cm^2/sec. This is to be compared with the film-flow diffusivities of 10^{-5} cm^2/sec measured for air-dry soil and 10^{-4} cm^2/sec for soils with water contents in the wilting range. At higher water contents, the film-flow diffusivity is much greater, and is of the order of 10^{-2} cm^2/sec at the upper limit of the field moisture range. Thus, in the wilting range, film flow probably accounts for at least 90 percent of the water movement and, at higher water contents, vapor movement should be entirely negligible.

The experimental data of Gurr, Marshall, and Hutton (*4*) indicate that a temperature gradient which in their experiments averaged 1.5°C/cm is required to produce a sufficient vapor pressure gradient for the water flux density by vapor diffusion to be equal numerically to the liquid flux density in the opposite direction produced by a moderate soil-water content gradient. These experiments with a loam soil included water contents extending well into the wilting range. The vapor-gap hypothesis, therefore, would appear to require the existence of a large radial temperature gradient at the root if liquid flux is to be negligible in comparison to vapor flux. The maintenance of such a temperature gradient would require, at the root, a refrigerating system of substantial capacity.

L. Bernstein
W. R. Gardner
L. A. Richards

Salinity Laboratory,
U.S. Agricultural Research Service,
Riverside, California

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It is certainly true, as the distinguished group of Riverside investigators have pointed out, that the addition of salts to liquid nutrient solutions depresses plant growth in such solutions. The greater the ability of the test plant to accumulate the salt in question, the less is this growth-depressing effect. Thus the growth of halophytes, which readily accumulate sodium ions, is less depressed by NaCl than is the growth of crop plants which do not readily accumulate sodium ions. I grant at once, therefore, that particular ions can be found which exert osmotic effects upon plant growth, either in nutrient solution or in soil at high levels of soil moisture.

The remaining question is, then, does high soil moisture tension reduce ion uptake by the plant root? The conclusion of Philip (*1*) that development of a vapor gap around the root, under conditions of high transpiration and low soil moisture, should depress salt uptake by the root finds experimental support in the work of Danielson and Russel (*2*). These workers have shown that moisture stress generated in solution by the presence of a nonabsorbable solute (mannitol) has less effect on ion absorption than an equal moisture stress generated in soil by soil moisture tension. The results indicate that moderate-to-high soil moisture tensions interfere physically with the movement of ions from soil to root. Perhaps the physical barrier to ion movement from soil to root generated by removal of water from the soil by the root should be given a less picturesque name than "vapor gap." Nonetheless it acts like one.

James Bonner
California Institute of Technology, Pasadena, California

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1. J. R. Philip, *Proc. Intern. Congr. Irrigation Drainage, 3rd Congr.* 8, 125 (1957); *Plant Physiol.* 33, 264 (1958).
2. R. E. Danielson and M. B. Russel, *Proc. Soil Sci. Soc. Am. Proc.* 21, 3 (1957).

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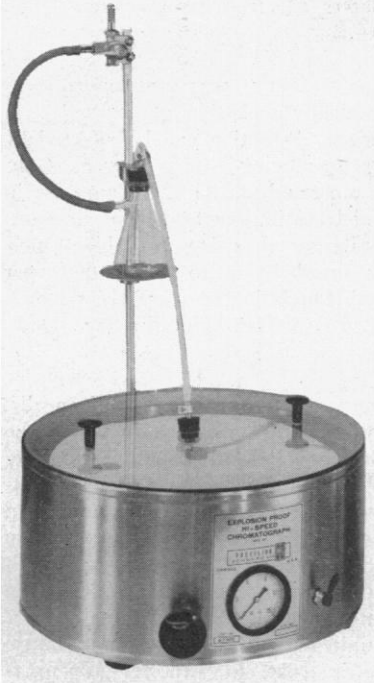

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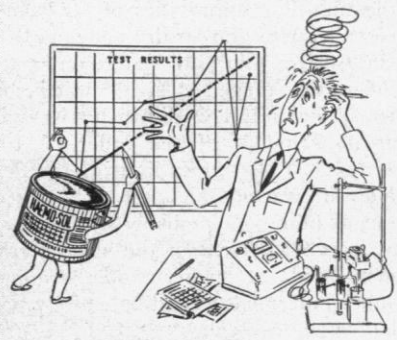

