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A NEW TECHNOLOGY FOR THE AUTOMATIC CHARGE CONTROL OF RECHARGEABLE BATTERIES

1. Technical Description

A. Problems the Innovation Solves:

CCS control eliminates today's problems in battery charging. The new technology is radically different and advanced beyond any other available. Digital analysis looks inside the battery and determines the precise moment of charge completion, with momentous amplifications:

- CCS works for all battery chemistries: NC, NM, NIFE, LiIon, Lead Acid, SLA, Alkaline, etc. One and the same charging unit is capable of charging different types, sorts or sizes of batteries or battery packs, single or series mounted.
- The battery life is extended to over 5000 cycles* without any consequential loss of battery capacity. This increases a NC's battery life span to more than 15 years, if charged daily.
- The average charging time is 20 minutes**
- Charging may start from any state of battery charge, just like filling up a gasoline tank. No discharge is required. On standby, a battery is ready at any time - with 100% full charge.
- No memory effect
- The new technology can correct memory effect, battery faults, and reconditions deeply discharged, old, flat batteries.
- External influences, i.e. temperature variations, etc. can not effect the precision and reliability of the charging process. There is no need for safety mechanisms like temperature, time cut off etc. No additional sensors are needed. The battery is connected by a simple two-lead wire.
- For the first time, batteries can be charged from variable energy sources without additional stabilizing. This is a special advantage for solar sources or feed back charging.
- The entire operation is computer guided and fully automatic, making battery charging unfailingly reliable efficient and simple. End-users need no technical expertise.

* For NiCd batteries, ** Charge cycles and time differ

B. How the Invention Works

a) General

The charge level of a battery is neither defined simply by the voltage, nor the cell temperature, nor the charge time, or the amount of the charge. Therefore the previous existing charging units are suitable only for specific batteries under specific conditions, and have shortcomings that can result in under- or over-charging.

Some quick-charge processes are based on those effects during the charge period, of voltage (e.g. dV method), charge current, or temperature, that do occur only when the battery is overcharged and gassing (see Fig. 1). By this, the batteries are damaged and their operating life is shortened. All charging methods so far stop charging based on the combination of a number of effects. They can not distinguish between the state of charge and other influences, which is a major limitation.

