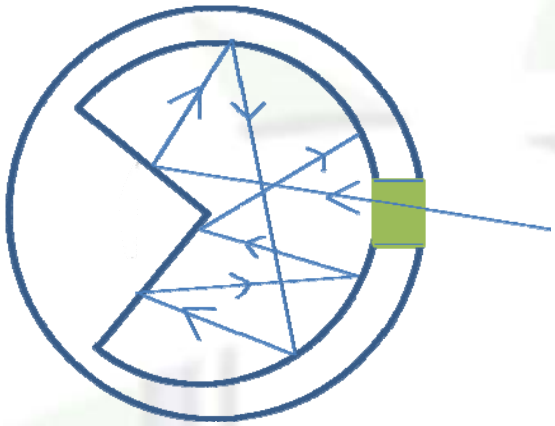
Head Radiation- Black Body, Thermopile

Black Body:

A body which absorbs all the radiations of shorter as well as longer wavelength which are incident on it is known as black body. Since it neither reflects nor transmits any radiation, it appears to be black. A black body when heated to a temperature it emits the full radiation corresponding to that temperature. Hence a black body can also be regarded as perfect emitter of radiation.

Example: lamp black, charcoal black, platinum black.

Ferry's black body: It consists of a double walled hollow spherical vessel having a small hole in it. The space between the two walls is highly evacuated.



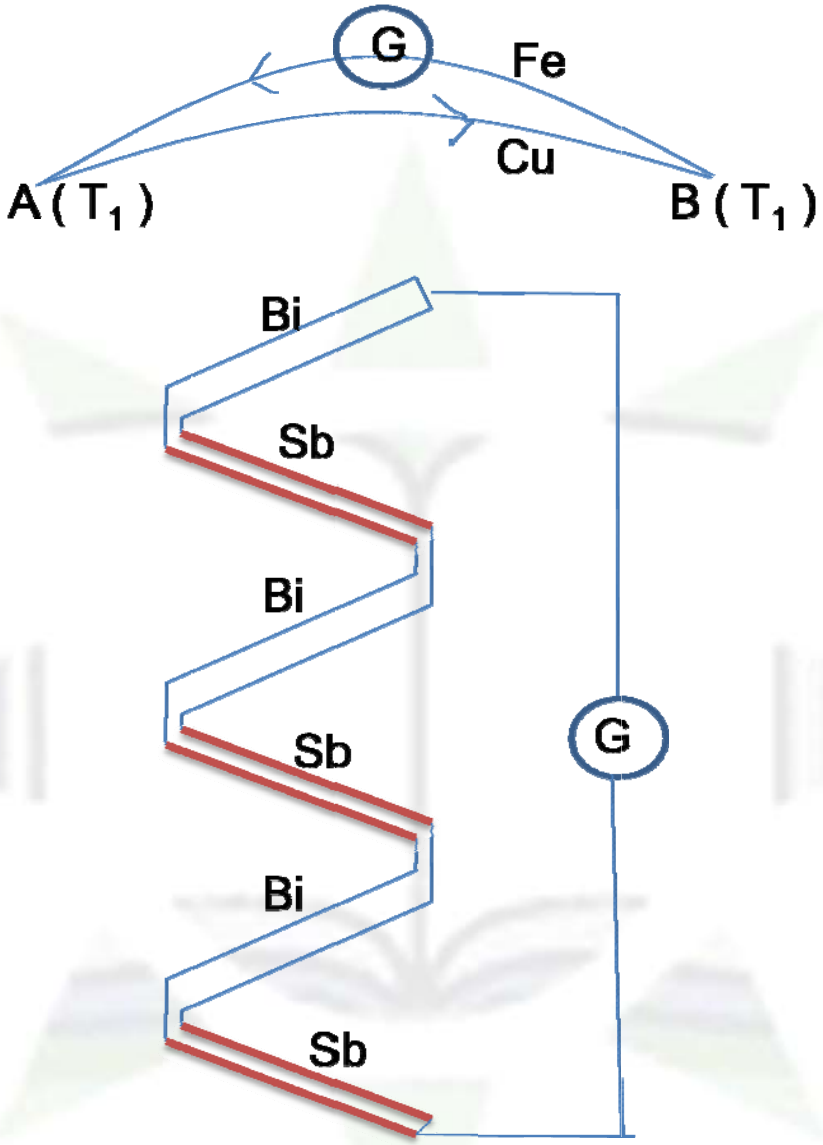
The space between the two walls is highly evacuated. The outer surface of the outer shell is highly polished and the inner surface of the inner shell is painted black. Since the outer surface is polished it reflects back any radiation incident on it. Moreover since the space between the walls is highly evacuated the flow of heat through conduction and convection is also prevented. The radiation to be absorbed is allowed to enter through the small hole and is absorbed by the black surface through multiple reflections.

There is a possibility of small amount of radiation escaping through the hole after reflection through the surface opposite to the hole. But any such possibility is prevented by projecting the surface opposite to the hole in the form of a point.

This black body when used as an emitter of radiation, it is immersed in a suitable temperature bath and the radiation issuing through the hole is used.

Detection and measurement of radiation:

Thermopile: This instrument is based on the thermo electric effect or Seebeck effect.

