B5 BATTERIES

BUTTON CELLS

CHEMICAL INDUSTRIES
RESOURCE PACK

Mercury button cells

Calculators, hearing aids, and other small electronics devices use tiny non-rechargeable "button" cells. The original technology for button cells was the mercury cell, which had a mercuric oxide (HgO) cathode, an anode made of an amalgam of mercury and zinc, and an electrolyte consisting of potassium hydroxide mixed with zinc hydroxide (or $Zn(OH)_2$).

The **anode** reaction is:

$Zn + 2OH^- \rightarrow ZnO + H_2O + 2e^-$

The **cathode** reaction is:

$HgO + H_2O + 2e^- \rightarrow Hg + 2OH^-$

Mercury cells had a highly constant cell voltage of 1,35 volts. A similar cell could be made with cadmium instead of zinc, providing a cell voltage of 0,91 volts. Since mercury is toxic, mercury cells are now banned in the US and some other countries; they are now only a historical curiosity.

Zinc-air button cells

Modern zinc-air button cells are similar to alkaline cells. The anode is powdered zinc mixed in a gel, the electrolyte is a layer of potassium hydroxide, and the cathode is a carbon disk, designed to support cathode reactions through the oxygen in the air. A porous teflon membrane allows air into the cell while preventing the electrolyte from leaking out.

The **anode** reaction is:

$Zn + 2OH^- \rightarrow Zn(OH)_2 + 2e^-$

The **cathode** reaction is:

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

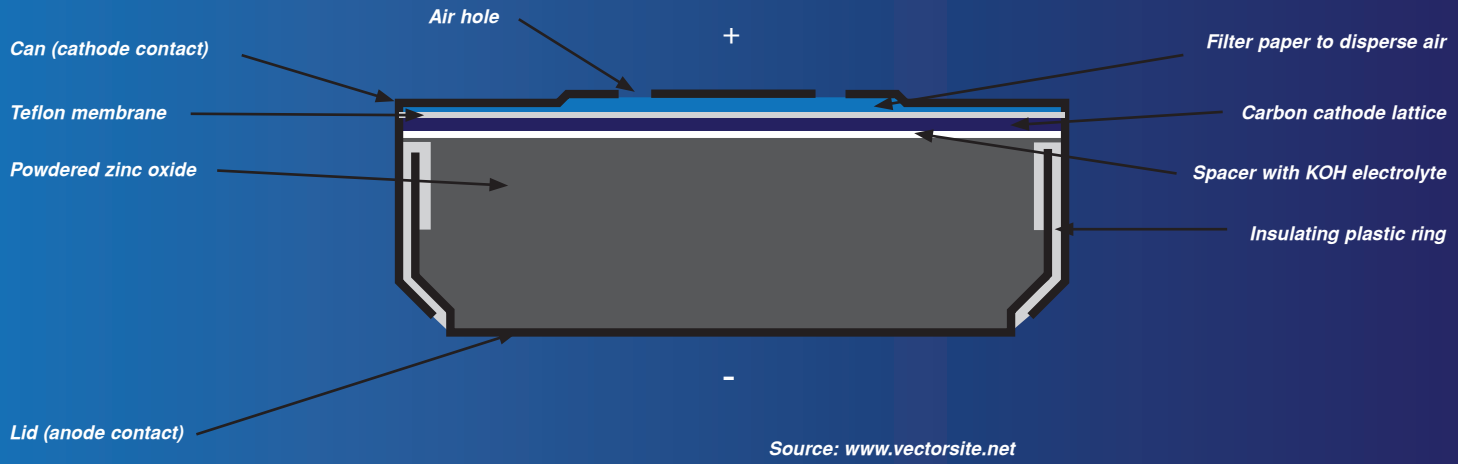
Zinc-air batteries have a cell voltage of about 1,65 volts. They have a very high energy density, but also have a high internal resistance and are not well suited to high-current applications. They have a long shelf-life provided that they are kept sealed.

Large zinc-air cells have been used in consumer equipment, at least on a limited basis, and very large zinc-air batteries have been experimentally used in vehicles.

Silver-oxide button cells

The silver oxide cell is similar in construction to the zinc-air type, with an anode of powdered zinc in gel with a potassium hydroxide electrolyte, except that instead of having a cathode made of carbon and exposed to the air, it is a silver screen pasted with silver oxide (Ag_2O). They have a cell voltage of 1,55 volts, a flat discharge curve, and long shelf life. They are not generally recharged, but can be recharged a limited number of times.

