



- (51) **International Patent Classification:**  
*H02J 3/12* (2006.01) *H02J 7/04* (2006.01)  
*H02J 3/28* (2006.01)
- (21) **International Application Number:** PCT/IB2013/054218
- (22) **International Filing Date:** 22 May 2013 (22.05.2013)
- (25) **Filing Language:** Italian
- (26) **Publication Language:** English
- (30) **Priority Data:**  
BO2012A000293 29 May 2012 (29.05.2012) IT
- (72) **Inventor; and**
- (71) **Applicant : SCARDOVI, Alessandro** [IT/IT]; Via Fas-  
anina, 773, I-40059 Medicina - Frazione Villa Fontana  
(BO) (IT).
- (74) **Agent: BRUNACCI, Marco;** BRUNACCI & PARTNERS  
S.r.l., Via Scaglia Est, 19-31, I-41126 Modena (IT).
- (81) **Designated States** (*unless otherwise indicated, for every  
kind of national protection available*): AE, AG, AL, AM,  
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,  
KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,  
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,  
NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,  
RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ,  
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,  
ZM, ZW.

- (84) **Designated States** (*unless otherwise indicated, for every  
kind of regional protection available*): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,  
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,  
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,  
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
ML, MR, NE, SN, TD, TG).

**Published:**

— *without international search report and to be republished  
upon receipt of that report (Rule 48.2(g))*

(54) **Title:** UNIT FOR CONTROLLING AND MANAGING FOR DEVICES OF THE TYPE OF BATTERY CHARGER

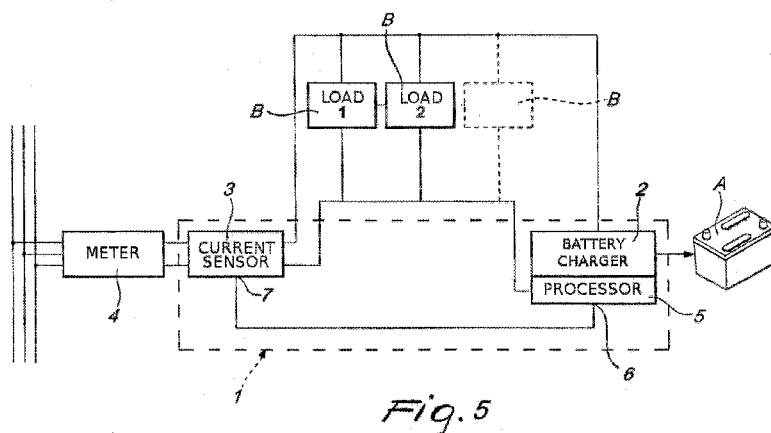


Fig. 5

(57) **Abstract:** The present invention concerns a control and management unit (1) for apparatus of the battery-charger (2) type which comprises an amperometric detector (3) fitted downstream of the energy meter (4) installed by the electricity utility supplier and a command processor (5) of the apparatus of the type of a battery charger (2), wherein the processor (5) is connected to the power mains downstream of the amperometric detector (3) and has an input (6) for a signal coming from an output terminal (7) of the amperometric detector (3) itself. The signal is defined by the value of the current instantaneously dispensed downstream of the meter (4).



## UNIT FOR CONTROLLING AND MANAGING FOR DEVICES OF THE TYPE OF BATTERY CHARGER

### Technical Field

The present invention relates to a control and management unit for apparatus of  
5 the battery-charger type.

### Background Art

In relation to the depletion of stocks of traditional energy resources, with special  
reference to hydrocarbons, and also because of the increase in pollution, electric  
vehicles are attracting increasingly greater interest in the transport sector.

10 Such vehicles comprise an electric motor designed to move the vehicles  
themselves: this motor is driven by sets of batteries with specific run times  
(when the batteries are down, they can undergo a recharging process by  
connecting them to a power supply source).

Over the years, battery technologies have evolved to adapt to market demands.

15 In particular, such evolution concerns:

- energy/weight and energy/size ratios, i.e., the maximization of storable  
energy per unit of weight and unit of volume. The optimization of these  
ratios aims at minimizing weights and overall dimensions of the sets of  
batteries in use;
- 20 – the maximum charging and recharging current, i.e., the obtaining of greater  
instantaneous power levels during discharge. In particular in the automotive  
field, where vehicle efficiency is important, it is important to be able to  
have at disposal high maximum current values instantaneously dispensable  
to provide the vehicle with good acceleration values. The high recharge  
25 current value on the other hand permits minimizing the time needed to  
completely recharge the set of batteries.

While, on the one hand, such battery upgrades have determined better  
performance of the supplied motors and faster recharge speed, they have also  
resulted in an increase in the current absorbed from the power mains which is  
30 hard to reconcile with the power availability envisaged by normal power supply  
contracts (especially in relation to household supply contracts, such as those for  
homes, shops and the like).

To overcome the various problems associated with battery recharging, the use is known of highly-complicated and costly recharge systems designed to optimize the recharge operations themselves and which also permit extending the life of the batteries.

- 5 The state of the art is represented by recharge systems, i.e., battery chargers which, following the setting of a number of battery parameters by the user (or by a specifically appointed skilled technician), ensure battery charging according to energy flows defined by means of suitable algorithms, which tend to extend the life and charging capacity of the battery. One of the parameters  
10 that can be set is the charge power.

Current lithium battery manufacturing technology requires a charge current intensity such as to permit a complete recharge in just a few hours.

