the λ point, and hence will ensure the stability of the dewar against small fluctuations in heat input. In practice, stable operation is restricted to the point below which $\rho_s/\rho \ll 1$. Above this temperature (approximately 2.1°K), (8a) is no longer valid, and $\dot{m}$ begins to decrease.

One possible criticism of a plug which passes only superfluid is that, if the temperature in the dewar manages to rise beyond the λ point, no liquid will be able to escape, and the dewar will eventually explode. Equation (8a) suggests a means for making a plug which will operate above the λ point as well as below. The equation indicates the surprising result that for superfluid, the flow rate, is to a first order, independent of the total cross-sectional area of the channels. This is true as long as the channels are large enough to maintain a flow rate below the critical velocity, [2] and small enough so that the heat conducted by the liquid is much smaller than that conducted by the metal. Thus, one can make the channels large enough to allow sufficient normal fluid to pass through the channels above the λ point, while (8a) guarantees that the superfluid will not pour out through the channels below the λ point. (Note that above the λ point other provisions will have to be made for temperature uniformity inside the dewar).

The equation of motion for a normal fluid below T_λ is [3]

$$\rho_n \frac{dv_n}{dt} = -\frac{\rho_n}{\rho}\nabla P - \rho_s S \nabla T + \eta \nabla^2 v_n \tag{10}$$

If one defines $\nabla P' = \rho_n/\rho \nabla P + \rho_s S \nabla T$, (10) becomes the Navier–Stokes equation

$$\rho_n \frac{dv_n}{dt} = -\nabla P' + \eta \nabla^2 v_n \tag{11}$$

For steady-state laminar flow in a circular channel, this yields the familiar Poiseuille equation

$$V = \frac{\pi}{128\eta} \frac{D^4}{L} P' \tag{12}$$

If, as discussed below, the plug consists of a long, narrow channel of width W, spacing D, and length L, the equation becomes

$$V = \frac{\pi}{128\eta} \frac{D^3 W}{L} P' \tag{13}$$

Above T_λ, one merely has to replace P' with P.

EXPERIMENTAL PROCEDURE AND PRELIMINARY RESULTS

The desired flow rate for the operational range of the plug is on the order of 10^{-3} g/sec. To date, the most satisfactory plug has been made from a tightly wrapped spool of 0.5-mil aluminum foil. Approximately 200 concentric layers of 0.5-in. wide foil have been factory wrapped on a 1.25-in. aluminum mandril. A thin aluminum ring was then shrunk around the outside to compress the layers and facilitate handling, making the outer diameter 2.25 in. with an interlayer spacing of approximately 10^{-4} cm. The plug is imbedded in a large copper block in order to increase the thermal conductance. The flow of helium takes place in the axial direction between the concentric layers.