August 1973

B73-10221

NASA TECH BRIEF

Goddard Space Flight Center

A Heat Flow Calorimeter

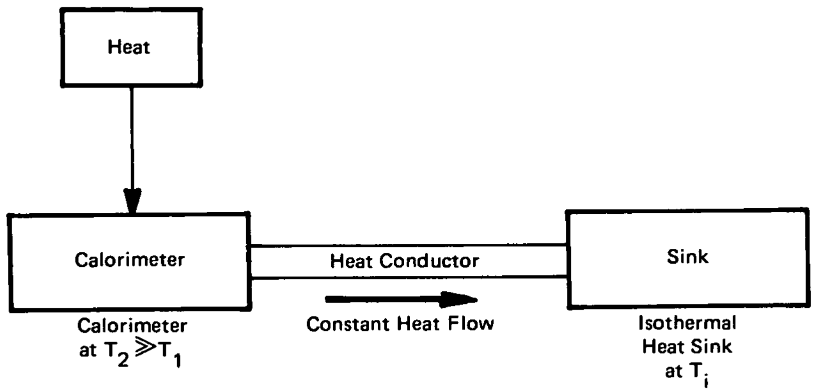

Figure 1. Schematic of Heat-Flow Calorimetry

The problem:

Nickel-cadmium cells are used in place of more conventional lead storage batteries when greater capacity/weight ratios are needed. The reaction mechanism for the nickel-cadmium cell is not known well enough, however, to allow calculation of heat effects. Therefore these must be determined with a calorimeter. Conventional calorimeters cannot be used because these cells generate more heat than can be held in the calorimeter.

The solution:

A heat-flow calorimeter can be used to measure the heat absorbed or evolved in a cell, by determining the amount of external heat that must be supplied to the calorimeter to maintain a constant flow to an isothermal heat sink.

How it's done:

The heat-flow calorimeter consists of a thermally isolated calorimeter vessel with a path for heat conduction to a heat sink. The heat sink is held at a constant temperature that is considerably lower than the calorimeter temperature. Figure 1 depicts the way in which the calorimeter works. A heater winding in the calorimeter (near the junction with the conductor) has enough power to keep the calorimeter at a constant temperature. Thus, the flow rate between the calorimeter and the heat sink is constant. A change in the amount of heat being generated inside the calorimeter will require a change in the amount of electric power needed by the heater to maintain a constant temperature.

In a steady state, the total heat (W_T) required to maintain the calorimeter at a temperature T_2 will be equal to the amount of heat passing to the heat sink. This heat will be from several sources: W_E, W_B, W_L, and W_C where $W_T = W_E + W_B + W_L + W_C$, and

W_E = heat added electrically to maintain a constant T_2,

W_B = heat generated (or absorbed) by the cell,

W_L = heat loss to the surroundings,

W_C = heat introduced by an optional calorimeter heater, and W_L, the heat loss, need not be known as long as it is constant.

Since W_T is constant, any change in W_B, heat evolved, must be reflected in a change in W_E.

~~(continued overleaf)~~

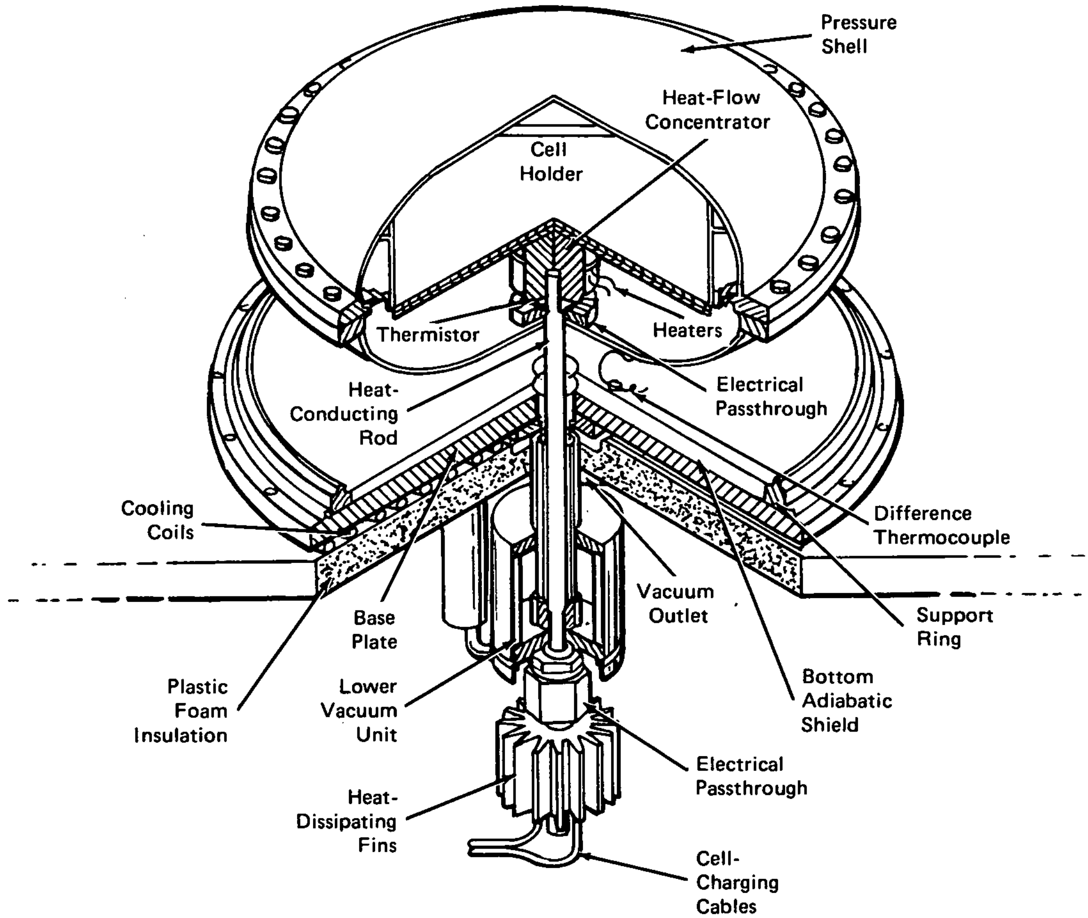

Figure 2. Quarter-Section Drawing of Calorimeter

Figure 2 is a view of a practical heat-flow calorimeter. The heat sink can be a liquid kept at its boiling point. In this way, any heat added to the heat sink will be used as heat of vaporization and will not change the temperature. This calorimeter will measure a heat flow of 30 watts to within 0.01 watts and can handle current flows through the calorimeter of up to 50 amperes.

Note:

No further documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Code 207.1
Greenbelt, Maryland 20771
Reference: B73-10221

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel
Goddard Space Flight Center
Code 204
Greenbelt, Maryland 20771

Source: William V. Johnston of
Rockwell International Corp.
under contract to
Goddard Space Flight Center
(GSC-11434)