This is one of the major characteristics as regards using batteries in the automotive field for example.

- 15 Naturally, cutting charge times implies a very high flow of energy (from the power mains to the battery) during the recharging phase and the power levels involved will therefore be high.

- By way of example only, for a residential user, considering a contracted power of 3 kW, the standard home residential contract, and also considering the use of  
20 high energy consumption home appliances (such as washing machine, oven or air conditioning), the maximum power dedicated to recharging could at most be 1 kW.

- The choice of this figure is made for the purpose of avoiding the contractual limit being exceeded with consequent disconnection by the automatic limitation  
25 system, considering absorption peaks must remain below 3 kW. With a similar setting, it is impossible to fully recharge a battery of standard capacity within an acceptable time.

- This problem will result in the user having to request an increase in maximum power available at the meter. In actual fact, the real exploitation of such  
30 available power will be restricted to only a few hours a day, in relation to the particular factor of the various electric appliances and the battery charger operating at the same time. Despite this, the fixed cost to be sustained (fee) to

have a higher exploitable energy threshold will in any case be a heavy one. This without ruling out that, in the event of many users upping their supply contract to be able to have at disposal the higher energy peaks suitable for fast and effective battery recharging, the utility supplier company will be forced to make  
5 investments in infrastructures, i.e., cables and transport and storage systems, to adapt these to the change in requirements.

#### Description of the Invention

The main aim of the present invention is to solve the problems referred to above by presenting a control and management unit for apparatus of the battery-  
10 charger type, which ensures a fast and effective recharge even in the case of a reduced maximum contractual power drawable from the power mains in compliance with the contract made with the utility supplier company.

Within the scope of this aim, one object of the invention is to provide a control and management unit for apparatus of the battery-charger type which enables  
15 the utility supplier company to ensure the correct supply of electricity in relation to the requirements of its users for recharging sets of batteries, without having to carry out specific jobs on existing infrastructures.

Another object of the invention is to provide a control and management unit for apparatus of the battery-charger type that optimizes the operating efficiency of  
20 the battery charger associated with it.

A further object of the invention is to provide a control and management unit for apparatus of the battery-charger type with reduced costs, easy to make and safe to apply.

This aim and these objects are achieved by a control and management unit for  
25 apparatus of the battery-charger type having the characteristics mentioned in claim 1.

This aim and these objects are also achieved through the application of a procedure for recharging a battery by means of a unit according to the invention having the characteristics mentioned in claim 9.

#### Brief Description of the Drawings

  
30

Other characteristics and advantages of the invention will become more evident from the description of a preferred, but not sole, embodiment of a control and

management unit for apparatus of the battery-charger type according to the invention, illustrated purely as an example but not limited to the annexed drawings in which:

fig. 1 represents a chart which shows the indicative distribution of the electric  
5 consumption of a home;

fig. 2 represents a graph which, according to the data in figure 1, shows the indicative trend of the electric consumption of a home and indicates, with a brace, the part of energy which can be used for the recharge with traditional recharging systems;

10 fig. 3 represents a graph which, according to the data in figure 1, shows the indicative trend of the electric consumption of a home in proportion to the energy potentially available for the recharge of batteries;

fig. 4 represents a graph which shows the energy trend available for the recharge of batteries with a unit according to the invention;

15 fig. 5 represents an indicative diagram concerning the installation of a unit according to the invention in an electric system;

fig. 6 represents the flow diagram of the procedure for the recharge of a battery through a unit according to the invention.

#### Embodiments of the Invention

20 With reference to such figures, globally indicated by 1 is a control and management unit for apparatus of the battery-charger 2 type.

The control and management unit 1 comprises an amperometric detector or current sensor 3 fitted downstream of the energy meter 4 installed by the electricity utility supplier.

25 The unit 1 also comprises a command processor 5 of the apparatus of the type of a battery charger 2.

The processor 5 is connected to the power mains downstream of the amperometric detector 3 and has an input 6 for a signal coming from an output terminal 7 of the amperometric detector 3 itself.

30 The signal coming from the output terminal 7 is defined by the value of the current instantaneously dispensed downstream of the meter 4.

According to one possible embodiment of definite application interest, the

processor 5 can comprise a logic apparatus suitable for comparing the current input value ( $I_{ass}$ ) measured by the amperometric detector 3 (which in this case will be made up of a real ammeter suitable for providing at output a signal proportionate to the value of the detected current) with a predefined current value, corresponding to the maximum current drawable from the power mains (Imax).

In practice, the logic apparatus will be able to check whether the value of current input ( $I_{ass}$ ) from the mains (and measured by the amperometric detector 3) is the same as the predefined value (Imax).

10 In the event of the two values being identical, the possibility is not contemplated of dispensing further current to the battery charger 2 for recharging a battery A. In the event instead of the value of the current input ( $I_{ass}$ ) being below the predefined value (Imax), further current can be drawn from the power mains to supply it to the battery charger 2 which has to recharge the battery A.

15 If instead, the value of the current input ( $I_{ass}$ ) is above the predefined value (Imax), the current absorbed from the power mains by the battery charger 2 will have to be reduced.

More specifically, the unit 1, according to the described embodiment, will be able to measure the value of the current input ( $I_{ass}$ ) instantaneously through the amperometric detector 3.

The logic apparatus of the processor 5 will compare the value of the current input ( $I_{ass}$ ) with the reference value (Imax) and will consequently control the operation of the battery charger 2.

25 The less the current absorbed by the other electric loads B, the more current will be available for the battery charger 2.

