EUROPEAN QUALIFYING EXAMINATION 1998

PAPER A
ELECTRICITY / MECHANICS

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PAPER A/1998

CLIENT'S LETTER

To the attention of Mr. P. A. Torney

Dear P. A.

Once again we have developed an invention that will surely have a big commercial success. It is intended to be used in portable electrical appliances, such as portable tools, camcorders, mobile telephones and lap-top computers. We hope to sell or license it widely to manufacturers of such appliances, as well as to battery manufacturers and battery charger manufacturers.

I enclose a description of an embodiment of our invention (with drawings) that has been prepared by our technical department. To allow you to assess our invention properly I also enclose copies of state of the art documents D1 and D2. D1 is a patent application that was published some years ago. D2 is an article that has been recently published in a magazine and describes a product of one of our competitors.

Yours faithfully

E. R. Finder

The single figure of the drawings illustrates in schematic form a battery charger and a ba tery pack. The battery pack 1 comprises a housing 12 with one or more rechargeable cells 14 conta the housing.

As is well known, such rechargeable cells 14, when in a charged condition, can provide electric current to power an electrical appliance. When the rechargeable cells 14 are in a discharged condition, they cannot provide electric power any more and require charging. This charging consists generally in applying to the cells 14, for a certain time, an appropriate electric current known as the charging current. Different types of rechargeable cells are known and the value of the charging current required depends on the type of cells to be charged. Furthermore, with some types of rechargeable cells, the value of the charging current must be varied during charging. It is therefore usual to use a charging programme that depends on the type of cells to be charged.

In the battery pack 1, the rechargeable cells 14 are connected between first and second terminals 16, 18 that are accessible from outside the housing 12. Terminals 16, 18 are provided to connect the battery pack 1 to an electrical appliance. Terminals 16, 18 are also used to provide charging current to the rechargeable cells 14 inside the pack.

The battery pack 1 is intended to be used as a power source for a portable electrical appliance. Formerly it was usual to provide a specific battery pack for each particular appliance, so that an appliance could only be powered by a single, specifically designed battery pack. The reason for this was that, frequently, the manufacturer of the appliance wanted to hinder use of battery packs from other manufacturers that could compromise proper operation of the appliance.

Now the tendency is to have a set of interchangeable battery packs for each appliance. Each battery pack of the set is suitable for powering the appliance but differs from the other battery packs of the set as regards the rechargeable cells included therein, which have different weights and capacities and thus also different prices. However the different battery packs of a set all have the same housing so as to be interchangeable. For example, a mobile telephone could be powered by three different interchangeable battery packs: a first "standard" pack with cells of low capacity, high weight and low price, a second "light" pack with cells of low capacity, low weight and higher price, and a third "premium" pack with cells

of high capacity, low weight and still higher price. Since the different battery packs of a se different rechargeable cells, they require different charging programmes, each of which is specifi adapted to the particular rechargeable cells included in the battery pack.

Thus it is necessary to be able to identify the different battery packs of a set, all of which have the same housing, in order to select the particular charging programme which is particularly adapted to the rechargeable cells of a particular battery pack. However, it is not easy to detect the type of the rechargeable cells 14 included in a battery pack by performing measurements at terminals 16 and 18 which constitute the only available access to the cells 14.

To allow identification, every battery pack 1 includes a resistor 20 inside its housing 12. The resistance value of resistor 20 is selected to be different for each battery pack of the set associated with a particular appliance. For example, the first "standard" pack mentioned above could include a resistor having a resistance value of about 10 Kiloohms; the second "light" pack could include a resistor having a resistance value of about 100 Kiloohms; and the third "premium" pack could include a resistor having a resistance value of about 1 Megaohm. Thus, the resistance value of resistor 20 contained inside the housing 12 identifies the type of rechargeable cells 14 included in a battery pack 1. The resistance value is a characteristic which can be detected easily. Furthermore, resistors are cheap, robust, and widely available with many different resistance values. However, other electrical components, such as for example capacitors or integrated circuits, could be used in place of resistors.

A first end of resistor 20 is connected to a third terminal 22 which is accessible from outside the battery pack 1. The second end of resistor 20 is connected to terminal 18 of the battery pack 1. It would also be possible to use two dedicated terminals for the resistor 20; however this would increase the number of terminals of the battery pack.

