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A Respiratory Airway-Inspired Low-Pressure, Self-Regulating Valve for Drip Irrigation RUO-QIAN WANG, AMOS G. WINTER, Dept. of Mechanical Engineering, MIT, GEAR LAB TEAM — One of the most significant barriers to achieving large-scale dissemination of drip irrigation is the cost of the pump and power system. An effective means of reducing power consumption is by reducing pumping pressure. The principle source of pressure drop in a drip system is the high flow resistance in the self-regulating flow resistors installed at the outlets of the pips, which evenly distribute water over a field. Traditional architectures require a minimum pressure of $\sim$1 bar to maintain a constant flow rate; our aim is to reduce this pressure by 90% and correspondingly lower pumping power to facilitate the creation of low-cost, off-grid drip irrigation systems. This study presents a new Starling resistor architecture that enables the adjustment of flow rate with a fixed minimum pressure demand of $\sim$0.1 bar. A Starling resistor is a flexible tube subjected to a transmural pressure, which collapses the tube to restrict flow. Our design uses a single pressure source to drive flow through the flexible tube and apply a transmural pressure. Flow into the flexible tube is restricted with a needle valve, to increase the transmural pressure. Using this device, a series of experiments were conducted with different flexible tube diameters, lengths and wall thickness. We found that the resistance of the needle valve changes flow rate but not the minimum transmural pressure required to collapse the tube. A lumped-parameter model was developed to capture the relationships between valve openings, pressure, and flow rates.

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