Along with the increase in energy consumption by other electric loads B, the processor 5 will reduce (proportionately) the value of the current absorbed by the battery charger 2 and vice versa.

30 In the event of no current being absorbed by other electric loads B, all the current available from the mains (equal to the predefined Imax value) can be conveyed to the battery charger 2, allowing the battery A (or of the batteries) connected to it to be very quickly charged.

The control obtainable through the unit 1 is potentially instantaneous (with continuous corrections of the current value available for the battery charger 2) even though the adoption of timers cannot be ruled out which pace the measurements taken by the amperometric detector 3 and the comparisons made  
5 by the logic apparatus of the processor 5.

According to a further embodiment, alternative to the previously-described solution, the amperometric detector 3 can be made of a current measurer to which is fitted in cascade a logical apparatus suitable for comparing the measured current input value ( $I_{ass}$ ) with a predefined current value ( $I_{max}$ ),  
10 corresponding to the maximum current drawable from the power mains.

In this case, the output terminal 7 of the amperometric detector 3 will be fitted downstream of the logic apparatus of comparison, for the purpose of providing a signal to the signal input 6 of the processor 5 which indicates the maximum intensity of the current that can be supplied to the battery charger 2.

15 In any case, i.e., according to both the previously described embodiments, the output terminal 7 of the amperometric detector 3 will comprise a signal transmitter according to a mode preferably selected from radio-frequency, wifi, bluetooth®, light waves, including infra-red and ultraviolet, electrical waves, sound waves and the like.

20 It is therefore pointed out that the sending of the signal to the signal input 6 can be both by means of wired transmission (power line, optical fibres and the like) and in remote (through a transmission in radio-frequency, wifi, bluetooth®, light waves, including infra-red and ultraviolet, and the like).

The use cannot be ruled out of components associated with the Web to exploit  
25 this to transfer information.

Within this scope, consequently, the input 6 of the processor 5 will comprise a signal receiver according to a mode preferably selected from radio-frequency, wifi, bluetooth®, light waves, including infra-red and ultraviolet, electric waves, sound waves and the like, in order to be able to effectively communicate with  
30 the output terminal 7 of the amperometric detector 3.

It must be pointed out that the unit 1 can advantageously comprise an interface module for interfacing with a computer network for the instantaneous control of

the recharge operations of at least one battery A connected to at least one battery charger 2 associated with the unit 1.

It can in fact be useful for the user to visually check how the recharge operations are proceeding and how energy consumption is being divided  
5 between the electric loads B and the battery chargers 2.

The procedure for recharging a battery through a unit 1 according to the invention consists in performing a series of consecutive stages.

It will first of all be necessary to measure the intensity of the overall current input ( $I_{ass}$ ) instantaneously absorbed downstream of the supplier's energy meter  
10 4 (with regard to Italy e.g., the ENEL meter).

Afterwards, it will be necessary to determine whether the value of the current input ( $I_{ass}$ ) is the same as the maximum value ( $I_{max}$ ) indicated by the supplier.

In this case, different strategies will have to be chosen according to the outcome of such comparison:

- 15 – if the value is above the maximum set value ( $I_{max}$ ) the charge current will have to be reduced by a value equal to the difference between the maximum set value ( $I_{max}$ ) and the measured instantaneous input value ( $I_{ass}$ ) acting on the battery charger 2;
- if the value is below the maximum set value ( $I_{max}$ ) the charge current will  
20 have to be increased by a value equal to the difference between the maximum set value ( $I_{max}$ ) and the measured instantaneous input value ( $I_{ass}$ ) acting on the battery charger 2.

It is pointed out that the value of the current absorbed by the mains ( $I_{ass}$ ) can exceed the limit value ( $I_{max}$ ) for short periods of time, penalty disconnection  
25 from the mains imposed by the power limiters installed by the energy utility supplier, and consequently the control system must perform the algorithm in a very short time.

It will therefore be necessary to check whether the charge of the battery A (or of the batteries) is complete.

30 In the event of the battery A being completely charged, it will be necessary to interrupt the supply of the battery charger 2. In the event instead of the battery A not being completely charged, the battery charger 2 will have to continue

operating.

The object to be achieved therefore by means of the unit 1 is to absorb from the mains the maximum current ( $I_{max}$ ) which the mains can supply in accordance with the contract that already exists with the supplier.

- 5 The unit 1 therefore continuously measures the current input ( $I_{ass}$ ) and adapts the battery charger 2 so this constantly draws the maximum current allowed. The result is that the current conveyed to the battery A is always the maximum possible and is modulated according to the loads B connected upstream in the rest of the mains.

- 10 Hence, the user can use any household appliance without worrying about the current conveyed to the battery A which will be automatically adapted.

The operating principle is the following: on the battery charger 2, the maximum instantaneous power is set, i.e., the contractual power agreed, e.g., in Italy, with ENEL Distribuzione. For household contracts, this value is normally 3 kW. The

- 15 battery charger 2, by reading the current through the amperometric detector 3 located in the proximity of the pre-existing meter 4 and calculating the absorbed instantaneous power, will update the maximum drawable current to be used for recharging at any given time.

- The chart in figure 1 shows an example of recharge considering a maximum  
20 power contract of 3 kW and the normal use of the resources of a home, considering very low absorption moments, e.g., T1 to T5, and high absorption moments, e.g., T6 and T7 (when the washing machine is switched on) or T12 to T15 (when the air-conditioning is switched on).

