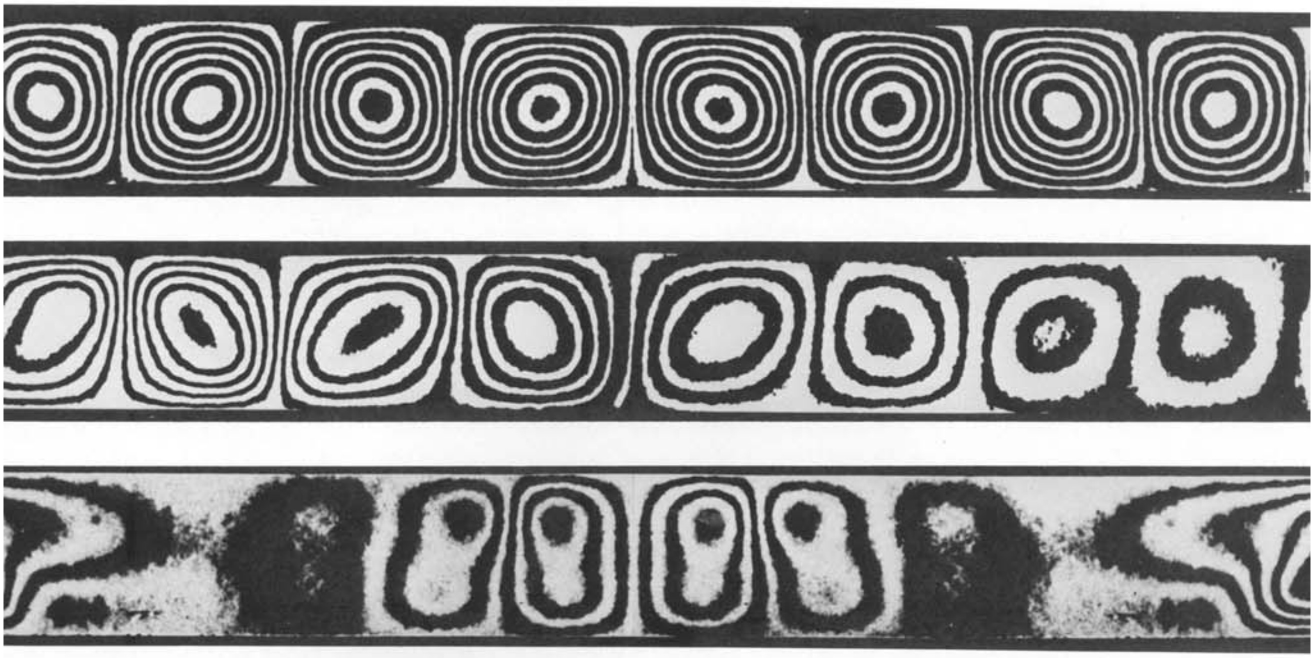
Bénard and Taylor Cells

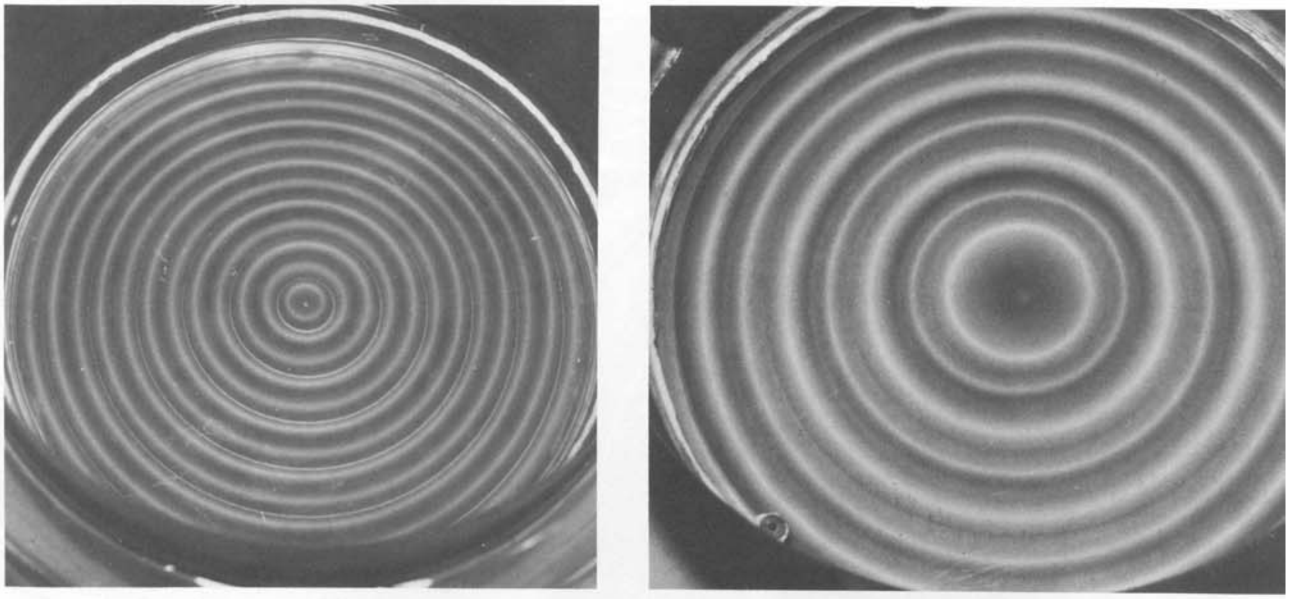
Author: John M. Cimbala, Penn State University
Latest revision: 15 February 2008

