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# A Model for Liquid Metal Current Limiters

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We present a simple model which describes the complex interplay between electromagnetic forces, inertia, and gravity in liquid metal current limiting devices utilizing the electromagnetic pinch effect. The dynamics of this system is described by a nonlinear differential equation for the fluid height. A bifurcation analysis of stationary states shows that for sufficiently high initial fluid levels the fluid height is a discontinuous function of the electrical current. The jump in fluid height above some critical current is accompanied by a strong increase of the total electric resistance of the system and results in the current limiting action of the device. An experimental study of the system confirms the predicted switching behavior. For low electric current the experiment is in quantitative agreement with the theory. Due to its conceptual and numerical simplicity our model enables us to isolate the pertinent parameters and scaling laws of liquid metal current limiters.

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