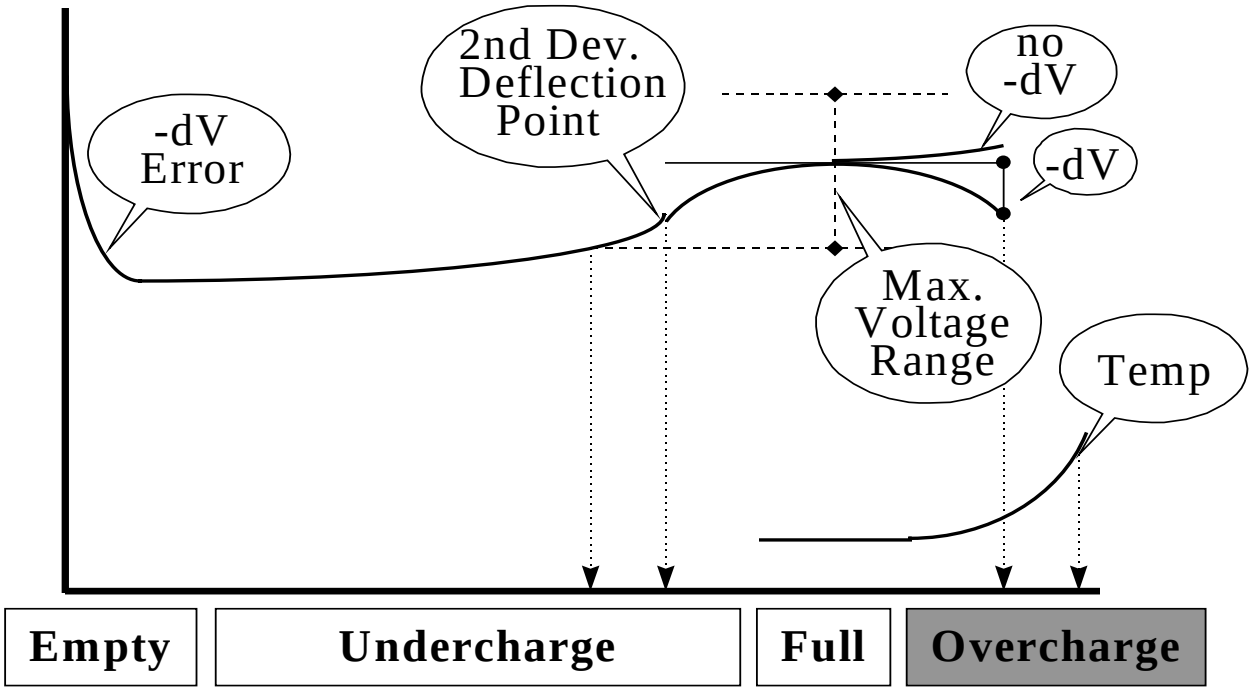

Fig. 1

- C/10 Charge: Battery manufactures recommend a 14 @ C/10 charge. Providing that the battery was not completely discharged and that the current loss will not be 40%, this advice of course will lead to overcharge.
- Max. Voltage is one of the worst charge termination methods because of uncertainty and variation. Some NC/NMH must be charged up to 2V/cell while others are overcharged at 1.45V. Even lead batteries show a 10% variation in voltage at the end of charge.
- Temperature sensing is based on heat generation by overcharging, instead of preventing overcharge. In addition, placement of the sensor is critical.
- -dV methods are based on overcharging like temp.sensing. In addition, it does not work with certain, bad, wrong or open cells.
- Second Deflection Point stops charging before the battery is fully charged. To overcome this the charge is prolonged several minutes. If a fully charged battery is connected it will be overcharged with this extra charge.

b) CCS, The New Battery Charging Process

The new invention differs from previous known processes in that not only a simple measurement condition (e.g. terminal voltage) is used to determine the charging state, but that by reference to the equivalent circuit diagram (see Fig. 2), from the trend of voltage and charge current, a value is determined and evaluated, which is related to the charging processes within the cell.

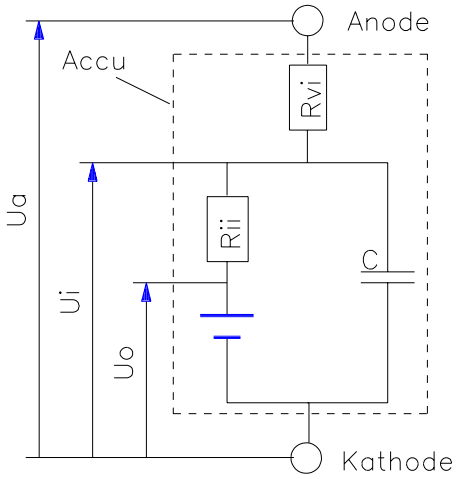

Fig. 2

This value is continuously monitored and evaluated by the CCS (see Fig. 3). It recognizes a characteristic trend change of the fully charged condition which is independent of battery type, number of cells, temperature, parasitic voltage losses, and external influences.

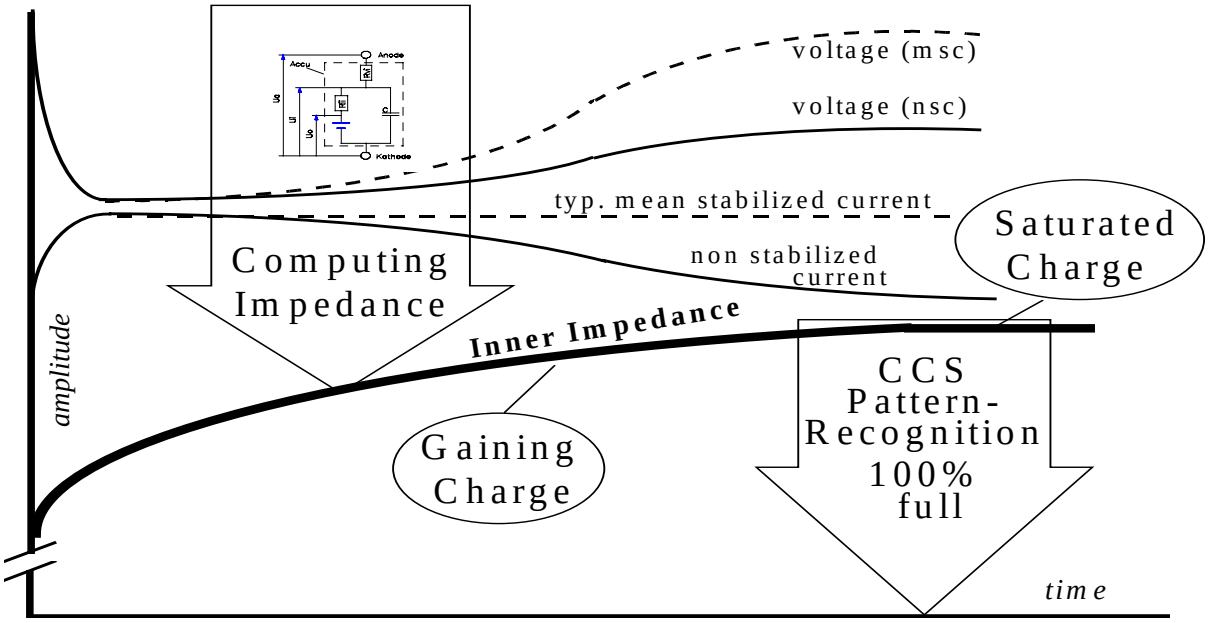

Fig. 3

The CCS recognizes the 100% full charge from the electrical charge parameters through digital analysis of the performance of the indicators.

Even an insignificant overcharging is prevented with exceptional reliability.