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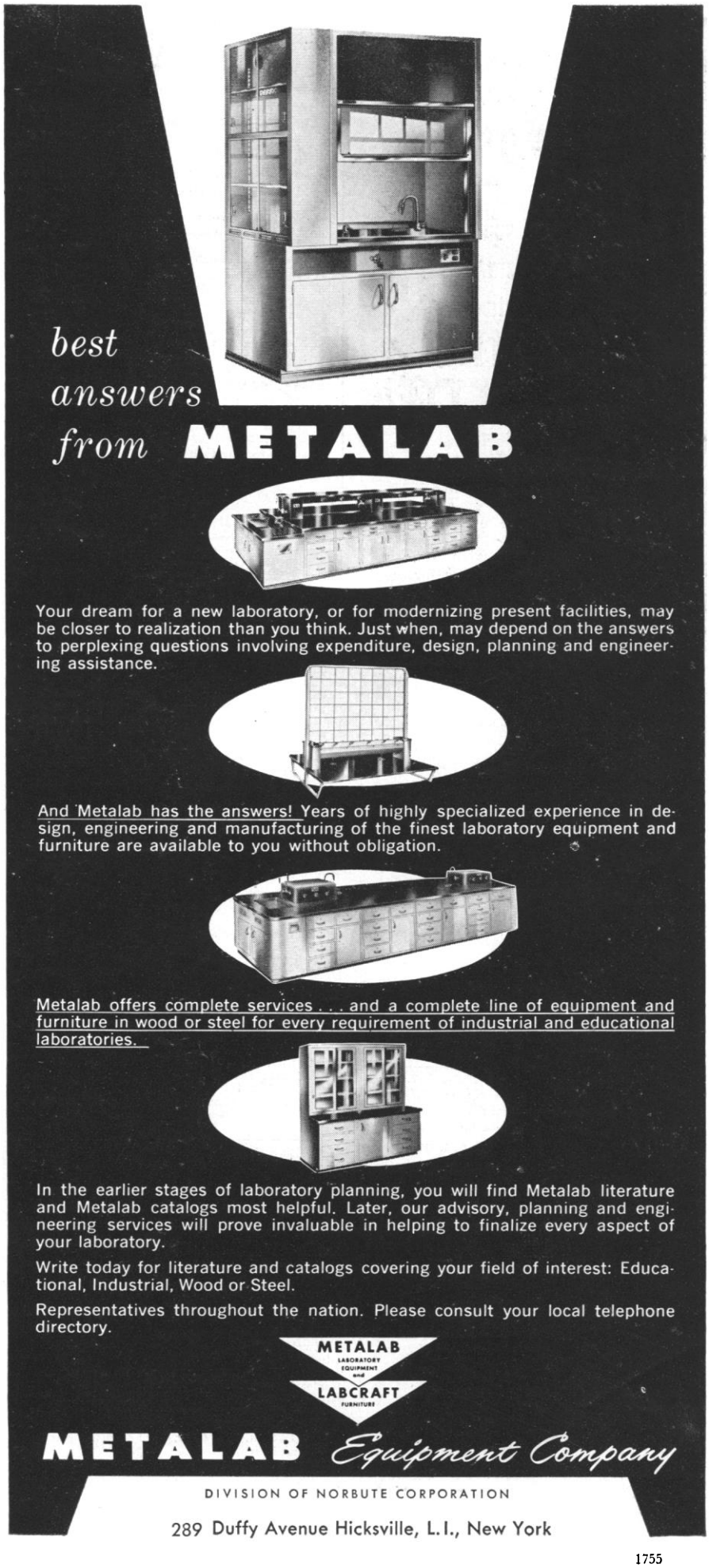

