

the cruise, which agreed fairly well with those made by the protected thermometers. No permanent place was fitted for the galvanometer or apparatus, and in consequence continuous and careful observations were not made.

Dr. Siemens gives, in the paper above cited, an account of some valuable and accurate observations made by one of the instruments on board the U.S.S. "Blake" in 1881. When accurate temperature observations are required from intermediate depths, this instrument is especially valuable, and it will in all probability be extensively used in future deep-sea investigations.

*Sources of Error.*—In Six's instruments there is a possible error from looseness of the indices, in consequence of which they are apt to be shaken out of their places by the jarring of the line. Errors from this source may be avoided to a great extent by attaching the thermometer to the line by means of an elastic or india-rubber "stop." Where the only scale is on a slip attached to the backing of the instrument, and is not engraved on the stem, there is a great liability to error through shifting of the thermometer relatively to the attached scale. Errors from this source are very liable to occur, and are due solely to defective instrument-making. No instrument of this kind should be sent out of the workshop, to be used on such important work as deep-sea investigation, which has not a scale etched on the stem.

The most serious source of error in the results of observations of the temperature of deep water by means of self-registering thermometers, has been the effect produced on them by the hydraulic pressure to which they are subjected at the moment of recording. This was early recognised.

Cavendish, who invented the self-registering thermometer, foresaw also the most important of the uses to which it could be applied. Thus he suggests that the higher regions of the atmosphere might be investigated by attaching it to a kite—balloons not having been then invented. With regard to deep-sea explorations, he says: "If instruments of the nature above described were to be used for finding the temper of the sea at great depths, some alteration would be necessary in the construction of them, principally on account of the great pressure of the water, the ill effect of which can, I believe, be prevented no other way than by leaving the tube open."<sup>1</sup> This was written in 1757, and it was not till 1762 that Canton proved that liquids are compressible. Cavendish therefore hoped that as the pressure would not produce distortion of the glass when the tube was open, it would have no visible effect on the apparent volume of the liquid. The device of leaving the thermometer open at the end was adopted by Aimé in some of his experiments, the effect of pressure on the apparent volume of the liquid being determined independently, and a correction applied accordingly.

Many attempts were made to use Six's and Walferdin's thermometers at great

<sup>1</sup> *Phil. Trans.*, vol. 1. p. 308, 1758.