As a result a 50-times higher charge current is permitted.

It is only limited by the electro/mechanical construction and the functional internal resistance of the cells and the corresponding permitted ($P = I^2 R$) temperature and voltage limits. Normal NC sinter cells can be fully charged using the BTI process with charge currents of 3CA corresponding to a charge time of 20 minutes. This is for empty batteries. For partly charged ones the time is correspondingly shorter. The batteries don't become hot and the short charge time has no negative effect on the life span of the battery. Even shorter charge times are possible.

Faulty operation, which in other charging processes does occur with completely flat cells, temperature variation, or bad contacts, can be avoided. With knowledge of the reaction of the components of the circuit diagram during charging, it is possible for the first time, to accept changing conditions, e.g. current fluctuations, and to separate those effects from the signs related to the charging state.

This is a further distinction compared with previously known methods because

Neither the charge current nor the voltage have to be kept at constant value.

By a new method of tuning the charger to the cells any unknown accumulator can be connected and charged without foreknowledge or preselections.
A further innovation is the CCS-Electronic protection of battery-packs or single batteries.

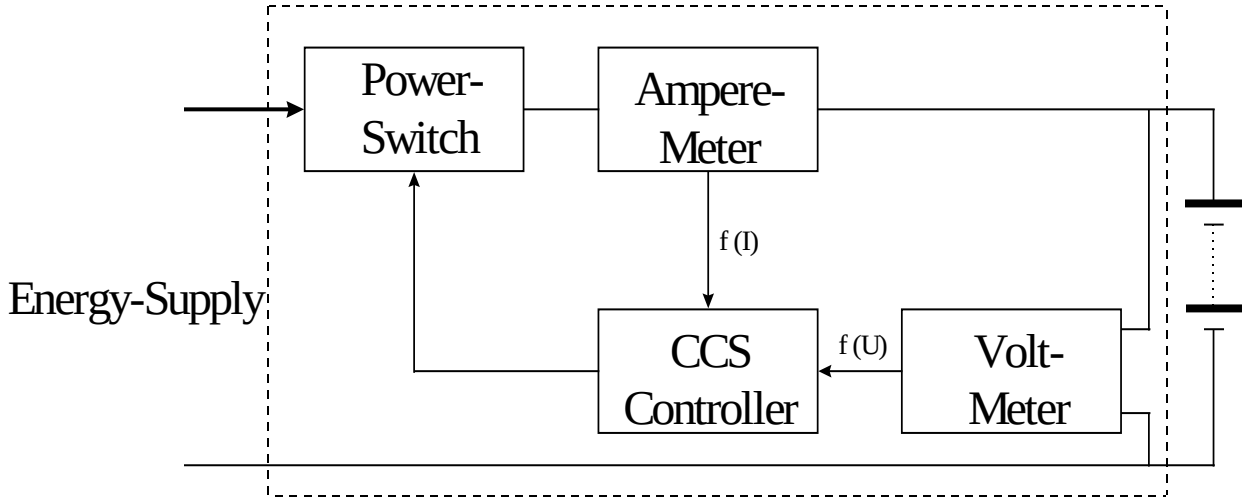

Fig. 4

CCS Simplified Schematic Diagram

Further details available:
- datasheets of charge controllers
- application notes

2. Technical Advantages of CCS

The present state of battery charging experiences great difficulties. The technology has not improved for quite some time. It even is kept back to some degree by misconception and scientifically unfounded doctrines. Many claim solutions on paper, which are disproved by short battery life and millions of discarded batteries.

Some of the CCS advantages are best understood by addressing these misconceptions:

A) Misconception: A battery is a defined object!

This is wrong. The imprecise assembly of Electrode and Electrolyte materials and their conditioning at the production stage, are already creating great differences. Cells are reacting electrochemical to pressure and temperature, etc. Variances are caused by Charge/Discharge cycles and the current used, by over and undercharging, by shelf time, etc. etc. (see Fig. 5)