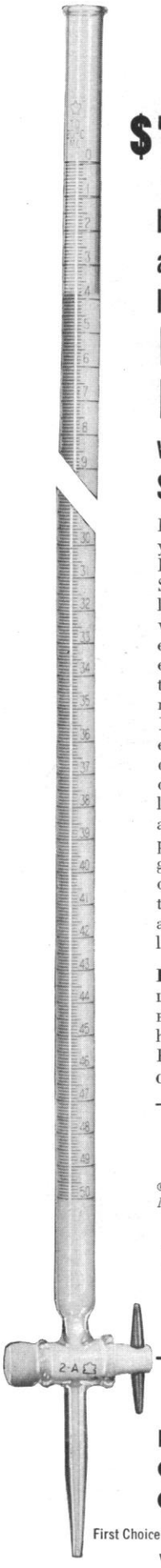

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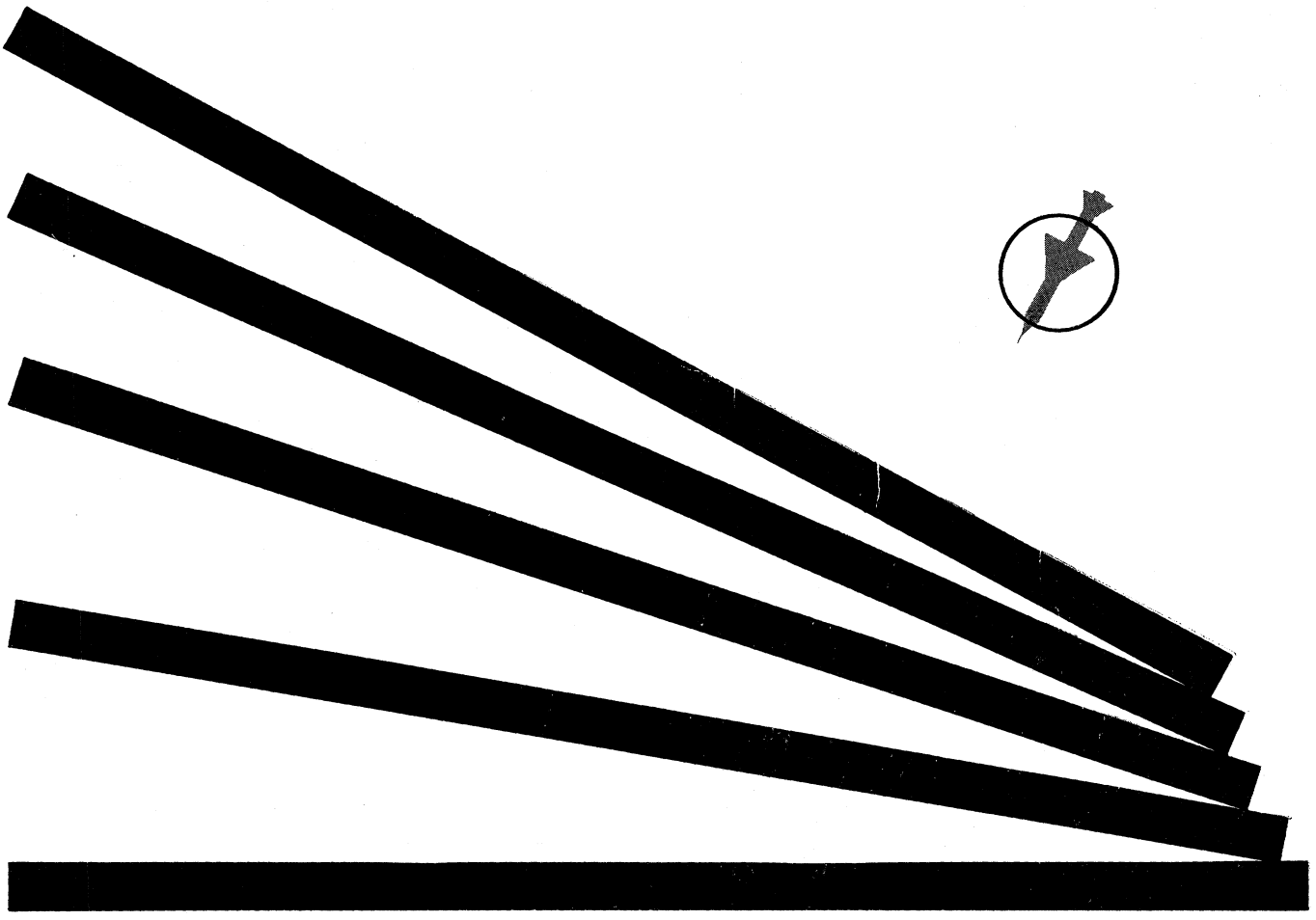