- The graph according to the figure 2 displays the data of the chart in figure 1: as  
25 can be seen, the graph shows the power absorbed by the appliances in the home and therefore the maximum absorbable power for the recharge, with traditional systems (with constant absorption), avoiding power limiter disconnection, is the difference between the maximum value 3 kW, and the maximum peak absorbed during the day of 2.3 kW, and is therefore 0.7 kW.

- 30 This way, the traditional charging system can be set at a constant power of 0.7 kW.

The invention instead permits changing this maximum value, during recharge,

depending on changes in absorption of the other devices connected to the same power mains (loads B).

The graph in figure 3 shows, by the line 8, the power absorbed by the loads B in the home; by the line 9, on the other hand, the values are represented calculated  
5 as the difference between the maximum contracted value of 3 kW, and the instantaneous power absorbed by the aforementioned loads B.

The graph in figure 4 identifies a lower area 10 which represent the energy normally available for the charge without adopting a unit 1 according to the invention; the entire area under the line 11, including the lower area 10, is the  
10 energy available for recharging with the unit 1. As can be seen the quantity of charge is considerably greater and could easily be more than double depending on the use of the electricity in the home.

Furthermore, this energy control system can be easily integrated in the new smart grid energy management system called "Smart Grid" built by the Italian  
15 company ENEL, the new energy management project, including that produced from renewable sources.

The unit 1 therefore consists of an amperometric detector 3 which conveys the acquired values towards the battery charger 2.

The amperometric detector 3 sends the measurements towards the battery  
20 charger 2 at a fixed frequency.

The processor 5 associated with the battery charger 2, which already has the preset maximum power value (dependent on the  $I_{max}$  maximum current because the mains voltage is fixed and constant) to be drawn from the mains, makes the calculation and sets the new value.

25 The following then occurs: the electricity arrives from the grid. Before being distributed the meter 4 of the energy supplier separates it and creates a private user grid. All the energy that passes through the meter 4 is measured and charged to the contracted user. This instrument has a double function: it measures the energy consumed and disconnects from the mains in case of  
30 malfunction of the private grid or in case of excess absorption. At this point, the energy is distributed to the user. The amperometric detector 3 measures the intensity of the absorbed current and is therefore fitted immediately downstream

of the pre-existing meter 4 (it could potentially also be installed immediately upstream of this but this possibility is not normally considered because that which is upstream of the meter belongs to the supplier and cannot be tampered with by the user).

- 5 The amperometric detector 3 of the unit 1 sends the details of the current input (I<sub>ass</sub>) at any given time towards the battery charger 2 by means of a suitable connection of one of its output terminals 7 to an input 6 of a processor associated with the battery charger 2 itself.

The battery charger 2 is connected to the private power grid of the home from  
10 where it draws the energy to be conveyed to the battery A to be charged.

The operation of the battery charger 2 is affected by the reading of the amperometric detector 3: the recharge algorithms are specific for each type of battery, and consequently the battery charger 2 itself must know various specific parameters which can be programmed inside during configuration, or else can  
15 be read directly by the battery A when this is connected to the battery charger 2. Besides these parameters, during configuration, the maximum power of the user's contract, or the maximum power to be absorbed from the mains, must be set which must in any case be less than the maximum power of the contract. This way, the battery charger 2 will absorb the maximum available power to  
20 prevent disconnection from the power mains due to excessive absorbed power.

The advantages of the unit 1 and of the procedure applied by it are the following:

- better exploitation of the electricity transport infrastructures, cables. The maximum capacity of the cables is in fact exploited without having to install  
25 new infrastructures;
- through the Internet or through the remote reading network of the meters 4, it conveys data concerning the energy still to be loaded and thus permits a better management of energy production by the electricity supplier;
- it avoids the user having to change contract with the energy utility company  
30 because it enables the user to more efficiently exploit the available energy without having to request more power from the supplier, a request which would increase contractual supply costs.

Positively, the present invention solves the previously-expounded problems, presenting a control and management unit 1 for apparatus of the battery charger type 2 which permits quick and effective recharging even in the case of a reduced maximum power drawable from the power mains in conformity with the contract made with the utility supplier company.

Usefully, the unit 1 ensures the utility supplier company is able to correctly supply electricity, in relation to the requirements of its users, to recharge sets of batteries A, without carrying out specific jobs on existing infrastructures.

Positively, the control and management unit 1 optimizes the operating efficiency of the battery charger 2 associated with it.

The invention thus conceived is susceptible to numerous modifications and changes, all of which falling within the scope of the inventive concept; furthermore, all the details can be replaced by technically equivalent elements.

Efficiently, it is specified that the  $I_{max}$  current can be changed automatically according to the time of day: in practice, time bands can be set in which to establish a different  $I_{max}$  value, in relation e.g. to different costs of the electricity supply according to the time of day, and different possible variations of the maximum power that can be absorbed from the mains according to particular supply contracts.

For this purpose, the unit 1 can comprise a timer (intended to pace the time during a single day and/or within long periods of time such as weeks, months, years, etc.) to a unit for setting the value of the  $I_{max}$  current enslaved to the timer: the setting unit therefore, in correspondence to the time read by the timer can raise and/or reduce the  $I_{max}$  intensity to adapt it to the contractual opportunities of that particular time.

Furthermore, it is crucial to point out that the unit 1 according to the invention can be used to recharge all types of batteries, including those not designed for automotive use, but for static build-up use. By means of the unit 1, it will in fact be possible to recharge any type of set of batteries, depending on the specific requirements to be catered to. This is especially useful to explain the great versatility of the unit 1 according to the invention.