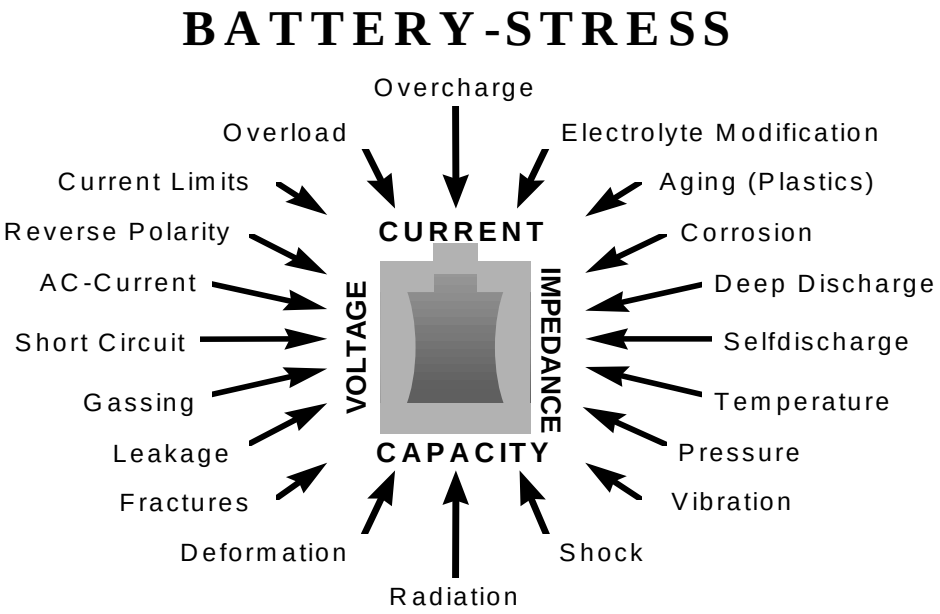

Fig. 5

REALITY: Batteries are not alike and one must be treated as an individual.

Only CCS does it.

B) Misconception: Charging fast is harmful!

Fast charging is only harmful with technologies who can not determine the precise moment of charge completion and therefore overcharge. Otherwise, even a high current will not harm the battery.

REALITY:

CCS is the only technology capable of fast charging and simultaneously extending the battery life.

C) Misconception: Fast charging requires special battery types!

Yes, but if a battery is charged to precisely 100% capacity and then turned off, there is no overcharge.

REALITY:

With CCS, all commonly known NC, NM and SLA batteries are suitable for fast charging.

D) Misconception: 140% charge is needed!

It is completely assumed that the charge/discharge relation ought to be 1.4:1 (14h and C/10 charge) since 40% of current will be lost.

Our tests with NC (see Fig. 6), NM and Lead Acid Batteries nevertheless show, that nearly the same amount of current charged can be taken out (98-100% for high quality batteries), provided charging stops at the exact point of charge completion.

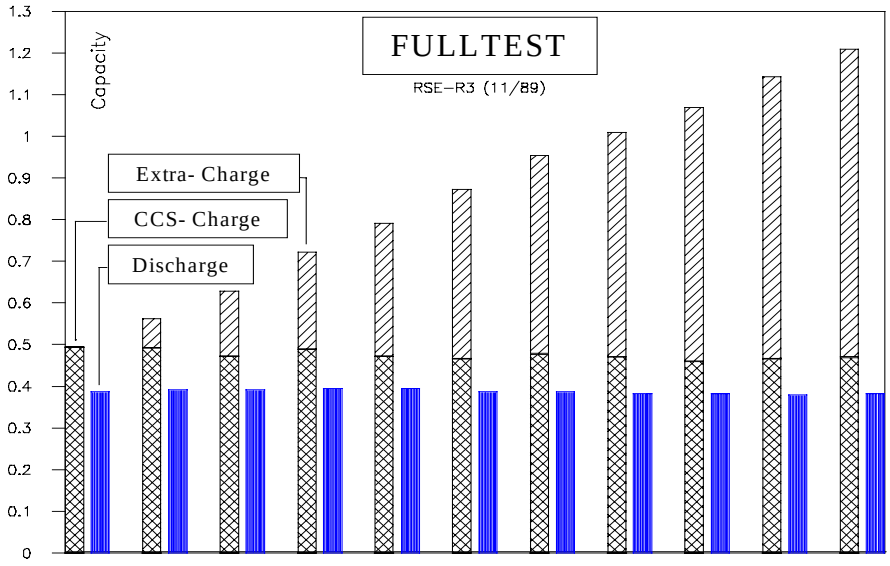

Fig. 6

The 'full test' demonstrates that the batteries are charged to 100%. Even with an increased energy supply no higher capacity can be reached. Depending on the age, the temperature and condition of the anodes, batteries of the same type may take different charges. The BTI/CCS process takes this capacity capability into account and always charges 100% of the useable capacity.

The cut off point is no longer determined by luck or by reaching a single specific value, but by cross-reference to various charge parameters. In this way the 100% full charge of the batteries is reached independently of the charge condition, temperature, etc., and both under- and over-charging are avoided.

REALITY: An extended charging time does not bring capacity gains, but results in overcharging with battery damage.
Only CCS stops charging at the precise moment of charge completion with 100% reliability and no overcharge.

E) Misconception: Pulse charging averts memory effect and increases battery life!
Some claim, that charging with high amplitude and a short duration current, as with pulse charging, averts the memory effect and increases the battery life span. In reality the waveform of the charge current has much less effect on the battery charging than the overcharge has. The power loss is I^2 x R. Accordingly a pulse/stop relation 1:3 is resulting in a nine times higher power loss.

REALITY: High current pulses are causing battery damage.
Only CCS does not overcharge and thus prevents memory effect and extends the life of a battery.

F) Misconception: Reflex Charging!
It is said, that reflex charging (=neg. discharge pulses while charging) prevents gassing, overcharging, dendrite creation, memory effect and increases battery life.

