depths, protecting them from pressure by enclosing them in strong metal tubes with a top firmly screwed on. This method was extremely uncertain and generally failed. The tube generally came up quite full of water, indicating that it had afforded no protection to the instrument inside it. In some instances Walferdin's thermometer, which is a straight-tubed instrument, and not curved like Six's, was used entirely enclosed in a glass tube hermetically sealed. In this way, of course, complete protection was afforded so long as the glass tube did not collapse.

The method of protection used in the case of the thermometers supplied to the Challenger has been described above. It consists in encasing the true thermometer bulb in another bulb partially filled with liquid to facilitate transmission of heat. The remainder of the space is filled with the vapour of the liquid. Any compression therefore which might be suffered by the outer bulb would produce no rise of pressure in the space between the two bulbs, and would therefore not be transmitted to the inner bulb.

The effect of pressure on a glass vessel is to produce compression and diminution of internal volume while it lasts. When the bulb of a thermometer is compressed and its capacity diminished, the liquid contained in it is squeezed up into the stem, and the top of the column stands higher than it did before, so that the compression of the bulb produces the same effect as a slight rise of temperature.

If now the thermometer be a self-registering one, and it be sunk to a certain depth in a sea of uniform temperature identical with that of the thermometer, the index or recording mechanism will indicate the rise of the thermometric column in the tube due to the compression of the instrument. If the same thermometer, at the same temperature to begin with, be carefully warmed, exactly the same apparent effect will be produced, namely, the thermometric column will rise, and when the temperature has risen to a certain height, it will place the index in exactly the same position as was the case when it was sunk in the sea of uniform temperature. If in the latter case the effect of pressure be neglected, we shall ascribe to the water at the particular depth a temperature higher than the true temperature by the thermometric equivalent of the shift of the index produced by the pressure of the column of water.

It does not require demonstration to show that the apparent effect of pressure on a thermometer will be almost wholly due to its effect on the bulb. The stem suffers compression also, but the apparent effect so produced is negligible compared with that due to the compression of the bulb. Hence when Six's thermometers had to be protected from pressure, it was held sufficient to protect the bulb. There seems to be considerable uncertainty as to who first proposed and carried out the preparation of thermometers with a double bulb, but they were certainly used on board H.M.S. "Cyclops" by Captain Pullen[1] in 1858, and there seems to be good reason for believing that the thermometers used by Sir John Ross in 1818 were protected by the same or some similar device.

[1] *Phil. Trans.*, vol. clxv. pp. 608, 609, 1875.