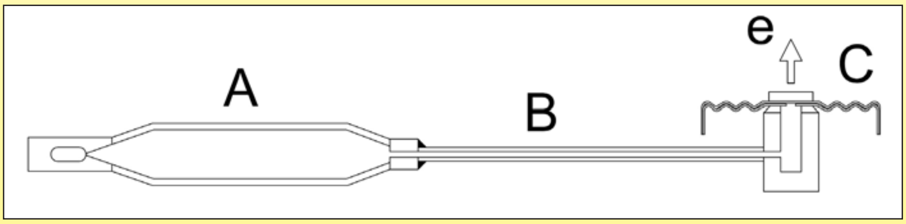
1.3.2 LIQUID METALLOIDS

Metalloids are on the borderline between metals and other materials. In thermostats, are only used sodium and potassium, and especially an eutectic mixture of the two, NaK, which as the interesting characteristic to be liquid in a wide range of temperature, from ambient temperature to over 900°C. It is also an excellent conductor of temperature.
These two characteristics have earned him to be selected as a coolant for nuclear plants.
For temperature measurement, it also has the advantage of having a linear expansion.
Its use in thermostats is relatively recent, and arose with self-cleaning ovens, because it allows devices withstanding high temperatures.
However, it must used in protected devices, without contact with air or water, because it is particularly reactive, flammable or explosive in contact with them.
It is also corrosive and requires special stainless steel diastats.

1.3.3 OILS

Many oils are used. They are always a compromise between a high coefficient of expansion, which allows small bulbs, a boiling point as high as possible, a freezing temperature as low as possible, a good linearity in the range expansion, a good thermal conductivity, and non-toxicity .
Among the most common, we must mention the xylols, oils used in heat exchangers, and silicone oils.
It is now possible to cover with these 3 types of liquids, ranges from -40 ° C to 400 ° C.

1.3.4 The thermal drift (Correction factor) of liquid filled bulb and capillary thermostats



The bulb and capillary thermostats have a closed subassembly called "Diastat".
This diastat, with bulb and capillary made of copper or stainless steel, is composed of 3 parts welded together:
1. The bulb (A), which is the reservoir of the largest portion of the liquid, and witch expansion as a function of temperature will be used to measure it. It is closed at its free end by welding after liquid filling.
2. The capillary (B), whose outer diameter varies depending on the manufacturer and type of thermostat, between 1 mm and 3 mm, which serves to transmit remotely the increase in volume of the liquid in the bulb
3. The bellows (C), consisting of two flexible cups welded together on their edges, having a diameter of 19 to 25 mm (sometimes up to 32 mm on industrial devices), which will convert the increase of the bulb liquid volume into mechanical displacement (e)

These three parts are filled with a liquid under vacuum. The expansion of the liquid, proportional to the temperature increase, causes the displacement "e", which is used to operate an electrical contact.
However, the expansion of the liquid in the capillary (B) and into the bellows (C) is not related to the temperature measured by the sensor (A), but to room temperature in which they are located, and cause therefore a parasite expansion of the liquid and therefore an unwanted mechanical displacement .
The design of a diastat tends to minimize this movement, by limiting the volume of liquid in (C) and (D) by 2 ways:
• By limiting the capillary internal diameter. The minimum diameter is a compromise between the technological possibilities of embodiment of the capillaries, the stresses due to bending of the capillary, and the water pressure losses permissible depending on the viscosity of the liquid used, and the pressure developed by the expansion.
• On the bellows: When filling the diastat, the two membranes forming the bellows are pressed against each other, without gap, and thus only a small amount of fluid can go between them. However the volume of liquid in the bellows increases progressively as the liquid in the bulb (A) expands by the temperature rise. The ratio of the drift therefore not only reports to the initial volume inside the bellow, but increase with the temperatures as this volume increases with the temperature rise on the bulb.

The counterpart of this design of the bellows with a small amount of liquid when filling the diastat is that no mechanical movement is possible below this filling temperature. In assembled thermostats, adjusting the set point is not possible below this temperature at which the bellows is empty. This area below the filling temperature is called "dead zone", and typically corresponds to an area where no temperature is printed on the thermostat knob.
The parasite drift of a bulb and capillary thermostat will be given in the data sheet and expressed in ° C / ° C or ° K / ° K
It depends on the volume ratio between the bulb and capillary + bellows. A large volume bulb is less sensitive to drift, and a short capillary also decreases it.
In the case of fixed temperature high limit thermostat, the small bulbs will lead to a high sensitivity to the ambient temperature on the thermostat body.