REALITY:
Physical and electrochemical fundamentals speak against this.

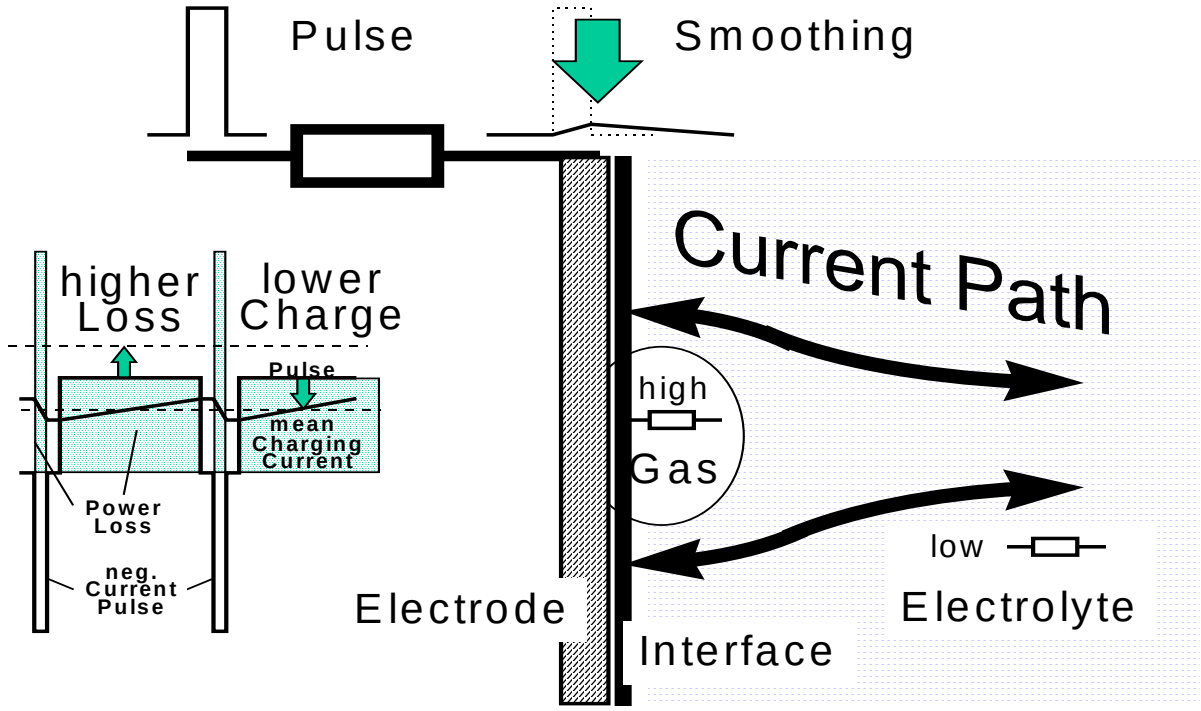

Fig. 7

a) Gassing occurs when a battery is already overcharged, yet the negative current pulses occur during the entire charging process.
b) Gas bubbles have a much higher impedance than the electrolyte and therefore can not be reduced by high negative pulses.

Avoided with CCS.

G) Misconception: Discharging of batteries prevents the memory effect!
Regular charging technologies can not determine the precise moment of charge completion and therefore overcharge with each charge cycle. The fuller the battery was before charging, the greater will be overcharge (see Fig. 8). Accordingly a lesser discharged battery will experience greater damage. This recognition was erroneously named memory effect, but it has nothing do to with the discharge memory of a battery. It is caused by over charging, which formats the electrode incorrectly. The finding is also confirmed by the fact that the memory effect shows up in batteries that were never discharged before.