In the illustrated embodiments, single characteristics shown in relation to

specific examples can, in point of fact, be exchanged with other different characteristics, existing in other embodiments.

In point of fact, the materials used, and the dimensions, can be any according to requirements and the state of the art.

**CLAIMS**

- 1) Control and management unit (1) for apparatus of the battery-charger (2) type characterized in that it comprises an amperometric detector (3) fitted downstream of the energy meter (4) installed by the electricity utility supplier  
5 and a command processor (5) of said apparatus of the type of a battery charger (2), the processor (5) being connected to the power mains downstream of said amperometric detector (3) and having an input (6) for a signal coming from an output terminal (7) of the amperometric detector (3) itself, the signal being defined by the value of the current instantaneously dispensed downstream of  
10 said meter (4).
- 2) Unit (1) according to claim 1, characterized in that said processor (5) comprises a logic apparatus suitable for comparing the current input value ( $I_{ass}$ ) measured by said detector (3) with a predefined current value ( $I_{max}$ ), corresponding to the maximum current drawable from the power mains.
- 15 3) Unit (1) according to claim 1 or 2, characterized in that said amperometric detector (3) is a current measurer to which is connected in cascade a logical apparatus suitable for comparing the measured current input value ( $I_{ass}$ ) with a predefined current value ( $I_{max}$ ), corresponding to the maximum current drawable from the power mains.
- 20 4) Unit (1) according to claim 3, characterized in that said output terminal (7) of said detector is fitted downstream of said logic apparatus of comparison.
- 5) Unit (1) according to one or more of the preceding claims, characterized in that said output terminal (7) of said detector (3) comprises a signal transmitter according to a mode preferably selected from radio-frequency, wifi, bluetooth®,  
25 light waves, including infra-red and ultraviolet, electrical waves, sound waves and the like.
- 6) Unit (1) according to one or more of the preceding claims, characterized in that said input (6) of said processor (5) comprises a signal receiver according to a mode preferably selected from radio-frequency, wifi, bluetooth®, light waves,  
30 including infra-red and ultraviolet, electric waves, sound waves and the like.
- 7) Unit (1) according to one or more of the preceding claims, characterized in that it comprises an interface module for interfacing with a computer network

for the instantaneous control of the recharge operations of at least one battery (A) connected to at least one battery charger (2) associated with the unit (1).

8) Unit (1) according to one or more of the preceding claims, characterized in that it comprises a timer and a unit for setting the value of the  $I_{max}$  current enslaved to said timer, for the automatic variation of the  $I_{max}$  current value in a predefined time.

9) Procedure for recharging a battery by means of a unit (1) according to the invention and a battery charger consisting of:

