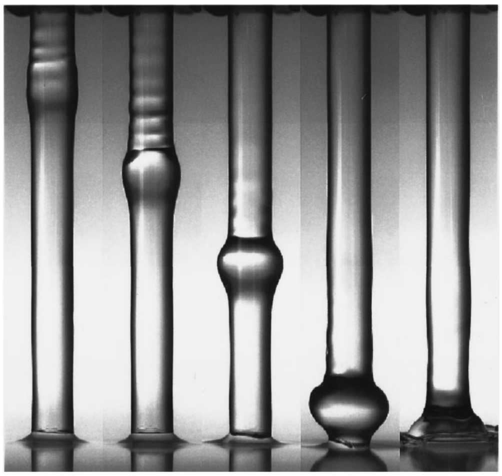

FIG. 1. Development of disturbance on the jet surface ($t=18$, 24, 30, 39, and 41 ms).

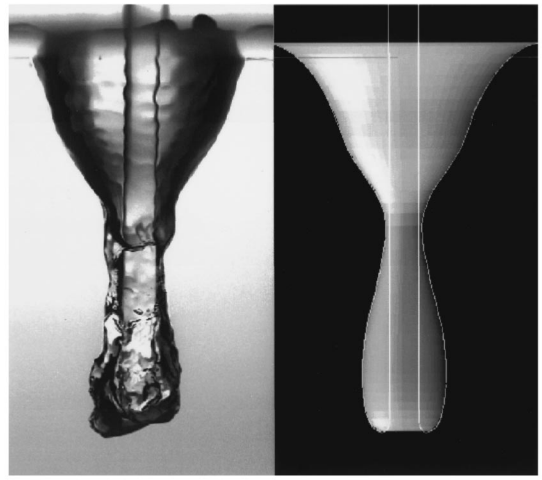

FIG. 3. Comparison with numerical simulation.

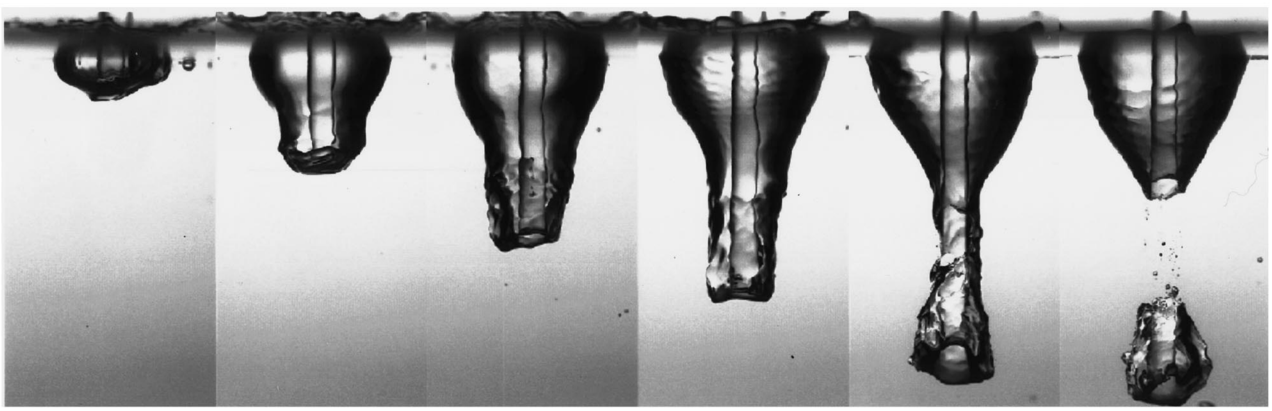

FIG. 2. Evolution of underwater air cavity ($t=47$, 57, 65, 71, 80, and 82 ms).

AIR CAVITY DUE TO JET DISTURBANCE

Submitted by Y. Zhu, H. N. Oğiz, and A. Prosperetti (The Johns Hopkins University)

These photographs show the process by which a disturbance on a continuous water jet falling into a water pool triggers air entrainment below the pool surface. The nozzle diameter D is 5.4 mm and the jet velocity U is 1.65 m/s, corresponding to a Reynolds number of 12 300 and a Froude number U^2/gD of 52. By opening the four solenoid valves located upstream of the nozzle, the jet flow rate is rapidly increased by 27%. The increased flow causes the formation of a bulge that develops under the action of gravity and surface tension (Fig. 1). Prior to the arrival of the disturbance, one notices a clear reflection of the jet in the surface and an upward curved meniscus around the jet, both suggesting that no air is entrapped although the Reynolds and Froude numbers exceed threshold values reported by earlier investigators (see, e.g., Bin[3]).

The evolution of the process after the bulge strikes the pool surface is shown in Fig. 2. The depth and width of the surface depression initially increase as the kinetic energy of the bulge and of the jet is transformed into potential energy. After reaching a maximum size, the motion reverses and the lateral surface of the cavity collapses against the jet entrapping a toroidal bubble below the undisturbed water level. The entrapped air with the severed jet inside continues to move downward before breaking up into smaller bubbles, while the remainder of the depression above the pinch-off point rises back toward the surface. Boundary integral simulations of the process have been carried out and found to be in good agreement with the experimental observations, as demonstrated in the example shown in Fig. 3 where the cavity is just about to pinch off.

This work was supported by the Office of Naval Research.