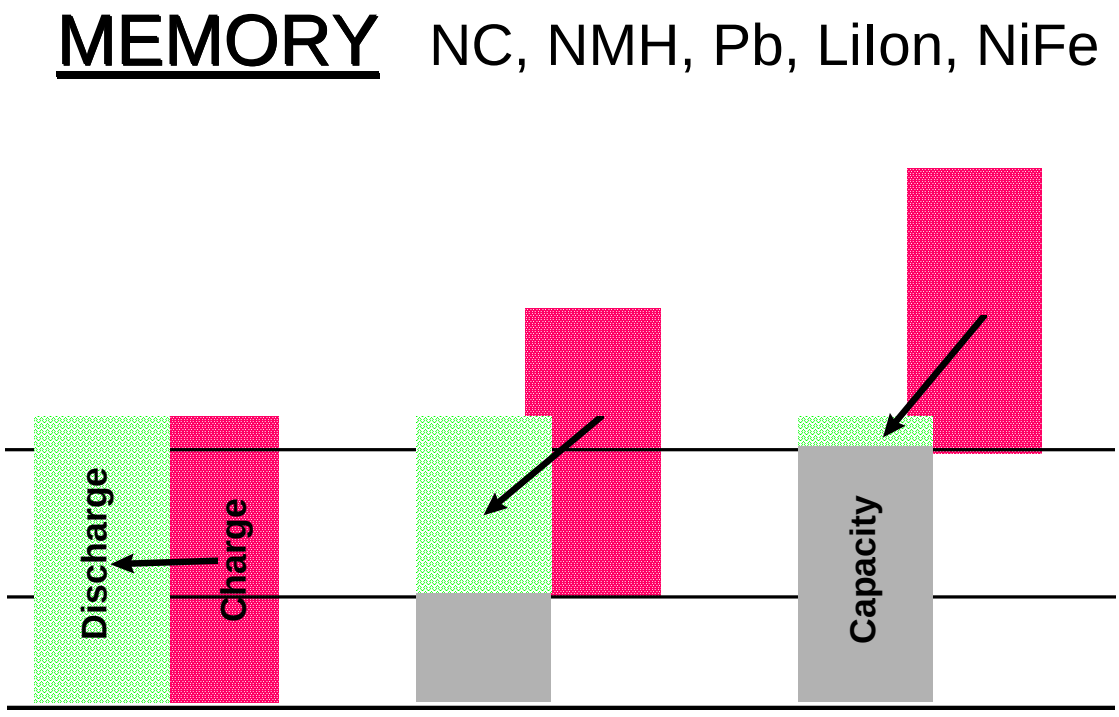

Fig. 8

REALITY: The memory effect is the memorization of overcharging, and discharging will not prevent the memory effect.
With CCS there is no memory effect.

H) Misconception: Only NC batteries are effected by the memory effect!
This erroneous assumption, besides heavy metal, was deemed to be the greatest disadvantage of NC's, and a good reason to push the more expensive development of NM and LiIon. The misconception probably strengthen since NC's were in widest use and a continued overcharging showcased the memory effect for NC's. Now, with the wider use of NM and LiIon and Lead Acid batteries, the memory effect is surfacing there as well. It highlights the importance of a charging system that prevents all overcharging and is not limited to a specific battery chemistry.

REALITY: Lead Acid, NM, and LiIon are also effected by a memory effect.
Only CCS works for all battery chemistries and prevents memory effect.

I) Misconception: Existing Battery Management Systems do not harm the battery life!

Battery management systems based on capacity balance, measuring of charge and discharge current with balancing the 100-140% CH/DISCH can neither prevent the overcharging nor the complete discharge, since it is not known when the battery is really full. Leak currents and self discharge also influence the calculation, yet they are indefinable due to temperature influences. So are the charge parameters. It is clear, that capacity balance does not recognize when a battery is full. As a result overcharging and shortening of battery life occurs (see Fig. 9).

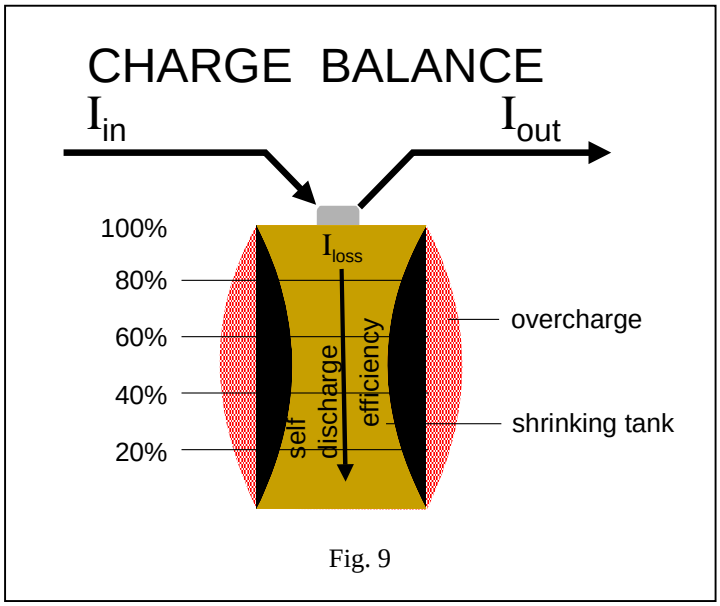

Fig. 9

Timing or temperature guided systems lead to strong overcharging of the batteries as well. Even though, they want you to believe differently, -dV (Delta Peak) can not prevent overcharging either. The charge termination "Deflection Point" occurs too early and before the battery is full.

Voltage directed charging systems are too much influenced by other conditions (type, electrolyte, temperature current, etc.) and therefore unreliable.

Furthermore: All present charge termination methods require constant current for NC cells or constant voltage for Lead Acid., Alkali-Mangan (RAM) and LiIon. A designer of portables therefore must commit for a specific charging system and a specific battery chemistry.