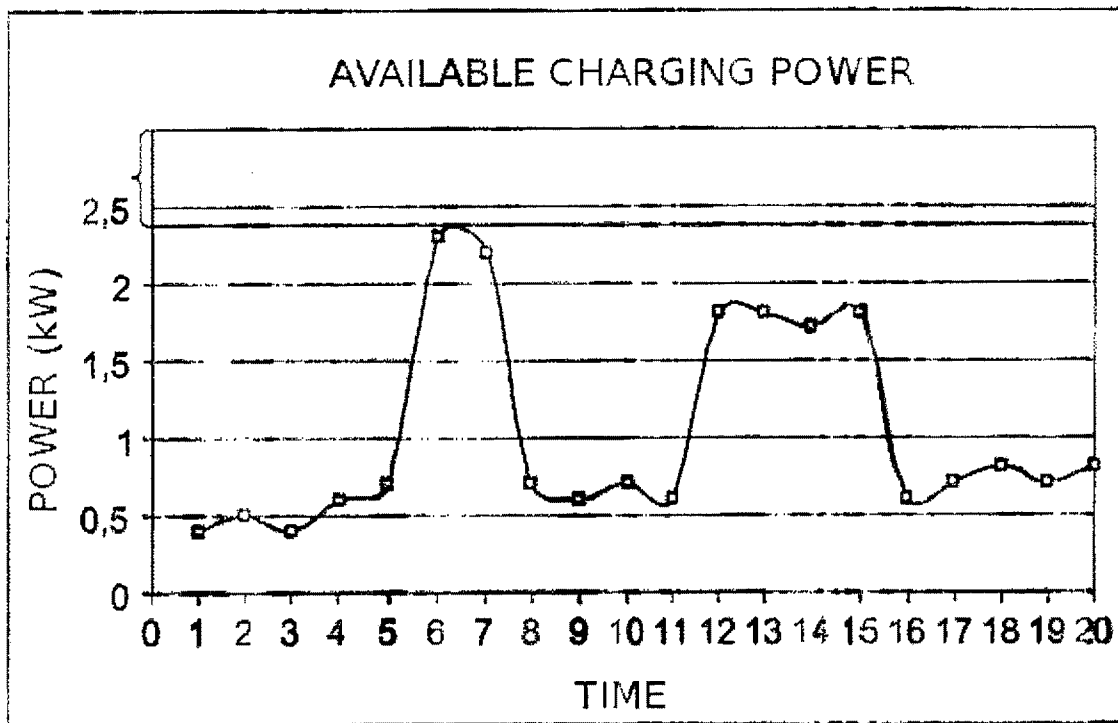
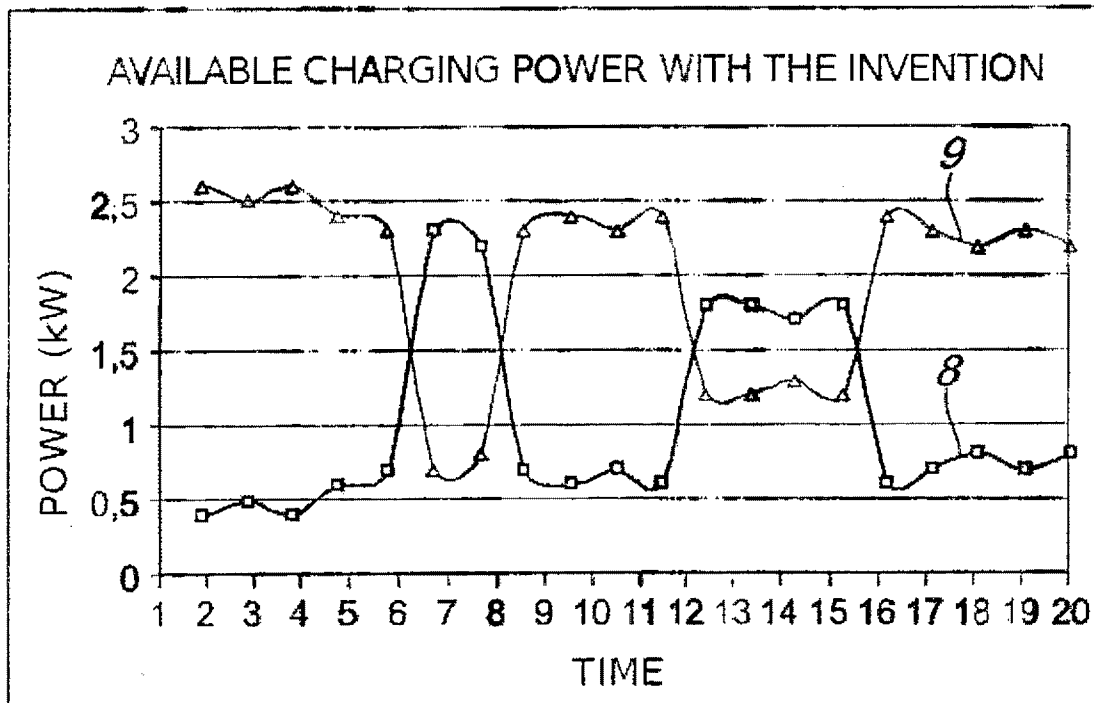
- measuring the intensity of the overall current input ( $I_{ass}$ ) instantaneously absorbed downstream of the supplier's energy meter (4);
- checking whether the value of current input ( $I_{ass}$ ) is the same as the maximum value ( $I_{max}$ ) set by the supplier:
  - if the value is above the maximum set value ( $I_{max}$ ) the charge current will have to be reduced by a value equal to the difference between the maximum set value and the measured instantaneous input value acting on the battery charger (2);
  - if the value is below the maximum set value ( $I_{max}$ ) the charge current will have to be increased by a value equal to the difference between the maximum set value ( $I_{max}$ ) and the measured instantaneous input value ( $I_{ass}$ ) acting on the battery charger (2);
- checking whether the charge of the battery (A) is complete:
  - in the event of the battery (A) being completely charged, it will be necessary to interrupt the supply of the battery charger (2);
  - in the event of the battery (A) not being completely charged, the battery charger (2) will have to continue operating.

