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(54) **HIGH-PRESSURE MICROHYDRAULIC ACTUATOR**

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See application file for complete search history.

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(57) **ABSTRACT**

Electrokinetic ("EK") pumps convert electric to mechanical work when an electric field exerts a body force on ions in the Debye layer of a fluid in a packed bed, which then viscously drags the fluid. Porous silica and polymer monoliths (2.5-mm O.D., and 6-mm to 10-mm length) having a narrow pore size distribution have been developed that are capable of large pressure gradients (250-500 psi/mm) when large electric fields (1000-1500 V/cm) are applied. Flowrates up to 200  $\mu$ L/min and delivery pressures up to 1200 psi have been demonstrated. Forces up to 5 lb-force at 0.5 mm/s (12 mW) have been demonstrated with a battery-powered DC-DC converter. Hydraulic power of 17 mW (900 psi@ 180  $\mu$ L/min) has been demonstrated with wall-powered high voltage supplies. The force and stroke delivered by an actuator utilizing an EK pump are shown to exceed the output of solenoids, stepper motors, and DC motors of similar size, despite the low thermodynamic efficiency.

**11 Claims, 8 Drawing Sheets**