As shown in the drawing, the battery pack 1 is connected to a battery charger 4 intended to provide a charging current to the rechargeable cells 14. The battery charger 4 can execute different charging programmes which are adapted to the different battery packs of a set associated with a particular

appliance to be powered by the battery pack. Furthermore, the battery charger 4 ca ally distinguish between the different battery packs of a set and select the appropriate charging p

The battery charger 4 comprises first, second and third terminals 42, 44, 46 respectively intended f connection to the corresponding first, second and third terminals 16, 18, 22 of a battery pack 1. The charger 4 also comprises a plug 48 for connection to an electric mains.

The charger 4 is provided with means for detecting the resistance value of the resistor 20 included in a battery pack 1 connected to it. For this purpose, the charger 4 includes a resistor 50 having one end connected to a constant voltage V, for example 10 volts, that is generated by a power supply 52 within the charger. The other end of the resistor 50 is connected to the terminal 46. Resistor 50 has a determined resistance value, for example 100 Kiloohms. With this arrangement, resistor 50 and resistor 20 of the battery pack 1 form a voltage divider that divides the constant voltage V. Thus, the voltage that appears at terminal 46 is indicative of the resistance value of the resistor 20 contained in the battery pack 1. With the exemplary values given above, the first battery pack would produce at terminal 46 a voltage of about 0.91 volts; the second battery pack would produce a voltage of about 5.00 volts; and the third battery pack would produce a voltage of about 9.09 volts.

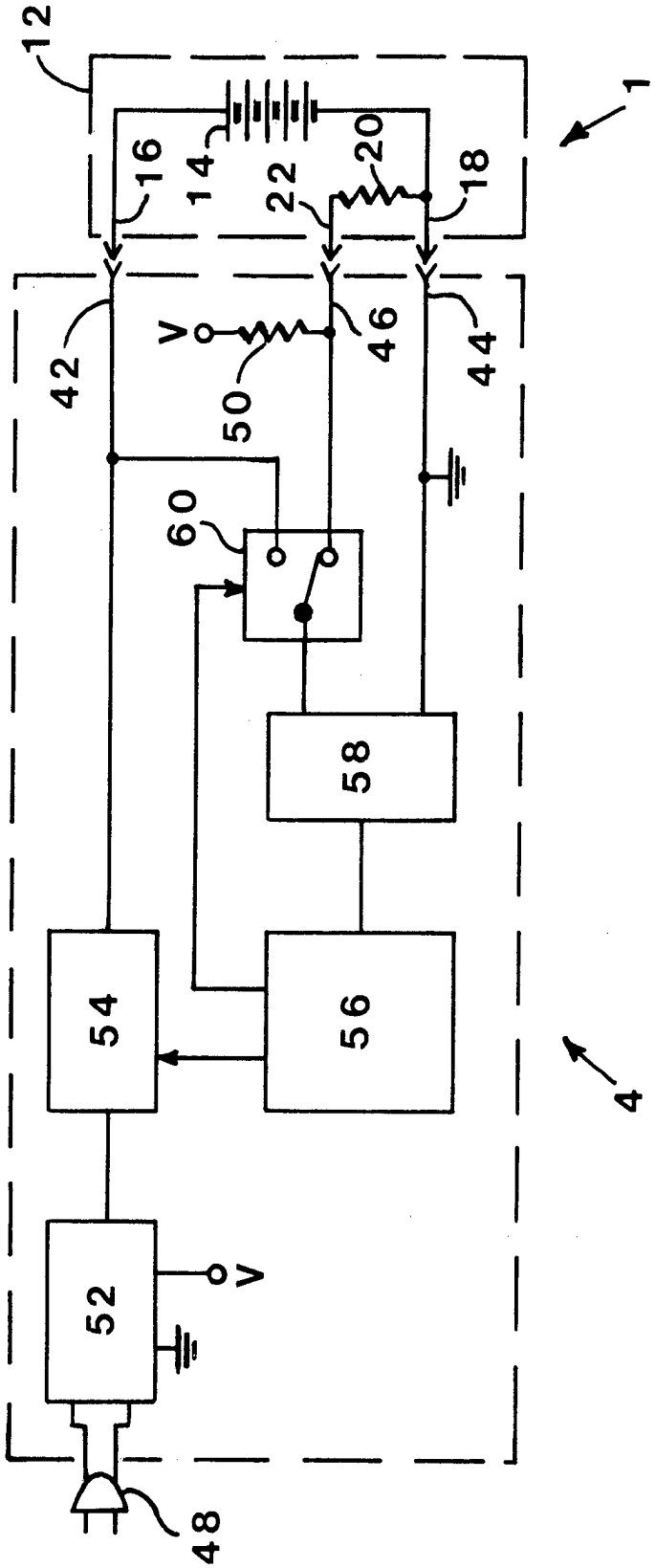
According to the voltage value produced at terminal 46 and hence the resistance value of resistor 20 of the battery pack 1, selecting means provided in the battery charger 4 selects a particular charging programme that is appropriate for charging the cells 14 of the battery pack 1 connected to the charger 4. This selection is foolproof since it is made automatically by the charger 4 and not by the user. The selecting means controls a regulator 54, which is supplied from the power supply 52, to provide a controlled charging current to terminal 42 of charger 4 in accordance with the selected charging programme. Terminal 42 of the battery charger 4 is connected to terminal 16 of the battery pack 1 and provides the controlled charging current to the rechargeable cells 14 of the battery pack 1.