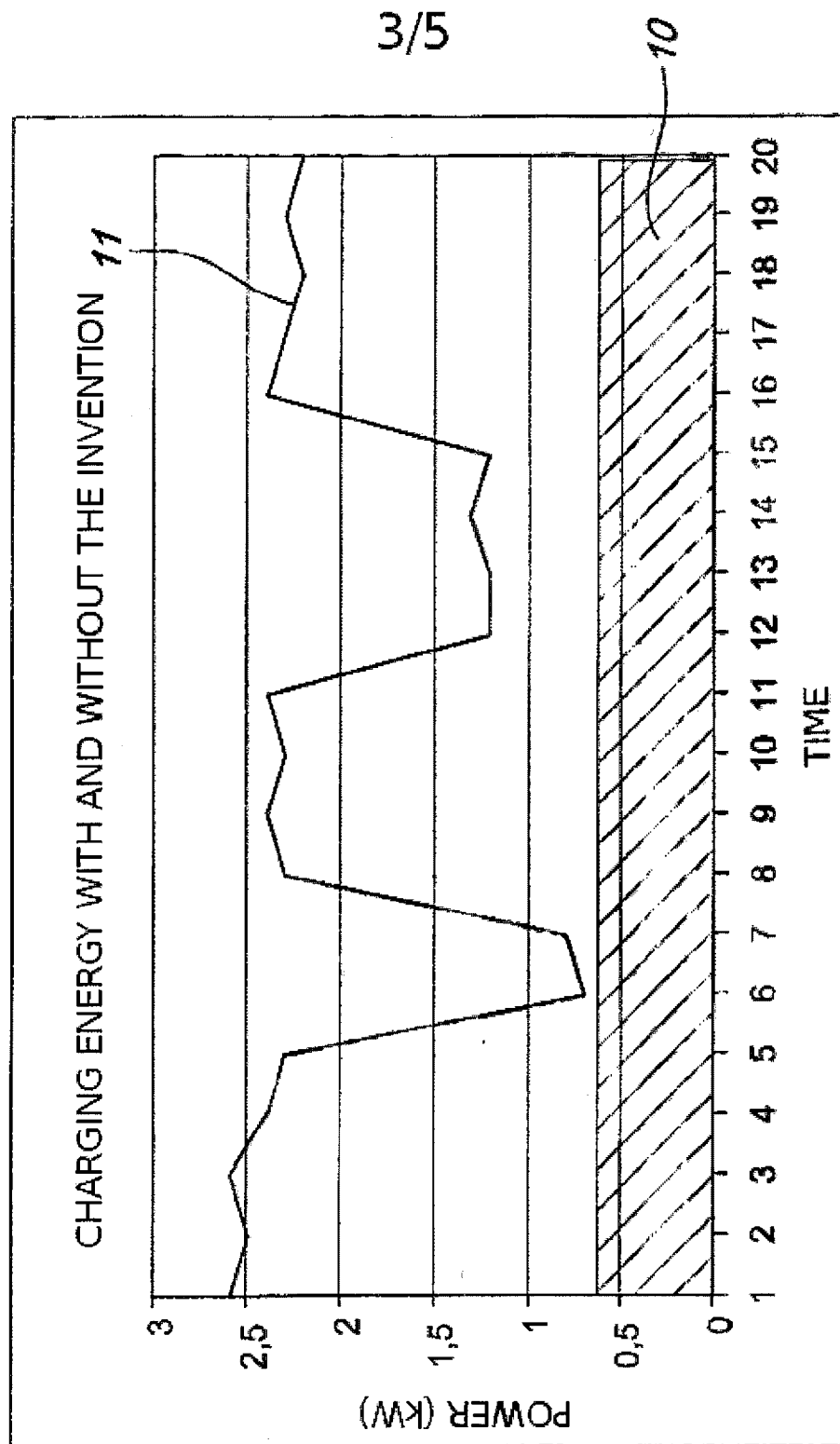
1/5

| TIME | HOME ABSORBED<br>POWER (kW) | AVAILABLE POWER FOR<br>CHARGING (kW) | EVENT                           |
|------|-----------------------------|--------------------------------------|---------------------------------|
| 1    | 0,4                         | 2,6                                  | ORDINARY HOME POWER CONSUMPTION |
| 2    | 0,5                         | 2,5                                  |                                 |
| 3    | 0,4                         | 2,6                                  |                                 |
| 4    | 0,6                         | 2,4                                  |                                 |
| 5    | 0,7                         | 2,3                                  |                                 |
| 6    | 2,3                         | 0,7                                  | WASHING MACHINE SWITCHING ON    |
| 7    | 2,2                         | 0,8                                  |                                 |
| 8    | 0,7                         | 2,3                                  | WASHING MACHINE SWITCHING OFF   |
| 9    | 0,6                         | 2,4                                  |                                 |
| 10   | 0,7                         | 2,3                                  |                                 |
| 11   | 0,6                         | 2,4                                  | AIR-CONDITION SWITCHING ON      |
| 12   | 1,9                         | 1,2                                  |                                 |
| 13   | 1,8                         | 1,2                                  |                                 |
| 14   | 1,7                         | 1,3                                  |                                 |
| 15   | 1,8                         | 1,2                                  |                                 |
| 16   | 0,6                         | 2,4                                  | AIR-CONDITION SWITCHING OFF     |
| 17   | 0,7                         | 2,3                                  |                                 |
| 18   | 0,8                         | 2,2                                  |                                 |
| 19   | 0,7                         | 2,3                                  |                                 |
| 20   | 0,8                         | 2,2                                  |                                 |

