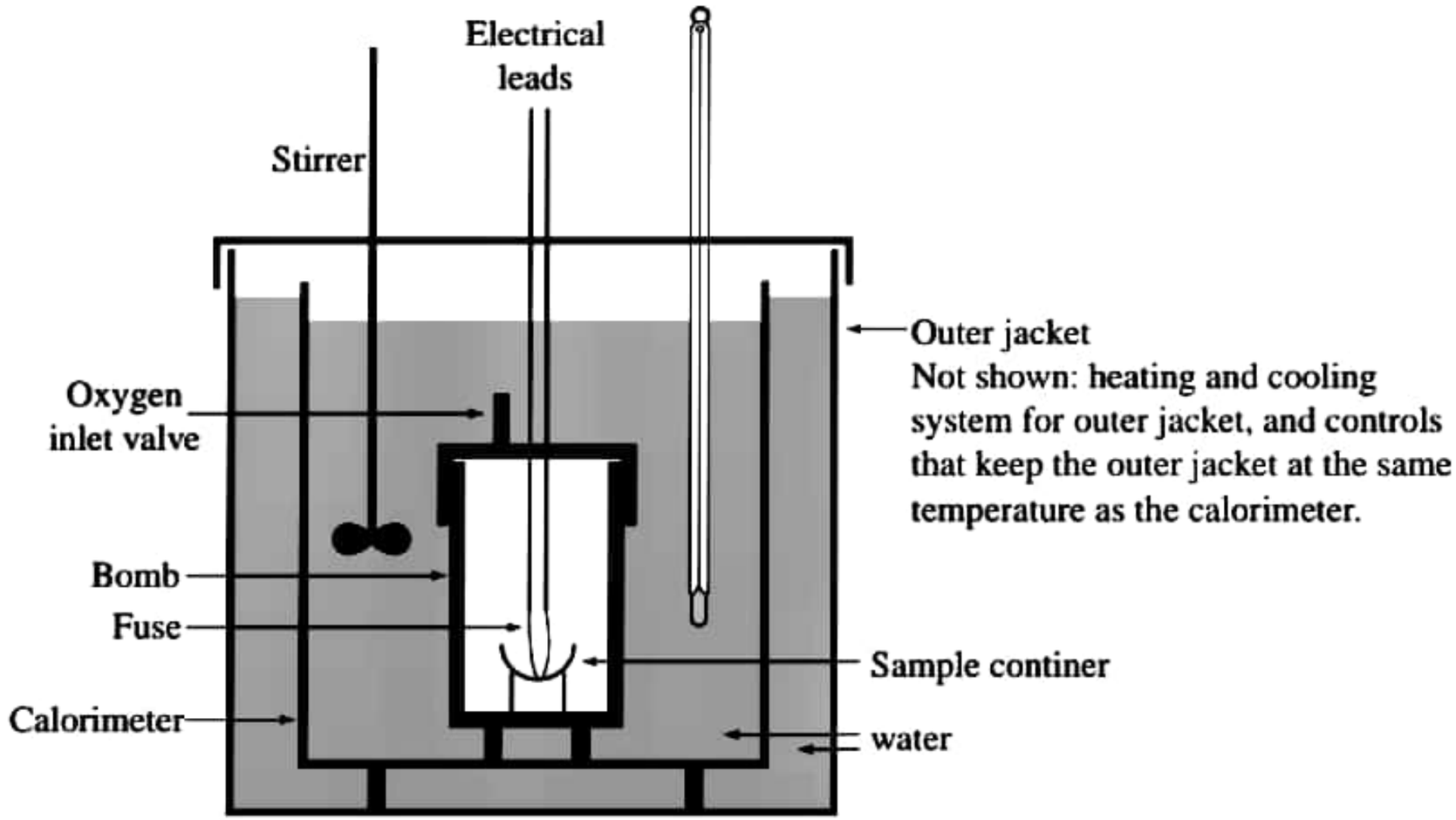
Bomb Calorimetry



6 BOMB CALORIMETER*

This apparatus is used to find the *calorific value of solid and liquid fuels.*

Construction : A simple sketch of bomb calorimeter is shown in Fig. 1. It consists of a strong cylindrical stainless steel *bomb* in which the combustion of fuel is made to take place. The bomb has a *lid,* which can be screwed to the body of bomb so as to make a perfect gas-tight seal. The lid is provided with two stainless steel *electrodes* and an *oxygen inlet* valve. To one of the electrodes, a small *ring* is attached. In this ring, a nickel or stainless steal *crucible* can be supported. The bomb is placed in a copper *calorimeter,* which is surrounded by an *air-jacket* and *water-jacket* to prevent heat losses due to radiation. The calorimeter is provided with an electrically operated *stirrer* and *Beckmann's thermometer,* which can read accurately temperature difference upto 1/100th of a degree.

