 with the new main battery 31 installed in the terminal apparatus, the voltage of the backup battery 32 is raised to its normal backup voltage V_1 within a few seconds after the new main battery 31 is installed in the terminal apparatus. If the main switch 81 is operated under the above condition that the voltage of the backup battery 32 is raised to its normal backup voltage V_1 , the lowest voltage of the backup battery 32 cannot be detected by any backup voltage monitoring system. As a result, the portable terminal apparatus is destined to be used for producing required digital information even if the procedural data in the memory elements 11 to 13 are partly damaged.

<Voltage Detection>

To overcome the aforementioned drawback, this embodiment of the portable terminal apparatus according to the present invention is designed to perform the following novel processes.

When the new main battery 31 is installed in the portable terminal apparatus, the RC delay circuit 54 of the timing signal generator 53 produces a voltage signal V_x to be applied to the input terminal 57a of the inverter 57 of the timing signal generator 53. As shown in Fig. 4 (a), the voltage signal V_x is moderately increased from the ground voltage to a certain voltage higher than the guaranteed lowest voltage V_0 as the capacitor 56 is firstly charged by the main battery 31. At this time, the inverter element 57 of the timing signal generator 53 is operated to have its output voltage V_Y opposite to the voltage signal V_x in the logic level and outputted on the output terminal 57b. As shown in Figs. 4 (a) and 4 (b), the output voltage V_Y of the inverter element 57 is varied in response to the voltage V_x and changed from the logic level "High" to the logic level "Low" when the voltage V_x is increased to the threshold voltage V_{th} of the inverter element 57. The voltage V_Y is inputted to the second negation portion 58a of the NOR element 58.

At the same time, the voltage V_A of the backup battery 32 is detected during a certain detecting time interval TD' by the voltage detection unit 51 which outputs a voltage detection data VP to the second negation portion 58b of the NOR element 58.

The voltage detection data VP is set at a logic level "High" by the voltage detection unit 51 in the case that the main battery 31 is normally installed in the

terminal apparatus to have a voltage higher than the guaranteed lowest voltage V_0 of each of the memory elements 11 to 13, but at a logic level "Low" in the case that the voltage of the main battery 31 has been decreased to a voltage lower than the guaranteed lowest voltage V_0 of each of the memory elements 11 to 13.

The voltage detection data VP from the voltage detection unit 51 is also applied to the data input terminal 61a of the latch circuit 61.

If the main battery 31 is normally installed in the terminal apparatus while the voltage of the backup battery 32 is still higher than the guaranteed lowest voltages V_0 of the procedure memory elements 11 to 13, the voltage detection data VP of the logic level "High" is inputted to the first negation portion 58a of the NOR element 58, and the voltage signal VY of the logic level "Low" is inputted to the second negation portion 58b of the NOR element 58 after the voltage signal Vx is increased to the threshold voltage of the inverter element 57. At this time, the NOR element 58 is operated to have its output signal Vth set at the logic level "Low" because the voltage signals VP and VY are different from each other. In this event, the latch circuit 61 is operated so as not to input the voltage detection data VP of the logic level "High". The output signal VOUT of the latch circuit 61 is therefore maintained at the previously cleared logic level "High".

If, on the other hand, the main battery 31 is installed in the terminal apparatus under the condition that the voltage of the backup battery 32 is decreased to a voltage lower than the guaranteed lowest voltage V_0 of each procedure memory element 11, 12 or 13 as shown in Fig. 5 (a), the voltage detection data VP of the logic level "Low" is inputted to the first negation portion 58a of the NOR element 58, and the voltage signal VY of the logic level "Low" is inputted to the second negation portion 58b of the NOR element 58 after the voltage signal Vx is increased to the threshold voltage Vth of the inverter element 57. At this time, the NOR element 58 is operated to have its output signal Vth set at the logic level "High" because both of the input voltage signals VP and VY are "Low" as shown Figs. 5 (b) to 5 (d). In this case, the latch circuit 61 is operated so as to input and latch the voltage detection data VP of the logic level "Low". The output signal VOUT of the latch circuit 61 is therefore set at the logic level "Low" by the latch circuit 61 as shown in Fig. 5 (e). In Fig. 5 (e), the output signal VOUT of the latch circuit 61 is initially set at the logic level "Low" by the reason that no data is latched by the latch circuit 61 when the main battery 31 is replaced by a new main battery. After the voltage of the backup battery 32 is, however, decreased to a voltage lower than the guaranteed lowest voltage V_0 of each of the procedure memory elements 11 to 13, the output signal VOUT of the latch circuit 61 may be initially set at the logic level "High" by the reason that the backup battery 32

can be recharged by the recharging unit 40 while a main battery 31 is temporarily installed with the main switch off.

