depending linearly on the quantum number n.

For an energy E greater than D, the classical motion found from (3) is

$$ax = \log[\{\cosh\theta\cosh(2\pi\nu_0 t\sinh\theta) - 1\}/\sinh^2\theta)]$$

where now $\cosh^2\theta = E/D$. This non-oscillatory motion corresponds to dissociated states. The intermediate case $E = D$ gives classically

$$ax = \log\tfrac{1}{2}\{1 + (2\pi\nu_0 t)^2\}$$

This classical picture may usefully supplement the quantum-mechanical results.

N. B. Slater

Department of Mathematics,
The University, Leeds.
Sept. 2.

[1] Morse, P. M., *Phys. Rev.*, **34**, 57 (1929).

Prediction of Critical Temperatures

In cases where critical temperatures are unknown they can be calculated from a number of empirical or semi-empirical formulæ[1], the simplest but least-accurate being Guldberg's rule. More accurate equations exist for estimating values for hydrocarbons, for example, those of Jatkar and Lakshminarayanan[2] and Watson[3], but these are unsuitable for use with phenolic and basic organic compounds which occur in coal tar.

The critical temperatures of fourteen paraffins, twenty-five aromatic hydrocarbons, four phenols and seven organic bases[4–6] have been correlated in these laboratories with the boiling point and density of the respective compounds[7,8] by the method of least squares. As a result it was found that the following equation predicts values in the range 260–530° C. with an accuracy of ±20·8° C., that is, with an average of ±5 per cent, with 95 per cent confidence:

$$t_c = 221{\cdot}6 + 1{\cdot}029\ t_b\ d_{20}$$

where t_c is the critical temperature (°C.), t_b is the boiling point (°C.), and d_{20} is the density at 20° C. (gm./ml.). (In the case of solids, liquid values were extrapolated back to 20° C.)

The major discrepancies are given by five hydrocarbons the omission of which reduces the limits of error to ±14·2° C.

D. K. H. Briggs
W. D. Drake

Research Laboratories,
Coal Tar Research Association,
Oxford Road,
Gomersal, Leeds.

[1] Partington, J. R., "An Advanced Treatise on Physical Chemistry", 646 *et seq.* (Longmans, Green and Co., London, 1949).
[2] Jatkar, S. K. K., and Lakshminarayanan, D., *J. India Inst. Sci.*, **28**, A, 1 (1946).
[3] Watson, K. M., *Indust. Eng. Chem.*, **23**, 360 (1931).
[4] "Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds", A.P.I. Research Project 44 (1953).
[5] Doss, M. P., "Physical Constants of the Principal Hydrocarbons" (The Texas Co., New York, 1943).
[6] Ambrose, D., and Grant, D. G., *Trans. Farad. Soc.*, **53**, 771 (1957).
[7] Coal Tar Research Association, "The Coal Tar Data Book" (Gomersal, C.T.R.A.).
[8] Egloff, G., "Physical Constants of Hydrocarbons" (Reinhold Pub. Corp., New York, 1946).

X-Ray Microscopy of Human Dental Pulp Vessels

Microradiographic studies of the human dental pulp vessels were prompted by the inadequate anatomical information on the pulpal vascular patterns, and by the statement that these vessels could not be visualized radiographically[1]. However, it has been shown that fine-contrast media of particle size 0·1–0·5μ (for example, 'Thorotrast', 'Micropaque') can be introduced by suction injection into the human dental pulp vessels and their vascular patterns demonstrated microradiographically[2].

Good results have been obtained by contact microradiography using a standard Philips 'Norelco' X-ray diffraction tube and an Ehrenberg–Hilger microfocus tube, with an effective focal spot of 1 mm. and 0·04 mm. respectively. The contact method, however, is limited partly by the size of the X-ray source and the grain-size of the recording emulsion, while the resolution cannot exceed that of the optical system used for enlarging the X-ray negative.

Recently better resolution and contrast, with consequently sharper image definition of all the vessels in the dental pulp, have been obtained by the projection method, using the X-ray projection microscope developed by Cosslett and Nixon[3]. The marked primary magnification (up to × 200 or higher) obtainable with this instrument, coupled with the high resolution afforded by its point source of X-ray emission (less than 1μ), makes it possible to image the smallest capillaries within the human tooth with great clarity.

This X-ray microscope has distinct advantages over the optical microscope in such dental studies by virtue of its penetration and depth of field. Its great focal depth results in all parts of the specimen being in focus, and permits the taking of stereomicrographs by shifting the specimen laterally between two exposures.

A section of human dental (bicuspid) pulp imaged in juxtaposition to a piece of 1,500 mesh silver grid,

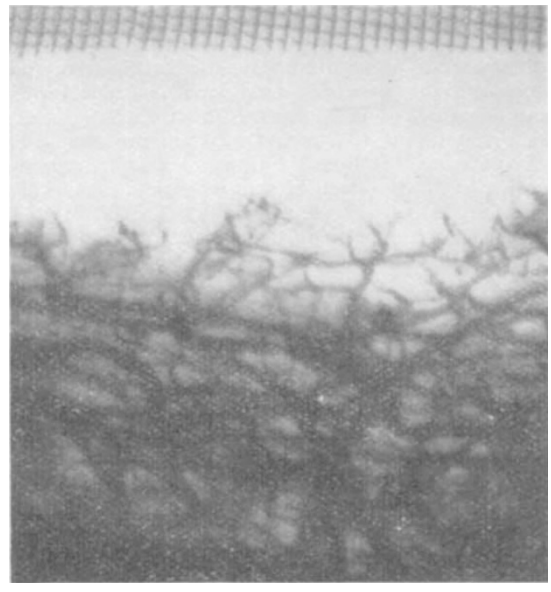

Fig. 1. X-ray micrograph of human dental pulp showing the capillaries of the subdentinal plexus imaged with 1,500 mesh silver grid