REALITY: *Only CCS works for all chemistries.*

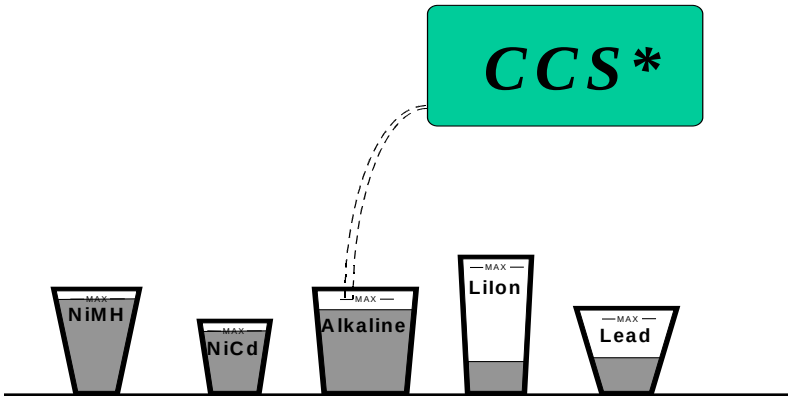

Fig. 10

Compared with the present technical state of battery charging, CCS not only overcomes many misconceptions and most prevalent problems of battery charging, but it is at the forefront of a new era in battery charging.

CCS is not merely conjecture but unquestionable confirmed by: Evaluation boards available to design engineers, test reports by engineers and reputed companies, commercial applications already in use.

REALITY:

CCS is worldwide unique and can not be reached by any other charging technology at this time.

3. Cost & Energy Impact:

- For NC batteries, per example, manufacturers are quoting 500 to 1,000 charge cycles. In real life most of these batteries have just a life of 100 cycles and often fail in much shorter time. As CCS is proving, much of it is the inadequate charging process, that cuts a battery life short. *With CCS a battery life of 5000 charge cycles can be reached.*

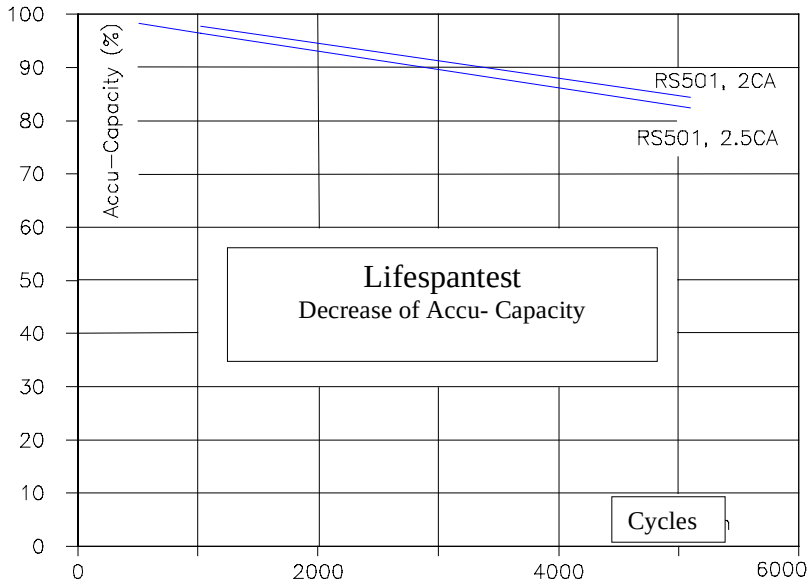

Fig. 11

In a five-month cycle-test, two commercially available NiCd batteries (500mAh) were charged 5000 times with the BTI charge unit at 2CA (1,06A) and 2,5CA (1,25A) respectively, and discharged for 10 minutes at 2CA(1A). At the end of the test the batteries supplied over 80% of their original capacity (see Fig. 11).

- Battery waste and the pollution of the environment with heavy metals is a serious problem. Investigations have shown, that with CCS more than 80% of the wasted batteries were to regenerate their rated capacity. By these features battery waste is dramatically reduced.

The increase in battery life span is of enormous benefit to consumer and industry, but is equally beneficial for the environment and ecology.

- CCS also reduces the charging time to about 20 minutes (NC) for further energy savings.
  Most manufacturers specify a charging duration of about 14 hours or more for NC's and a charge current of around 0.1CA. It must be realized that the energy supplied to an already fully charged battery will not be charged but will irreversibly damage the battery by the cracking of pressure of the electrolyte (gassing) and by the increase and temperature. With higher currents these effects increase exponentially.
- CCS also requires no discharge cycle, and batteries can be charged from any state of battery charge. This is especially advantageous for military and emergency units, as well as for battery management of electric cars.
- A CCS Charge Controller detects the moment of the 100%full state with the highest known precision under all known circumstances. Therefore no additional sensors with contacts and leads are needed (e.g. NTC/PTC-temperature protection or measurement). Even shorted or wrong cells will switch off fail-safe and do not need further protection.

4. The next step for battery charging

CCS is patented worldwide, and has been nominated and won an award for technical innovations in Europe.

There are numerous commercial applications successfully in use (see Fig. 12).

