VARIABLE POWER LENS AND METHOD

TECHNICAL FIELD

This invention relates to variable power optical lenses, and to means for changing the focal lengths of the lenses.

BACKGROUND ART

Variable focal length optical lenses are of great value, particularly in the area of eyeglasses or spectacles. The human eye, after a person reaches the mid-forties, loses its natural flexibility for focusing on both near and far objects. As a consequence, most people require spectacles to assist them for both reading and long-distance vision. Several products are available for this purpose: reading spectacles, bifocal spectacles, and multifocal spectacles; but each has its drawbacks. Reading spectacles must be put on before beginning to read, assuming they can be found when needed. Bifocals allow close distance viewing, but only at restricted low angles which generally require the wearer to tilt his head to an unnatural position. Multifocal spectacles allow correction for a continuum of distances, but an even sharper angular restriction is involved and constant tilting of the head is required to focus on an object at a given distance. Moreover, some people experience difficulties in adjusting to bifocals and multifocal spectacles.

Spectacles with variable power lenses in which the focal length can be changed in response to the touch of a switch, or movement of a lever on or near the frame of the glasses are obviously of potential advantage to a user. U.S. Pat. Nos. 4,261,655 and 4,418,990 disclose fluid-filled flexible lenses which can be adjusted to provide variable power. The flexibility of the materials and the fluid in these lenses permit controlled variation in their focal lengths. One limitation in this approach, however, is that the optical quality of the lens is not preserved during focal variations. Failure to maintain the optical quality of a lens results in distortion that is usually unacceptable to a wearer. The problem arises because the shape variation of the surfaces of the lenses do not remain substantially spherical during focal variations. Ideally, the outer surface of a lens should be spherical before a focal change takes place, it should remain spherical after such change.

An object of the present invention, therefore, is to provide a new and improved variable power lens that solves the problems described above and achieves other advantages for spectacles as well as for magnifying glasses, or lenses or mirrors within various optical instruments (e.g., variable focus ocular lenses in a microscope).

DISCLOSURE OF INVENTION

A variable power lens according to the present invention comprises a pair of optical membranes each having a periphery, and at least one of which is flexible. Frame means are provided for holding the membranes with their peripheries in juxtaposition such that the surfaces of the membranes and their peripheries define a predetermined volume. A refractive fluid fills the volume; and control means, operatively associated with the frame, are provided for selectively imposing forces on the periphery of the membranes which vary the fluid pressure. The membranes and the frame are constructed and arranged so that the surfaces of the membrane are displaced in a substantial spherical manner in response to changes in pressure in the fluid.

Numerous applications exist for the variable power lens according to the present invention. One example is variable focus eyeglasses with round or non-round lenses. As is well known, elderly people need different glasses for different viewing distances. Because the flexibility of the eye lens is gradually lost with age, it is common for people to use glasses for reading, and to remove these glasses when the distance to a viewed object increases. Recent methods to alleviate the inconvenience of putting on and then removing glasses have included "bifocals", and more recently, "multifocals" spectacles. The user of such spectacles must restrict his viewing direction by looking up or down in order to attain the desired focal length. Often, this imposes severe difficulties on the user in terms of neck strain and inqconvenience. The present invention permits a single pair of glasses to be designed for reading, or short distance viewing, and for longer or far-sighted distances. A structure similar to normally shaped glasses may be built to carry two variable lenses to which a small conduit is connected. The conduit, which may be concealed within a decorative part of the spectacles, is effective to transfer fluid to and from a small source of fluid under the influence of a controlling mechanism. The source may include small containers kept on each side of the frame for the spectacles carrying the lenses, or elsewhere in a pocket. The control mechanism, which can be a piston-cylinder, or other type of pressurizing arrangement, may be activated by a lever utilizing manual or motorized energy. Multiple positions of the lever, which produce different fluid pressures between the membranes of the lenses may be provided corresponding to different focal distances of the lenses. This example can be further improved by the introduction of automation.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of the present invention are shown in the accompanying drawings wherein:

FIG. **1***a* is a perspective view of a lens showing a portion of a membrane according to the present invention;

FIG. **1***b* is a section of a frame for holding membranes according to the present invention;

FIG. **1***c* is a cross-section of a frame and two membranes mounted therein;

FIG. **2** is a perspective view of a frame comprising several independent segments for mounting the membranes of the lens;

FIG. **3***a* shows coordinates describing the points on the surface of a membrane;

FIG. **3***b* is a cross-section of a membrane showing the direction of fluid pressure applied to the membrane;

FIG. **4** shows a conduit and components of a mechanism for pressurizing the fluid;

FIGS. **5***a* and **5***b* indicate a frame for mounting a lens according to the present invention wherein the volume of fluid between the membranes remains fixed, but providing for changes in fluid pressure; and

FIG. **6** is a block diagram of an automated system for controlling the power of a lens as a function of the distance of an object from the lens.

DETAILED DESCRIPTION

Before discussing details of the present invention, a comment on the theory behind the operation of the