*Fig. 1*

2/5

*Fig. 2**Fig. 3*

*Fig. 4*

4/5

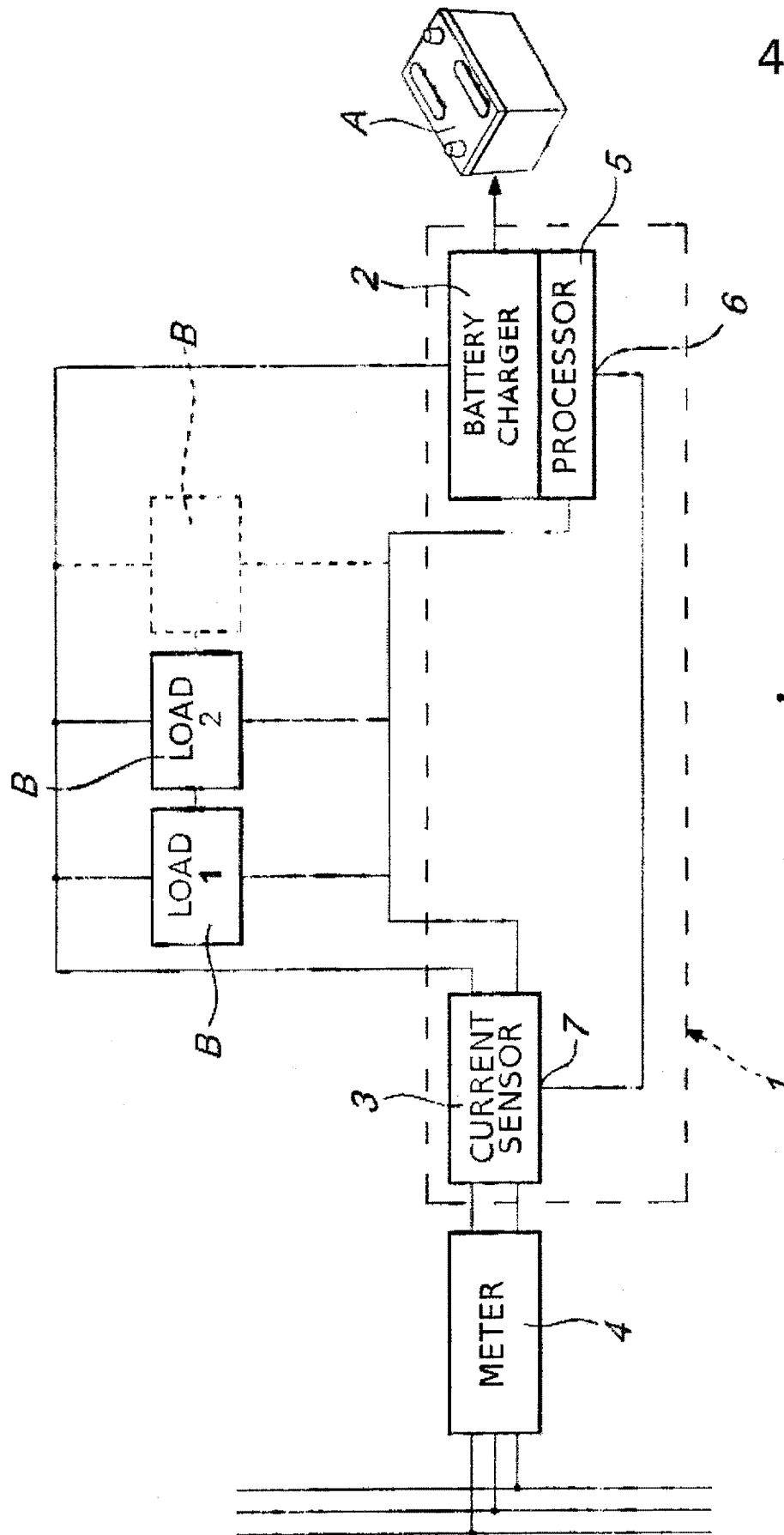
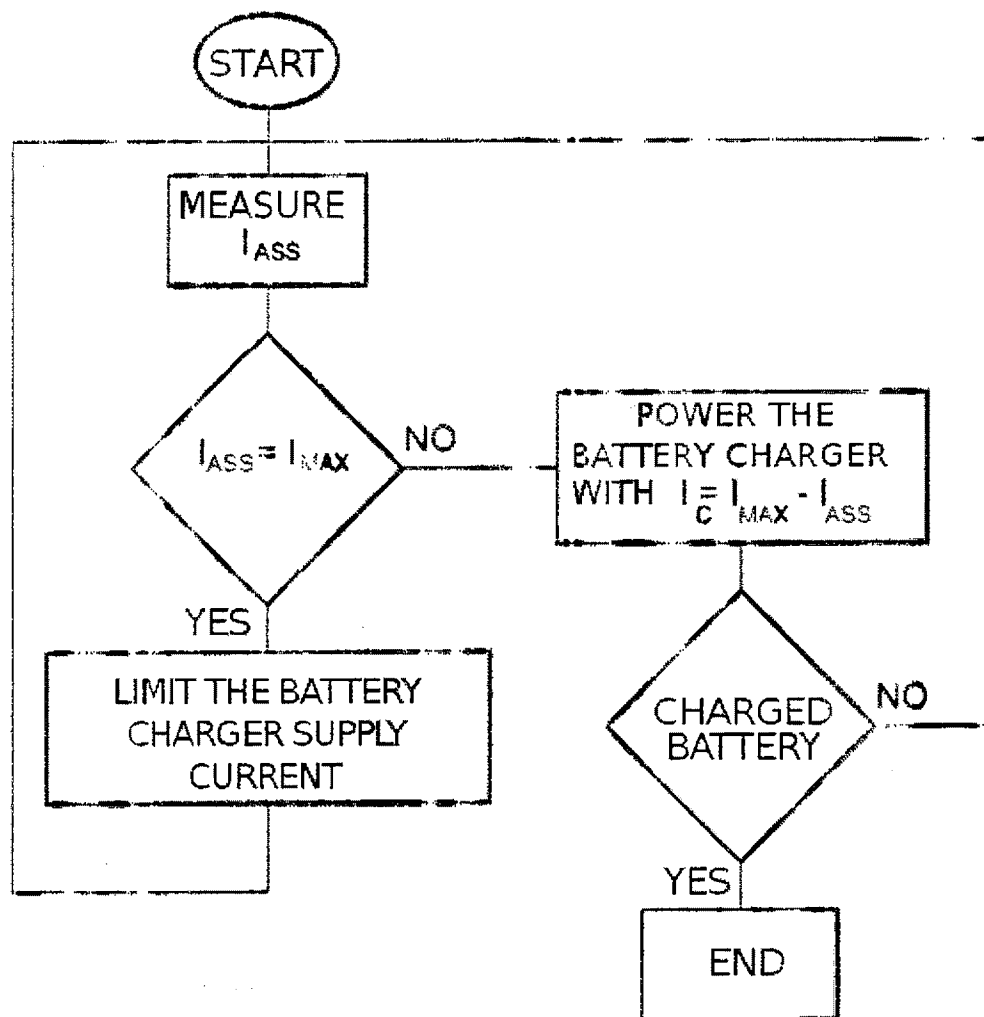


Fig. 5

5/5

*Fig. 6*