bc in b gives the maximum apparent supervelocity D_2'. The slope of the asymptote Oc' to the curve bc gives the steady high velocity D_2. If R denotes the radius of the charge, z_b and z_o ordinate values according to Fig. 1, $n = D_2/D_1$ and $m = D_2'/D_2$, we get $z_b = R\sqrt{m^2 - 1}$, $z_o = z_b\ (1 - m/n)$ and $t_b = (z_b - z_o)/D_1$.

Fig. 2 shows a streak camera photo of a charge of gelatinized ammonium dynamite with 35 per cent nitroglycerine/nitroglycol (1 : 1). It was initiated by a donor charge of the same explosive detonating with high velocity. Both charges were in a common tube of 'Plexiglass' with 36 mm. interior and 40 mm. exterior diameter separated by an air gap of 40 mm. The transition point was 27 mm. from the end of the receiver. From Fig. 2 we get: $D_1 = 3{,}030$ m./s., $D_2 = 5{,}760$ m./s. and $D_2' = 7{,}350$ m./s. This gives $n = 1{\cdot}89$, $m = 1{\cdot}28$, $z_b = 22{\cdot}5$ mm., $z_o = 7{\cdot}3$ mm. and $t_b = 5{\cdot}0$ µs.

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Damped Free Oscillations of a Gyroscopic System

THE equations of motion of a gyroscopic system consisting of a symmetric rotor of axial moment of inertia C mounted in heavy gimbals are:

$$\left.\begin{aligned} A\ddot{\theta}_1 + c_1\dot{\theta}_1 + Cn\dot{\theta}_2 &= 0 \\ -Cn\dot{\theta}_1 + B\ddot{\theta}_2 + c_2\dot{\theta}_2 &= 0 \end{aligned}\right\} \quad (1)$$

where n is the constant angular velocity of the rotor about its axis; θ_1 and θ_2 are small angles denoting rotations about the outer and inner gimbal axes respectively; c_1 and c_2 are the corresponding coefficients of viscous friction; A is the moment of inertia of the entire system about the outer gimbal axis and B that of the inner gimbal plus rotor about the inner gimbal axis. These equations are based on three principal assumptions: (1) the centres of mass of the rotor and of the gimbals lie at the intersection of the gimbal axes, (2) the axis of the rotor is nearly perpendicular to the axis of the outer gimbal, and (3) the axes of rotation are principal axes of inertia. If there is no friction at the gimbal axes, equations (1) define a free, undamped oscillation in which the rotor axis performs a conical whirl about its central position and the gimbals vibrate at frequency $p = Cn/\sqrt{AB}$.

Now it is well known that friction normally reduces the frequency of free vibrations of an oscillatory mechanical system. The gyroscopic motion defined by equations (1), however, provides an exception to the rule, as may be seen by eliminating θ_2 from (1). This gives

$$\dddot{\theta}_1 + \left(\frac{c_1}{A} + \frac{c_2}{B}\right)\ddot{\theta}_1 + \left(\frac{c_1c_2 + C^2n^2}{AB}\right)\dot{\theta}_1 = 0 \quad (2)$$

Equation (2) represents a damped free oscillation the frequency, p_d, of which is:

$$p_d = \sqrt{\left[\frac{C^2n^2}{AB} - \frac{1}{4}\left(\frac{c_1}{A} - \frac{c_2}{B}\right)^2\right]} \quad (3)$$

Thus the frequency of the damped oscillations will normally be less than that of the undamped oscillations. However, when:

$$\frac{c_1}{A} = \frac{c_2}{B} \quad (4)$$

an exceptional and interesting case occurs, for then p_d is independent of both c_1 and c_2. This condition might easily arise in practice. Even if it were only approximately true, the decrease in frequency due to damping would still be very small: it would, for example, be considerably less than that associated with a conventional system having a single degree of freedom.

It is also interesting to note that if (4) is satisfied, the motion can never be critically damped and must remain oscillatory, even although the damping coefficients and hence the rate of decay of oscillations may become very large.

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CHEMISTRY

Precision and Accuracy in Gas Chromatographic Analysis

THE extensive use of gas chromatography to provide quantitative information on the composition of mixtures of organic compounds has prompted an investigation designed to give some indication of the reliability expected. With the exception of the gas density balance, the commonly used detectors do not give a response which can be predicted accurately from the physical or chemical properties of the compounds concerned, so that for highest accuracy calibration is necessary. The development of high-sensitivity detectors has made possible the achievement of high column performance by virtue of the smaller sample loads used, but since reproducible loading becomes more difficult the use of internal standards becomes desirable.

The most widely used high-sensitivity detector is the argon ionization detector devised by Lovelock[1], which combines very high sensitivity with a high degree of stability to changes in rate of flow of gas, temperature and pressure. The linear range of the detector at any given applied voltage is limited but adequate, and a wide dynamic range is achieved by change of applied voltage.

The argon detector in its present form is of robust construction, and when used with suitable power supply and electronic circuitry is capable of giving very accurate and reproducible results. Experience shows that the major cause of detector malfunction is through contamination of the argon carrier gas with either organic or inorganic substances.

Quantitative results obviously rely on the proper functioning of the detector, and a knowledge of the way in which accuracy and reproducibility can be affected is essential.

Organic contamination of the argon entering the detector causes an increase in the background current. Superimposition of a chromatographic peak on this background could result in the observed response extending into the non-linear region. Variation in the level of organic contamination produces a variation in the detector background