such a way that no resonant circuit could have been formed with a natural wave-length greater than about 1 metre at most. There were no high-frequency choke coils in the circuit which might have led to uncertainty in this respect. Bridging or earthing the filament leads through condensers gave the same result, although the energy picked up by the wave-meter appeared to be radiated mainly from this part of the circuit.

While it remains open to question whether the conclusions stated at the end of the first paragraph are necessarily true of all modes of electronic oscillation, it is at least clear that there is no fundamental reason to doubt their general validity.

E. C. S. MEGAW.

Research Laboratories,
General Electric Company, Ltd.,
Wembley.
Dec. 12.

¹ *J. Inst. Elec. Eng.*, **72**, 313 (1933).

² *M. v. Ardenne, Naturwiss.*, **22**, 561 (1934).

³ *Phys. Z. Sowjetunion*, **1**, 768 (1932).

Limits of Inflammability of Hydrogen and Deuterium in Oxygen and in Air

In the course of a study of the propagation of flame in mixtures of hydrogen with air and with oxygen, a comparison has been made between the limits of inflammability of deuterium and of hydrogen at atmospheric pressure. The determinations were made in a small vessel, 22 mm. in diameter and 45 cm. long. The deuterium used contained more than 99 per cent D_2 .

(a) *Lower Limits.* The lower limit of inflammability of each gas in air and in oxygen was the same under the same conditions, but the limits for H_2 were about 1 per cent lower than for D_2 ; they were for H_2 , 3.9 per cent upward and 9.1 per cent downward; and for D_2 , 4.9 per cent upward and 10.2 per cent downward. The values differ from those obtained by Clusius and Gutschmidt¹ with air mixtures (4.1 and 9.6 per cent for H_2 , 5.65 and 11.0 per cent for D_2), but these authors used a larger vessel with mixtures at a lower initial pressure (400 mm.).

(b) *Upper Limits.* From the values of the lower limits it would be anticipated that the upper limits of D_2 would be lower than those of H_2 ; actually they are slightly higher. The values obtained were, for H_2 , 94.2 per cent in O_2 , 73.0 per cent in air; for D_2 , 94.7 per cent in O_2 , 75.0 per cent in air. The values for upward and downward propagation were the same in each instance.

It can readily be shown that, when oxygen is not in excess (that is, except at the lower limit), the limit of inflammability is determined mainly by the thermal balance (heat produced against heat absorbed by diluting gas²). This can best be understood by regarding each such limit mixture as a mixture of the heat-producing 'basic mixture', $2H_2 + O_2$, with excess gas as diluent. By adding H_2 , N_2 , H_2 and N_2 , or CO to the mixture $2H_2 + O_2$, we should finally attain approximately the same limit mixture. In other words, all limit mixtures should contain the same concentration of basic mixture, $2H_2 + O_2$, since the specific heats of these diluting gases are approximately the same. The following are the results obtained for downward propagation:

$2H_2 + O_2$	(a) + H_2 (upper limit H_2 in O_2)	17.4 per cent
	(b) + H_2 and N_2 (upper limit H_2 in air)	16.8 "
	(c) + N_2	16.8 "
	(d) + CO	17.1 "

The agreement is not quite so good for D_2 :

$2D_2 + O_2$	(e) + D_2 (upper limit D_2 in O_2)	15.9 per cent
	(f) + D_2 and N_2 (upper limit D_2 in air)	15.6 "
	(g) + N_2	16.8 "

At the lower limit (that is, dilution of basic mixture with oxygen or air), the concentration of $2D_2 + O_2$ is 15.3 per cent and is in good agreement with the values (e) and (f); for $2H_2 + O_2$ the value is appreciably less than in (a) and (b), namely, 13.6 per cent. Certain other effects come into play when limits for upward propagation are considered.

W. PAYMAN.
H. TITMAN.

Safety in Mines Research Station,
Buxton.
Jan. 9.

¹ Clusius and Gutschmidt, *Naturwiss.*, **22**, 693 (1934).
² Payman, *J. Chem. Soc.*, **115**, 1436 (1919).

Paramagnetic Relaxation

WHEN a paramagnetic substance, which follows Curie's law, is subjected to an alternating magnetic field, a certain amount of heat has been found to be developed per second in the substance. At room temperature only a very feeble effect could be observed for various paramagnetic substances. But at low temperatures, on account of the increased susceptibilities and the decreased specific heats, better conditions for the study of this phenomenon might be expected. Prof. W. J. de Haas kindly put the facilities of the Kamerlingh Onnes Laboratory at my disposal. The effect proved to be very large indeed at low temperatures. At 14° , for example, in a field of amplitude 8 gauss and frequency 2×10^7 , the increase in temperature of the calorimeter filled with ferric alum amounted to 0.04° per second.

So far, experiments have been carried out with chromic alum, ferric alum and, as a control, with the non-magnetic aluminium alum. The amount of heat developed in the paramagnetic substances proved approximately to be: (a) proportional to the square of the amplitude of the magnetic field; (b) proportional to the square of its frequency; (c) inversely proportional to the absolute temperature. So the effect can be described by a relaxation time of the magnetic vector, which is independent of field strength, frequency and temperature. This time is about 10^{-10} sec. for ferric alum.

The experiments are being continued. Details as well as a theoretical discussion will appear in *Physica*.

C. J. GORTER.

Kamerlingh Onnes Laboratorium,
Leyden.
Laboratorium Teyler's Stichting,
Haarlem.
Dec. 16.

Effect of Time and Intensity of Radium Radiation upon the Inverting Capacity of Yeast

ALTHOUGH the view has often been expressed that the radiation of living cells must modify the action of some of their contained enzymes, experiments upon the enzymes *in vitro* have given either negative results or produced only a slight inhibition, even when very heavy doses of X- or γ -radiation have been applied. For this reason, Havard¹ considers that the