boundary of the high conducting layer. As the velocity increases this charged layer is partly removed by the wind so that the electric field can penetrate the highly ionized region and increase the effectiveness of charge separation. The charge in the shielding layer is carried away by the wind and an equal and opposite charge is carried to the ionizer by the action of the field on ions in the ionized layer.

An analysis for the physical model just described which calculates the current generated by the removal of the shielding layer charge as a function of wind velocity and externally imposed field has been worked out (Hill and Hoppel[3]) and will be presented at the Fifth International Conference on Atmospheric Electricity as part of a paper[4] on radioactive collectors. Here we cite only the equation for the current per unit width without derivation.

$$\frac{i}{w} = \epsilon \frac{\Delta\lambda}{\lambda(z_o)} V_x E \left[\exp\left(-\frac{\lambda(z_o)x}{\epsilon V_x} \right) - 1 \right]$$

where

$$E = E(\infty) \exp\left\{ 0.34 \frac{\Delta\lambda}{\lambda(z_o)} \left[\exp\left(-\frac{\lambda(z_o)x}{\epsilon V_x} \right) - 1 \right] \right\}$$

where

V_x is the velocity aspirating the ionizer,
$E(\infty)$ is the perpendicular component of the electric field far enough from the collector to be uninfluenced by the shielding charge,
$\Delta\lambda$ is the change in conductivity across the boundary of the highly ionized layer and is determined from the ionization rate and recombination coefficient.
$\lambda(z_o)$ is the conductivity at the boundary and here taken to be half of $\Delta\lambda$.
x is the length of the ionizer.
ϵ is the permittivity of free space.

Equation (1) has been verified experimentally as shown in Fig. 1 which compares currents generated by an ionizer in a wind tunnel as a function of velocity with those predicted by Eq. (1) for different values of electric field.

References

[1] Sullivan, Jr., E, "Study of Wind Effects on Electrostatic Autopilots," *Journal of Aircraft*, Vol. 11, No. 4, April 1974, pp. 221–224.

[2] Hill, M. L., "Introducing the Electrostatic Autopilot," *Astronautics and Aeronautics*, Vol. 10, No. 11, Nov. 1972, pp. 22-31.

[3] Hill, M. L. and Hoppel, W. A., "The Fundamentals of Electrostatic Stabilization of Aircraft," Memo BAF-74-01, Jan. 1974, Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md.

[4] Hill, M. L., and Hoppel, W. A., "Effects of Velocity and Other Physical Variables on the Currents and Potentials Generated by Radioactive Collectors in Atmospheric Electric Fields," accepted for presentation at the Fifth International Conference on Atmospheric Electricity, September 1974 (also to be published with *Proceedings of the Conference*).

Reply by Author to M. L. Hill and W. A. Hoppel

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I WOULD like to thank Messrs. Hill and Hoppel for their comments on my paper and also for providing me with a more detailed version of their theory which was of assistance in preparing this response.

In reply to the comment that the ionizers are insulated, I would like to state that, within the context of the model, the electric field pattern is as shown in my Fig. 4 until charge begins to flow. When this charge begins to build up on the insulated region between the ionizers, however, the electric field lines will then terminate on the ionizers only. Thus, the "number" of field lines serving as charge paths to the amplifier is essentially unchanged. I chose not to elaborate on this point in the interest of simplicity.

The first comment, however, concerning the ion mobilities is a valid one and does raise a serious objection to the model as proposed. I feel that their model presents a picture of this phenomenon which is much closer to reality.

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Comment on "A Criterion for Assessing Wind-Tunnel Wall Interference at Mach 1"

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GOODMAN[1] proposes a criterion for determining conditions for negligible wall interference in a sonic stream. The criterion that the tunnel similarity parameter G must be order one or greater for negligible interference is mathematically and physically unrealistic. The analysis contains several oversimplifications which are commented on here. Equation numbers and notation are those used in Goodman's Note.

Goodman's analysis adopts the transonic small disturbance equation for $M_\infty = 1$. The local linearization approximation is used to reduce the non-linear mixed elliptic-hyperbolic equation to a linear parabolic equation. This simplification results by assuming that the local flow acceleration $(\gamma + 1)\ U_X/U_\infty$ is a positive number λ throughout the flowfield. The flow problem is then likened to a one-dimensional heat conduction problem with the streamwise direction x becoming the time-like variable and the lateral direction z the space-like variable. The semi-infinite problem $0 \leq z \leq \infty$ corresponding to unbounded flow past an airfoil is considered. Body boundary conditions are applied at $z = 0$, and all disturbances are assumed to vanish at $z = \infty$.

The analysis is oversimplified in at least two respects. First, the assumption that the acceleration λ is positive throughout the flow field is erroneous. In fact λ may be positive, zero, or negative. The heat conduction problem as stated is ill-posed since the diffusity "constant" λ^{-1} changes sign. Thus, the relation following Eq. (4), $z \geq O\,(x/\lambda)^{1/2}$ which forms the basis for the criterion is impractical. Second, the wind-tunnel wall boundary condition is not considered in the analysis. The tunnel case corresponds to a heat conduction problem in a bounded domain $0 \leq z \leq H$ with appropriate conditions specified at both boundaries. As such, a solid wall would correspond to zero heat transfer ($\phi_z = 0$), a freejet to a constant temperature boundary (ϕ = constant), and ventilated walls to

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