ALTHOUGH presenting comments of general interest, neither Dingle nor Warren (preceding communications) have referred to the particular point of our note[1].

The mathematical relation[1]:

$$T = e^{\psi} \qquad (1)$$

where $\psi = \int g(\theta)\, d\theta$ (see ref. 1), while e^{ψ} itself represents the specific integrating factor depending on the temperature[2,3], inherently (in accordance with Caratheodory's statement of the Second Law of Thermodynamics[4]) shows that $T = 0°$ K if the independent variable, $\psi = -\infty$. It follows that the absolute zero, $T = 0°$ K, necessarily is an unattainable limit in the linear Kelvin temperature scale as shown at once by the asymptotic behaviour of its own explicit argument, the specified integrating factor e^{ψ} ($\psi = -\infty$).

This conclusion is reached without recourse to Thomson's (Lord Kelvin's) proposed temperature scale[5] or, for that matter, to the already known classical thermodynamic methods as given by Warren (preceding communication and ref. 5).

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Shock Wave Compression of 'Plexiglas' in the 2·5 to 20 Kilobar Region

PRECISE data concerning the Hugoniot equation of state for polymethyl methacrylate ('Plexiglas', 'Lucite' polymers, and 'Perspex') are lacking at pressures below 20 kbar. Accurate dynamic data in this pressure region are helpful when the polymer is used as an attenuator material for forming shocks in the lower pressure region, and in general are necessary to understand its rheological behaviour under the high strain-rate conditions of shock compression. Solid materials customarily exhibit shock instability at pressures somewhat larger than the yield stress in uniaxial strain. This instability gives rise to an 'elastic precursor' wave front preceding the main shock front[1]. Such a structural wave might be expected in 'Plexiglas' since an indication of a yield zone was found in the vicinity of 2 kbar in measurements of the static linear compressibility by the method of Hughes and Maurette[2], and it is of interest to know if it does occur.

The dynamic compressibility of 'Plexiglas' in the range from 2·5 to 20 kbar was studied using the wedge and optical lever technique described by Fowles[3]. The experimental arrangement is shown in Fig. 1. The explosive adjacent to the specimen, detonating with velocity U_D, induces a shock which decays with distance from the explosive-'Plexiglas' interface, thus permitting collection of data through a range of pressures in one experiment. Care is taken to ensure that the specimen is long enough, so that the shock is steady during measurements. Shock velocity and associated free-surface velocity are measured simultaneously. A relation between free-surface velocity and material velocity before reflexion enables one to calculate the stress component normal to the shock front and corresponding compression by means of the shock jump conditions expressing conservation of mass and momentum[4]. Reference is made to Fowles[3] for details of the measurements and their reduction to values of shock velocity U_s, material velocity u_p, stress P, and shocked volume, V.

Cast 'Plexiglas', determined by photoelastic examination to be freer of structure and residual strain than extruded or moulded material, was used. The initial density,

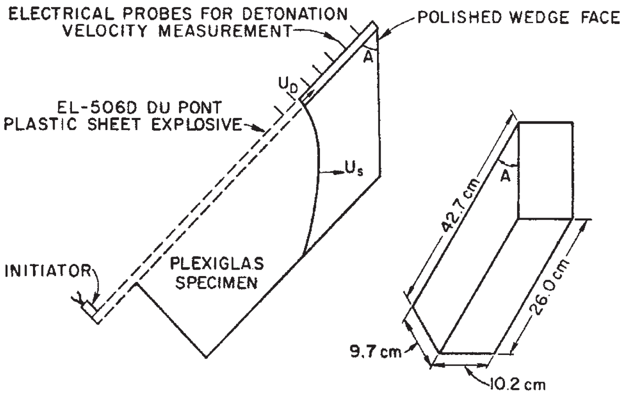

Fig. 1. Side view of experimental arrangement

$1/V_0$, was 1·18 g/cm³. Two experiments, with different explosive thicknesses, were required to cover the pressure range, and a region of overlap gives a check on reproducibility. The results are shown in Table 1. Fig. 2 shows the record from the shot yielding data over the range 6·5 to 19·0 kbar. No structured wave was observed in either shot within the resolution of the system, which was such that a 0·03-kbar step could be detected.

Table 1. SUMMARY OF EXPERIMENTAL DATA

Pressure P (kbar)	Shock velocity U_s (mm/μsec)	Material velocity u_p (mm/μsec)	Compression V/V_0	Pressure P (kbar)	Shock velocity U_s (mm/μsec)	Material velocity u_p (mm/μsec)	Compression V/V_0
2·5	2·900	0·073	0·975	6·5	3·080	0·176	0·943
2·7	2·940	0·077	0·974	7·0	3·097	0·189	0·939
3·0	2·980	0·086	0·971	8·0	3·121	0·215	0·931
3·5	3·025	0·098	0·967	9·0	3·143	0·240	0·923
4·5	3·070	0·125	0·959	11·0	3·177	0·291	0·908
5·5	3·101	0·150	0·952	13·0	3·204	0·343	0·893
6·5	3·130	0·176	0·944	15·0	3·228	0·394	0·878
7·5	3·157	0·202	0·936	17·0	3·250	0·446	0·863
8·5	3·183	0·228	0·928	19·0	3·270	0·488	0·851

Shot No.:	9,652	9,653
Wedge angle A:	29° 56′	30° 0′
Explosive thickness:	0·457 mm	1·270 mm

Fig. 3 is a plot of shock velocity as a function of material velocity for each shot. The difference between points in the two shots over the region of overlap is within the limits of experimental precision, ±1 per cent in shock velocity and ±5 per cent in material velocity, and the dashed line representing the average is taken as the curve of U_s plotted against u_p. Two values for acoustic velocity are shown—2·68 mm/μsec (ref. 5) and 2·77 mm/μsec, the latter measured by us, using the method of Goettleman[6]. The Hugoniot, that is, the pressure-volume, curve is plotted in Fig. 4, along with Bridgman's hydrostatic isothermal data[7]. The precision, calculated from that for U_s and u_p, is ±0·3 per cent in V/V_0 and ±5 per cent in P.

The stress difference between the Hugoniot and the isotherm is seen to reach a maximum of about 3 kbar at

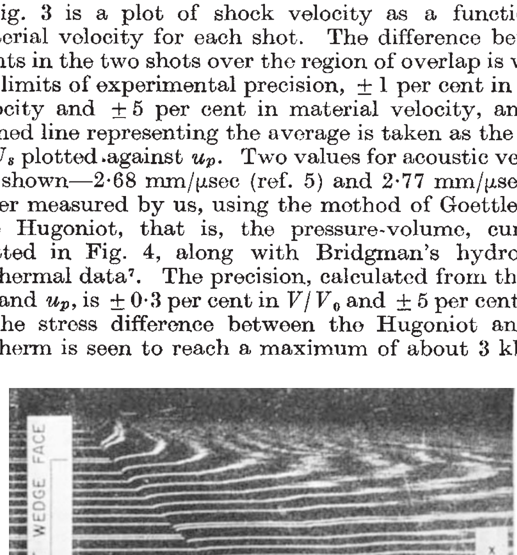

Fig. 2. Smear camera photograph of shot covering pressure range 6·5 to 19·0 kbar