LETTERS TO THE EDITOR

PHYSICS

Detection of the Onset of Instability in a Cylindrical Magnetohydrodynamic Flow

DURING the past few years the classical small perturbation analysis for the prediction of criteria of stability in hydrodynamic flows has been extended to cover several cases where the fluids are electrical conductors and magnetic fields are present[1].

The experiment described here concerns the circular flow between stationary cylinders of a conducting liquid which is driven by the interaction of an axial magnetic field with radial currents. If the gap between the cylinders is small compared with their radii, the drop in voltage across the gap for simple laminar flow is approximately:

$$\begin{aligned}\Delta V &= \frac{Id}{2\pi L R_1 \sigma}\left\{1 + \frac{M^2}{12}\right\} \qquad (1)\\ &= \Delta V_{\Omega} + \Delta V_{\eta}\end{aligned}$$

where I is the total current passed between the cylinders (if the current in the liquid is axially and azimuthally constant), d is the gap, R_1 is the inner cylinder radius, L is the cylinder length, σ is the conductivity, and $M = \sqrt{\frac{\sigma}{\eta}}\,Bd$ is the Hartmann No., η is the viscosity and B the axial magnetic flux density (all in M.K.S. units). ΔV_{Ω} and ΔV_{η} are the drops in voltage due to ohmic and viscous dissipation, respectively. The small perturbation analysis gives equations identical to those for pressure-driven circular flow with an axial magnetic field. For these the theoretical stability criteria have been established[2]. There is a critical value of k for any given M: where

$$k = Re\,.\sqrt{\frac{d}{R_1}}$$

$$\text{and } Re = \frac{\rho u_m d}{\eta},\; u_m = \frac{\Delta V_{\eta}}{Bd}$$

The magnetic field has a stabilizing influence, and lengthens the cells of the post-critical flow. If B is fixed, ΔV should fall progressively below the value given by expression (1) above the critical point.

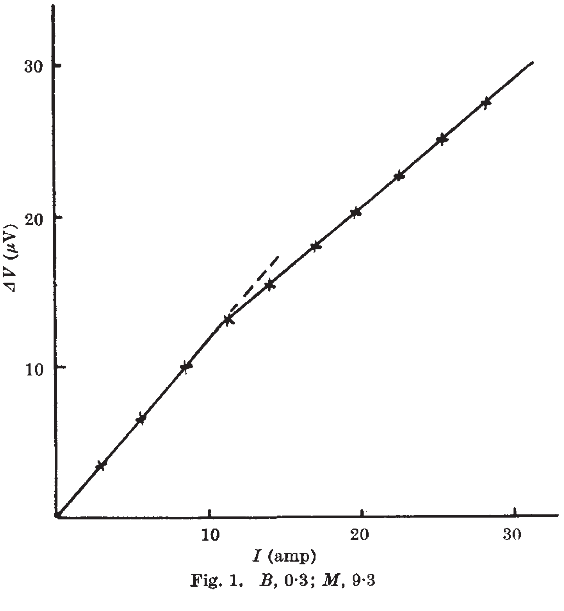

Fig. 1. B, 0·3; M, 9·3

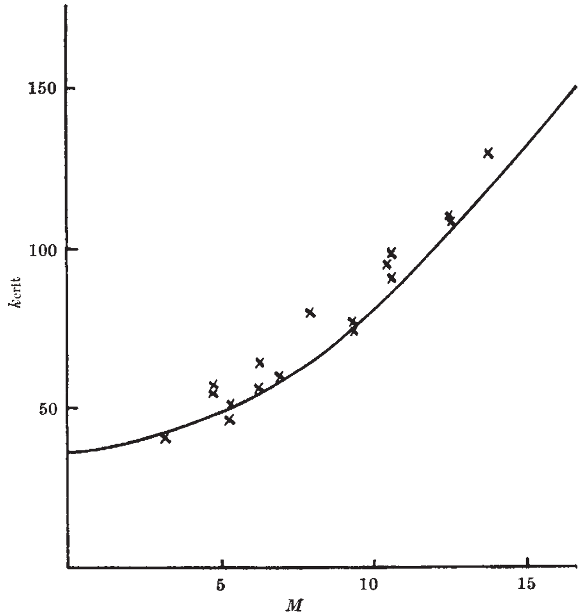

Fig. 2

In the apparatus $R_1 = 0{\cdot}026$ m, $L = 0{\cdot}05$ m, $d \simeq 0{\cdot}0012$ m (three values were used). The maximum field obtainable was 0·5 webers/m². The cylinders were of high conductivity copper and the liquid was mercury. Fig. 1 shows the results of a typical experimental run. Fig. 2 shows the experimental values of k_{crit} and the theoretical curve for perfectly conducting walls. The chief source of experimental error was the variations in d due to the mercury–copper amalgam layer. The experimental points tend to lie above the theoretical curve, and this is probably due to the small gap assumption.

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[1] Chandrasekhar, S., *Hydrodynamic and Hydromagnetic Stability* (1961).

[2] Chandrasekhar, S., *ibid.*, 422 (1961).

Electron Transfer in Irradiated Vacuum Cavity Chambers

GREENING[1] has explained the residual current in an ionization chamber, when the pressure is reduced to very low values, in terms of the transfer of slow electrons between the electrodes. He has proposed a theory for the saturation characteristics of evacuated chambers under irradiation. On the basis of a review of experimental data, he suggested an electron energy spectrum emitted from the walls, namely, the low-energy part of the electron spectrum from 0–41 eV could be represented by $KE^{\frac{1}{2}}e^{-E/8}$ per unit energy interval and the high-energy part of the electron spectrum from 41–∞eV by $\frac{64{\cdot}5K}{E^2}$ per unit energy interval, where E is the electron energy and K is a constant. Generally it is necessary to know the directional distribution of the electrons emerging from the wall before the saturation characteristic of a vacuum