

LETTERS TO THE EDITOR

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A CHALLENGE TO MATHEMATICIANS

HERE is a problem which I wish to offer as a challenge to mathematicians, especially those who deem themselves so superior that they will not touch anything in elementary mathematics even with a broken rod. But the great mathematical philosopher, A. N. Whitehead, has said that elementary mathematics is one of the most characteristic creations of modern thought by virtue of the intimate way in which it correlates theory and practice. I now come to my problem for which I require a strictly *non-visual proof*, a proof which should make the least appeal to intuitive relations perceived by the physical eye.

*Problem:* Two intersecting straight lines (or planes) and a point not incident on either of them are taken in a plane (or space). Show that the line joining the feet of the perpendiculars from the point to the straight lines (or planes) subtends at the given point an angle which is always the supplement of that angle between the two straight lines (or planes) in which the given point lies.

If a figure is drawn or a model is prepared, the property becomes visually evident but real mathematics does not and should not seek the help of the eyes of the body but the eye of the mind. An algebraic identity is not true because you can write it down and see it.

Will mathematicians take interest in the above little problem which is very useful in

settling angular ambiguities which teachers glibly pass over in their routine teaching?

Mysore,  
 July 30, 1948. A. A. K.

EFFECT OF INCREASING FREQUENCIES ON THE ULTRASONIC DIFFRACTION PATTERNS

DAVID,<sup>1</sup> basing himself on Brillouin's work, has developed a theory which leads to the following expression for  $I_{\pm}$ , the intensity of the +1 or -1 order diffraction line in the case of normal incidence.

$$I_{\pm} = I_m \left[ \frac{\sin \frac{\pi \lambda L}{2 \mu_0 \lambda^{*2}}}{\frac{\pi \lambda L}{2 \mu_0 \lambda^{*2}}} \right]^2$$

$\lambda$  is the wavelength in vacuum of light that is being diffracted,  $\lambda^*$  is the wavelength of sound or the grating element in the liquid,  $\mu_0$  is its refractive index and L is the length of the sound field.  $I_m$  stands for the maximum intensity of this line, which occurs when the obliquity of the sound wave front is such that the diffracted ray is emerging in a direction which corresponds exactly to that of Bragg reflection. This condition is attained for the first order lines when the tilt angle  $\theta$  is  $\sin^{-1} \lambda/2\mu_0\lambda^*$ . It is easily seen from the above ex-

pression that for a given  $\lambda$ ,  $L$  and  $\mu_0$ ; increasing sound frequency which means a decreasing value of  $\lambda^*$  will result in a rapidly diminishing value for  $I_{\pm}$  because the numerator within the brackets never exceeds unity while the denominator, containing  $\lambda^*$  in its fourth power, goes on increasing. Thus the angular range in which the diffraction lines persist goes on diminishing, the lines themselves being steadily weakened in the normal incidence position until they disappear altogether for the first time when  $\lambda^*$  is such that the relation  $\lambda L/2\mu_0\lambda^{*2} = 1$  is satisfied. This is an important result. A revival of intensity for still lower values of  $\lambda^*$  is indicated but this will be so small that lines, if they reappear, will be of very feeble intensity. They will again disappear when  $\lambda L/2\mu_0\lambda^{*2} = 2$  and thereafter it should be extremely difficult to observe the patterns at all.

The same result may be obtained in a different manner. Raman and Nagendra Nath,<sup>2</sup> starting from very simple considerations, concluded that the diffraction effects will periodically disappear, as the obliquity  $\theta$  of the sound wave front from the position of normal incidence takes values successively equal to  $\tan^{-1}n\lambda^*/L$  with  $n = \pm 1, \pm 2, \pm 3$  and so on,  $n=0$  being excluded. This is due to the fact that a plane light wave front entering the liquid under such conditions emerges without any corrugations in it. It is obvious that such a destructive effect will take its full toll of the diffraction pattern if it occurs for the first time at an obliquity which is the same as would otherwise have given rise to a maximum intensity for the first order diffraction line. In other words, if  $\lambda^*$  has become low enough to satisfy the condition  $\tan^{-1}\lambda^*/L = \sin^{-1}\lambda/2\mu_0\lambda^*$ , there will appear no diffraction spectra even in favoured positions, not to speak of normal incidence. If we are dealing with small angles the above condition reduces to  $\lambda L/2\mu_0\lambda^{*2} = 1$ . In practice, however, there may be small remnant intensities in narrow angular ranges roundabout the appropriate obliquities. As in the previous case, a feeble revival of intensity is indicated for still smaller values of  $\lambda^*$ , but conditions favourable for total destructive interference again occur when  $2\lambda^*/L = \lambda/2\mu_0\lambda^*$  which is the same  $\lambda L/2\mu_0\lambda^{*2} = 2$ . Thereafter it should be extremely difficult to observe the patterns at all.

