



**Gastight nickel/hydride storage battery of the
round-cell type**

The invention relates to a gastight nickel/hydride storage battery of the round-cell type having a positive nickel hydroxide electrode and a negative electrode whose active material comprises a hydrogen-storage alloy, and having a separator which separates the electrodes.

The currently commercially available nickel/hydride storage batteries in accordance with the above definition of generic class are in general based on the wrapped-cell principle of construction. In the latter, thin, large-area and flexible electrodes form, together with an intervening separator, a roll which is inserted into a cylindrical casing can composed of nickel-plated steel sheet. A cell lid, which tightly seals the casing can and is insulated from it, is in electrical contact with one of the wound electrodes and forms one cell pole, while the can base forms the other cell pole.

To this extent, conventional nickel/hydride storage batteries, for example of the type described in EP-PS 419 221 do not basically differ from the known Ni/Cd storage batteries in the round-cell design. Common to all the electrodes used therein is the fact that they have metallic supporting matrices to which the active material is applied by means of various, in some cases expensive procedures. The electrodes of the Ni/Cd storage battery of the round-cell type are generally sintered electrodes whose support is composed of a thin, perforated nickel sheet with nickel powder sintered onto it.

However, there is also a choice of other support materials, such as fine-mesh metal gauzes, expanded metals or metal-foam matrices, both for the electrodes of the Ni/Cd storage battery and also for those of the Ni/hydride storage battery. Thus, owing to a developed electrode technology, very thin laminates can be produced by rolling-out a dry mixture composed of the respective

active material, for example an alloy powder capable of storing H_2 , and an addition of conducting agents and binders, and these can then be rolled into a nickel gauze. In a similar way, nickel hydroxide electrodes are produced in the form of rolled electrodes from a dry mixture of nickel hydroxide with additions, inter alia, of nickel powder and PTFE powder as binder.

A so-called foam electrode takes the form of a metal-foam support, usually composed of nickel. The metal foam is remarkable for extremely high porosity (its pore volume reaches at least 95%) and for a high electrical conductivity. The active mass is introduced into the open pore system of this matrix body by packing with slurry or paste and the electrode is then dried.

The metal reinforcements just mentioned are indispensable for the current collection, the mechanical strength and the manipulability during assembly of strip or wound electrodes. However, their disadvantage is an appreciable dead weight and the production costs, which sharply increase the total price of the electrodes.

A secondary cell which is disclosed in German Offenlegungsschrift 2256077 and whose electrode set comprises two sintered ceramic, porous metal tubes which are inserted into one another in telescope fashion as a result of a slight conicity with the insertion of a separating element and one tube of which is impregnated with a positive active material and the other tube of which is impregnated with a negative active material, also has this disadvantage. As a result of the residual cylindrical cavity in this electrode arrangement, the known round cell not only has an appreciable dead volume but does not offer the prospect of high energy density either because of the voluminous metallic matrix material of the electrodes.

Finally, the VARTA reference book entitled "Gasdichte Nickel-Cadmium-Akkumulatoren" ("Gastight nickel-cadmium storage batteries") (VDI Verlag GmbH, Düsseldorf, 1978), pages 155/156, discloses a very similar arrangement of mass electrodes in a cylindrical

cell, but with the difference that positive electrode and negative electrode are not inserted into one another in the form of tubes but as powder compacts moulded to form half-shells.

5 Such alkaline round cells have not gained acceptance, however, in the Ni/Cd system because their current-carrying capacity has proved inadequate. In addition, in contrast to a wound cell, the separator volume between the two mass electrodes is insufficient to
10 have a necessary buffering action with respect to the water of reaction formed during charging, which disappears again during discharge. The separator has either a very low (discharged state) or a very high (charged state) degree of filling with electrolyte and,
15 in the latter case, would prevent the gas consumption in a sealed storage-battery cell.

 The object of the invention is therefore to provide a nickel/hydride secondary cell which is fitted with inexpensive electrodes but is not inferior in its
20 current-carrying capacity and in its capacity data to the existing storage batteries of the round-cell type.

 The object is achieved, according to the invention, with a nickel/hydride storage battery as defined in Patent Claim 1.

25 According to the latter, it has proved beneficial to provide, for both electrode polarities of the storage-battery cell, mass electrodes in the form of powder compacts which are arranged in the cylindrical casing can so as to be coaxially fitted into one another and,
30 together with an intervening separator, completely fill the cross section of the casing can.

 Mass electrodes in the form of pressed powder tablets are per se the typical electrodes of Ni/Cd button cells. These cells have a low self-discharge when not in
35 use and when stored, but are suitable only for low and medium loads. At the same time, even the electrode tablets used in the button cells and composed of Ni(OH)_2 and Cd(OH)_2 powder require a metal-gauze reinforcement by being pressed into a small basket of nickel-wire fabric



for reasons of mechanical stability and better current collection.

According to the invention, however, any metallic collector matrix is unnecessary in the case of the novel electrodes.

Particularly advantageously, the positive electrode of the nickel/hydride storage battery according to the invention is produced from a dry mixture of nickel hydroxide and nickel metal powder, and also additions of cobalt and/or cobalt hydroxide and a binder such as PTFE by moulding to produce annular pressed bodies which are introduced into the casing can as a stack and are pressed once again so that they form a tubular cathode.