1. Bénard cells (buoyancy-driven convection cells)



139. Buoyancy-driven convection rolls. Differential interferograms show side views of convective instability of silicone oil in a rectangular box of relative dimensions 10:4:1 heated from below. At the top is the classical Rayleigh-Bénard situation: uniform heating produces rolls parallel to the shorter side. In the middle photograph the temperature difference and hence the amplitude of motion increase from right to left. At the bottom, the box is rotating about a vertical axis. *Oertel & Kirchartz 1979, Oertel 1982a*

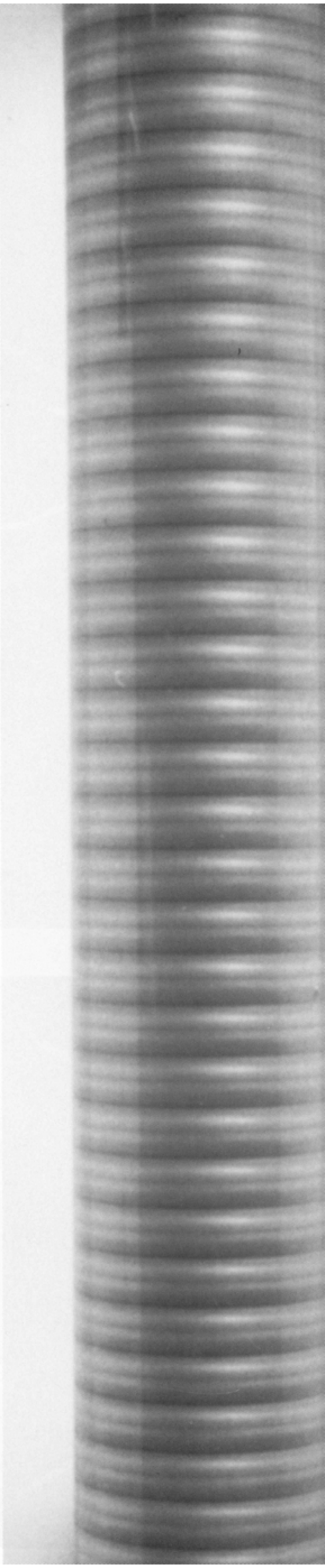
From: Van Dyke, M., *An Album of Fluid Motion,* Stanford, CA, The Parabolic Press, 1982, p. 82.

