

vessel *H*. Before entering *H* the gas passed through the cold trap *I* at 4 °K. After most of the gas was transferred into *H*, valve 4 was closed and the gas allowed to warm up and enter the high pressure Toepler pump. From this stage on the procedure was the same as with <sup>4</sup>He. Before filling with the gas the calorimeter and high pressure Toepler pump had to be evacuated. In the case of <sup>4</sup>He the system was pumped for 3 days and then flushed several times at pressures up to 2000 atm with clean <sup>4</sup>He. In the case of <sup>3</sup>He this method could not be followed. The system was therefore first thoroughly flushed with hydrogen in order to avoid contamination with <sup>4</sup>He and then pumped for 11 days. From tests with <sup>4</sup>He and a helium leak detector, this time was known to be sufficient to empty the system adequately.

#### 2.4. Determination of molar volume and mass of sample

The molar volume of the helium samples was not determined directly but inferred from the melting data of Mills & Grilly (1955), and Grilly & Mills (1959). As the samples were held at constant volume melting took place over a finite temperature interval. The temperature at the beginning of the melting range,  $T_m$ , was obtained by taking heating curves. A well pronounced kink in the curve of temperature against time was observed which allowed  $T_m$  to be estimated to within 0.002 degK. From this temperature the pressure at the beginning of melting,  $p_m$ , and the molar volume  $V$  could be calculated using the data of Mills & Grilly.

For the measurements on <sup>4</sup>He the mass of the sample was obtained in the following way. After completion of the heat capacity measurements the high-pressure Toepler pump was disconnected at valve 3 (figure 4) and the low-pressure Toepler pump connected to this valve. The gas filling the calorimeter and the dead space up to valve 3 was then transferred quantitatively by means of the Toepler pump to a stack of calibrated volumes *K*. The volumes *K* (roughly 0.6, 1.2 and 2.4 l.) had been calibrated by weighing with water. They were immersed in a water bath whose temperature could be determined to about 0.01 degK. The pressure in *K* was read on the constant volume manometer *L* to better than 0.1 mm using a cathetometer. The mass of helium gas was determined from the  $p$ - $V$ - $T$  data given by Keesom (1942) after due corrections for dead space had been applied. The dead space consists of the two high-pressure capillaries *D* and *E* (0.016 cm<sup>3</sup>), the Bourdon gauge *F* (0.058 cm<sup>3</sup>), and the calorimeter side of the closed valve 3 (0.0018 cm<sup>3</sup>). The whole dead space correction is approximately 2.3% and is estimated to be known to better than 15%. The accuracy of the mass determination is estimated at 0.5%.

From the mass determination and the molar volume  $V$ , the volume  $v$  of the high-pressure cell could be calculated. The results for  $v$  (about 1.46 cm<sup>3</sup>) obtained in this way showed a slightly increasing cell volume with increasing pressure which agreed with the elastic data for drill rod steel. The average deviation of  $v$  found in the four <sup>4</sup>He experiments from a straight line is 0.2%.

In the case of <sup>3</sup>He it was not thought feasible to transfer the cell content after each measurement to the calibrated volumes. The mass of the samples was instead calculated from the molar volume  $V$ , obtained as described above, and the cell volume  $v$ , obtained from the measurements on <sup>4</sup>He as described.