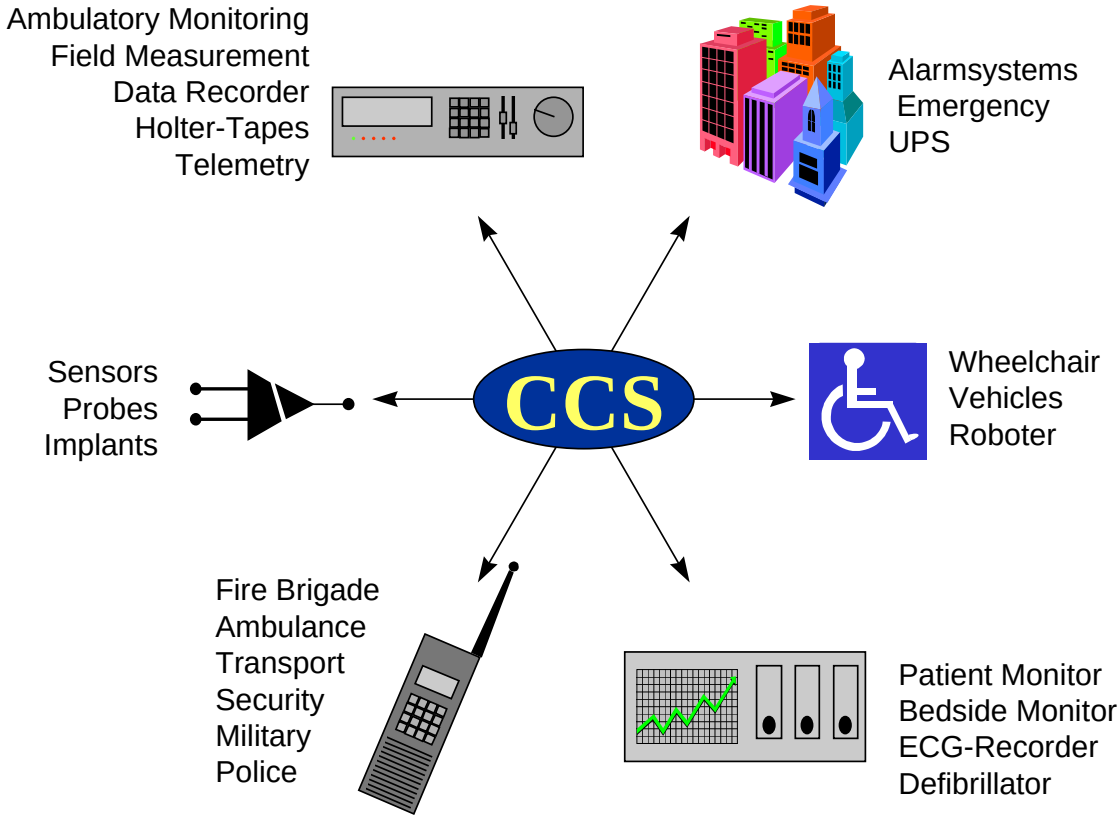

Fig. 12

CCS Products:

* CCS Charge Controllers
* CCS Charge Modules
* CCS Evaluation Boards
* Customer Specific Design

The CCS Technology is also of special value to the Medical field, for Governments and Emergency groups, where reliability and safety is of the greatest importance.

Over the past 7 years, there have been app. 5000 charging stations converted to CCS (Broadcast Stations, Fire Departments, Rescue Units, Police Department, OMV, and others).
These units are on active duty without interruptions and CCS test highly successful. Battery defects, insufficient charge levels and especially premature battery failures are no longer an issue.

Other utilization's are for:
Military, Radio, Portable Phones, Toys, Security Systems, UPS, Vehicles, etc..

Rudolfstrasse 14, A-8010 Graz, AUSTRIA
Tel. ++43/316/ 32 60 31, Fax: 38 18 08

5. Progress/Advantages

- ☺ NEW, PATENTED SHUTOFF CRITERIA
- ☺ Microcomputer controlled charge up to 100%exactly
- ☺ For all battery types (NC, NM, Lead Acid, SLA, LiIon, etc.)
- ☺ Wide range of operation (battery voltage and capacity)
- ☺ Safe quickcharge in minutes
- ☺ Extended battery life (>5000 cycles)
- ☺ Independent of precharging state, no discharge needed
- ☺ Independent of external influences (contact, etc.)
- ☺ Wide temperature range (-20 to +85C)
- ☺ Automatic recharge and maintenance charge
- ☺ Battery defect recognition
- ☺ Simple 2 lead wire connection, no additional sensors
- ☺ No adjustments or calibration during production
- ☺ Proved industrial application
- ☺ FOOLPROOF

How can we help you?

We can help you with data sheets, application notes, general assistance and with Evaluation-Boards which will help you to save time.

We can evaluate existing chargers and demonstrate upgrades and improvements.

We would welcome the opportunity to discuss how we can be of service to you.

How to get more information?

Latest information is available on our Homepage:

http://www.bticcs.com

Should you require more information, please do not hesitate to call us or to send a fax or email.

When ever you will improve battery charging CCS will be the solution.