The selecting means comprises a microcomputer 56 which, as indicated by an arrow in the Figure, controls regulator 54. An analog-to-digital converter 58 receives at its input the voltage present at terminal 46 through a switch 60 and converts this voltage to a digital value that is provided to the microcomputer 56. Upon receiving the digital value representative of the voltage at terminal 46, the

microcomputer 56 selects one of a number of different charging programmes stored the microcomputer 56 then controls the regulator 54 in accordance with the selected charging progra so that an appropriate charging current is provided to the rechargeable cells 14 of the particular batter pack 1 connected to the charger 4.

The voltage on the rechargeable cells 14 normally increases during the course of a charging programme. Preferably, to provide optimum charging of the cells 14, the course of a charging programme can be influenced in response to the voltage on the rechargeable cells 14. For this purpose, the charger 4 is provided with switch 60 that, as indicated by an arrow in the Figure, is controlled by the microcomputer 56. Before starting the charging programme, the microcomputer 56 places the switch 60 in the position shown in the Figure, in which the switch 60 connects terminal 46 to the input of the analog-to-digital converter 58. When the microcomputer 56 has selected the charging programme, it places the switch 60 in its other position, in which the switch 60 connects terminal 42 to the input of the analog-to-digital converter 58. In this other position of the switch 60, a digital value representative of the voltage at terminal 42, which is the voltage on the rechargeable cells 14, is provided by the analog-to-digital converter 58 to the microcomputer 56. In response to this digital value, the microcomputer 56 controls the regulator 54 and hence the course of the charging programme.

CLIENT'S DRAWING



DOCUMENT D1 (State of the Art)

It is well known that attempting to charge non-rechargeable batteries, such as carbon-zinc and alkali batteries, results in various adverse effects, such as the release of electrolyte, which can corrode and damage the device into which the battery is inserted, or a temperature increase which could lead to destruction or even explosion of the non-rechargeable battery.

The general object of the present invention is to provide a system for charging rechargeable batteries while avoiding the possibility of providing charging current to a non-rechargeable battery.

There is shown in the Figure a battery charging system including a special rechargeable battery 1 and a battery charger 2. The battery 1 has first and second terminals 11, 12. The illustrated battery 1 is a nickel-cadmium cell of substantially standard shape. However, the invention can also be applied to battery packs containing more than one rechargeable cell.

The charger 2 has first and second charging terminals 21, 22 arranged to contact the terminals 11, 12 respectively when the battery 1 is received in the charger 2. The charger 2 comprises a DC current source 23 that can provide current to terminals 21, 22 which is adapted for charging a nickel-cadmium cell.

