Thus, the refractive power can be readily changed in a broad dioptic range, particularly if combined with a refractive interface **80** of fixed optical power.

The refractive change is achieved by one medium (e.g., air) being fully replaced by another medium (e.g., saline) in layer **78**. The medium exchange is facilitated by the difference of densities of the two media. In FIG. **6**, **82** is the outermost hydrophilic layer with low refractive index, **78** is the inner layer with higher refractive index, and **80** is the refractive interface between layers **78**, **82** in the form of a Fresnel-like lens.

The full replacement of medium can be also facilitated by including a thin flexible membrane **79** separating the media from each other in such a way that the membrane is closely adjacent to one or the other interface of layer **74**. Being of uniform thickness, the membrane does not itself contribute to the overall refractive power of IOL **10**. Such a membrane must be compatible with both fluids. It can be made, for instance, of silicone rubber, natural rubber, polyurethane, vinyliden chloride (Saran), polyethylene, or plasticized polyvinylchloride. The overall volume of layer **74** remains the same so that the channels **76** have to be connected to containers of variable volume, each containing one of the fluids and both preferably located outside the optical zone of IOL **10**.

The change of the refractive power can be also achieved by changing the curvature of the interface between two of the layers having different refractive indexes. One approach is to have two layers formed by fluids, separated by a thin membrane which does not itself contribute to the refractive power. By changing volumes of the layers (the sum of their volume being constant) the separation membrane, and hence the interface, changes its curvature. For example, referring to FIGS. 7A, 7B, layers **93**, **94** are chambers filled respectively with media of different refractive index, and a deformable membrane **95** forms a thin interface between them. The volumes of layers **93**, **94** can be changed since they are connected to containers of variable volume (not shown) respectively via channels **96**, **98**. Membrane **95** can be made of a flexible material, and can be deformed into a spherical shape by a pressure differential between the layers **93**, **94**.

Finite changes in pressure (or volumes) in layers **93**, **94** can cause finite changes in the shape of membrane **95**, and thus in the refractive power of the interface. Such an arrangement could be utilized for continuous accommodation if the volume of the chambers could be derived from the tension in the ciliary muscles of the eye. The change of membrane geometry between two preset shapes can be achieved by changing the liquid volume adjacent to the membrane in exactly the preset increment.

In FIGS. 7A, 7B, outermost soft layer **91** has high water content and low refractive index; layer **92** has high refractive index and one convex interface; layer **93** is the layer of a fluid medium with very low refractive index, such as air; and layer **94** is the layer with a liquid medium with refractive index higher than that of layer **93**. FIG. 7A shows the higher refractive state of IOL **10** with layer **95** convex (from direction of the incident beam). FIG. 7B shows the lower refractive power state with layer **95** concave.

Because the sum of the volumes of layers **93**, **94** is constant, the media in layers **93**, **94** should be supplied from separate containers subject to equal volume changes. If one medium is a gas, such as air, its supply container can have fixed volume but changing pressure.

Referring to FIGS. 8A, 8B, 8C, a container **100** having a variable volume (where FIGS. 8A, 8B respectively show its configuration with its maximum and minimum volume) includes a deformable wall **101** formed by a bistable rigid membrane. The advantage of bistability is that the volume within container **100** can have only two stable values corresponding to volume changes in the corresponding layer in the IOL to which it is connected via a channel **103**.

If variable volume containers are used to serve both media (which is advantageous in any case, and especially if both media are liquids) then it is advantageous to use an arrangement (FIG. 8C) where the bistable membrane **101** forms a partition wall between two compartments of a single container **104**, the two compartments containing different media, assuring that the volume changes in both sides of membrane **104** are the same but of opposite signs. The pressure on membrane **101** operating to force the volume change is generated, for example, by permanent magnet elements **102** attached to membranes **101** with opposite polar orientation for containers **100** which contain the two media (in the case of FIGS. 8A, 8B). In the case of FIG. 8C a single magnetic element **102** suffices. The pressure can be generated by another magnet brought near to the outside the eye, which will push membrane **101**, if seated in a convex position, into a concave position (if element **102** has the same polarity as the external magnet), or pull it from the concave position to the convex position if the polarities are opposite. The major advantages of direct magnetic action are that the magnetic field generates the necessary energy without an auxiliary power source (such as a battery); strong interference magnetic fields are rare; and no transducers or actuator elements are necessary. The same type of containers with variable volume and magnetic action can be used with the embodiments that involve changing the refractive index (i.e., exchange of two media in the same layer) or curvature of interface between two layers (membrane interface).

Other embodiments are within the following claims.

We claim:

1. An artificial intraocular lens for insertion into an eye comprising

an optical body for placement across the optical axis of said eye for refracting images received via the cornea of said eye in order to focus said images on the retina of said eye,

an outer surface that encloses said optical body and is exposed to fluid within said eye,

said optical body comprising an outer layer on which said outer surface lies and an inner layer having an internal refractive surface, and

means for selectively changing the refractive power of said internal refractive surface by changing the contour of said internal refractive surface.

2. The lens of claim **1** wherein said inner layer comprises

a pair of chambers separated by a flexible membrane forming said internal refractive surface,

said chamber respectively containing two fluids having different refractive indexes, and

means for controlling said fluids to change said contour of said membrane.

3. The lens of claim **2** wherein

said means for controlling comprises