A solid cylindrical pressed body which is composed of a dry mixture of powdered hydrogen-storage alloy and additions of PTFE and soot and which is surrounded by a separator is inserted as anode in a close-fitting manner into the cavity of the cathode. The cross section of the casing can is exhaustively utilized by this arrangement of two mass electrodes.

Expediently, the anode pressed body is divided into a number of smaller cylinders equal to that of the cathode rings. To receive a collector nail, the anode cylinders have central bores whose diameter is somewhat smaller than that of the collector nail. The collector nail, which is composed of nickel-plated copper or brass, is part of the casing lid.

After metered addition of the electrolyte, the casing can is firmly sealed with the lid, which is electrically insulated from the can, the collector nail being pressed into all the anode cylinders and a firm contact thereby being made with the hydride electrode.

The subject of the invention is explained below with reference to the figures.

Figure 1 shows a flow chart for the basic manufacturing procedure of an Ni/hydride cell according to the invention.

Figure 2 shows a general plan of the components of an Ni/hydride cell according to the invention.



Figure 3 shows the structure of an Ni/hydride cell according to the invention in sectional view.

According to Figure 1, the positions 1 to 12 denote the various working procedures in the electrode
5 manufacture and also the subsequent stages in the assembly of the cell.

Thus, the production of the positive electrode comprises the steps of:

1. mixing $\text{Ni}(\text{OH})_2$, CoO and PTFE (or PE),
- 10 2. granulating and feeding the fine component produced back into the mixing vessel,
3. pressing the rings,
4. introducing the rings into the can.

In parallel therewith, the negative electrode is
15 produced in the steps of:

5. mixing the alloy material with PTFE and soot,
6. granulating and feeding the fine component produced back into the mixing vessel,
7. pressing the cylinders,
- 20 8. packing the cylinders into a separator.

The cell construction continues with the steps of:

9. introducing the cylinders into the can,
10. metered addition of the electrolyte,
- 25 11. sealing the can with the lid,
12. activating the cell (charging).

Figure 2 illustrates the essential components of the nickel/hydride cell according to the invention, namely the casing can 1, four cathode rings 2, four anode
30 cylinders 3 with bores 4, the separator 5 and the casing lid 6 with collector nail 7.

Figure 3 shows the cell structure comprising the parts mentioned, including the separator sleeve 5, in a

cross-sectional view, the casing 1 surrounding the cell components not being shown.

5 A particular advantage of the electrode compacts used according to the invention is that they are formed solely of positive or negative active material and do not have any reinforcement, for example by an additional nickel woven gauze. This contributes to a very appreciable cheapening of the production costs.

10 A manufacturing advantage for the novel Ni/hydride round cell furthermore results from the fact that largely standardized cell cans, cell lids, collector nails and separators such as those which are production standards in the manufacture of primary alkali/manganese cells can be used for their manufacture and are used on
15 a large scale therein, in particular for the construction of the so-called R6 round cell. Their MnO_2 rings are geometrically identical to the rings of the positive Ni(OH)_2 electrode in the Ni/hydride cell according to the invention. The solid cylindrical powder compacts for the
20 negative hydride electrode can be produced with simple tools and provided with bores.

In total, the production of the cell according to the invention is very inexpensive not only because of the usability of already existing cell components from the
25 primary manufacture, but also because of the usability of standard tools from this production area. No further new process developments, but at most adaptations of existing steps are necessary.

30 With a positive electrode/negative electrode design ratio of 1/1.2, Ni/hydride round cells according to the invention of the AA (R6) format can achieve a capacity of not more than 2 Ah.

The current-carrying capacity is indeed lower than in the case of a comparable Ni/hydride wound cell.
35 The maximum capacity of the latter is, however, only 1.5 Ah.

Since, in contrast to the Ni/Cd storage battery, no water enters into the current-yielding reaction equation in the case of the Ni/hydride storage battery,

the separator does not undergo either a total filling of its pores with, or a total discharge from its pores of, water of reaction formed in the charge/discharge cycle. The gas consumption is consequently not interrupted, with
5 the result that, despite its small relative volume and low buffer capacity for water, the separator fully meets the requirements for a gastight cell operation.



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Patent Claims

1. Gastight nickel/hydride storage battery of the round-cell type having a positive nickel hydroxide electrode and a negative electrode whose active material
5 comprises a hydrogen-storage alloy, and having a separator which separates the electrodes, characterized in that both electrodes are mass electrodes in the form of powder compacts which are arranged so as to be coaxially fitted into one another and, together with an
10 intervening separator, completely fill the cross section of the casing can.
2. Nickel/hydride storage battery according to Claim 1, characterized in that the positive electrode comprises cylindrical-ring powder compacts (2) which are pressed
15 into the cylindrical casing (1) as a stack and form a tubular cathode, and in that, with the insertion of the separator, the interior of the tubular cathode is filled by the pressed active material of the negative electrode.
3. Nickel/hydride accumulator according to Claim 2,
20 characterized in that the negative electrode is formed from cylindrical powder compacts of a hydrogen-storage alloy material which also form a stack and which have central bores (4) for receiving a current collector.
4. Nickel/hydride storage battery according to Claim
25 3, characterized in that the current collector of the negative electrode comprises a nail (7) which is welded onto the casing lid (6) and which is pressed into the central bores of the negative electrode.
5. Nickel/hydride storage battery according to one
30 of Claims 1 to 4, characterized in that the pressed powder body of the positive electrode is formed from a dry mixture of nickel hydroxide, nickel metal powder and additions of cobalt metal powder and/or cobalt hydroxide.