find values of R_E given in Table I
ect the second order terms in the cal-
sure.
ons concerning the flow of heat have
heat by the ordinary diffusive mecha-
by the counterflow mechanism. That
dering the results of Zinovieva (*10*)
ient; when these are applied to the
mount of heat carried by the normal
ders of magnitude smaller than that
en at the largest ΔT's.
is that the kinetic energy associated
eat flow by internal convection. The
end of the slit will be conveyed as
nal fluid convection. The total heat

$$\bar{v}_n + \tfrac{1}{2}\rho_s v_s^2 \bar{v}_s \,. \qquad (37)$$

n and defining $q_i(z)$ as the heat cur-
int z in the slit, i.e., $q_i(z) = \rho s T v_n$,

$$- \rho_s^2) \quad sT) \left(\frac{\bar{q}_i(z)}{\rho s T}\right)^2 \Bigg] . \qquad (38)$$

ll for temperatures above 1.1°K and
eriments under discussion, except in
2°K the maximum value of this term
here $\rho_s = \rho_n$ it is of course zero; and
s kinetic energy terms cannot appre-
its.
section is the influence upon the heat
s through shear. According to the two
a truly classical fluid with a classical
ume per second by shear may be ex-
ction Φ in the form used by London

$$\Big)^2 + \eta'(\nabla \cdot \mathbf{v}_n)^2 . \qquad (39)$$

ons made previously, the dominant
. (39) becomes upon averaging across

the slit:

$$\Phi = \frac{12\eta_n \bar{v}_n^2}{d^2} = \frac{\bar{q}^2}{T\Lambda d^2} \,. \qquad (40)$$

The total amount of heat generated in the slit per second through the action of viscous forces may be found by integrating this expression over the volume of the slit:

$$\dot{Q}_\Phi = -\int \Phi\, dV = -\int_0^d \int_0^w \int_0^L \frac{\bar{q}^2}{T\Lambda d^2}\, dx\, dy\, dz = \frac{w}{d}\int_{T_0}^{T} \frac{\bar{q}^2}{T\Lambda}\, \frac{dz}{dT}\, dT$$
$$= -\, w d\bar{q} \int_{T_0}^{T_1} \frac{dT}{T(1 + \alpha d^2 \bar{q}^2)} \qquad (41)$$

Using (25) and assuming in the first approximation that the heat generated does not appreciably perturb the temperature gradient in the slit.

In the lower temperature range we may neglect $\alpha d^2 \bar{q}^2$ compared with unity and Eq. (41) becomes

$$\dot{Q}_\Phi = -w\, d\bar{q} \ln T_1/T_0 \,. \qquad (41a)$$

Clearly this term is comparable in magnitude with the total heat $\dot{Q} = w\, d\bar{q}$ and it would at first sight appear that dissipative processes might appreciably affect the over-all heat transport for a given temperature difference. We shall now show that this is not the case, and that in fact the Rayleigh term is responsible for normal fluid generation resulting in the increase in the normal fluid flux between the hot and the cold ends of the slit.

The average normal fluid flux entering the slit at the hot end of the slit is $\bar{\mathbf{N}}_1 = (\rho_n \bar{\mathbf{v}}_n)_1$ gm/cm²-sec and that leaving the cold end is $\bar{\mathbf{N}}_0 = (\rho_n \bar{\mathbf{v}}_n)_0$ gm/cm²-sec. The change in flux is then $\overline{\Delta \mathbf{N}} = (\rho_n \bar{\mathbf{v}}_n)_1 - (\rho_n \bar{\mathbf{v}}_n)_0$ gm/cm²-sec and we assert that this difference arises from the generation of normal fluid within the slit by viscous forces. The effect of normal fluid generation in the slit may be included in the equation of continuity in the manner suggested by Zilsel (*30*):

$$\frac{\partial \rho_n}{\partial t} + \nabla \cdot \rho_n \mathbf{v}_n = \Gamma \qquad (42)$$

where Γ(gm/cm³-sec) represents the generation term for normal fluid (there is of course an equal sink term for superfluid). In steady state flow the time derivative vanishes, and the total change in normal fluid flux may be found by integrating (42) throughout the slit volume. The heat required to generate Γ is $\Gamma s_\lambda T$ (the lambda point entropy s_λ enters because Γ refers to generation of normal fluid alone rather than fluid of density ρ_n, and the approximation $\rho_n/\rho = s/s_\lambda$, valid in the temperature range of interest, is used). Neglecting for the moment dissipation arising in the Gorter-Mellink term we identify this heat