For  $\lambda = 5400 \times 10^{-8}$  cm.;  $L = 8$  mm.;  $\mu_0 = 1.333$ ;  $\lambda^*$  satisfying the above conditions comes out as 0.004 cm. and 0.0028 cm. corresponding to frequencies of 37 and 53 Mcs./sec. in water. Experiments, specially designed to cover the high frequency regions, have yielded results which are in agreement with the above conclusions. At 50 Mcs./sec., the first order diffraction lines in water could be recorded faintly in normal incidence. In that position, they are not obtained at all, if sound frequencies in the range 100 to 200 Mcs./sec. are used.<sup>3</sup>

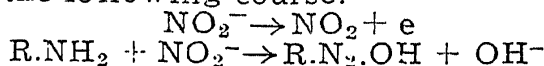
Andhra University,  
Waltair, July 27, 1948.

S. BHAGAVANTAM.

## THE ELECTROLYTIC PREPARATION OF ROCCELIN

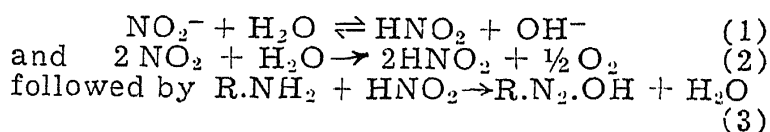
THE electrolytic preparation of azo-dyes was first carried out by Löb.<sup>1</sup> Löb claimed to have prepared, by electrolysis molar proportions of an amine, a suitable coupling component, usually a phenol, and sodium nitrite in a neutral or alkaline medium at a platinum anode with vigorous stirring, the dyes Roccelin, Orange II, Congo red, Chrysamine G and Di-anisidine blue. Löb does not give experimental details or yields or describe the quality of the dyes prepared by this method. Brockman and Griffin<sup>2</sup> confirm Löb's results so far as the dyes Roccelin and Orange II are concerned but report that they were unable to prepare Congo red and Chrysamine G as claimed by Löb. Brockman and Griffin state the yield of the dye Roccelin to have been quantitative with over 95% current efficiency.

This claim is open to doubt, in view of the mechanism proposed for the reaction. Löb, who discovered the reaction, suggested that it took the following course:



The diazo-compound would then couple in the usual way with the phenol or other coupling component to give the dye.

Glasstone, in a review<sup>3</sup>, proposes a somewhat different course:



Though this is not stated by Glasstone, Eq. 2 evidently involves the action of discharged nitrite ions. It will be seen that in either scheme of reaction the discharge of nitrite ions is a necessary step in the formation of the diazo-compound. However, the reaction can be carried out only in a neutral or alkaline medium, for obvious reasons. The reaction represented by Eq. 1 in Glasstone's scheme would be shifted to the left in an alkaline solution, and at the same time, hydroxyl ion discharge is likely to predominate over nitrite ion discharge at the anode, on account of the very high mobility of the hydroxyl ion and its lower discharge potential. The first stage of the reaction, that is the diazotisation of the amine, can therefore never take place with 100% current efficiency in any event. Apart from this, the second stage, namely the coupling of the diazo-compound with the coupling component depends both on the rate of diazotisation of the amine and on the alkalinity of the reaction medium.<sup>4</sup> When a naphthol is the coupling component, the medium is generally kept alkaline though not excessively so. Brockman and Griffin have carried out the electrolysis in neutral solution which means that in the course of electrolysis the vicinity of the anode would have become distinctly acid, so that the coupling reaction would be slowed down. The result would be a drop in the current efficiency, and the yield of dye would be far less than that claimed by Brockman and Griffin.

1. *Physikal. Z.*, 1937, 38, 537. 2. *Proc. Ind. Acad. Sci.*, 1935, 2, 413. 3. *Nature*, 1948, 161, 927.