It will be understood from the foregoing description that the voltage of the backup battery 32 is detected by the voltage detection unit 51 during the backup voltage detecting time interval TD' starting at the battery installation time t_2 when the main battery 31 is installed in the portable terminal apparatus and ending at the timing signal generating time t_4 when the timing signal V_{th} of the logic level "High" is outputted from the timing signal generating unit 53 to the latch circuit 61. The backup voltage detecting time interval TD' is shorter than the second time period TD which is equal to the recharge delay time interval starting at the battery installation time t_2 and ending at the recharge start time t_2' when the recharging unit 40 starts to recharge the backup battery 32.

<Data Holding>

When the main battery 31 is installed in the terminal apparatus, the latch circuit 61 is energized in the same manner as above and operated to keep the voltage level of the output signal V_{OUT} until the clear signal SC is inputted to its reset terminal 61d from the main circuit 20 to set the output signal V_{OUT} at the logic level "High".

During the voltage detecting process and the data holding process previously mentioned, the delay element 45 is operated to delay the above recharge start time t_2' from the end of the backup voltage detecting time interval TD' .

Although the recharge start time t_2' is delayed by the delay element 45 for the second time period TD after the replacement of the main battery 31, the second time period TD shorter than one second is extremely short in comparison with the first time period T_{NB} longer than one month. Accordingly, the voltage of the backup battery 32 is varied within an extremely narrow range from an upper voltage to a lower voltage almost the same as the upper voltage during the second time period TD .

The second-time period TD is also sufficient to check the voltage detection data, but negligible for the operator of the terminal apparatus to become aware of a time-lag after the main switch is operated to electrically connect the main circuit to the new main battery.

<Battery Recharge>

After the above voltage detection and data holding processes, the recharging unit 40 starts to recharge the backup battery 32 through the diode 41 by receiving electricity from the main battery 31 through the delay element 45. The voltage V_A of the backup battery 32 is therefore moderately increased to the normal backup voltage V_1 .

<Data Check>

The main switch 81 is then operated to electrically connect the main battery 31 to the main circuit 20. At this time, the judgment unit 70 of the main circuit 20 is operated to judge on whether the coded procedural data are normally stored in the procedure memory elements 11 to 13 on the basis of the output signal VOUT.

If the output signal VOUT is judged as being at the logic level "High", the backup voltage of the backup battery 32 is judged by the main circuit 20 as being maintained at a level higher than the guaranteed lowest voltage V0 of the procedure memory elements 11 to 13. In this case, the main circuit 20 is operated to get ready for conducting the aforementioned normal operation.

If, on the other hand, the output signal VOUT is judged as being at the logic level "Low", the backup voltage of the backup battery 32 is judged by the main circuit 20 as being reduced to a level lower than the guaranteed lowest voltages V0 of the procedure memory elements 11 to 13. In this case, the main circuit 20 is operated to get ready for conducting the following alerting operation.

<Alerting>

When the output signal VOUT is judged as being at the logic level "Low", the main circuit 20 is operated to produce a second alerting signal to the lighting indicator 91. At this time, the lighting indicator 91 issues a warning by emitting light on the basis of the second alerting signal. If the portable terminal apparatus has a display device, the alerting signal may be formed by message data for displaying an alerting message or the like on the display device.

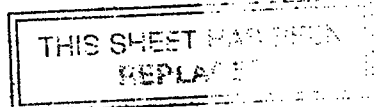
The main circuit 20 is then operated to output the clear signal to the reset terminal 61d of the latch circuit 61 after the above alerting signal is produced by the main circuit 20. With the clear signal inputted to the latch circuit 61, the latch circuit 61 is operated to have the latched voltage detection data cleared out and to have a cleared logic level "High".