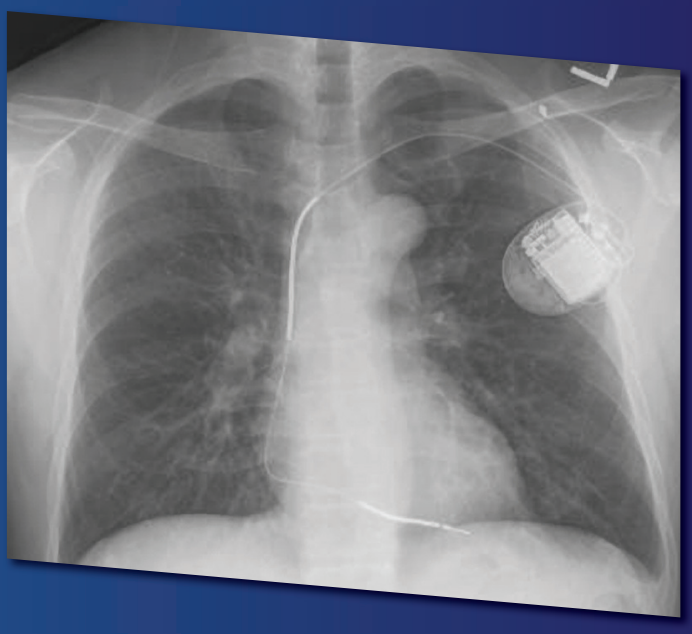
Zinc-air button cell



Source: www.vectorsite.net

An implantable cardioverter-defibrillator (ICD)

Source: Wikipedia



A normal chest X-ray after placement of an ICD

Source: Wikipedia

Comparing button cells

The mercury cell and the silver cell are quite similar. Both use a zinc anode in a basic medium as the reducing agent. The one employs HgO as the oxidising agent, the other Ag_2O, and both use a steel cathode. The solid reactants are compacted separately with KOH, with moist paper for a salt bridge. These cells are most commonly used in watches and calculators, with the silver cells used in cameras, heart pacemakers, and hearing aids. Both are very small, with relatively large voltage. The silver cell has a very steady output and is non-toxic. Discarded mercury cells could release the toxic metal in the environment. Silver cells are expensive.

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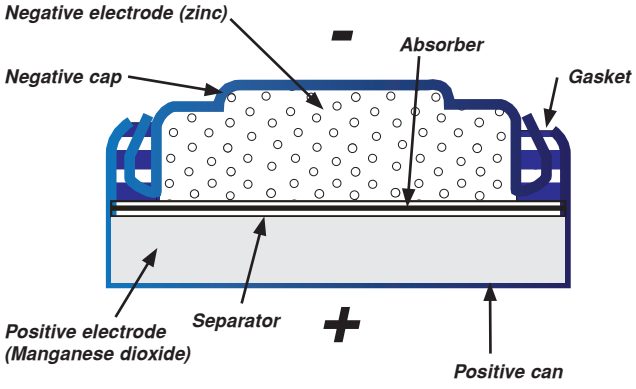
Section through a mercury button cell



Source: Battery Handbook

Batteries in pacemakers

The earliest practical implantable cardiac pacemakers appeared in the late 1950s, powered by Zn/HgO batteries. Throughout the 1960s most implanted pacemakers continued to use Zn/HgO batteries. However, following the introduction of lithium/iodine batteries for cardiac pacemakers in 1972, the usage swung rapidly toward electrochemical power sources based on lithium.

Several lithium-based battery chemistries were introduced. The lithium/iodine system has provided small, simple, highly reliable power sources with power characteristics almost ideally suited to the requirements of cardiac pacing for more than three decades.

The hybrid cathode battery system has since been introduced in other implantable devices including cardiac pacemakers, hemodynamic monitors and drug-delivery devices. The total number of implants powered by hybrid cathode batteries stood at more than 100 000 in January 2005.

In the future this chemistry is expected to find application in the full range of implantable device applications requiring primary batteries, including devices that constantly monitor the rate and rhythm of the heart and can deliver therapies, by way of an electrical shock.

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