circular polarization; the deviation of the spot on the scale is therefore doubled.

The experiments give no more than the order of the torque of the waves, chiefly because the value of the Poynting vector is rather uncertain. Moreover, as the absorbing screens have a size comparable with the wave-length, diffraction, non-uniformity in the distribution of currents and phase differences are perturbing factors in the measurements. From a qualitative point of view, however, the agreement with the theory is complete; the rotations of the moving systems were ample and very stable, so that we may safely infer that circularly polarized electromagnetic waves possess angular momentum.

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March 4.

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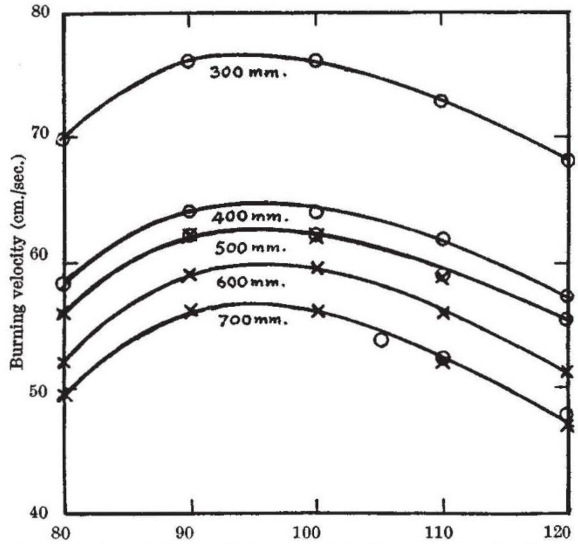
## Effect of Pressure on Burning Velocity

THE measurement of burning velocity is important in providing results for testing the various theories of flame propagation[1–4]. Linnett and Wheatley[5] have recently reviewed the earlier work on the effect of pressure on burning velocity, and from this and from their own experiments on ethylene–air mixtures conclude "that burning velocities are affected by pressure and that, for some hydrocarbons, as the pressure is lowered the burning velocity increases". However, some of the earlier results quoted have been obtained by methods which suffer from several defects, as pointed out by Sherratt and Linnett[6]; and the results of Garside, Forsyth and Townend[7] on ethylene–air mixtures, also quoted by Linnett and Wheatley, show no progressive change in burning velocity with decrease in pressure. On the other hand, recent work by Badin, Stuart and Pease[8] on flames of nitrogen–oxygen–butadiene 1,3 and helium–oxygen–butadiene 1,3 at atmospheric and reduced pressures has shown an increase in burning velocity with reduction in pressure to 300 mm. of mercury; a decrease for the helium mixture was observed as the pressure was further reduced.

We have recently developed a new procedure for evaluating burning velocities from the shadow and direct photographs of a flame[9], and we have used this to study benzene–air flames at pressures below atmospheric. The accompanying diagram shows the burning velocity–mixture composition curves at various pressures and for two diameters of burner. For the two burners, of 1·0 and 1·27 cm. diameter, the values of burning velocity down to a pressure of 400 mm. of mercury are in good agreement, suggesting that the effect of burner diameter does not become important within this pressure-range, although it may be important when a greater reduction of pressure is made.




Mixture strength (per cent air required for theoretical combustion)
×—×—, Burner diam. 1·0 cm.; O—O—, burner diam. 1·27 cm.

It can be seen from the diagram that there is an increase of burning velocity as the pressure is reduced, and the results from 700 mm. to 400 mm. of mercury agree well with the prediction of Tanford and Pease that the burning velocity should vary inversely as the fourth root of the pressure.

The present work is to be extended to other hydrocarbons using burners of increasing diameter as the pressure is reduced. The results so far obtained, however, are in substantial agreement with the conclusions of Linnett and Wheatley.

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Two recent communications in *Nature*[1,2] have discussed the effect of pressure upon burning velocity and have referred to the square root law of Tanford and Pease[3] as leading "to the inverse fourth root law for the variation of velocity with pressure". This statement is not strictly true. The square root law, after a number of simplifying assumptions, predicts that the burning velocity should vary with pressure as the square root of $\Sigma x_i/B_i$, where $x_i$ is the mol fraction of an active species at the equilibrium surface, and $B_i$ is a factor previously defined[4], which is comparatively invariant with pressure. Where hydrogen atoms carry most of the burden of energy transfer into unburnt gas, we should expect $x_H$ to vary approximately as the inverse square root of the pressure, and, hence, roughly an inverse fourth root variation of burning velocity. For precise calculation, however, equilibrium computation of the $x_i$ is required. One mixture for which such a calculation has been made is stoichiometric butadiene – air[5]. The calculated burning velocity ratio for one atmosphere as against half an atmosphere pressure was found to be 0·88, as compared to a fourth root value of 0·84. Thus, as Gaydon and Wolfhard[6] point out, the burning velocity may decrease with pressure less sharply than a fourth-root relation would predict.