As will be understood from the foregoing description, the backup battery of the portable terminal apparatus according to the present invention can be recharged soon after a new battery is installed in the terminal apparatus, although the main circuit is operated to judge on whether the voltage of the backup battery is higher than the guaranteed lowest voltage of the procedure memory element after the main switch is put on.

According to the present invention, the portable terminal apparatus is operated to indicate the damage of the procedural data memory when the coded data in the memory element is damaged. It is therefore possible for the portable terminal apparatus according to the present invention to be prevented from being operated until the digital information producing unit of the main circuit fails to produce acceptable digital

information due to the damaged data in the procedural data memory.

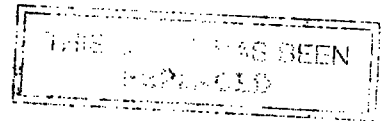
It will be understood by those skilled in the art that the foregoing description is in terms of preferred embodiments of the present invention wherein various changes and modification may be made within the appended claims.

**WHAT IS CLAIMED IS:**

1. A portable terminal apparatus for producing digital information in accordance with predetermined procedures, comprising:
 - a procedural data memory for storing predetermined procedural data representative of part of said predetermined procedures at a voltage higher than its predetermined guaranteed lowest voltage;
 - a digital information producing unit for producing said digital information on the basis of said procedural data stored in said procedural data memory;
 - a replaceable main battery for supplying said procedural data memory and said digital information producing unit with electricity at a voltage higher than said guaranteed lowest voltage of said procedural data memory;
 - a rechargeable backup battery for substituting for said main battery and supplying said procedural data memory with electricity at a backup voltage higher than said guaranteed lowest voltage when said main battery is discharged to its voltage lower than said backup voltage;
 - a recharging unit for recharging said backup battery by receiving said voltage from said main battery;
 - control means for controlling said digital information producing unit and said recharging unit; and
 - a main switch element operable to electrically connect said main battery and said digital information producing unit and to have said digital information producing unit produce said digital information on the basis of said procedural data;wherein said control means includes:
 - a voltage detection unit for detecting the voltage of said backup battery to produce voltage detection data;
 - a delay element for delaying the starting of recharging said backup battery by said recharging unit until said voltage detection unit detects the voltage of said backup battery;
 - a data holding unit for holding said voltage detection data until said main switch element is operated to electrically connect said main battery and said digital information producing unit; and
 - a judgment unit for judging on whether said procedural data are normally stored in said procedural data memory on the basis of said voltage detection data when said main switch element is operated to electrically connect said main battery and said digital information producing unit.
2. A portable terminal apparatus as set forth in claim 1, in which said voltage

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detection unit has a timing signal generator for generating a timing signal and outputting said timing signal in case when said voltage detection unit detects during delay time produced by said delay element that said voltage of said backup battery is decreased to its voltage lower than said guaranteed lowest voltage of said procedural data memory, and when said timing signal is inputted to said data holding unit to have said data holding unit hold said voltage detection data from said voltage detection unit.

3. A portable terminal apparatus as set forth in claim 1, in which said data holding unit has a latch circuit for latching said voltage detection data from said voltage detection unit.

4. A portable terminal apparatus as set forth in claim 3, in which said voltage detection unit has a voltage detector for detecting said voltage of said backup battery and a timing signal generator for generating a timing signal while said recharging is delayed by said delay element, said timing signal being inputted to said latch circuit to have said latch circuit latch said voltage detection data from said voltage detection unit.

5. A portable terminal apparatus as set forth in claim 1, in which said delay element has an input terminal electrically connected to said main battery and an output terminal electrically connected to said recharging unit.

6. A portable terminal apparatus as set forth in claim 1, in which said control means further includes a clear signal generator for generating a clear signal to be inputted to said data holding unit, said data holding unit having said voltage detection data cleared out when said clear signal is inputted to said data holding unit from said clear signal generator.

7. A portable terminal apparatus as set forth in claim 1, which further comprises an alert element for issuing a warning signal representative of said procedural data damaged in said procedural data memory on the basis of judgment of said judgment unit whether said voltage of said backup battery is decreased to its voltage lower than said guaranteed lowest voltage of said procedural data memory in the past.

8. A portable terminal apparatus as set forth in claim 7, in which said alert element is constituted by a lighting indicator for emitting light.

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