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 transcutanously 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.

[0014] The pumping system employs ionic polymer metal composite (IPMC) synthetic muscles. These synthetic muscles are made from ionic polymeric (polyelectrolyte) gels chemically treated with platinum (IPPC). They exhibit large motion sensing and actuation capabilities in a distributed manner. IPMCs are three-dimensional networks of cross-linked macromolecular polyelectrolytes with internal electrodes that swell, shrink, bend or generally deform in an electric field. Conversely, IPMCs are capable of generating an electric field or voltage as a result of being manipulated. Thus, direct computer control and monitoring of large expansions and contractions of ionic polymeric gel-noble metal composite muscles by means of a voltage controller has been achieved. The IPMCs require only a few volts for actuation. These muscles can be cut as small as needed and still preserve their functional properties. Accordingly, this technology is incorporated into the present invention as will be explained in more detail later.

[0015] Accordingly, it is a principal object of the invention to provide a self powered diaphragm pump having a synthetic muscle actuator.

[0016] It is a major object of this invention to provide a family of implantable pump assemblies having a common actuator mechanism, the size and shape of the pump and the actuator mechanism selected in accordance with a predetermined function.

[0017] It is another object of this invention to provide a family of implantable pump assemblies having a common actuator mechanism, the size and shape of the pump housing selected in accordance with the physical parameters of an intended implant area.

[0018] It is another object of the invention to provide such a pump assembly having an automatically controlled pumping rate.

[0019] It is still another object of the invention to provide an improved, biologically implantable pump assembly having a pumping rate which is controllable in response to sensed local pressure conditions.

[0020] It is another object of the invention to provide an implantable pump assembly which can derive electrical power from muscle movement.

[0021] It is another object of the invention to provide an implantable pump assembly which can be used to administer drugs.

[0022] It is another object of the invention to provide a miniature pumping system for controlling ocular pressure having means to generate power from the movement of the ocular muscle.

[0023] It is another object of the invention to provide a miniature pumping system which can be interrogated electronically while remaining implanted in the body.

[0024] It is another object of the invention to provide an improved method and apparatus for controlling glaucoma including a micropump which is implanted into the anterior chamber of the eye.

[0025] It is another object of the invention to provide an improved method and apparatus for controlling glaucoma including a micropump where pump operation is controlled in accordance with the disease state of the optic nerve and the sensed ocular pressure.

[0026] It is yet another object of the invention to provide an improved, biologically implantable pump assembly having a draining tube with a relatively wide outlet end to disperse the outflow of fluid.

[0027] It is yet another object of the invention to provide an improved, biologically implantable synthetic muscle based diaphragm pump assembly having constant flow therethrough to prevent occlusion of the drainage tube.

[0028] Finally, it is a general object of the invention to provide improved elements and arrangements thereof in an apparatus for the purposes described which is dependable and fully effective in accomplishing its intended purposes.

[0029] These and other objects of the present invention will become readily apparent upon further review of the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Various other objects, features, and attendant advantages of the present invention will become more fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views, and wherein:

[0031] **FIG. 1**(*a*) is a side elevational view, partly in section, of the basic structure of a pump assembly of the present invention.

[0032] **FIG. 1**(*b*) is a sectional view of a detail of **FIG. 1**(*a*) detailing the attachment of the diaphragm within the pump housing.

[0033] **FIG. 1**(*c*) is a sectional view of a detail of an alternative embodiment of **FIG. 1**(*a*) detailing the attachment of the synthetic muscle diaphragm within the pump housing.

[0034] **FIG. 2** is a plan view, partly in section, of the pump assembly of the present invention.

[0035] **FIG. 3** is a side elevational view, partly in section, of the pump assembly of the present invention showing upward deflection of the pump diaphragm actuator.

[0036] **FIG. 4** is a side elevational view, partly in section of the pump assembly of the present invention showing downward deflection of the pump diaphragm actuator.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] Referring now to FIGS. **1**(*a*) - **4**, a pump assembly, generally indicated by the numeral **10**, is shown. The assem-