corresponding to the cut-off in an isotropic material of permeability μ_z. Beyond this, γ_g becomes positive and the wave is propagated. This propagation should continue down to zero waveguide size, and the guide wave-length will decrease progressively and indefinitely. It can also be shown that the group velocity of the wave is negative and therefore that the wave travel is in the opposite direction to the energy flow.

Results of an experimental investigation on two sizes of ferrite-filled circular waveguide are shown in Fig. 1. The diameters were 1/8 in. and 9/16 in. respectively, below and above the cut-off diameter at 10,000 Mc./s. as normally calculated, assuming an isotropic permeability equal to μ_z. The attenuation is plotted against magnetic field. The full curves for positive field refer to the case where the effective transverse permeability is negative, and it is apparent that the attenuation is greater through the large-diameter waveguide. The dotted curve for negative field is of the normal type for positive permeabilities, and the small waveguide is beyond cut-off. It was also confirmed experimentally that in the anomalous propagation in the 1/8-in. diameter guide the phase velocity was negative.

Experiments were not carried out on the effect of varying the wave-length; but it would be expected that the small-diameter waveguides would continue to propagate as the frequency is reduced over the whole range that $\mu - k$ is negative. This lies between the gyromagnetic resonance frequency, given by $\omega = \gamma H$, and the inversion frequency given by $\omega = \gamma B$, where γ is the gyromagnetic ratio of the electron, and H and B are the magnetic field and induction, respectively, in the ferrite.

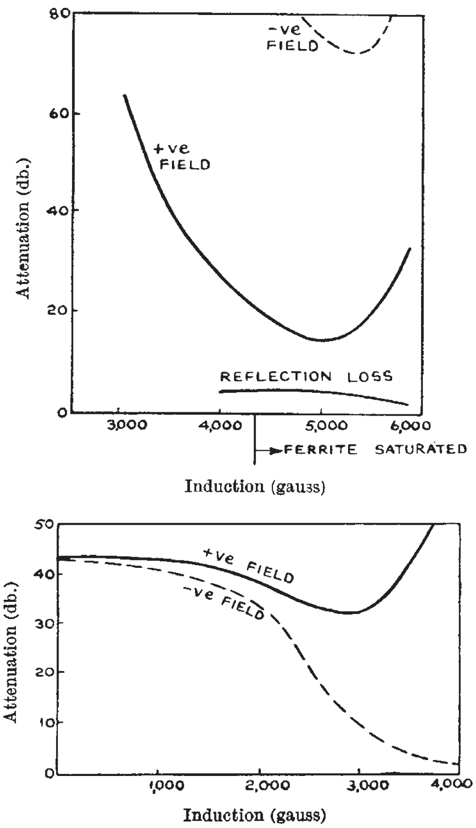

Fig. 1. Specimens of ferroxcube $B2$ at 10,200 Mc./s., with the following diameters: 0·125 in. (upper graph); 0·562 in. (lower graph)

G. H. B. Thompson

Standard Telecommunication Laboratories, Ltd.,
Progress Way, Great Cambridge Road,
Enfield, Middlesex. April 14.

[1] Polder, D., *Phil. Mag.*, **40**, 99 (1949).

[2] Suhl, H., and Walker, L. R., *Bell System Tech. J.*, **33**, No. 3, 579.

A Double-walled Vessel for the Distillation of Highly Inflammable Liquids

The apparatus described below[1] provides a safe means of distilling or refluxing highly inflammable liquids. It has the added advantages of heat economy and the avoidance of bumping. The inner portion A of a double-walled vessel (Fig. 1) contains the liquid to be distilled or refluxed, C, and is connected by joint G to a condenser in the appropriate position. The outer portion B is connected to a reflux condenser E and contains, therefore, only a small amount of inert non-inflammable heating liquid D, with a boiling point slightly in excess of that of C. In view of the enclosed nature of the heating bath, a surprisingly small external heat source suffices, and very even heating of the entire vessel A occurs with little bumping.

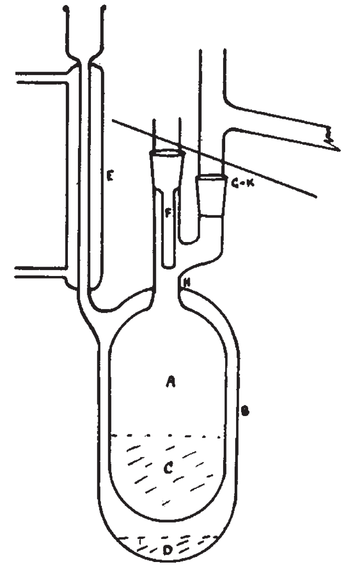

Fig. 1. A, internal flask, round or elongated, with all-glass sea at H; B, outer jacket; C, liquid for distillation; D, higher boiling point; E, water-jacketed condenser; F, thermometer pocket; G, ground joints; H, all-glass seal

Dimensions of the apparatus are not critical, though the distance between the bottoms of A and B should be sufficient to avoid direct contact of liquid D with vessel A.

The advantages of the apparatus are that fire risk is largely eliminated, since the simultaneous fracture of both vessels together is improbable; in this unlikely event, the inflammable liquid would be mixed immediately with the non-inflammable bath liquid. A break of vessel A or B only would not be dangerous.

C. C. Smith

Department of Colloid Science,
University of Cambridge. Jan. 21.

[1] Provisional Brit. Patent No. 30407.