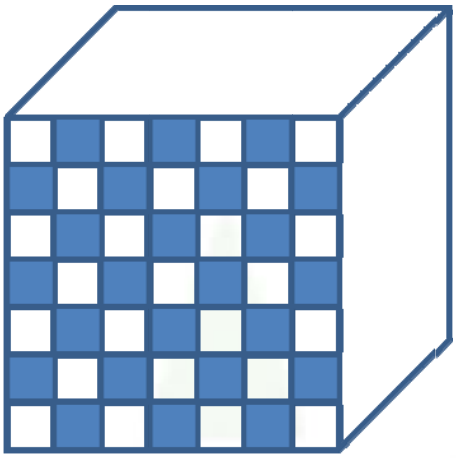


When the junction of two dissimilar metals are kept at two different temperature a current flows through the circuit known as thermo-electric current and the phenomenon is known as Seebeck effect.

Rods of antimony and bismuth are arranged as shown. One set of junctions shielded while the other set of junction is exposed to radiation. The temperature of the two sets of junctions will become different a thermoelectric current flows through the galvanometer.

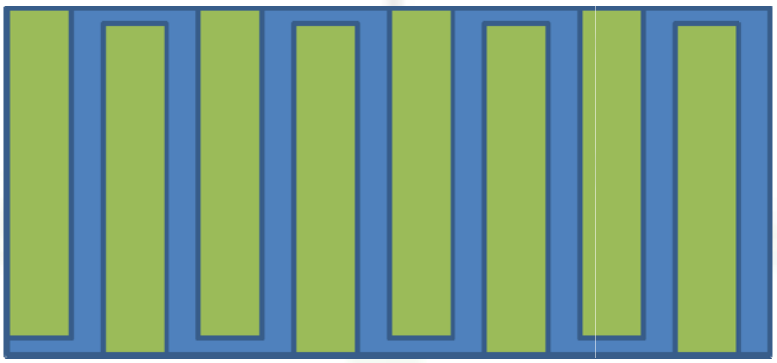
By measuring the deflection the radiation falling on that set of junction can be calculated.

Lesslie cube: An improved form of thermopile is known as Lesslie cube.

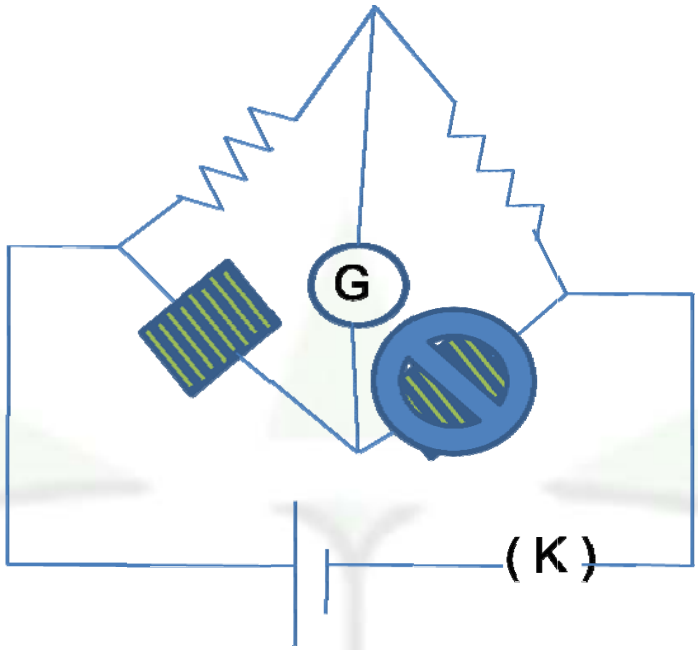


The rods of antimony and bismuth are arranged in a plane with their alternate ends soldered. Many such planes are arranged one over another with a continuity so as to form a cube. All the junctions lie on the two opposite faces of the cube. One of these opposite faces is highly polished and the other is painted black. The polished face is shielded and the blackened face is exposed to the radiation to be measured. The two sets of junctions being at two different temperatures the galvanometer connected between the two diagonal gives a deflection. Measuring the deflection the radiation can be calculated.

(2) **Bolometer**: It is based on the principle of variation of resistance with temperature.



It is based on the principle of variation of resistance with temperature. Thin strips of platinum having a thickness between 1 to 2 x 10^{-3} mm are arranged in series in a non conducting frame slate. So as to resemble a grating or a grid of parallel elements. The strips are painted black so that it can absorb almost all the radiation incident on it. Such an arrangement has a total resistance of about 5 ohm. Since it has a very small mass a very small amount of radiation can raise the temperature appreciably and hence the resistance of the bolometer also increases.



Two such bolometers exactly identical in all respect are connected in the third and fourth arm of Wheatstone bridge. The ratio arms are kept equal. The bridge is balanced one of the two bolometer is shielded and the other is exposed to radiation. Due to radiation incident on it, the temperature and hence the resistance increases the bridge is out of balance, galvanometer gives a deflection. A change in temperature by $0.001^{0}C$ galvanometer gives a noticeable deflection. Measuring the deflection of the galvanometer the radiation incident on the bolometer can be calculated.