A Cylindrical Thermal Conductivity Cell for Gases at Pressures to 3,000 Atmospheres†

By Professor E. W. Comings, B.S.Ch.E., Sc.D., A.I.Ch.E., A.Ch.Soc.,*
W. B. Lee, B.S.Ch.E., M.S.Ch.E.* and F. R. Kramer, B.S.App.Ch., B.S.Ch.E., A.Ch.Soc.*

INTRODUCTION

MEASURED VALUES of the thermal conductivity of gases at elevated pressures are needed in equipment and process design and they are of interest in connexion with the development of the theory of intermolecular action and transport. Recent measurements have shown wide deviations from predicted behaviour especially in the critical region (Leng and Comings 1957, Lenoir and others 1953)‡ and with gas mixtures (Junk and Comings 1953). The behaviour becomes more complex as the molecular structure becomes more complex. The critical region for mixtures extends to much higher pressures (Comings 1956) than for pure compounds.

APPARATUS

A thermal conductivity cell of relatively simple design has been constructed to operate at pressures up to 3,000 atm. and at temperatures up to about 400 deg. F. The thermal conductivity cell is contained in the cavity of a high-pressure vessel constructed of SAE 4340 steel. The cavity is large enough to hold the cell with a clearance of about ⅜ inch thick annulus. The vessel closure is fitted with six electrical leads and with a connexion for admitting the gas under test to the cavity. An additional electrical lead passes through the body. The high-pressure vessel is completely immersed in a constant-temperature oil bath.

A diagram of the cell is shown in Fig. 5.5. Heat flows outward radially from a central copper cylinder B, across a thin layer of the test gas and into a copper cylinder C or C'. Two interchangeable outer cylinders are used to provide two thicknesses of gas layers, about 0·006 and 0·009 inch respectively. B and S gauge 32 platinum wire, 0·00795 inch diameter, is wound in spiral grooves in the solid cylinder A. A high-temperature cement surrounds the wire and fills the grooves. Cylinder A is inserted through a hole in cylinder B. The platinum wire serves as both a heating element and a resistance thermometer. B and S gauge 38 platinum wires 0·0040 inch in diameter are wound in spiral grooves around the outside of cylinders C and C' in the same manner as for cylinder A. These wires serve as resistance thermometers. Heat flows from the cylinders C or C' to the body of the pressure vessel through corrugated aluminium sheet (1/32 inch) arranged as shown in Fig. 5.6.

Axial heat flow from the inner cylinder B is reduced to a negligible proportion of that from the heating wire

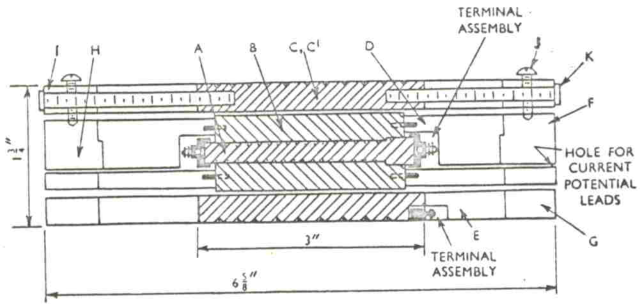

Fig. 5.5. Thermal Conductivity Cell

A, B, C, C' Copper cylinders.
D Solid disks of '400' Supra mica.
E Rings of moulding compound.
F, H Copper end pieces.
G, I Copper ends.
J Set screws.
K Steel bolts.

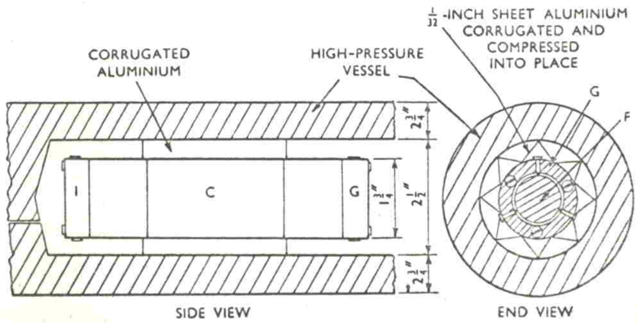

Fig. 5.6. Final Assembly

The MS. of this paper was received at the Institution on 30th January, 1957.
This paper was presented during Session 5 of the Conference. Discussion on this paper appears on p. 211.
* *Purdue University, Lafayette, Indiana, United States of America.*

‡ *An alphabetical list of references is given in Appendix 5.II.*