



(19) **United States**

(12) **Patent Application Publication**
Soltanpour et al.

(10) **Pub. No.: US 2002/0013545 A1**
(43) **Pub. Date: Jan. 31, 2002**

(54) **SYNTHETIC MUSCLE BASED DIAPHRAGM PUMP APPARATUSES**

(76) Inventors: **David Soltanpour**, Larchmont, NY (US); **Mohsen Shahinpoor**, Albuquerque, NM (US)

Correspondence Address:
Alfred F. Hoyte, Esq.
733 15th Street, N.W.
Washington, DC 20005 (US)

(21) Appl. No.: **09/841,191**

(22) Filed: **Apr. 25, 2001**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/586,962, filed on Jun. 5, 2000, which is a continuation-in-part of application No. 09/015,759, filed on Jan. 29, 1998, now Pat. No. 6,168,575.

Publication Classification

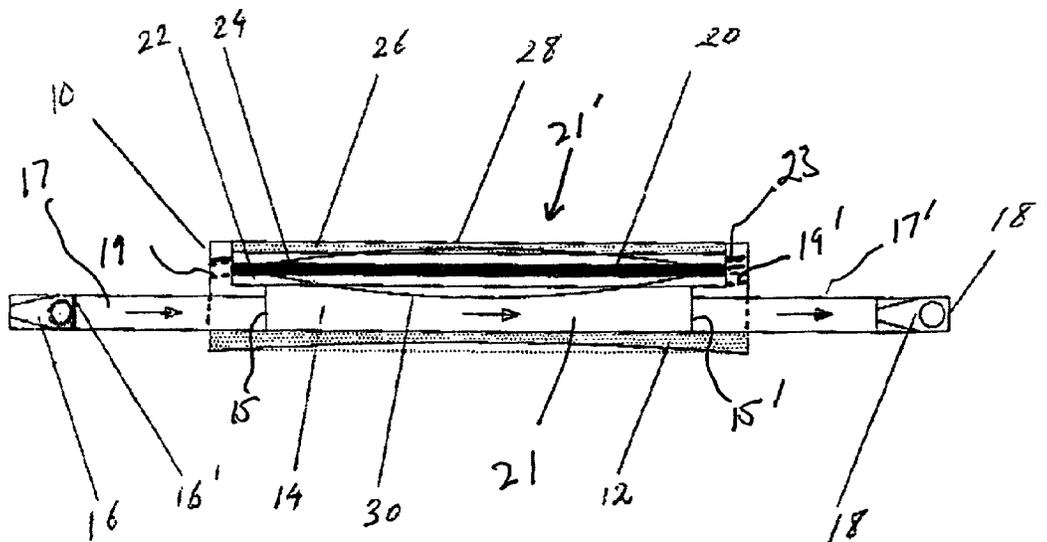
(51) **Int. Cl.⁷ A61M 5/00**

(52) **U.S. Cl. 604/9**

(57) **ABSTRACT**

Implantable, pressure adjustable diaphragm pump systems which are scalable and are characterized by a common type of actuating mechanism. The pumps may be inductively and

transcutaneously powered via adjacent, mutually inductive electromagnetic coils. Alternatively the pumps may be effectively "self" powered using a synthetic muscle attached to a local bending or twisting force. The pumps may be used in a range of applications from mechanical applications to medical applications such as intraocular pressure control for glaucoma patients, bodily fluid drainage control, and drug delivery systems. These pump systems each include a pumping chamber having an anterior end attached to an implantable influent conduit. In the case of an ocular pressure control device, the influent conduit is inserted into the anterior chamber of the eye. A flexing ionic polymer conductor composite IPCC synthetic muscle, which is a type of ionic polymer metal composite (IPMC) synthetic muscle, functions as the primary actuator. The posterior end of the pumping chamber is connected to an effluent or drainage conduit, which may drain bodily fluids or dispense drugs to an area of the body. A key feature of the invention is the self or secondary power generation system in the form of a much larger piece of IPCC synthetic muscle which, in the case of glaucoma prevention systems, may be placed on the globe surface (sclera) of the eye and attached to and secured by the extraocular muscles of the eye. An alternative external power system includes a biocompatible induction coil with gold wire armature that can be transcutaneously activated, adjusted, and computer-interrogated and controlled by a surgeon. The device of the invention is further equipped with a pair of adjustable variable flow valves placed at the juncture of the inlet and effluent conduits with the pumping chamber. The valves are used to regulate fluid flow through the pumping chamber. A pressure regulating system including a pressure sensor and pump controlling microprocessor may also be used with the inventive system.



Micro-Pump Equipped With Electrically Controllable Artificial Muscle Diaphragm