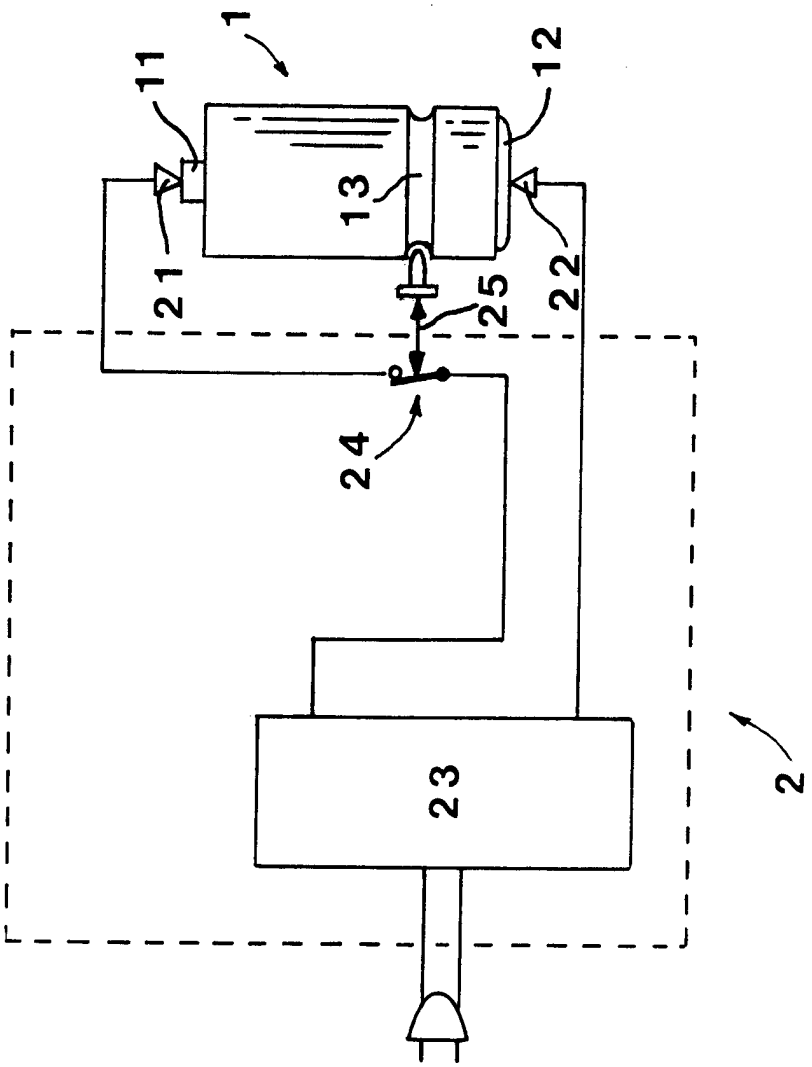
The charging system of the invention uses a special rechargeable battery 1 which includes a groove 13 around its periphery.

The charger 2 furthermore includes a switch 24 arranged in the line connecting the current source 23 to the terminal 21. The switch 24 has a movable actuating member 25 and is biassed so that, when no battery is present in the charger 2, it is in its closed position as shown in the drawing. When a special rechargeable battery 1 is placed in the charger 2, the actuating member enters the groove 13 and the switch 24 remains closed allowing charging current to flow to the special rechargeable battery 1. On the other hand, when

a non-rechargeable battery, not having a groove 13, is placed in the charger 2, the actuating [illegible]25 opens the switch 24, so that no charging current can flow to the battery.

Thus, the system of the invention uses the presence of groove 13 to identify batteries that can be charged by the charger 2. Of course, the person skilled in the art will appreciate that the groove 13 could be replaced by other means, such as a projection on the periphery of the battery.

DRAWING OF DOCUMENT D1 (State of the Art)



DOCUMENT D2 (State of the Art)

NEW BATTERY CHARGER COMES ON THE MARKET

The new battery charger provides maximum convenience to users of rechargeable battery packs even when different interchangeable battery packs can be used to power one and the same appliance.

Apart from connecting the charger to the mains and placing the battery pack in the charger, all the user has to do is select the type of battery pack to be charged and thereafter push a start button (labelled "START" in the Figure).

To select the type of battery pack a rotatable selection knob (labelled "TYPE" in the Figure) is provided on the charger. There is no danger of error because each battery pack carries an identification sign ("A" in the Figure) that is printed on the housing of the battery pack so that it can be clearly seen, even when the battery pack is placed in the charger.

The user must simply rotate the selection knob to the position corresponding to the identification sign carried by the battery pack that is inserted in the charger. A microcomputer provided inside the charger then selects a charging programme that is specially adapted to the type of the inserted battery pack. As soon as the start button is pushed, the microcomputer controls a regulator to provide the charging current in accordance with the selected programme. Thus, there is no risk of damaging a battery pack by charging it according to an inappropriate programme.