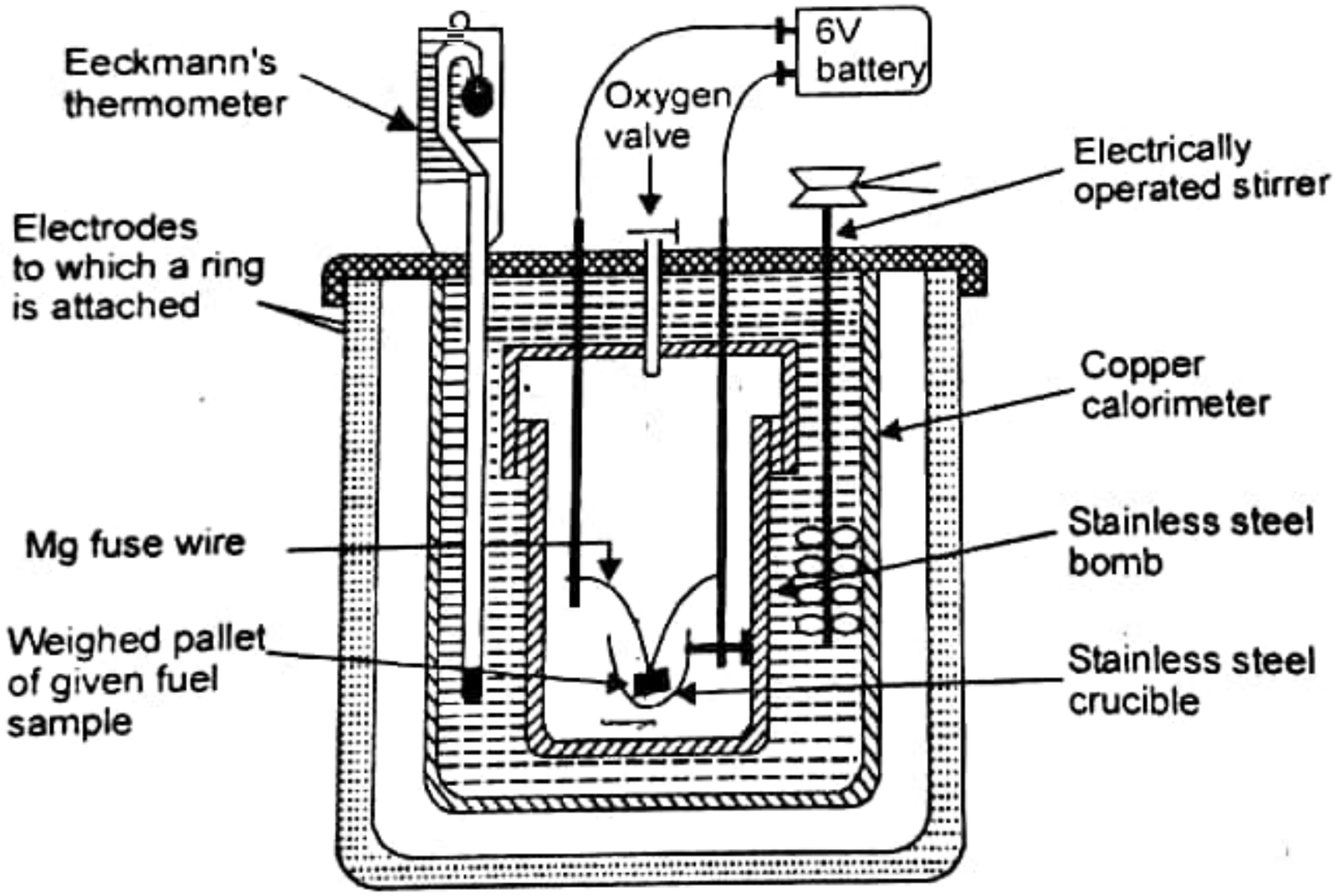


Fig. 1. Bomb calorimeter

Working : A known mass (about 0.5 to 1.0 g) of the given fuel is taken in clean crucible. The crucible is then supported over the ring. A fine magnesium wire, touching the fuel sample, is then stretched across the electrodes. The bomb lid is tightly screwed and bomb filled with oxygen to 25

atmospheric pressure. The bomb is then lowered into copper calorimeter, containing a known mass of water. The stirrer is worked and initial temperature of the water is noted. The electrodes are then connected to 6-volt battery and circuit completed. The sample burns and heat is liberated. Uniform stirring of water is continued and the maximum temperature attained is recorded.

Calculations : Let x = mass in g of fuel sample taken in crucible ; W = mass of water in the calorimeter ; w=water equivalent in g of calorimeter, stirrer, thermometer, bomb, etc.; t_1 = initial temperature of water in calorimeter ; t_2 = final temperature of water in calorimeter ; L = higher calorific value in fuel in cal/g.

$\therefore$ Heat liberated by burning of fuel $= x\,L$

and heat absorbed by water and apparatus, etc. $= (W + w)\,(t_2 - t_1)$

But heat liberated by the fuel = Heat absorbed by water, apparatus, etc.

$\therefore \quad x\,L = (W + w)\,(t_2 - t_1)$

or $$\text{HCV of fuel } (L) = \frac{(W + w)(t_2 - t_1)}{x} \text{ cal/g (or kcal/kg)} \quad ...(ii)$$

Note : The *water equivalent of the calorimeter* is determined by burning a fuel of *known calorific value* and using the above equation. The fuels used for this purpose are *benzoic acid* (HCV = 6,325 kcal/kg) and *naphthalene* (HCV 9,688 kcal/kg).

If H = percentage of hydrogen in fuel, then :

$\frac{9H}{100}$ g = Mass of H_2O from 1 g of fuel = 0.09 H g

$\therefore$ Heat taken by water in forming steam

$= 0.09\,H \times 587$ cal ($\because$ Latent heat of steam = 587 cal/g)

$\therefore$ LCV = HCV – Latent heat of water formed

$= (L - 0.09\,H \times 587)$ cal/g (or kcal/kg) ...(*iii*)