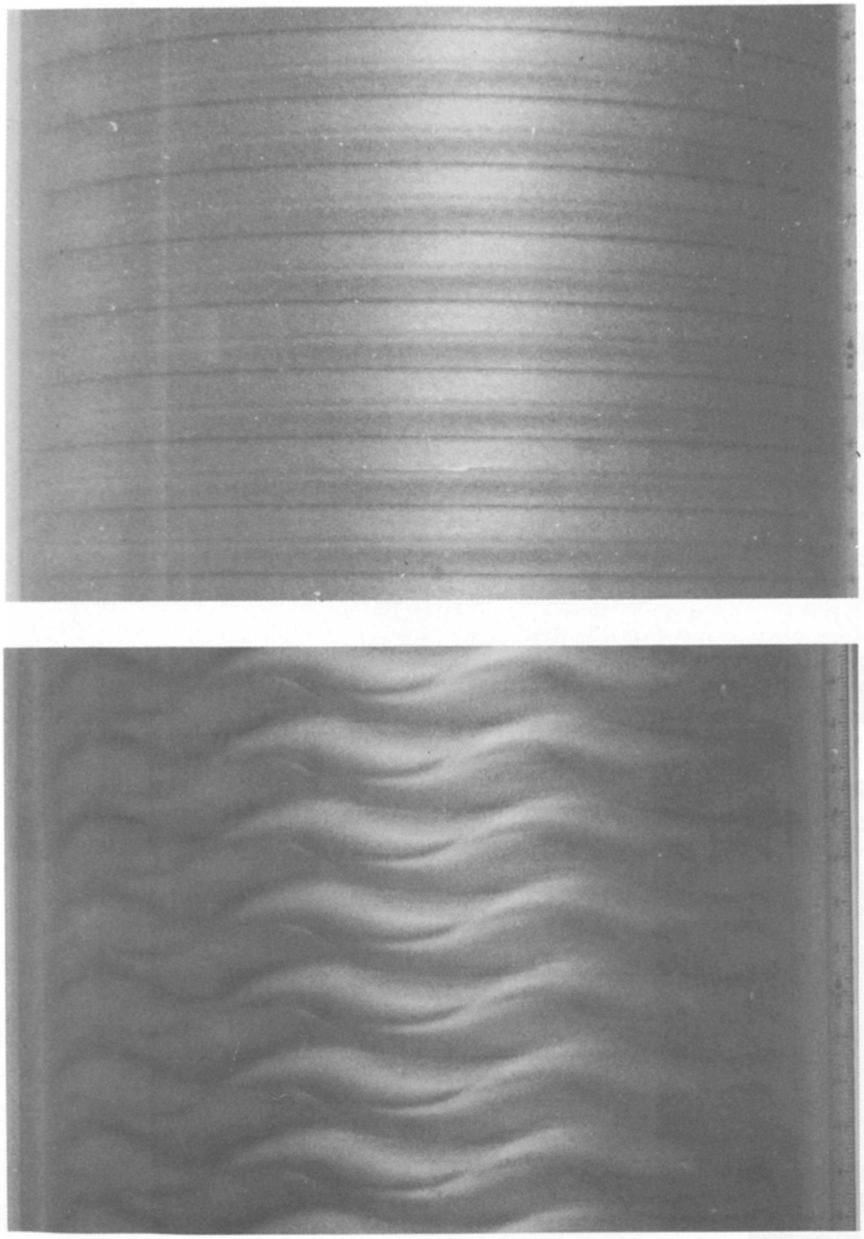


140. Circular buoyancy-driven convection cells. Silicone oil containing aluminum powder is covered by a uniformly cooled glass plate, which eliminates surface-tension effects. The circular boundary induces circular rolls. In the left photograph the copper bottom is uniformly heated at 2.9 times the critical Rayleigh number, giving regular rolls. At the right, the bottom is hotter at the rim than at the center. This induces an overall circulation which, superimposed on regular circular rolls, produces alternately larger and smaller rolls. *Koschmieder 1974, 1966*

2. Taylor cells (in the narrow gap between two concentric cylinders; inner cylinder rotating)

127. Axisymmetric laminar Taylor vortices. Machine oil containing aluminum powder fills the gap between a fixed outer glass cylinder and a rotating inner metal one, of relative radius 0.727. The top and bottom plates are fixed. The rotation speed is 9.1 times that at which Taylor predicts the onset of the regularly spaced toroidal vortices seen here. The flow is radially inward on the heavier dark horizontal rings and outward on the finer ones. The motion was started impulsively, giving narrower vortices than would result from a smooth start. *Burkhalter & Koschmieder 1974*





128. Laminar Taylor vortices in a narrow gap. A larger inner cylinder in the apparatus to the right gives a radius ratio of 0.896. Again only the inner cylinder rotates. The upper photograph shows the center section of axisymmetric vortices at 1.16 times the critical speed. In the lower, at 8.5 times the critical speed, the flow is doubly periodic, with six waves around the circumference, drifting with the rotation. *Koschmieder 1979*

From: Van Dyke, M., *An Album of Fluid Motion,* Stanford, CA, The Parabolic Press, 1982, p. 76.