Notice from equation (1) that F(v) is dimensionless. There must be a speed intrinsic to the cutting process upon which v can scale, an intrinsic speed c of order 10-100 in/sec. The speed of a water jet at 1000 atm is about 1500 ft/sec, and the speed of shear waves in rock is 5000 ft/sec or better. Both are much too high to serve as the intrinsic speed for rock cutting.

The theory of hydraulic rock cutting must admit a surprising variety of phenomena, including cavitation, brittle fracture, and permeability. A rectilinear water flow passing at high speed over a granular interface would exert little shear stress, because the interface would be in a state of almost complete cavitation. The jet curves against the cutting surface as shown in Fig. 1, however, and the curvature induces a high surface pressure, which closes cavity bubbles and exposes the grains to direct impact from the water. The surface pressure would keep the grains in their sockets, were it not for the finite permeability of the rock. Permeability gives rise to a pore pressure beneath the cutting surface, which relieves the normal force on the grains and allows them to be shorn away. The intrinsic speed c is found to be $k\tau_o/\mu_r g$, where k is the permeability of the rock, μ_r is its coefficient of internal friction, and g is a typical grain diameter.

A mathematical theory based on those phenomena is constructed in the next five sections and compared to measurements of Olsen and Thomas in Section 7. The data are not exhaustive but do cover a three-decade range of v. The data serve mainly to enhance the plausibility of the theory and to fix a universal constant, the coefficient μ_w of Coulomb friction between water and rock under cavitational conditions.