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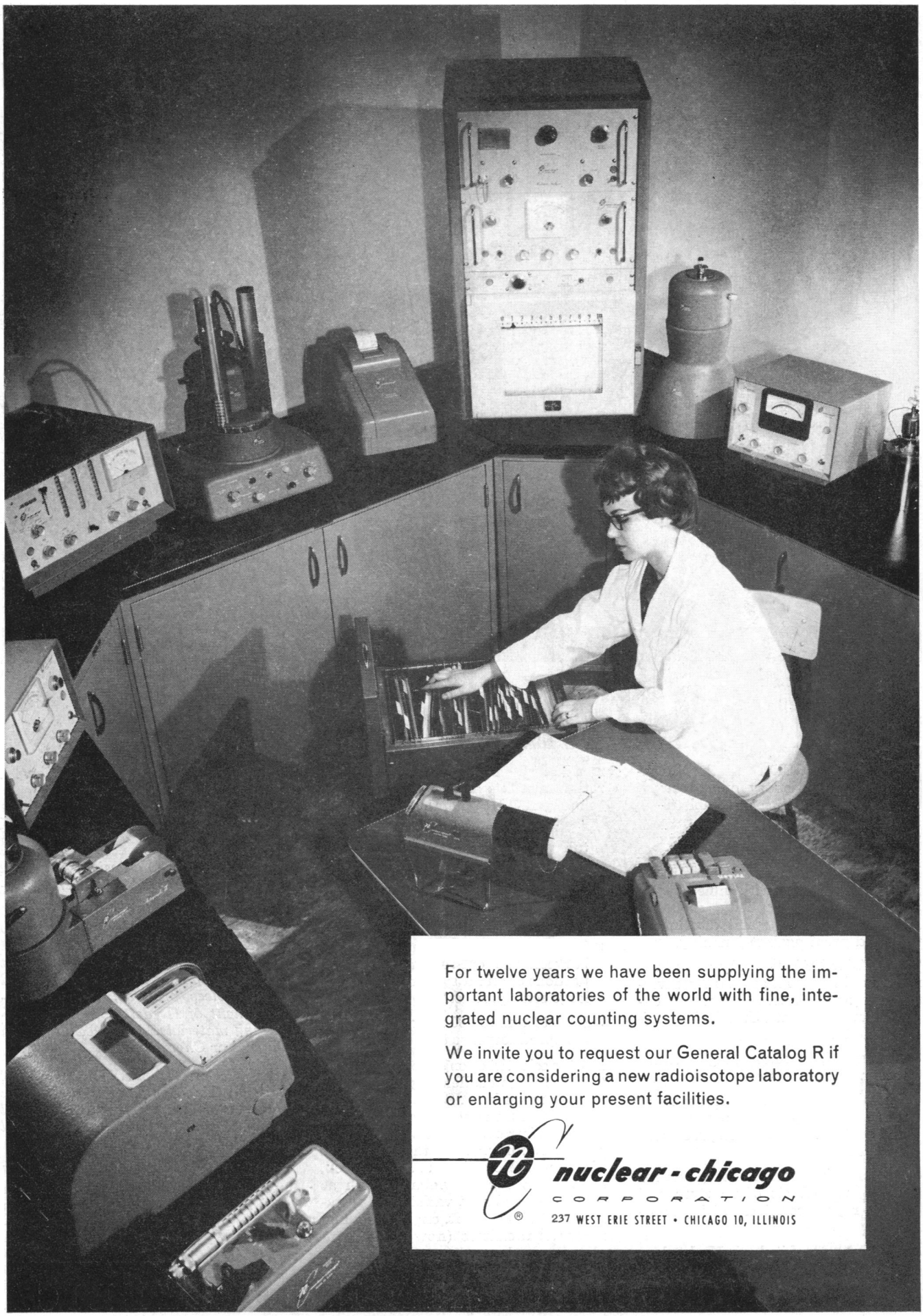

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